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India's Advancement in Agriculture, Technology, and Management—What Next, and Why?

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Abstract

In the recent years, the economic stagnation of India has raised grave concern among Indian leaders. They have identified the causes and are taking remedial measures accordingly. However, we think, these curative actions would serve *ad hoc*, and the Indian government needs to take steps towards the sustainable growth. Many people in leadership have already pointed out that India needs to focus on innovation for its further growth. However, their argument often lacks the justification why innovation is an urgent need for India. India is often compared with China. Some people argue as China has focused on research, India should compete. The statement—other countries are investing in innovation so India should—is neither convincing nor helpful. Therefore, in this paper, we would illustrate the Solow Growth Model in the Indian context, which would provide some convincing insights that innovation is the next required measure for the sustainable growth of India.

Keywords

Real GDP, Innovation, Research and Development, Economic Growth, Solow Growth Model, India

1. Introduction

On August 28, 2013, the rupee hit an all-time low of 68.70 against US dollar. The rupee has lost almost 20% of its value in 2013 and is one of the world's worst-performing currencies [1]. Many causes were attributed to this economic turmoil, such as the Indian export-import account deficit, jump in oil prices in the wake of the fears of a military action against Syria (India imports almost 80% of its oil), a slowdown in India's growth rate (hit its

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lowest level in a decade) [1]-[5]. The Indian government took several corrective actions to stem the rupee's decline. For instance, the Indian government-imposed restrictions on the amount of money that companies and individuals can send out of the country, increased duty on gold imports (one of the biggest contributors to India's current account deficit), increased the interest rate for the banks which wished to borrow money and put a daily limit, and so forth [1]-[5]. Nevertheless, despite those steps, the rupee continued to slide. The measures taken were piecemeal, *ad hoc*, and non-intriguing [1] [2].

We argue all other causes or corrective actions for the financial turmoil as *ad hoc*, except the decline in real Gross Domestic Product (GDP). Planning Commission, Government of India reported the real Gross Domestic Product (GDP) growth rate of 9.32% in 2010-2011 and 6.21 in 2011-2012, whereas only 4.96% in the year 2012-2013 [6]. The continuous decline of real GDP is a sufficient clue for Indian government for getting hold of its corrective actions. Since India's independence in 1947, it took three key measures: 1) agriculture—the green revolution; 2) technology—information technology revolution; 3) management—liberalization, privatization, and globalization. Undoubtedly, these measures kept fueling Indian economic growth; however, now the time has come to think towards the fourth corrective actions, which is innovation. Many developed or developing countries, such as USA, UK, Canada, Australia, and nowadays China have put tremendous efforts and funds for innovation.

Many pundits from India always advocate investing in innovation, but they throw a little light why investing in innovation is needed for future growth of India. At times, pundits say that the India nation spends only 0.9% of GDP on innovation keeping us behind compared to other nations [7]. People in leadership often state that India is falling behind in the race to become a global leader in science and technology; therefore, India should invest more in research [7]. India is often compared with China that, as China is focused on research, India should compete [8] [9]. We argue that the mere statement or comparison, other countries are investing in innovation so India should, is neither convincing nor helpful [8] [10]-[12]. A concrete argument is needed to convince the decision-makers. In this paper, first, we have reviewed past Indian reforms in agriculture, industrial, technology, and management. Second, we would explain the Solow growth model in the Indian context, which would provide insights that innovation is the next required measure for the sustainable development and growth of India [13].

2. India's Past—Agriculture, Technology, and Management

India's per capita income increased by only about 1% annualized pace, for the three decades after Independence. India's agriculture sector revolutionized (Green Revolution) during these three decades. The use of high-yielding varieties of seeds, increased use of fertilizers, and improved irrigation facilities collectively bettered the condition of agriculture by increasing crop productivity, improving crop patterns, and strengthening forward and backward linkages between agriculture and industry. This Green Revolution was not all of sudden; instead, it involved focused efforts of Indian (earlier Imperial) Council of Agricultural Research. To date, India has highly complex agricultural research organizations in the world. Likewise, India underwent an economic reform in 1980 and opened the market to the world through economic liberalization. India started providing a free-market economy since 1991 [14]. The government regulation was relaxed in the service sectors. Consequently, communications, insurance, asset management, and information technology output grew rapidly with very high exports of IT enabled services. In sectors, such as telecommunications, aviation, logistics, the privatization proved to be highly effective and efficient; and overall growth was beyond the expectation. Some Indian states had a relatively liberal regulatory environment; therefore, they showed better economic performance than the restrictive states [14]. As can be seen in **Figure 1**, the real GDP growth has declined since 2010.

