An Analytical Look at Innovation in Poverty, Unemployment, and Slow Growth

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Abstract

Technical innovation systems research has been consistently conducted for the past two decades. Consequently, it has evolved into a specialized domain where novel methodologies are always being developed. The importance of understanding this concept stems from the productive sector's aspiration to explore new markets and possibilities. Additionally, a comprehensive understanding of it is necessary for the formulation of government policies that promote economic growth, employment, and income. Although attempts were made to comprehend innovation systems as socio-technical systems, there was a failure to accurately grasp the dynamics of global growth. Instead, the focus was placed on devising methods to enhance competitiveness and explore untapped markets. This concept, which asserts that only good microeconomic results result in beneficial macroeconomic effects, has been marginalized. The intricate and innovative perspective on the correlation between urbanization, expansion, technological advancements, and macroeconomic structural shifts has been disregarded. This paper aims to examine and analyze several issues related to this topic. Firstly, it investigates the impact of the deceleration of urban population growth on the utilization of productive capacity in various important sectors. Secondly, it explores how changes in the composition of products, resulting from the saturation of urbanization processes, influence the behavior of productive units. Lastly, it examines the effects of shorter product lifecycles on income distribution. The comprehensive viewpoint is valuable for comprehending the worldwide context in which socio-technical systems are established, as well as the difficulties faced in evaluating their ability to mitigate labor and poverty issues.

Keywords- Analytical Look at Innovation in Poverty, Unemployment, and Slow Growth

Introduction

The correlation between economic progress, technical breakthroughs, and improved human welfare is a prominent subject in economic literature. Nevertheless, the increasing difficulties in addressing poverty, structural unemployment, and the decline in global economic activity require a comprehensive analysis of the problem. This is especially important because the ongoing crisis, which started in 2007 and has worsened since 2009 and 2010, suggests that it is not solely a financial system crisis but rather a more intricate issue. This study aims to provide substantial hypotheses that might provide a broader explanatory framework for the phenomena under investigation. Irrespective of various ideologies, this setting aims to facilitate comprehension of the reasons behind the sustained decrease in global development rate and the emergence of a divided society, offering a perspective that deviates from conventional beliefs. When considering future possibilities and trying to understand the underlying structural factors that will fuel economic growth in the next few decades, it is important to view the role of China, India, and other emerging countries in a different, more optimistic light. Section 2 provides an explanation for the importance of these connections and gives a concise overview of the theoretical framework that led to the establishment of the fundamental principles governing the relationship between growth and welfare, as well as the relationship between innovation and growth. The majority of product growth may be ascribed to advancements in technology. This notion is being contested partly due to the fact that, even in contemporary times, the ongoing influx of workforce, capital, and natural resources, together with extensive urbanization and territorial expansion, seem to be crucial factors for explaining and stimulating growth. Section 3 provides an analysis and explanation of many important long-term global economic patterns utilizing basic indicators such per capita GDP growth. The following data presents the GDP per urban resident variable, which aims to illustrate the trends of different metrics when urbanization is taken into account as an intervening variable.

Section 4 provides a partial analysis of the theoretical foundations for the connections among urbanization, technical advancement, economic growth, and the distribution of wealth. The rationale for this argument is both straightforward and compelling: 1) the phenomenon of global urbanization is not just driven by economic activity, but rather it plays a substantial role in generating yearly gross product due to its encompassment of diverse and interrelated activities. 2) Ultimately, the pace of global population increase, migration patterns within and between nations, and the level of urbanization already attained all influence the process of urbanization. If the process reaches saturation without any additional dynamic factors, the potential for product growth to reach that level will likewise approach that level, leading to market saturation. Nevertheless, the primary significance of technical innovation is in its capacity to provide distinct commodities and services that might alleviate the repercussions of this slow process of market saturation, together with innovative production methods. This is why Section 5 goes back to this point, and deals with five issues that have been generally overlooked, or not considered in an integrated way, namely: a) many innovation processes are not necessarily "innovative"; they simply replace consumer goods (as they are understood by classical economics) with others with a shorter life cycle in order to maintain the activity level and expand markets; b) not all productive sectors can resort to this type of innovation because they imply different life cycles and production scales; c) whereas financial capital can easily migrate from one activity to another, physical capital and the abilities required for production are not fully convertible, or at least not in the short and mid-term; d) in the absence of an increase in productivity, shorter product life cycles imply that, for the same capital return rate, the capital recovery factor will occupy a larger part of the price of the good or service, which is a structural limitation to better income distribution; e) in productive processes, innovation tends to reduce employment, which is another obstacle to better income because the total employment demand will tend to be smaller than its suplly at a global scale. The current crisis is expected to closely resemble the crisis that occurred in the mid-1970s. To understand this, we analyze the transition from the Fordist cumulative model to the flexible accumulation

