

Economic Development, a Theoretical Approach

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Abstract: *this article aim is to introduce to the economic development approach based on economic theory in order to rise the standard economic development pioneer analysis. Since both the growth and the development economics theories faced a methodological crisis between the 1970s and the 1990s which led growth theory regained interest with the model of Romer (1986), in contrast, development economics became empirical in developing countries study, thus too restrictive in the explanation of some phenomenon without data This article shows the way, long run growth through increasing returns can hold in developing countries for the least developed countries' economic integration to be successful.*

Keywords: *increasing returns, convergence, long run growth, technology transfer, development, growth, methodological crisis, country's economic classification*

I. Introduction

This is not exactly a paper about Paul Romer?, What is it about? In the first place, I am unqualified to write such a paper, in essence, the Romer I know is the provider of the needed ingredient for the growth literature crisis to cease in the middle of the 1980s. The economic growth literature faced a crisis from the early 1970s to the middle of the year 1980s caused by the Solow (1956) work consequences. The convergence notion generated was unable to explain the countries differentials in economic development levels over time. The crisis ends up in the middle of the 1980s when Romer brought an explanation of the world countries heterogeneity on the basis of knowledge in his article of 1986² and later on with endogenous technological change (Romer, 1990), thus show off how increasing returns can arise from a given economic structure and long run growth can hold. Indeed, this work is a reflection where the major figure appears to be Romer since it includes his original papers of 1986 and 1990. I recognize my weakness to make the comparison I intend to do with the development economics pioneer crisis held between the 1970s and the 1990s when economists looked at those set of ideas with fresher eyes and recognize them to have finally a sense after all (Murphy, Shleifer, and Vishny, 1989³; Krugman, 1994⁴, Loubaki, 2013⁵). Unfortunately that observation orientated the theory toward empirical work mostly, in regard to developing world (Huiran and Wang, 2013; Duggan et al, 2016), and launch early development investigation research around the 1990s on the basis of Ashton (1948) in regard to developed world to explain the industrial revolution which appears first in England in eighteen century and how it spreads all over the whole Western countries (Ashton, 1948; Rostow, 1960; Allen, 2001, 2009; Mokyr, 2009⁶; Galor and Weil, 2000⁷; Galor, 2011⁸). Since the fall of the development theory was caused by the lack of method in social science, thus, focusing in econometrical models keeps hidden some unknown aspects of development economics societies that can't be explained because of the difficulty to collect data related to some phenomenon related to

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² Romer, Paul, 1986, Increasing Returns and Long Run Growth, *The Journal of Political Economy*, Vol. 94, No. 5, pp. 1002-1037

³ Those authors modeled the theory of *the Big Push* due to Rosenstein-Rodan (1943)

⁴ The author surveyed the Pioneer of Economic Development though fall in order to render how to make it rise since that set of ideas have a sense

⁵ This article looks for poverty reduction paths since the conjunction of medicine and agriculture improves sustainability in an economic environment where prevail HIV/AIDS, medical care and food shortages explaining global development crisis. On the basis of Rosenstein-Rodan's coordinate investments proposal, a cooperative unit in charge of some aspects of development where entities goals correlate legitimate coordinate investments policy application conducted by International Donors in Cooperation with Poor Countries' Governments highlighted by relative technological change adoption making medicine and agriculture technologies intercept for a better achievement of the same goal summarized by the link between sustainability improvement and poverty reduction. This economic policy shows-off *multiple poverty reduction paths existence* due to relative technological change and knowledge diffusion movements, the one ensuring the steady state stability exists.

⁶ This author argued that the Industrial Revolution was caused by the Enlightenment, that is by the growth of science and Analytical thinking

⁷ This paper develops a unified growth model that captures the historical evolution of population, technology, and output. It encompasses the endogenous transition between three regimes that have characterized economic development. The economy evolves from a Malthusian regime, where technological progress is slow and population growth prevents any sustained rise in income per capita, into a Post-Malthusian regime, where technological progress rises and population growth absorbs only part of output growth. Ultimately, a demographic transition reverses the positive relationship between income and population growth, and the economy enters a Modern Growth regime with reduced population growth and sustained income growth

⁸ The author explains the transition from Malthusian to modern economic growth models that start from maximizing individuals in closed economies with one undifferentiated good. Galor asserts that technological progress is a positive function of education and population size.

traditional societies. Moreover, according to Lucas, (1988), growth study is related to known phenomenon of the societies in contrast to development economics where they are hidden. Therefore, the ambition of this article is to widen the development economics vision in providing a new orientation of its study toward a theoretical approach. Therefore, this article introduces to the theory of development economics on the basis of the work of Romer (1986) in order to provide a larger vision of development compared to the one mostly proposed, specifically by the great international organizations researchers based on econometrical methods (Easterly, 2009; Kremer et al, 2015; Kremer, 1993; Docquier-Delacroix, 2012), thus mainly focused on restrictive studies of little precise aspects of development economics societies. More precisely, this article highlights some reflections in two correlated themes. *One is the strange crisis appeared in the literatures of economic growth and economic development pioneers* almost at the same time in methodological aspects. In the concern of the development economics, it was caused by the difficulties to express ideas through formal models (theoretical or empirical) whereas for the economic growth theory, the crisis was caused by the difficulties to introduce increasing returns in the neoclassical competitive growth model. Specifically in dynamic optimization models in order to explain the sources of countries' heterogeneity without the equalization theorem among the countries to play caused by the hypothesis of the decreasing character of marginal productivity of physical capital, thus countries appear to be the same over time since the poor grow faster than the rich countries. But during decades, that last finding couldn't be proved empirically until the introduction of the Emerging countries in the economic system which contradict the rejection of the convergence notion generated by the Solow (1956) finding. Nevertheless, before that time, how to render growth endogenous was the main question, thus the both theories lost their interest as long as appropriate answers couldn't be find in the 1970s. Indeed, both growth and development economics articles became incomprehensible for the one and not interesting enough for the others, thus could no more be published specifically in development economics. Growth theory performs in static international trade models where the existence of both the long run growth equilibrium and optimum was avoided in dynamical models, thus lost their interest despite of Knight (1925)⁹ advices on the dynamic models challenges. The growth theory began to turn around looking for the way to introduce increasing returns in the dynamic models and keep the competitive character or the neoclassical growth model specificity at the same time which was difficult to do because the Euler law couldn't work anymore, since it yields technology to be remunerated as the other input of production such as capital and labor stocks, the firms will face losses caused by the profit maximization condition which yields to set profit to zero. *The second theme is how to express development economics theoretically* i.e how to model development economics ideas through mathematical models rather than empirical approaches which mostly prevail¹⁰. Indeed, in that aspect, the pioneers of development economics are the main figures of the new development approach proposed in this article based on the theoretical modeling of the economic development literature.