Now, the next questions arise if the real GDP growth rate will keep declining like this, become stagnant after declining to a particular level, or go upward after some time. Another related issue arises regarding the steps that India needs to take for its sustainable growth rate. Therefore, a fundamental understanding of the growth model is required, including identification of potential factors that might affect the growth. In the following sections, we explain the growth model, including the identification of growth factors.

3. What Next for India and Why

As mentioned in the Introduction section, many people have argued to promote innovation in India. We concur with the argument and wish to supplement their argument with the justification why boosting innovation should

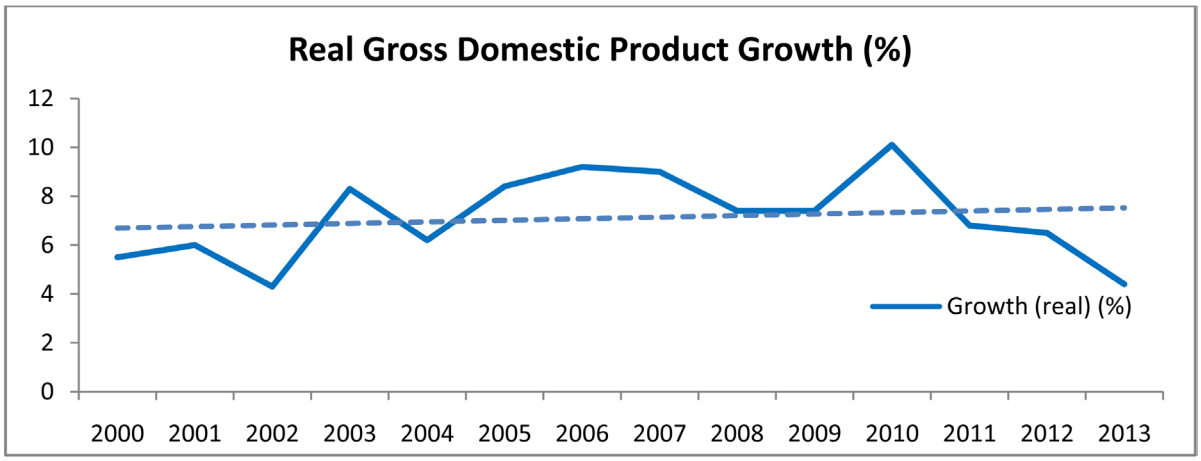

Figure 1. Real gross domestic product growth (%) obtained from Index Mundi http://www.indexmundi.com/.

be a focus for India. We would illustrate our argument by discussing growth models, India's current situation, and direction required in the future. Robert Solow (American economist, Massachusetts Institute of Technology, Nobel Prize 1990) proposed a growth model by applying the production function model [13] [15]-[18]. A production function is a mathematical equation or graph that shows the relationship between physical inputs and physical outputs for a business.

$$Q = AK^a L^b \tag{1}$$

where A is multifactor productivity, K is capital, L is labor, Q is output, a and b are less than one, and $a + b = 1$. According to Solow's model, any increase in Q could come from one of three sources. An increase in Labor L would imply a reduction in Q/L or output per worker due to diminishing returns to scale. An increase in capital K would increase both, output, and Q/L. An increase inmultifactor productivity A would increase Q/L or output per worker.Defining $q = Q/\mathrm{L}$ and $k = K/L$, that is, letting small letters equal per capita variables, we have

$$q = Ak^a \tag{2}$$

We will examine 1) how the model $q = Ak^a$ works when growth comes through capital accumulation, and 2) how it works when growth is due to innovation. First, let us assume that:

- Saving function: let us assume we accumulate capital by saving 25%, that is,

$$s = 0.25q \tag{3}$$

- Equilibrium condition: if the only source of growth is capital accumulation, the economy will reach an equilibrium or steady state.

$$s = k \tag{4}$$

- If multifactor productivity $A = 100$ and $a = 0.5$, then

$$q = 100k^{0.5} \tag{5}$$

- If multifactor productivity $A = 200$ and $a = 0.5$, then

$$q = 200k^{0.5} \tag{6}$$

- If multifactor productivity $A = 300$ and $a = 0.5$, then

$$q = 300k^{0.5} \tag{7}$$

We plotted data obtained from **Tables 1-3**, as shown in **Figure 2**.

4. Discussion and Conclusion

Figure 2 indicates two key points: 1) growth due to only capital accumulation reaches a steady state; 2) boosting

Table 1. Capital, output, saving, and change in output.

Capital (k)	Output ($q_i = 100\ k^{0.5}$; $i = 1, 2, 3, \cdots$)	Savings ($s = 0.25q$)	Change in output ($cq = q_{i+1} - q_i$)
100	1000	250	-
250	1581	395	581
395	1988	497	407
497	2229	557	241
557	2361	590	131
590	2429	607	69
607	2464	616	35
616	2482	621	18
621	2491	623	9
623	2496	624	4
624	2498	624	2
624	2499	625	1
625	2499	625	1
625	2500	625	0

Table 2. Capital, output, saving, and change in output.