model, as discussed in references [18-21]. This part also comprises tangible evidence that substantiates this line of reasoning. An econometric cross-section study conducted over the periods of 1960-1975 and 1975-1990 serves as the foundation for both the analytical model and the examination of the relationship between urban population growth and economic expansion. (Appendix I: Methodological and empirical aspects of urbanization, economic growth, and technological progress). Section 6 emphasizes on innovation systems, which are seen as socio-technological systems due to their involvement of R&D institutes and other firms. When considering the global economy instead of just a single country or company, the question arises as to whether this approach effectively prevents the worsening of dual society, poverty, and unemployment. It is important to determine whether there is a significant inclination towards the mistaken belief that improved competitiveness will automatically result in better macroeconomic performance. In essence, this study challenges the Schumpeterian theory that suggests the positive outcomes of "creative destruction" in the world since the end of the "golden years". It argues that the global development context has progressed to a stage where new theoretical perspectives and an innovation system approach are necessary. By adopting this methodology, the system will be perceived as a complex socio-technical system, and a portion of the research and development endeavor should be specifically focused on maintaining a harmonious equilibrium between research activities and these intricate interconnections. Ultimately, the analysis reveals the specific topics that warrant concentrated scientific inquiry.

2. Exploration of Theoretical and Practical Aspects of Innovation and Economic Development

Economic theory has extensively highlighted the strong correlation between technological innovation and economic growth. A significant amount of theoretical, conceptual, and empirical research has been conducted to demonstrate a favorable association between these two factors. Certain authors choose for [1]. Since Adam Smith's time in 1776, there has been contemplation on the theoretical connection

between innovation and economic progress. In addition to explaining the positive impact of dividing labor to increase productivity, he also emphasized the need of having a separate research and development role in the economy, as well as an early method of transferring technology from suppliers to users in capital equipment and processes. In 1957, Solow was the first to include the concept of "innovation" into formal economic development models [2]. The fundamental connection between innovation and growth may be attributed to Abramovitx's research at Stanford University in the mid-1950s [3]. However, it has been a significant amount of time since that conceptual framework was initially introduced. Lucas and Romer [4,5] have constructed more intricate models that explore the relationship between innovation and economic development. As a consequence, endogenous capacity theories have been developed, incorporating an indicator set that is linked to empirical validation. Additionally, alternative models have been proposed, which consider factors such as R&D activities, proxies for skills, education, and similar variables. Therefore, economic models that attribute development only to the growth of capital and labor have been substantially surpassed by the inclusion of the "residual" factor, which emphasizes technology, especially innovation, as the primary explanatory factor. On the other hand, the evolutionary approach, influenced by Schumpeter, has generated a substantial amount of literature and research exploring the connection between technological innovation and significant changes in economic cycles through processes of "creative destruction" [6-10]. Since ancient times, economic expansion has been regarded as a distinct objective, closely associated with the improvement of human welfare, even in pre-modern ages [11]. In 1377, the renowned Arabian economist Ibn Khaldun articulated in his work Muqaddimah (known as Prolegomena in the Western world) that as civilization advances and its population grows, the labor force also expands. Consequently, with the growth in profits, there is a corresponding elevation in the expectations and demands for luxury, leading to a rise in the prevalence of luxury. Crafts are produced with the intention of acquiring opulent goods. The town's profits increase once more due to its heightened value. The output has significantly increased compared to its prior