Indeed, this paper presents the crisis faced by the both theories, *first* and wonder if the economic growth theory improvements are able to supplement the lacking social science methodology in the development economics for it to rise again in a *second* time. The approach proposed consists on introducing Romer (1986) endogenous growth theory inside the development theory proposed by Lewis (1954). Since knowledge is the engine of growth for the first author, good production factors transfer from one place to another is the best way yielding to development for the second author. Consequently, this article assumes *third*, that knowledge transfer from developed to developing countries is the right approach leading to economic integration of the poor countries in this 21th century where the context of globalization prevail in the world economy. We find that, development is a process which occurs over time and from under development to growth locus, four steps can be viewed through the dynamics of the economy movements. A given country may cross each step through knowledge investment, thus knowledge transfer from developed to developing countries may yield increasing returns and lead to the long run growth settlement and stability. Since both the developed and developing countries move at the same constant rate over time, convergence occurs and finally the development character adopted in this article brings a new classification of the countries in the world. Indeed, development theory rose since it is able to explain some unknown aspects without data through the new methodological approach proposed here. The four economic development steps highlights by the analysis are: the traditional society where land product is the main wealth of the nation in the spirit of the Rostow (1960) view. The second step is the under development¹¹ or the poverty trap¹² inside which the economic path of a given country is kept, we can find poor countries or low income countries according to the World Bank classification. The third step is the transition toward market based economy and actually many countries still in transition, like middle income

⁹ Frank Knight used to be a student of Young at Cornell University.' Subsequent work demonstrated that it is possible to construct consistent, general equilibrium models with perfect competition, increasing returns, and externalities

¹⁰ The overlapping generations models are due to Diamond (1965) in economics whereas Econometric approach is due to Cass (1965) and Koopmans (1965)

¹¹ This term is the one used by the development economics pioneer to design an economically depressed country

¹² This term is used by the growth theorists to design growth absence in a given country which they explain by knowledge investment absence (see Azariadis and Drazen, 1990)

countries according to the World Bank countries classification. The fourth step is the one which gathered high income countries or industrialized countries since they exhibit increasing returns and long run growth over time vehicled by knowledge diffusion and adoption (Alvarez-Buera-Lucas, 2008, 2013-Coleman, 2001; Perla, Tonetti, and Waugh (2014)). The convergence notion displayed by the analysis consists on making the dynamical path moves at the same constant rate over time toward different stages of the economic path until the highest locus is reached. Consequently, this article provides theoretical foundations of development economics integration in the world market.

The scientific contribution of this article focuses on three main aspects which are: *first*: it is a theory of economic development which attempt to pursue the economic development pioneer thought theoretically. *Second*, increasing returns and long run growth are included in the economic development analysis. Those ingredients were omitted by the first development theories despite of their evocation by the growth theorists contemporary with development economists a long time ago (Lewis, 1954 and Hirschman, 1958 with Solow, 1956 and Roseinstein-Rodan, 1943 with Knight, 1944) until today, the goal is to propose a new view able to accelerate economic integration of the poor countries in the world market. *Third*, a new classification of the countries in the world is provided since development path is a dynamic process which moves over time through knowledge investment and adoption measured by the economic growth rate level, so that integration in the world market of the countries depressed economically depends on knowledge diffusion.

