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Introduction:

Traditional models (presented before 1980s) which claimed to explain the reasons and process of economic growth had rarely considered improvement in quality of technology (or innovation) as the main reason for economic growth. Most of the traditional models such as Harrod-Domar, Lewis etc focused on Capital (K) as the famous factor of production that individually suffered from the diminishing marginal productivity. In fact, the famous Neo-classical model of economic growth (Solow version) assumed that both traditional factors of production such as Labor (L) and Capital (K) go through decreasing returns to scale, which means by just applying more capital, or more labor alone, the economies would experience slower rather than higher rate of growth. Therefore in that model we thought the growth is basically coming from "outside factors" such as increased international trade, lower taxation or reduced regulation. This assertion also promoted the argument that growth is "exogenous" rather than "endogenous". The whole picture of endogenous growth was further drastically changed when Paul Romer (Nobel Prize winner of 2018) arrived on the horizon in 1990s to promote the argument that technological change as against mere Capital (K) can in fact be the prime driver of economic growth. This paper will analyze the traditional arguments of growth and compare them with what Paul Romer's contribution is to the growth dilemma. The present

paper is structured as follows: Section 1 surveys the neoclassical model that claims that growth is exogenous and Section 2 is used to make the main point that innovation, technological growth and entrepreneurship all contribute to economy in a serious way and the growth can be endogenous too. Section 3 points out the main features of this argument as applied to India's case in a limited sense of the term.

Section 1: Traditional Neoclassical Model of Economic Growth

In 1970s and 1980s a group of economists, called Neoclassical Economists, led by Nobel Prize winning Robert Solow started arguing that economic growth is better achieved by external factors such as freer international trade, fewer regulations, less administrative controls, lower taxation and fewer bottlenecks to the free markets. Focusing on their argument of open trade, in general, this was termed as the argument that believes economic growth is exogenous (caused by outside factors, rather than inside factors such as government interference in growth process, traditional growth contributors such as labor (L) and capital (K) and the aggressive policies). One of the main questions is why would they argue something like that?

In Paul Romer's words:

- We can share discoveries with others.
- There are incomprehensibly many discoveries yet to be found.

The economic jargon for this first point is the "non-rivalry of knowledge;" the jargon from math and computer science for the second point is "combinatorial explosion."

I've been pleasantly surprised about how well this article seems to have served its dual purpose. Non-economists have said that it helped them understand why unlimited growth is possible in a world with finite resources. Professional colleagues have been intrigued by the discussion of combinatorial explosion and its interaction with non-rivalry. Specialists and non-specialists have both latched onto the concept it points to of a meta-idea: an idea about how better to discover ideas. (see Romer (2018)).

Coming back to the Neoclassical model of growth and to summarize what was the main contribution of Solow led Neo-classical model of economic growth consider the following: If production GDP (Y) is based on the Cobb-Douglas Production function then the famous equation is as follows:

$$Y = A. \; K^{j}. \; L^{1-j}. \; e^{t} \quad \text{……………………………………………………}(1)$$

Where Y = GDP the growth indicator or total production

K = capital stock; notice that an increase in K will create more capital applied to the production process

L = Labor stock of the country; also notice that an increase in L will create more labor employed in the production process

A = constant inputs employed such as land

e = other inputs which give an exogenous shock to the production process including the freer international trade, lower taxes, lower regulation etc (popularly called Solow Residual)

j = degree of increase in output when higher employment of K is done. (Same applied to 1-j which is the degree of increase in GDP when higher labor is employed) The design of Cobb-Douglas production function requires that $0 < j < 1$.