level. Furthermore, the second and third increases transpire. The initial work fulfilled the requirement for survival, but all subsequent endeavors cater to indulgence and affluence [11]. Since 1940, governments have primarily prioritized the reduction and prevention of the adverse consequences of long-lasting economic crises or recessions. Undoubtedly, this worry arises from the realization that no industrial society can endure unless it can provide the resources for ongoing reproduction, which is the ultimate goal of improving human welfare. In a contemporary society, this suggests the potential to guarantee access to employment and jobs, which will consequently enable individuals to earn the necessary income to meet their fundamental needs, as well as additional, non-essential needs that are influenced by personal preferences and the economic imperative to sell goods and services in the marketplace. Therefore, with the occurrence of the "great depression," Keynes' theories became the prevailing economic practices until the emergence of "stagflation" (also referred to as stagnation with inflation) from 1965 to 1975. In post-World War II macroeconomic theory, it was believed that inflation and recession were mutually incompatible. Subsequently, several endeavors have been made to prove that neoclassical and monetarist policies may yield better economic results. However, some argue that the prevailing perspective is only the outcome of new axiomatics and their formalization by scholars, lacking empirical evidence to support it [12]. Nevertheless, there is indisputable evidence that, despite recurring crises, global per capita output has been increasing. This has added more confusion to the accurate understanding of the limitations on growth, to which the Club of Rome has made substantial contributions over the years via innovative research on the depletion of resources and the subsequent focus on the significance of attaining sustainable development. This has repercussions not just on the environment and natural resources, but also on society. The ongoing debate on "convergence" revolves around the influential research conducted by Baumol, Barro, and Sala-i-Martn [13, 14], as well as more recent studies [15], and investigations into the relationship between equality and development stages as proposed by Kustnetz [16]. The divergent results of empirical assessments may have a greater impact on their significance than the

aspirations that economic progress fosters for human welfare. If China and India persist in significantly contributing to the promotion of innovation, it is possible that the world economy might achieve its highest level since the initial surge of growth that occurred after the Second Industrial Revolution. Furthermore, certain analyses of the current global economic growth pattern suggest that it could potentially offset the decrease in activity in the United States and Japan. However, these interpretations oversimplify the role of innovation as the main catalyst for growth [1,17]. The empirical findings in the debates over growth, convergence, and equality are influenced by these readings. When considering evolution and a wider range of explanations, they also overlook potentially more important factors that could explain various factors driving growth. These factors include the recent distribution of global production, as well as significant links between technological advancements, shorter product lifecycles, urbanization, and income distribution. The aforementioned conceptualizations are inadequate in adequately elucidating the international crisis that occurred in late 2007, as well as the subsequent job losses. In addition, they were unable to provide an explanation for the seeming paradox of a developed world experiencing a serious crisis while developing nations are on the rise and there is a high demand for essential raw materials, which, in certain circumstances, fuels economic expansion. Endogenous development and innovation approaches, although having a notable detrimental impact on the worsening situation, fail to provide a sufficient explanation for the rising poverty and inequality, despite the presence of broader global dynamics that before the crisis. This is valid even when considering the impact of market globalization, as these and other factors may justifiably contribute to variations in competitiveness ratings among countries. Regrettably, the detrimental effect of "innovation" on the potential for equitable income distribution, as well as the significance of innovation due to market saturation, have received insufficient attention.

3. What is the implication of the economic growth data?

Despite intermittent crises, there is a commonly held belief that global per capita output has consistently grown over the past 50-60 years. Moreover, the traditional theory that

regarded the growth of primary factors like labor, capital, and land as crucial has been discarded in favor of an explanation of growth that has, in recent years, given excessive importance to technological innovation as the main catalyst for growth. While technical advancement is not completely disregarded, the expansion of capitalism is primarily associated with these fundamental explanatory factors rather than with geographical expansions. Territorial expansion inherently entails urbanization as an essential element of the industrial production model. Nevertheless, the current figures employed to illustrate an increase in productivity simply calculate the ratio of the gross world product (GWP) to the entire population, serving as evidence of humanity's ongoing advancement.