Increasing returns and scale economies are as old as the pin factory of Adam Smith (1776) with some ingredients of the contributions of other economists such as David Ricardo (1817), Thomas Malthus (1798), Franck Ramsey (1928), Allyn Young (1928), Franck Knight (1944), Joseph Schumpeter (1934), Cass (1965), Diamond (1965) and Koopmans (1965). The first model to be considered as a growth model is the Ramsey (1928) model where he provided an optimization method of saving at the time when the growth engine was the capital stock such that the rate of saving multiplied by the marginal utility of money always equalize the amount by which the total net rate of enjoyment of utility falls short of the maximum possible of enjoyment. The second growth models serial are due to Harrod (1939) and Domar (1946) who find similar conclusions so that the literature gathered their work in one and considered the Harrod-Domar economic growth model as a single one. The characteristic and powerful conclusion of the Harrod-Domar line of thought is that even for the long run, the economic system is at best balanced, on a knife-edge of equilibrium growth path. Where the magnitudes of the key parameters are the saving ratio, the capital-output ratio, the rate of increase of the labor force to slip ever so slightly from dead center, the consequence would be either growing unemployment or prolonged inflation¹³. Harrod and Domar view of the long run is related to the notions of the multiplier¹⁴, the accelerator, the capital coefficient provided by Keynes (1936). Thus the previous model used only short run economic tools to study long run growth. In contrast, the long run growth equilibrium is the domain of the neo-classical analysis highlighted by Solow (1956) both in regard to its existence and stability over time established since the production factors are substitute rather than in fixed proportion leading to the knife edge economic path as in the Harrod and Domar model. The stability of the long run growth provided by Solow (1956) is empirically confirmed by the work of Denison published in 1962 on the basis of US data. Cass (1965) and Koopmans (1965) brought Ramsey's analysis of consumer optimization back into the neoclassical growth model for an endogenous determination of the saving rate. The crisis in growth theory came from the impossibility to show increasing returns explaining growth longevity over time. Consequently, growth theory died as an active research field by the early 1970s, when the oil shocks of 1973 and 1979 took place and yield the world economics to face crisis of the debt in developing countries and both growth fall as well as unemployment increase in the developed world. Indeed, growth theory couldn't find the remedy to the economic crisis in industrial world for about 15 years period during which, macroeconomic research thus only focused on empirical work essentially like short-term fluctuations, rational expectations into business-cycle models, improved approaches to policy evaluation, and the application of general-equilibrium methods to real business-cycle theory (Barro and Sala-i-Martin, 2004). In developing economies, the debt crisis led to macroeconomics stability policies conducted by the World Bank and by the IMF in the countries which have chosen to beneficiate of those organizations help in economy. In the context of research, the solutions proposed also remained focused on empirical works mostly (see the World Bank and the IMF development reports) and built the development measure called IDH¹⁵ due to Amartya Sen for the World Bank.

The inclusion of a theory of technological change in the neoclassical framework is difficult, because the standard competitive assumptions cannot be maintained. But several attempts were made by Arrow (1962),

¹³ The Harrod and Domar model follow Keynes (1936) book where product equilibrium without unemployment doesn't exist, therefore, the optimal path is on a knife edge only i.e there still existing unemployment whatever be the level of output measured by GDP

¹⁴ The multiplier of investment for example means that the product increases on the amount of k i.e $dY/dI=k=1/1-c$ where c is the margin propensity to save since the consumption is a function of income like, $C=C_0+cY$

¹⁵ Human Development index measure devevelopment in regard to life expectancy, the literacy rate and the GDP per capita improvements over time

Levhari (1966) and Sheshinski (1967), the difficulties faced when working with dynamic optimizing models were avoided by assuming that output as a function of capital and labor, exhibits increasing returns to scale whereas, the marginal product of capital is diminishing given a fixed supply of labor. Therefore, the rate of growth of output is limited by the rate of growth of the labor force. Uzawa (1965) is considered to be an aggregate model of growth rather than a model of a specific industry and describes an optimizing growth model in which both intangible human capital can be produced. Unfortunately, it doesn't possess increasing returns to scale and only considered a borderline case of constant returns to scale with linear production of human capital, thus unbounded growth yields. Shell, (1967) is an optimizing model which takes the rate of technological change as exogenously given. Phelps, (1966); Von Weizsacker, (1966) assume knowledge to be accumulated by devoting resources to research, thus the production of consumption goods exhibits constant returns as a function of tangible inputs i.e physical capital and labor, therefore exhibits increasing returns as a function of tangible and intangible inputs. Weitzman (1970), Dixit, Mirrlees and Stern (1975), Skiba (1978) are continuous-time optimization problems with some form of increasing returns. Majumdar and Mitra (1982) and Dechert and Nishimura (1983) are discrete-time models which study similar issues where the questions of existence of the competitive equilibrium are avoided. Those models rely on either bounded instantaneous utility or bounds on the degree of increasing returns in the problem i.e they consider the production function $f(k)$ to be such that $f(k)/k$ is bounded from above. Finally, after the mid-1980s, research on economic growth experienced a boom, beginning with the work of Romer (1986) who discovered how to exhibit increasing returns in the competitive equilibrium model by solving a social planning problem rather than by considering the maximization problem of an individual agent who takes as given the path of some endogenously determined aggregate variable. More precisely, Romer (1986) is the first paper which presents a fully specified model of long-run growth in which knowledge is assumed to be an input in production that has increasing marginal productivity. It is essentially a competitive equilibrium model with endogenous technological change where growth rates can be increasing over time due to knowledge increase effects, thus large countries may always grow faster than small countries, thing which remains difficult to show before. Lucas (1988) shows off the existence of increasing returns to scale from human capital component initiated by Becker (1964) and Schultz (1963) in the spirit of the work of Romer previously quoted. Romer (1990) attempt is to explain the endogenous formation of technological change denoted A included in the production function, thus considers technological progress to be endogenously determinate by the firm's profit maximization problem where technology is characterized by the fact that it is a non rival partially excludable good. Thus, non convexity is introduced inside the analysis of economic growth by this character which rules out a competitive equilibrium existence possibility. The equilibrium yield is no more a competitive one but a monopolistic case. Consequently, Eicher (1996) and its elaboration, Loubaki (2012)¹⁶ are frameworks where human capital and technological change intercept in order to ensure the long run growth existence and stability over time. Much research on endogenous growth literature has been directed at the process of technological diffusion. Perla, Tonetti, and Waugh (2014) is a model where heterogeneous firms continuously face a choice whether to produce a variety of a differentiated product or to search for a better technology. Grossman and Helpman (2014) is a model where a fall in trade costs is neutral with respect to the incentives for knowledge acquisition if the fixed costs of exporting are null. Otherwise, diffusion can accelerate or decelerate in response to globalization, depending on the nature of the cost function for searching for new technologies. Sampson (2014) is a model where there is free entry by new inventors of differentiated products. They draw their technologies for producing their inventions from a distribution that reflects the technologies found among incumbent producers. Sustained growth is driven by perpetual improvement of technologies for production, as each new technology builds on the others. Alvarez, Buera, and Lucas (2014) explore another mechanism that links globalization to diffusion in their model of idea flows. They start from the supposition that firms learn from those with whom they conduct business. Each country has a current best-practice for producing each good, à la Eaton and Kortum (2002). Product managers meet others at some exogenous rate. When a meeting occurs, the manager observes the technology of her contact and adopts that technology if it is better than her own. The distribution of contacts depends upon the distribution of productivities among active producers. In autarky, the source distribution for the learning reflects the distribution of productivities in the domestic economy. Trade improves the source distribution by replacing some less efficient domestic sellers with more efficient foreigners.