Recognize now that increase in capital stock alone (K) will increase GDP, but ever so slowly. This is because j is smaller than one and increase in K will have diminishing returns as very nicely explained by the law of diminishing marginal returns. Since (1 – j) is smaller than one, same law of diminishing marginal returns will apply to labor employment as well. Therefore individually when K and L are employed in higher amounts, the diminishing returns will warrant us that increase in GDP will be slower and slower. Moreover, when both K and L are increased simultaneously, the increase in GDP has an equi-proportionate increase. This is the case of constant returns to scale. Therefore the conclusion is that the traditional factors of production K and L have the diminishing marginal returns when applied individually, and have the constant returns to scale when applied together. So, the best growth that K and L can bring about is the increase in their proportion (say for example, 2% increase in K and L simultaneously will increase GDP by only 2%)

Then the question of high growth can be solved not by traditional factors of production such as K and L but by non-traditional factors such as freer markets, lower regulation, lower taxes, less government interference etc. Therefore the growth was considered to be exogenous and “e” in our equation 1 is popularly termed as “Solow Residual”. Now add to the above argument the

contribution made by Paul Romer, who pointed out that one of the other things that can make growth possible is the infusion of technology and innovation. Other issues ensued too. Consider for an example, an attempt to give credibility to third factor of production (In the Equation 1 above) namely, human capital (H), Greg Mankiew, David Romer and David Weil (1992) argued that the value of j can be even smaller if contributions of other factors of production are recognized. For example, with third factor of production j can be 1/3. In any case, the traditional neoclassical model with two or three factors of production assumes a closed economy, and more importantly same level of technology.

Section 2: The "Idea of Ideas" and the Innovation as the Factor of Production

In Romer's model as discussed before, the technological change or innovation becomes the key factor of production. Increase in the application of innovating techniques can lead to increasing marginal productivity. In fact infusion of one idea in an equipment can pave a way for another idea and it keeps on building itself further. Consider the computers or the i-phones. There has been tremendous improvement in these equipment as more and more is being invented to aid its performance. Thus, new ideas can feed on themselves and the marginal productivity keeps on increasing. Chad Jones recently explained the idea of ideas very nicely as follows:

Here is the key insight: ideas – designs or blueprints for doing or making something – are different from nearly every other good in that they are *non-rival.* Standard goods in classical economics are rivalous – as more people drive on a highway or require the skills of a particular surgeon or use water for irrigation, there's less of those goods to go around. This rivalry

underlies the scarcity that is at the heart of most of economics and gives rise to the Fundamental Welfare Theorems of Economics.

Ideas, in contrast, are non-rival – as more and more people use the Pythagorean theorem or the Java programming language or even the design of the latest iPhone, there is not less and less of the idea to go around. Ideas are not depleted by use, and it is technologically feasible for any number of people to use an idea simultaneously once it has been invented. (see Jones 2018)

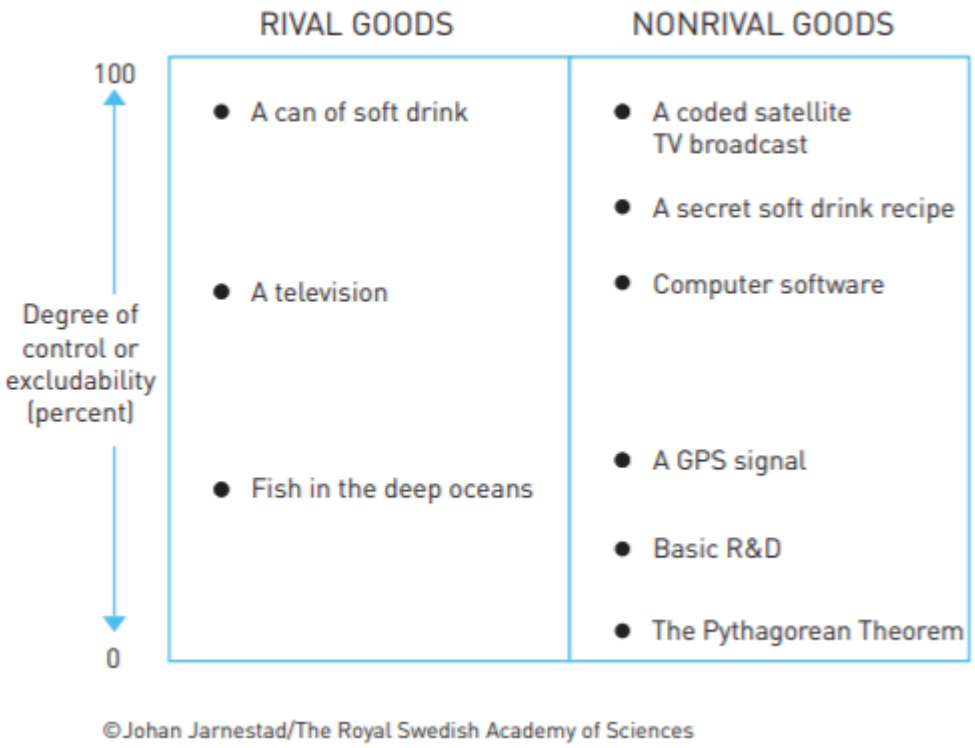
Or, better yet, see the following excerpt from Nobel lecture about the examples of non-rival nature of things:

A key insight was to develop the economics of ideas based on their non-rivalrous nature. In particular, an idea (or blueprint) can be utilized by many economic agents at once without impeding the possibility of potentially unbounded additional users. This endows ideas with a natural property to generate aggregate non decreasing returns to scale (constant rather than increasing to obtain balanced growth). At the same time, Romer noted that the non-rivalrous character of ideas would render investments for their creation unprofitable unless ideas are partially excludable, so that there is scope to regulate access by potential users.

For example, you could use encrypting technology or limited access platforms to charge user fees. Also, rules introduced by governments could limit imitation that left inventors unrewarded. Indeed, the function of intellectual property right (IPR) protections, such as patents, is to provide inventors with incentives to innovate and propel technological change.

Indeed, by exploring the determinants of incentives for economic agents to conduct R&D and generally make productivity-enhancing investments, one could study the role of institutional rules and policies in shaping the trajectory of productivity improvement that ultimately determines long-run prosperity as well as development through catch-up growth. Researchers have relied on the insights from EGT to study the impact of public policy and political economy factors shaping up how societies prosper or stagnate based on the nature of their institutions.

Romer's work opened up the possibility of more encompassing approaches, including cross-fertilization of ideas between fields, to the study of catch-up growth and international development. This research has included the study of why poverty traps can emerge, how growth take-offs happen, what determines whether a country's growth trajectory converges or diverges relative to other economies, how are "convergence clubs" shaped, and so on. Not all of these phenomena can be characterized in the context of traditional neoclassical or exogenous growth models relying solely on analysis of markets or economic policies. (See Maurice Kugler, Berkeley Economics, October 17, 2018)



The above table is useful to make the difference between rival goods and non-rival goods. Clearly, the goods on the right side have increasing marginal returns as higher application of these can increase the output on a continuous basis. In the next section we shall discuss how these ideas were useful to explain some of the technological revolution in India especially in 1990s to 2010s.

India's Experience of Technology Growth in Recent Times

In case of India, the impetus given by growth in technology in 1980s and 1990s has helped the economy grow very fast but that pace of infusion of more technological innovation has not continued with the same speed as before. Nonetheless the tremendous economic growth fueled by newly found love for freer international trade and technological change has made miracle in Indian economy. As D. Arun Kumar puts it "As a result of these sustained efforts through various funding schemes, significant progress has been made in certain technology sectors, particularly in strategic industries such as space sciences, nuclear technology, defense technology, aviation and information technology. India's defense research laboratories have successfully developed light combat aircraft, ballistic missiles, satellite communications and several other technologies of strategic importance. Looking at some of the examples mentioned above we notice that, most of these developments are in highly specialized and niche areas, with long gestation periods and far removed from scope for immediate application for direct public domain, but have been internationally acclaimed. These fields are highly capital intensive and depend on continuous government support. Another important development has been that of Information Technology (IT hereafter) and IT enabled services sectors in India, recognized globally as highly competitive sectors. The IT-ITES industry has two major components: IT Services and business process outsourcing (BPO). The growth in the service

sector in India has been led by the IT-ITES sector, contributing substantially to the increase in Gross Domestic Product (GDP), employment, and exports. The sector has increased its contribution to India's GDP from 1.2% in Financial Year 1998 to 7.1% in Financial Year 2011". (See D. Arun Kumar in the reference list)