Specifically, the global indicator (GWP/individual) is likely to return to pre-crisis levels when the global economy recovers from the 2009-2010 crisis. However, this recovery is expected to be less diverse and exhibit a long-term downward trend. After the conclusion of the crisis, the world would observe a constant emergence of novel wealth patterns. Nevertheless, the urban population index has exhibited more variability during the three extended time periods being examined. This poses significant concerns regarding the correlation between growth and limitations on urbanization, as well as the economic activity required to sustain the product's future capacity to produce revenue and employment opportunities. Nevertheless, by 1975, these ratios were about equal, even though the yearly average rise in GDP per urban inhabitant between 1960 and 1975 exceeded the growth in GDP per total inhabitant by over 100%. This highlights a crucial element of the subsequent ideas: urbanization is primarily the driving force behind genuine economic progress, rather than merely being a consequence or a method of global product growth, as is occasionally thought. The investigation will focus on the significance of this fact in relation to the overall long-term decline in economic activity, as well as the potential outcomes of growth once global urbanization processes reach completion. Ultimately, despite efforts to mitigate

economic downturns and analyze the underlying factors, there is a noticeable decline in the global trend of economic expansion.

4. The issue of structural overcapacity and its repercussions on urbanization, development, and technological transformation

The proliferation of urbanization coincided with significant concentrations of technological advancements that occurred during the preceding two centuries. Each of these groundbreaking techniques has been extensively documented in the literature [6-0]. Moreover, there has consistently been a correlation between technological advancement and prolonged economic cycles. This methodology establishes a correlation between extensive networks of technological advancements and extended periods of economic cycles known as Kondratieff cycles. As an illustration, the steam engine emerged and underwent advancements throughout the period from 1770 to 1840, a time when the textile, iron, and some chemical industries held sway. Between 1830 and 1890, there was a significant increase in the utilization of the railway, steam engine, and machine tools. During this period, several technological advancements such as steel, electricity, processed gas, and synthetic materials emerged, paving the stage for the significant developments that occurred between 1880 and 1940. Over time, engineering, electrical equipment, steel, and wire saw widespread utilization. Between 1930 and 1990, there was a significant development and widespread use of vehicles, aircraft, radios, oil, plastics, aluminum, and electrical appliances. Television, computers, robotics, nuclear power, the aerospace industry, revolutionary medicinal research, biotechnology, and nanotechnology all coexisted together. The aforementioned enhancements led to the emergence of novel sectors such as electronics, biotechnology, robotics, and computers, alongside the ongoing investigation of unexplored domains. The proliferation of these technologies and their advancement have been driven by the contemporary metropolitan way of life. The gradual accumulation of these technical advancements throughout time has led to the process of urbanization. The extent of global

urbanization will determine the evolution of these technologies and the size of their respective markets. Hence, it is evident that the progress of diverse technologies, including automobiles and various modes of transportation like buses, trucks, ships, and airplanes, along with the overall improvement in communication, particularly the growing significance of telephony, computer science, and satellite advancements, have played a crucial role in the transformation of small cities into larger ones and the proliferation of large cities since 1950. It encompasses a diverse array of technological procedures associated with the city and its urban infrastructure, including fuel stations, shopping malls, schools, roads, airports, ports, storage facilities, office buildings, homes, factories that manufacture various consumer goods (both partially completed and finished), and the machinery and equipment involved in the routine distribution of goods and services. Nevertheless, the growth of these many economic endeavors, together with the rise in agricultural output, is precisely what generated employment prospects in connection with both internal and, at times, international migration. The rise of megacities and huge cities in general was heavily influenced by these processes, as well as the roles that some cities played in regional, national, and international contexts [22-26]. Concentration of some activity leads to the formation of smaller population centers. Urban areas, countryside regions, and tiny population centers increasingly establish extensive and modern networks of interconnectedness and infrastructure. A small city has the potential to progressively transform into a huge metropolis in an ongoing and continuous manner. This is incorrect, as the technique cannot be indefinitely repeated without intentionally destroying any remaining functional capacity. The process eventually reaches a saturation point, which is the natural limit when market saturation occurs and production capacity exceeds exhaustive usage. This leads to a condition referred to as "structural overcapacity," which ultimately diminishes the efficacy of counter-cyclical conventional policy. Currently, there are three important aspects of this phenomenon that deserve attention: 1) urbanization has a maximum limit, meaning that eventually the entire population will reside in cities; 2) the number of people living in cities is influenced by global