On the other part, three set of questions are viewed continuously in development economics that allow us make a classification of the theory. *The first set of questions* concerns the grand issues of the subject which

¹⁶ This article examines how endogenous human capital of the developed countries expressed by professors trained there and endogenous human capital of the developing countries expressed by their students, interact in the developing country's education sector to create higher quality goods. Private and public incentives to invest in human capital accumulation finance the employment of the skilled labor in the education sector, while non rival technology is a by-product of the education process. Both the optimal and the competitive equilibria define the efficient point able to lead the economy to the long-run growth. This point is also the locus where knowledge calls policy as the required efficiency to reduce the brain drain phenomenon. Indeed, the model provides theoretical foundations of the relative lack of the high skilled labor in developing countries.

include: the objectives of economic policy, or what constitutes development; the role of the state and the merits of planning and of markets; the determinants of growth and distribution; policies towards industrialization and international trade; and the effects of population growth. These questions have, of course, long been part of economics in general. But it is a distinguishing feature of development economics that they have always been central and many of the major economic contributions to their understanding have come from research on development (Nukse, (1953); Rosenstein-Rodan, (1943); Scitovsky, (1954); Hirschman, (1958), Harrod, (1939) and Domar, (1946), Romer, (1986); Lucas, (1988); and Scott, (1989)). Early planning empirical models were initially concerned with feasibility or consistency of different sectoral targets and were based on the input-output methods developed by Leontief (1941), Stone (1970), Stone and Stone (1977) and Chenery (1956). They were soon extended in a number of directions. Early examples of the use of input-output and linear programming techniques in the analysis of choice in development planning are Chenery and Clark (1959), Chenery and Bruno (1962), Chenery and Strout (1966), Sandee (1960) (see also Chenery, 1965, for reviews). *The second set of questions* concerns the development of techniques and tools for the analysis of problems of policy mainly focused on empirical works, principally planning models, cost-benefit analysis, and methods for the examination of tax and price reform. Such issues, if narrowly defined simply as problem-solving techniques, are in some respects less deep and exciting than the former class but, on the other hand, they allow for greater clarity of analysis and for results which are more explicit. Many of the most important contributions to these basic empirical methods in economics have come from development economics. From a broader perspective they may be seen as part of a central and difficult area of economics - the theory of policy in imperfect economies (Todaro (1969), Harris and Todaro, 1970), Leibenstein (1957), Mirrlees (1976) and Stiglitz (1976) and developed by Bliss and Stern (1978a, b), Dasgupta and Ray, 1987). The equilibrium analysis of risk in markets is the one where consumers or producers act to maximize expected utility or profits and where markets allow for some speculation or insurance has seen important application in development economics to the problems of price stabilization. Most studies of commodity-price stabilization focus on producers or exporting countries and examine schemes involving buffer stocks, for example, for smoothing prices or incomes for example, Newbery and Stiglitz (1981). *The third group of questions* is more heterogeneous but the common feature is the tightly focused microeconomic study of a phenomenon, market or location where the details of institutions, geography, health or culture play a crucial role. The studies assembled under this heading do not together reflect a single theme but illustrate an approach to intellectual enquiry which has found some of its most notable examples in development economics (Newbery (1988), Berck and Cechetti (1985), Ravallion (1988), Bigman (1982, 1985), Turnovsky et al. (1980). Newbery (1988), for example, concludes that ration shops and food entitlements may be more cost-effective in protecting consumers than price stabilization policies. Ravallion (1987)), Harris and Todaro, 1970) suppose the idea that there is a link between consumption and job performance and that this link may influence wages and the allocation of labor goes back to Leibenstein (1957). It was set out rigorously by Mirrlees (1976) and Stiglitz (1976) and developed by Bliss and Stern (1978a, b), who also examined empirical evidence on the assumptions and predictions of the theory. Dasgupta and Ray, (1987), have recently returned to some of these ideas. The equilibrium analysis of risk in markets, where consumers or producers act to maximize expected utility or profits and where markets allow for some speculation or insurance, has seen important application in development economics to the problems of price stabilization. Most studies of commodity-price stabilization focus on producers or exporting countries and examine schemes involving buffer stocks, for example, for smoothing prices or incomes (Newbery and Stiglitz (1981). Food prices, however, affect consumers as well and fluctuations can involve questions of survival. Here, the possibilities of holding stocks, borrowing or lending, and the correlation between food prices and income become crucial. We can ask how markets allocate the risks in these contexts and whether the role of speculation is stabilizing or destabilizing. One should ask whether storage is best carried out publicly or privately and if the latter whether it should be subsidized. For contributions see Newbery (1988), Berck and Cechetti (1985), Ravallion (1988), Bigman (1982, 1985), Turnovsky et al. (1980). Newbery (1988), for example, concludes that ration shops and food entitlements may be more cost-effective in protecting consumers than price stabilization policies. Ravallion (1987) has applied some of the theoretical ideas of the literature on price uncertainty in his investigation of markets and famines in Bangladesh. He concludes on over reaction to new information on future scarcity during the famine of stabilized price markets.