"However, one of the unwanted side effects of the technological growth is that too much growth in technology distributes the newly created income unequally. In the recent years, rising income inequality and jobless growth have been subjects of discussion and debate. A February 2018 New World Wealth report ('Global Wealth Migration Review', goo.gl/R9x5qX) claimed that India is the second-most 'unequal' country in the world, with millionaires controlling 54% of the wealth. In Japan, the most equal country, millionaires control only 22% of national wealth. India's average national income is $1,800 (about Rs 132,300) a year. However, 80% of Indians earn less than the average. Only 6% Indians earn more than Rs 240,000 a year. To get into the top 1% bracket, one needs to make just over $20,000 (Rs 1,469,600) a year. And this top 1% is generating 73% of the wealth." (see Banik in the Reference List)

With a widening income inequality, it may not be possible to sustain growth that India is witnessing at present. So what can be done? First of all, one needs to understand that the real culprit of unequal income is not the growth in technology. The real culprits are the lagging other sectors that do not grow as fast as the advancing technology sector. Therefore more reforms are needed for creating higher entrepreneurship, making more innovation, educational progress, designing efficient legal system and labor laws, high morale in productive activities and improved social attitudes leading to the total factor productivity. Real sustainable growth

is a result of these characteristics of an economy. Therefore all segments of India need to pay attention to achieving higher growth in these aspects for a long period ahead. Unfortunately, right now it does not look like the policy makers of the economy in general are making progress in that direction. In fact, some policy steps such as de-monetization and newly adopted Goods and Services Tax (GST) have proven to be badly implemented policy steps that have not shown very many positive effects

Thus India's future, just like future of any aspiring economy is dictated by how much growth the technology makes via innovation and entrepreneurship, and how much growth all sectors contribute. With the given complex nature of Indian polity and society, this is supposed to be a big challenge, unless all involved sectors as well as individuals show tremendous understanding of the problem and willingness to dissolve their differences whether the disagreements are economic, political or religious. Economic growth on a long-term basis is a serious (albeit grand) achievement which does not come along without contributions by even a small part of this complex economic machine. Despite the efforts of policy makers, big challenges have big, complex solutions. In the year 2020 however, it appears that politicians are bogged down more by the other things than economic. For example the Citizenship Amendment Act (CAA) and construction of Ram temple and similar issue have taken a priority over the urgently needed economic changes. The start of general election year has made political issues of greater importance than the economic restructure. Thus when economic reforms are needed in labor laws, stronger infra-structure in terms of roads and transportation, legal system revamping, labor laws revision policy makers are in a mood to address more political issues. This may not lead to another round of economic miracle, in fact this make even lead to slower economic

growth. Only future would tell if the private sector responds favorably or not to lead another round of economic expansion for the Indian economy.

Bibliography and References:

1) Banik, Nilanjan, "Times of India and Economic Times Article", October 22, 2018. //economictimes.indiatimes.com/articleshow/66307882.cms?from=mdr&utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.

   Berkeley Economics, 2018

2) D. Arun Kumar, 147.153.169.153 on Wed, 11 Dec 2019 20:45:26 UTC
   All use subject to https://about.jstor.org/terms

3) Jones, Chad, "New ideas about new ideas: Paul Romer, Nobel laureate"
   VOX, CEPR Policy Portal, Stanford University, 12 October 2018

4) Mankiew, Greg, Romer, David and Weil, David, "Empirics of Economic Growth", Quarterly Journal of Economics, pp. 407-438, 1992.

5) Romer, Paul M. "The Origins of Endogenous Growth", Journal of Economic Perspectives, Volume 8, Number 1, Winter 1994, pp. 3-22.

6) Romer, Paul M (1986), 'Increasing Returns and Long-Run Growth', *Journal of Political Economy* 94: 1002-37.

7) Romer, Paul M (1990), 'Endogenous Technological Change', *Journal of Political Economy* 98(5): S71-102.

8) Solow, Robert M (1956), 'A Contribution to the Theory of Economic Growth', *Quarterly Journal of Economics* 70(1): 65-94.