demographic trends and the rate at which urbanization occurs; and 3) the market size for existing products is greatly impacted by the rate of urbanization and the level of disposable income. The latter is derived from the current model's distribution patterns, the proportion of different producing sectors, and the structural modifications in the manufacturing process. According to this view, there is an inseparable connection between "effort and income" (however this relationship is being disrupted by both revenue from the banking system and aid programs for the jobless and impoverished). If we recognize that the process of urbanization is approaching its natural limit and that demographic trends for the next fifty years or longer are already emerging and somewhat predictable, we can deduce that the evolution of urban population follows a logistic curve. What are the characteristics of a logistic curve, and how does it pertain to the situation being discussed? Initially, the variable's progression approaches the "roof" or asymptote, and this curve may be separated into two segments: the first segment exhibits exponential growth, while the second segment signifies a lower growth rate compared to the first. Consequently, the process will consist of two distinct phases: an initial period of fast expansion, followed by a subsequent phase when the dynamics will either dissipate or decline and approach a stable state after reaching a particular turning point.

Summary

Although innovation is sometimes touted as the ultimate solution, the obstacles faced by innovation systems in the global context are distinct from those previously documented. Two aspects highlighted in this study are: 1) The process of urbanization is nearing, or will soon reach, a state of complete saturation, indicating an unprecedented level of market saturation. This is anticipated to impact both the use of current global capacity and the generation of new employment opportunities. While it may serve as a practical solution, it might also lead to intentional harm. The issues arising from shorter product lifecycles are connected to the previous point. When there is no tangible gain in productivity, it is contended that technical advancements that

prioritize novel product designs for similar purposes benefit society, but they impede the mass dissemination of these items by restricting income distribution opportunities. Given that industries always experience times of reduced dynamism or even regress in terms of productivity, it becomes crucial to have models that can predict the influence of upcoming clusters of breakthroughs on global added value. Additionally, it is important to examine the consequences of introducing products that have extended lifecycles and include advanced technical features and superior quality. Consequently, the socioeconomic system will require fresh concepts about social structure and the job market. There is no comprehensive study approach that covers several concerns such as the distinction between work and leisure time, the reevaluation of criteria for leisure time use and income distribution, and the implications of the increasing disconnect between effort and reward.

Reference

[1] H. Torun and C. Çicecki, "Innovation: Is the Engine for the Economic Growth?" The Faculty of Economics and Administrative Sciences, Ego University, Izmir, April, 2007.

[2] R. M. Solow, "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, Vol. 39, 1957, pp. 312-20

[3] N. Rosenberg, "Innovation And Economic Growth

[4] P. Romer, 1987, "Growth Based on Increasing Returns Due to Specialization.", American Economic Review 77(2): 56-62

[5] Robert Lucas, (1988), "On the Mechanics of Economic Development", Journal of Monetary Economics, 22, 3-42.

[6] G. Dosi; R. Nelson, An Introduction to Evolutionary Theories in Economics. Economics Journal of EVolutionary Economics, Vol. 4, pp. 153-172. Springer, Berlin, 1994.

[7] C. Marchetti, "Society as a Learning System: Discovery, Invention, and Innovation Cycles Revisited", Tech. Forecasting and Social Change, Vol. 18 (1980), pp. 267-282.