This article is presented like follow, section2 setup the theoretical model in two steps where the first is devoted to the basic Romer (1986) model presentation and the second is the theoretical economic development model elaboration upon Romer model, section3 presents the results derived from the analysis conducted, section4 presents a short discussion of the results derived from the analysis and finally, section5 concludes on the analysis.

II. The theoretical development economics model

2.1 The Model of Romer (1986)

Consider a discrete-time model of growth with two periods in a given developed country where exist S identical consumers with a twice continuously differentiable, strictly concave utility function $U(c_1, c_2)$, defined over consumption of a single output good in periods 1 and 2. Let each consumer be given an initial endowment of the output good in period 1. Suppose that production of consumption goods in period 2 is a function of the state of knowledge, denoted by k , and a set of additional factors such as physical capital, labor, and so forth, denoted by a vector x . To restrict attention to a choice problem that is essentially one-dimensional, assume that only the stock of knowledge can be augmented; the factors represented by x are available in fixed supply. We can represent the technology of firm i in terms of a twice continuously differentiable production function F that depends on the firm-specific inputs ki of price λ_2 and x_i of price λ_3 and on the aggregate level of knowledge in the economy, K . If N is the number of firms, we can define the aggregate level of knowledge such as

$$K = \sum_{i=1}^N k_i$$

By the hypothesis of the homogeneity of F in k_i and in x_i and by the assumption that F is increasing in the aggregate stock of knowledge, K , it follows that F exhibits increasing returns to scale.

Let \bar{x} denote the per capita (and per firm) endowment of the factors that cannot be augmented and let \bar{e} denote the per capita endowment of the output good in period 1 i.e Y_1 .

To calculate the equilibrium, we define a family of restricted maximization problems indexed by K i.e the model is a standard competitive growth model with externalities where each firm maximizes profits taking K , the aggregate level of knowledge, as given. Consumers supply part of their endowment of output goods and all the other factors x to firms in period 1. With the proceeds, they purchase output goods in period 2. Consumers and firms maximize taking prices as given, $(\lambda_i)_{i=1,2,3}$. As usual, the assumption that agents treat prices and the aggregate level K as given could be rationalized in a model with a continuum of agents. Here, it is treated as the usual approximation for a large but finite number of agents. Because of the externality, all firms could benefit from a collusive agreement to invest more in research. Although this agreement would be Pareto-improving in this model, it cannot be supported for the same reasons that collusive agreements fail in models without externalities. Because we assume the homogeneity of F with respect to factors that receive compensation, profits for firms will be zero and the scale and number of firms will be indeterminate. Consequently, we can simplify the notation by restricting attention to an equilibrium in which the number of firms, N , equals the number of consumers, S . Then per firm and per capita values coincide. Assuming that all firms operate at the same level of output, we can omit firm-specific sub-scripts.

To calculate the equilibrium defining a family of restricted maximization problems indexed by K , we define a function $\Gamma : \mathbb{R} \rightarrow \mathbb{R}$ that sends K into S times the value of k that achieves the maximum for the problem $P(K)$, this suggests fixed points of Γ as candidates for equilibrium

U is strictly concave and $F(k, K, x)$ is concave in k and in x for each value of K , $P(K)$ will have a unique solution k for each value of K . (The solution for x is trivially \bar{x} .) In general, the implied values for c_1 , c_2 and k have no economic meaning. If K differs from Sk , then

$F(k, K, \bar{x})$ is not a feasible level of per capita consumption in period 2. The equilibrium requires that the aggregate level of knowledge that is achieved be $K=Sk$

To calculate an equilibrium define a family of restricted maximization problems indexed by K

$$P(K) = \underset{k \in [0, \bar{e}]}{\text{Max}} \{U(c_1, c_2)\} \tag{1}$$

Sc

$$c_1 \leq \bar{e} - k$$

$$c_2 \leq F(k, K, x)$$

$$x \leq \bar{x}$$

The Lagrangian can be expressed such that

$$\Omega = U(c_1, c_2) + \lambda_1(\bar{e} - k - c_1) + \lambda_2(F(k, K, x) - c_2) + \lambda_3(x - \bar{x}) \tag{2}$$

The first order conditions can be expressed such that

$$\frac{\partial \Omega}{\partial c_1} = 0 \Rightarrow U'_{c_1} = \lambda_1 \tag{3}$$

$$\frac{\partial \Omega}{\partial c_2} = 0 \Rightarrow U'_{c_2} = \lambda_2 \tag{4}$$

$$\frac{\partial \Omega}{\partial \lambda_1} = 0 \Rightarrow c_1^* = \bar{e} - k \tag{5}$$

$$\frac{\partial \Omega}{\partial \lambda_2} = 0 \Rightarrow c_2^* = F(k, K, x); \tag{6}$$

$$\frac{\partial \Omega}{\partial \lambda_3} = 0 \Rightarrow x = \bar{x}^* \tag{7}$$

Since the firm takes both prices and the aggregate level Sk^* as given, a trivial application of the sufficient conditions for a concave maximization problem demonstrates that k^* and \bar{x}^* are optimal choices for the firm. By the homogeneity of F with respect to its first and third arguments, profits will be zero at these values.