Capital (k)	Output ($q_i = 200\ k^{0.5}$; $i = 1, 2, 3, \cdots$)	Savings ($s = 0.25q$)	Change in output ($cq = q_{i+1} - q_i$)
625	5000	1250	-
1250	7071	1768	2071
1768	8409	2102	1338
2102	9170	2292	761
2292	9576	2394	406
2394	9786	2446	210
2446	9892	2473	107
2473	9946	2486	54
2486	9973	2493	27
2493	9986	2497	14
2497	9993	2498	7
2498	9997	2499	3
2499	9998	2500	2
2500	9999	2500	1
2500	10,000	2500	0

multifactor productivity factor A is required to overcome the steady state. As can be seen in **Figure 1**, the real GDP growth of India has reached its steady state. Current policies of India emphasize capital accumulation, whereas India needs an increase in multifactor productivity factor A (Equation (2)). An increase in A may come from innovation in methods of production, such as improved technology, organization, transportation, infrastructure, and so forth. After the independence of India, better technology and management in agriculture served as the multifactor productivity factor A and provided a boost up. Similarly, in 1980 and 1990, India got another economic boost up due to improvement in technology (Information and Communication Technology) and

Table 3. Capital, output, saving, and change in output.

Capital (k)	Output ($q_i = 300\ k^{0.5}$; $i = 1, 2, 3, \cdots$)	Savings ($s = 0.25q$)	Change in output ($cq = q_{i+1} - q_i$)
2500	15,000	3750	-
3750	18,371	4593	3371
4593	20,331	5083	1960
5083	21,388	5347	1057
5347	21,937	5484	549
5484	22,217	5554	280
5554	22,358	5589	141
5589	22,429	5607	71
5607	22,464	5616	36
5616	22,482	5621	18
5621	22,491	5623	9
5623	22,496	5624	4
5624	22,498	5624	2
5624	22,499	5625	1
5625	22,499	5625	1
5625	22,500	5625	0

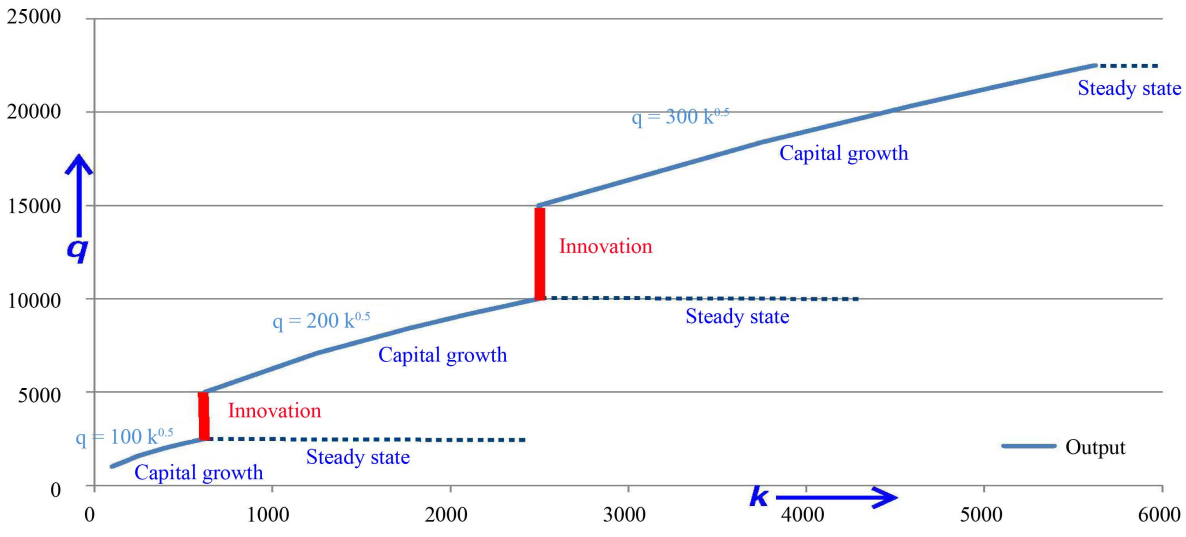

Figure 2. Illustration that represents equations $q_i = 100\ k^{0.5}$; $i = 1, 2, 3, \cdots$; $q_i = 200\ k^{0.5}$; $i = 1, 2, 3, \cdots$; $q_i = 300\ k^{0.5}$; $i = 1, 2, 3, \cdots$ and drawn using arbitrary values of "k".

management policies (Globalization, Privatization, and Liberalization). Again, the time has come to focus on boosting multifactor productivity factor A, which is nothing but innovation. Growth by capital accumulation has a limit, whereas economic growth by innovation is limitless.

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