[8] Ch. Freeman, C. Pérez, Structural Crises of Adjustment, Business Cycles and Investment Behavior, Dossi et al. Technical Change and Economic Theory. Pinter,

London; 1988. [9] G. Mensch, “Stalemate in Technology”. Ballinger Pub. Co., Cambridge, Mass., 1978.

[10] C. Freeman, , L. Soete, (1997), The Economics of Industrial Innovation, 3. Edition, London.

[11] Ibn Khaldun, Muqaddimah, 2:272-73, quoted in Dieter Weiss (1995), “Ibn Khaldun on Economic Transformation”, International Journal of Middle East Studies 27 (1), p. 29-37 [30].

[12] P. Davidson, John Maynard Keynes, in Great Thinkers in Economics, Palgrave, Macmillan, 2007-2009. [13] J. Barro, y X. Sala-i-Martín (1992), “Convergence”, Journal of Political Economy, Vol 100, nº 2

[14] W. J Baumol, (1986): Productivity, Growth, Convergence and Welfare: What the Long-Run Data Show, American Economic Review, 78, 5, December. [

15] E. Moncayo, (2004), El debate sobre la convergencia económica internacional e interregional: enfoques teóricos y evidencia empírica, Revista eure (Vol. XXX, No. 90), pp. 7-26, Santiago de Chile, septiembre 2004 [16] S. Kuznets, (1955), Economic Growth and Income Inequality, The American Economic Rewiew, Volume XLV, March 1955, number one.

[17] A. Gurría, (2007), Lecture, OECD Secretary-General at the Copenhagen Business School, Copenhagen, Denmark

[18] Harvey, 1990, D. Harvey, The Condition of Posmodernity. An Enquiry into the Origins of Cultural Change. Oxford: Basil Blackwell Ltd.; 1990. (Spanish Translation, Buenos Aires: Amorrortu; 1998.)

[19] Schor and Il-You,1995; J. Schor, J., Il-You, Capital, The State and Labour. WIDER, UNU Press. GB: E.Elgar; 1995.

[20] Glyn et. al, 1988; A. Glyn, A. Hughes, A. Liepitz,; A. Singh, , The Rise and Fall of the Golden Age. Helsinki: WIDER, UNU; 1988.

21] Liepitz, 1986) A. Liepitz, New Tendencies in the International Division of Labour: Regimes of Accumulation and Modes of Regulation. Scott, A.; Storper, M. Production,

Work, and Territory: the Geographical Anatomy of Industrial Capitalism. Allen and Unwin, Boston. 1986.

[22] I. Wallerstein, World – System Analysis, Theory and Methodology. Sage Publications; London,1982.

[23] 1982; Okita et al., 1979; Okita et al., 1979 S. Okita, T. Kuroda, M. Yasukawa, Y. Okazaki and K. Iio. Population and Development: The Japanese Experience. Hauser, P., pp. 327-338. Syracuse University Press; New York 1979.

[24] Gilbert. & Gugler, 1992; J. Gugler, The Urban-Rural Interface and Migration. Gilbert, A. & Gugler, J. Cities, Poverty and Development, Urbanization in the Third World. Oxford University Press; London,1993. [25] Masini, 1994; E.B. Masini, Impacts of mega-city growth on families and households, Mega-City Growth and the Future, pp 215-230, Tokyo: United Nations University Press; 1994.

[26] Hobsbawm, 1994). E.J., Hobsbawm, Historia del Siglo XX, (History of the XXth Century) Ed. Crítica, Buenos Aires, 2003, p. 566.

[27] A. Van der Woude; A.; Hayami, J. de Vries, Urbanization in History: A Process of Dynamic Interactions. Oxford: Clarendon Press; 1990.