Consider next, the problem of the consumer, thus income to the consumer will be the value of the endowment, $I = \lambda_1 \bar{e} + \lambda_3 \bar{x} = \lambda_2 F(k^*, Sk^*, \bar{x}) + \lambda_1 (\bar{e} - k^*)$

The problem of the consumer becomes

$$Max_{c_1, c_2} \{U(c_1, c_2)\} \tag{8}$$

Sc

$$I = \lambda_1 \bar{e} + \lambda_3 \bar{x} = \lambda_2 F(k^*, Sk^*, \bar{x}) + \lambda_1 (\bar{e} - k^*)$$

Note that the marginal rate of substitution for consumers will equal the private marginal rate of transformation perceived by firms, the first order condition becomes

$$\frac{\frac{\partial U(c_1^*, c_2^*)}{\partial c_1}}{\frac{\partial U(c_1^*, c_2^*)}{\partial c_2}} = \frac{\partial F(k^*, Sk^*, \bar{x})}{\partial c_1} \tag{9}$$

Because of the externality, this differs from the true marginal rate of transformation for the economy,

$$\frac{\partial U(c_1^*, c_2^*)}{\partial c_1} + S \frac{\partial F(k^*, Sk^*, \bar{x})}{\partial c_2}$$

Arguments along these lines Γ can be used quite generally to show that a fixed point of a mapping like \bar{x} defined by a family of concave problems $P(K)$ can be supported as a competitive equilibrium with externalities. The necessary conditions from a version of the Kuhn-Tucker theorem generate shadow prices associated with any solution to $P(K)$. The sufficient conditions for the problems of the consumer and the firm can then be used to show that the quantities from the solution will be chosen in an equilibrium in which these prices are taken as given. Conversely, an argument similar to the usual proof of the Pareto optimality of competitive equilibrium can be used to show that any competitive equilibrium with externalities for this kind of economy will satisfy the restricted optimality condition implicit in the problem $P(K)$

That is, if K^* is an equilibrium value of aggregate knowledge, then K^*/S will solve the problem $P(K^*)$. Thus equilibria are equivalent to fixed points of the function F i.e any fixed point K^* of Γ can indeed be supported as a competitive equilibrium, observe that $P(K^*)$ is a concave maximization problem with solution $k^*=K^*/S$, $c_1^* = \bar{e} - k^*$, and $c_2^* = F(k^*, Sk^*, \bar{x})$ Since it is concave, standard necessary conditions for concave problems apply, indeed $F(k^*, Sk^*, \bar{x})$ exhibits increasing returns to scale.

2.2 The model of development based on Romer (1986)

To introduce the development theory inside the growth theory of Romer (1986), we adopt Lewis (1954) in order to transfer knowledge contains in good also called technology from developed to developing countries through international trade which remains exogenous inside the model in order to make increasing returns emerge in the context of long run growth existence over time in least advanced economies. We assume in the model that the developing country's firms hold human capital sufficiently trained to handle high developed countries technology. To introduce technology transfer in the Romer model, we consider a developing country, where K^d denote the amount of the developed world technology transferred to j firms in the developing country

to be expressed such that $K^d = \sum_{i=1}^M k_j^d$ where $M < N$, k_i^d is per-capita knowledge of the firms, M is the number of firms in the developing country. Then the production function is now expressed such that: $F(k^d, K^d, x^d)$ which is concave in k^d and in x^d for each value of K^d , $P(K^d)$ will have a unique solution k^{d*} for each value of K^d . In general, the implied values for c_{1d} , c_{2d} and k^d have no economic meaning, therefore, we have, $S^d k^d = K^d$ because $S^d = M$

Where k^d , is per-capita knowledge of each firm of the developing country, K^d , is the aggregate knowledge of the developing country's firm, x^d is a set of additional factors such as physical capital, labor, and so forth of the developing country and S^d is the number of consumers in the developing country. If K^d differs from $S^d k^d$, then $F(k^d, K^d, x^d)$ is not a feasible level of per capita consumption in period 2. The equilibrium requires that the aggregate level of knowledge be achieved. By the homogeneity of $F(k^d, K^d, x^d)$ in k^d and in x^d and by the assumption that $F(k^d, K^d, x^d)$ is increasing in the aggregate stock of knowledge, K^d it follows that, $F(k^d, K^d, x^d)$ exhibits increasing returns to scale in the poor country

U^d is strictly concave and $F(k^d, K^d, x^d)$ is concave in k^d and in x^d for each value of K^d , thus $P(K^d)$ has a unique solution k^d for each value of K^d

$$\text{Max}_{c_{1d}, c_{2d}} \{U[(c_{1d}, s_{1d}), (c_{2d}, s_{2d})]\} \tag{10}$$

Sc

$$I^d = \lambda_1^d e^{-d} + \lambda_3^d x^{-d} = \lambda_2^d F(k^{d*}, S^d k^{d*}, \bar{x}^{-d}) + \lambda_1^d (e^{-d} - k^{d*})$$

In contrast to before, here the agent has the constraint of health state expressed by the variable, s_i ¹⁷

Note that the marginal rate of substitution for consumers will equal the private marginal rate of transformation perceived by firms, the first order condition becomes

$$\frac{\frac{\partial U(d_1^*, d_2^*)}{\partial d_1}}{\frac{\partial U(d_1^*, d_2^*)}{\partial d_2}} = \frac{\frac{\partial F(k^{d*}, S^d k^{d*}, \bar{x}^{-d})}{\partial d_1}}{\partial d_2} \tag{11}$$

Where $(c_{id}, s_{id}) = d_i$ for $i=1,2$

Because of the externality, this differs from the true marginal rate of transformation for the economy,

$$\frac{\partial U(d_1^*, d_2^*)}{\partial d_1} + S^d \frac{\partial F(k^{d*}, S^d k^{d*}, \bar{x}^{-d})}{\partial d_2}$$

That is, if K^{d*} is an equilibrium value of aggregate knowledge, then K^{d*}/S^d will solve the problem $P(K^{d*})$. Thus equilibria are equivalent to fixed points of the function F^d i.e any fixed point K^{d*} of Γ^d can indeed be supported as a competitive equilibrium, observe that $P(K^{d*})$ is a concave maximization problem with solution $k^{d*} = K^{d*}/S^d$,
 $c_{1d}^* + s_{1d}^* = e^{-d} \cdot k^{d*}$,
 $c_{2d}^* + s_{1d}^* = F(k^{d*}, S^d k^{d*}, \bar{x}^{-d})$

$$\tag{12}$$

$$\tag{13}$$

$$\tag{14}$$

Since $P(K^{d*})$ is concave, standard necessary conditions for concave problems apply, indeed $F(k^{d*}, S^d k^{d*}, \bar{x}^{-d})$ exhibits increasing returns to scale.

Definition: the stationary equilibrium is the locus on the space where all the variables grow at the same constant rate, g i.e:

$$\frac{K^*}{K^{d*}} = \frac{Y^*}{Y^{d*}} = \frac{S c_1^*}{S^d c_{1d}^*} = \frac{S c_2^*}{S^d c_{2d}^*} = \frac{S(e^{-d} - k^{d*} - s_{1d}^*)}{S^d(e^{-d} - k^{d*} - s_{2d}^*)} = g$$

III. Results

Proposition1: technology transfer from developed to developing countries exhibits increasing returns to scale and the convergence property to a common long run growth rate, g in the globalized economy

Proof: at the aggregate stationary level, we have

$$k^{d*} = K^{d*}/S^d, <k^* = K^*/S \text{ therefore, } c_{1d}^* + s_{1d}^* = e^{-d} \cdot k^*, <c_l^* = e^{-d} \cdot k^*, \text{ therefore,}$$

¹⁷ We introduced health in the Romer model to fit more with the idea that it is applied to developing country's study since development is measured by HDI which includes health state rather than GDP alone

$$c_{2d}^* + s_{1d}^* = F(k^{d*}, S^d k^{d*}, \bar{x}^d) = Y^d < c_{1d}^* + s_{1d}^* = \bar{e} - k^* < F(k^*, S k^*, \bar{x}) = Y$$

According to definition 1, the growth rate is defined such that

$$\frac{K^*}{K^{d*}} = \frac{Y^*}{Y^{d*}} = \frac{S c_1^*}{S^d c_{1d}^*} = \frac{S c_2^*}{S^d c_{2d}^*} = \frac{S \left(e^{-d} - k^{d*} - s_{1d}^* \right)}{S^d \left(e^{-d} - k^{d*} - s_{2d}^* \right)} = g$$

Therefore, we can find the expression announced above, indeed the developed and the developing countries grow at the same common rate, g

Proposition 2: because the developed and the developing countries grow at the same common rate, convergence may occur over time

Proof: according to definition 1, we can write, $Y^* = g Y^{d*}$, therefore, since technology transfer increases the growth rate, then at certain level over time i.e when $g \rightarrow 1$ then $Y^{d*} \rightarrow Y^*$ which means convergence occurring through the time may yield catching up. Indeed, we can classify the countries category which turns out to be close to the one provided by the World Bank i.e

If $0 < g < 1$ then it is a middle income country in general but if g is high enough and quite close to the limit, then it is an emerging country. Otherwise if g is low enough, then the country still in transition toward market based economy. If $g = 1$ then it is a high income country which is under market based economy law. If $g = 0$ then it is a poor country kept under a poverty trap. Finally, if $g < 0$ then the country is a traditional society without capital and living with land product in the spirit of the work of Rostow (1960)

Proposition 3: according to the theory built highlights by figure 1, economic development of a given country is a four steps process where the first is the traditional society ($g < 0$) in the spirit of the work of Rostow (1960)¹⁸, the second step is the countries kept in under development trap ($g = 0$) in the spirit of the work of Azariadis-Drazen (1990), the third step is the countries which are doing their transition toward the market based economy ($0 < g < 1$) and finally, the fourth step contains the countries which exhibit increasing returns and long run growth exhibition ($g \geq 1$) i.e Industrialized countries

Figure 1 summarizes the whole theory built and highlights the old idea that, development is a process with several stages, we find that they can be gathered on four steps where the *first step* is similar to the first stage evocated by Rostow (1960). *The second step* is assimilated to under development view provided until the 1950s when discussions began on the forthcoming freedom of the countries under the Western countries political power, thus are explained by the pioneer of development economics. Rosenstein-Rodan's solution to under development is provided by a coordinated, broadly based investment program also called *the Big Push*. Hirschman disagreed, arguing that a policy of promoting a few key sectors with strong linkages, then moving on to other sectors to correct the disequilibrium generated by these investments, and so on, was actually the right approach. Arthur Lewis development theory emphasizes dualism among modern and traditional sectors of good production which causes under development, thus the absorption of low skilled workers from traditional sector into modern sector was the right approach leading to development. Fleming (1954) promotes the role of intermediate goods in production as the way to develop faster a given country. In this category, we can find poor countries with negative growth rate like Democratic Republic of Congo, Mali, Center of Africa,.... Those countries growth absence is assimilated to a kept inside a poverty trap evocated by Azariadis-Drazen (1990) in the literature of growth caused by human capital investment absence. *The third step* is the transition toward market based economy which is occurring in many countries around the world after the end of "Communism" in 1989 so that since the 1990s at least all the countries in the world except North Korea are doing their transition in order to be integrated inside the world market. Still, some middle income countries transition is not finished yet. That category includes countries like China, Congo (Republic) and some other countries in Latin America like Brazil, Venezuela, etc... *The last step* gathered countries which exhibit increasing returns and long run growth or industrialized countries, inside which we can find OECD countries like United States of America, Western European Countries like Great Britain, Germany and some Asian countries like Japan and South Korea for example.