[28] Kozulj 2001, Urbanización y Crecimiento: Resultados de las Correlaciones entre Población Total, Población Urbana y en Grandes Ciudades con el Nivel del PBI para Series de Corte Transversal a Nivel Mundial en el Período 1950-1990, (Urbanization and Growth: Results of the Correlations between Total Population, Urban Population and Population in Large Cities with GNP Level for Cross-sectional Series on a World Scale in the 1950-1990 Period) FB/ Working Papers 03/01, Bariloche, Argentina, August 2000.

[29] Kozulj, 2003, People, Cities, Growth and Technological Change: from the golden age to globalization, en Technological Forecasting and Social Change, 70 (2003) 199-230, Elsevier Science, NL.

[30] Bauman, 2001, En busca de la política, (In search for Politics) FCE, Buenos Aires, 2001.

[31] Shenhar et al. (1998), A.J. Shenhar , Z. Hougui, , D. Dvir, , A. Tischler Y. y Sharan, , Understanding the defense conversion dilemma, in Technological Forecasting and Social Change Vol. 59 (3), 1998 (November), North - Holland., Elsevier.

[32] Jeremy Rifkin, (2003) J. Rifkin, , El sueño europeo: cómo la visión europea del futuro está eclipsando el sueño americano, (The European Dream: How the European view of the future is outshining the American Dream) Buenos Aires, Paidós Estado y Sociedad 123.

[33] R. Kozulj, (2005),. ¿Choque de Civilizaciones o Crisis de la Sociedad Global? Problemática, Desafíos y Escenarios Futuros, Ed. Miño y Dávila, Madrid, 2005.

[34] Allianz Global Investors, Analysis & Trends, The sixth Kondratieff –long waves of prosperity, January 2010.

[35] ILO, Global Statistics on the Labour Market page, By_Country_FULL_EN.xls.

[36] Evelyn Fox Keller 2000, Le siecle du gen, Gallimard, Paris, 2003.

[37] N., Georgescou Roegen, (1971), The Entropy Law and the Economic Process, Harvard University Press: Cambridge, Massachusetts.

[38] F. Geels, , From sectoral systems of innovation to sociotechnical systems: Insights about dynamics and change from sociology, and institutional theory. Department of Technology Management, Eindhoven University, IPO 2.10, P.O. Box 513, 5600 MB Eindhoven, The Netherlands, Research Policy 33 (2004) 897–920

[39] T. R. La Porte,, Social Responses to Large Technical Systems: Control or Anticipation. Kluwer Academic Publishers, Dordrecht, NL.1991 Malerba, F., 2002. Sectoral systems of innovation. Research Policy 31 (2), 247-264.

[40] T. P. Hughes,, Networks of Power, Electrification in Western Society, 1880-1930. Johns Hopkins University Press, Baltimore.

[41] T. P. Hughes,, 1987. The evolution of large technological systems. In: Bijker, W.E., Hughes, T.P., Pinch, T. (Eds.), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. The MIT Press, Cambridge, Massachusetts, 51-82.

[42] R. Mayntz and T. P. Hughes, The Development of Large Technical Systems. Campus Verlag, Frankfurt, 1988.

[43] C. M. Wesley,, Businnes Cycles: 10-17, Burt Franklyn, New York, 1970.

[44] Perrin S. Meyer, W. Jasón Yung and Jesse H. Ausubel, in A Primer on Logistic Growth and Substitution: The Mathematics of the Loglet Lab Software, published in Technological Forecasting and Social Change an International Journal, North Holland Vol. 61, No. 3, July 1999.

[45] Fu chen Lo. The Impacts of Current Global Adjustment and Shifting Techno-Economic Paradigm on the World City System. Fuchs, R., E. Brennan, J. Chamie; F. Ch. Lo and J. I. Uitto. Mega-City Growth and the Future. Tokyo: United Nations University Press; 1994.

[46] Penn World Table (Mark 5.6 a) The Center for International Comparisons at the University of Pennsylvania

[47] United Nations, World Urbanization Prospects, United Nations, 2001.

[48] W. J Baumol, (1967), Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis. William J. Baumol. The American Economic Review, Volume 57, Issue 3 (Jun., 1967), 415-426.