IV. Discussions

The results found stipulate that, knowledge provided from technology transfer is the engine of economic development and yields production to grow at the same constant rate both in developed and in developing countries, that rate equals consumption and health variables relative rate and the whole move at the

¹⁸ In Rostow (1960), the traditional society is the one with land as the main wealth source, where science and technology do not exist yet, production is traditionally determinate

same rate avoiding inflation for the system to remain stable. The development of the industry is able to absorb the excess unemployed labor so that, the system is stable over time. This finding is a great revolution in development economics pioneer, since increasing returns and long run growth stability can be established included in a development model and stipulate that economic integration of the developing countries may accelerate through convergence in growth rates first and in income after. Therefore, knowledge through technology transfer is a mechanism of economic integration. We've seen that, development is a dynamic process which crosses different stages highlights like an escalator continuous function with four steps until the reach of the growth zone since the last step is the one a given country is willing to achieve and can be successfully be achieved since increasing returns can emerge to make the economy reaches its long run growth locus. The model classifies the whole world countries in conformity with the new paradigm following economic integration and the exit of "communism" political though which prevail during a long time i.e from the 1960s and the 1990s specifically in developing countries. The classification provided is a mixture of several approaches due both to development economics and to growth theorists as well to the World Bank and Rostow (1960) classification of the countries in function of their income measured by the comparison between the size of the population and the GDP of the country (see figure 1 for summary of the model's results)

V. Conclusion

The model presented aim was to establish increasing returns and long run growth in economically depressed areas specifically in Africa which still under developed until today so that, discussions on its emergence possibilities remain useful. We've shown that, increasing returns can be introduced inside a theoretical development economics model, so that the development approach provided in this article is relied to those of the pioneer as well as to growth theory applied to poorest countries difficulties to get developed so that, knowledge is similar to technology transfer. Knowledge evocated here is the one contained inside things and carried to developing countries through international trade which we assumed to be exogenous in the model like the required skill labor to handle high developed countries technology is. Since the idea generated needs human capital trained at high levels for the technology acquired to be efficient in growth generation. The model used to elaborate the study and to leave results emerge from it is based on Romer (1986) model where knowledge in developed countries turns out to correspond to technology transfer in developing countries in order to capture development through long run growth and increasing returns concepts. Lewis (1954) concept of labor transfer turns out to be technology transfer from developed to developing countries able to make industry emerge and unemployed labor absorption to reduce poverty which is a component of under development dilemma. The weakness of the model comes from the fact that training in new technology is not discussed for the project to hold and both increasing returns to emerge for long run growth existence and stability to be obtained. Consequently, we find that technology transfer from developing to developed countries exhibits increasing returns and long run growth and show-off a convergence possibility since increasing returns generated make the developing country's path to grow at a common rate as the developed country in the long run. The result obtained links the theories of growth and development through knowledge which can't be kept secret (Romer, 1990) and may freely flows from one place to the other. Finally, the model assimilates development to a dynamical process which moves over time toward several steps depending on knowledge investment done, thus yields to characterize countries at each step according to the income hold as well as the stage achieved i.e the model built provides a new classification of the countries in the world where increasing returns and long run growth emergence represent the last step a given country must reach for its transition toward market based economy to be successfully done.

The theory can be summarized according to figure 1

When $g < 1$ the society is traditional, when $g = 0$, the economy is underdeveloped, when $0 < g < 1$, the economy is in transition toward market based economy and finally when $g \geq 1$, there are increasing returns and long run growth

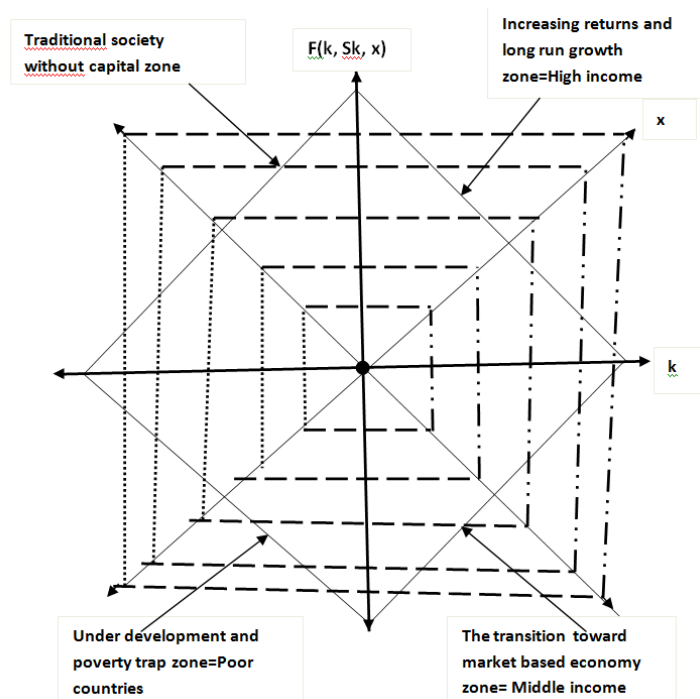


Figure 1: summary of the theory

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