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Trends and Dynamics of Economic Growth: Empirical Analysis of India and Singapore

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Abstract: This paper investigates the multifaceted dynamics of economic growth in India and Singapore over a span of 50 years, utilizing the Solow and Romer models to decompose growth into its core components: total factor productivity (TFP), capital, and labor. Through a detailed growth accounting methodology, we analyze how these elements contribute distinctly to the GDP trajectories of these two contrasting economies. Our analysis reveals that while both labor expansion and capital accumulation play pivotal roles in short-term growth, it is the enhancement of TFP that emerges as the crucial determinant of sustainable economic progress over the long term. In Singapore, a developed economy characterized by its status as one of the Asian Tigers, TFP and labor productivity have been the primary drivers of its more consistent and long-term growth. Conversely, India's growth has been more influenced by capital accumulation, particularly following economic liberalizations that spurred foreign investment and industrial diversification. The findings underscore the importance of TFP growth in both developing and mature economies, highlighting its significance in policy formulation aimed at stimulating economic development. This study not only charts a historical analysis of growth patterns but also aligns them with theoretical underpinnings that suggest pathways for future economic strategies in similar emerging and developed markets.

Keywords: TFP Growth, Solow Growth Model, Romer Model, Growth Accounting.

1. Introduction

As one of the most crucial indicators of a country's well-being, economic growth influences individuals' standards of living while also opening up more opportunities for investment. When looking at economic growth in India and Singapore in the last 50 years, based on the trend of real GDP growth, and the contribution of each input using the growth accounting model, we find that most of India's economic growth is due to the accumulation of capital, or to the increased utilization of existing resources, which can be better described by the Solow model. Singapore, on the other hand, as one of the Asian Tigers, has experienced more long-term economic growth due to increases in labor productivity and TFP. This paper is organized as follows: Section 2 examines the conceptual relationship between labor productivity and for the two countries under study; Section 3 illustrates the trend of real GDP and real GDP per capita by combining the historical policies and theoretical

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models; Section 4 describes changes in factors affecting economic growth in different subperiods and concludes that TFP has a significant impact on long-term economic development.

2. Total Factor Productivity and Labor Productivity

2.1. Methodology and Modelling Framework

Labor productivity, as a single-factor productivity, is interpreted as the average total output produced per unit of labor input. Despite its comparability and ease of calculation, it only offers a partial evaluation of productivity and also captures the combined effect of several factors, which might cause interpretation issue [1]. TFP, by contrast, captures the overall increased input efficiency as well as technology improvements as opposed to increasing input utilization per se.

The Solow formulation emphasizes capital accumulation and concludes that although countries' capital stock may cause GDP to grow at different rates in the short run, it will eventually reach a steady state in the long run [2]. On the other hand, the Romer Model emphasizes the role of endogenous technology change in economic growth, and increasing idea stock will eventually lead to an positive economic growth in the long run [3]. Both models theoretically indicate a positive relationship between TFP and labor productivity. TFP is a key determinant of labor productivity as technological advancements increase production efficiency, enabling more output with the same input. Conversely, higher labor productivity can promote technology adoption and diffusion, leading to TFP growth. Productive workers are better equipped to utilize new technologies, further enhancing productivity and TFP.

The starting point for estimating TFP and labor productivity is to construct a production function showing how inputs are combined to produce the total output. The Cobb-Douglas function is used as follows:

$$Y = AK^{\alpha}(HL)^{1-\alpha} \tag{1}$$

where Y is the aggregate output, K is the total capital stock, A is Total Factor Productivity, and α measures the importance of labor in output. In this paper, we consider both human capital(H) and labor(L) as two distinct inputs with the same output elasticity for simplicity. By using the production function and the data of PWT10.0, TFP is calculated as a residual in a growth accounting framework, after adjusting the contribution of fiscal capital, labor and human capital [4]. The time trend graph with various output elasticity α is shown (Figure 1):

$$A = \frac{Y}{K^{\alpha}(HL)^{1-\alpha}} \tag{2}$$

Though we assume a constant return to scale for simplicity, in many developing countries, it seems implausible to use these assumptions for calculation in reality. Furthermore, there are other difficulties in measuring TFP, such as estimating parameters, data used, and when TFP growth doesn't reflect technical change. These are the reasons why our estimation might be different from the official statistics [5].

To calculate labor productivity over 60 years, we compute the formula $\frac{Y}{L}$. The Figure 2 illustrates a trend time path of labor productivity of two countries, where the yellow line shows the labor productivity in Singapore and the blue flatter line shows the labor productivity in India.

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Figure 1: Total Factor Productivity of two countries, 1950-2020.

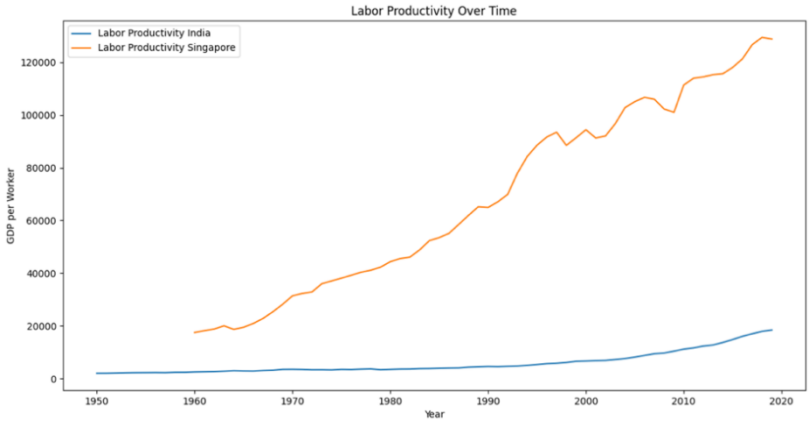

Figure 2: Labor productivity of two countries, 1950-2020.

2.2. Empirical Analysis on India and Singapore

From 1950 to 2020, both TFP and labor productivity in India and Singapore showed upward trends. India's TFP remained below 0.5 until the 1990s, rising post-economic reforms to nearly 1 by 2020, with labor productivity following a similar pattern. Singapore's TFP and labor productivity grew steadily until the 1990s, after which labor productivity continued to rise despite volatility. However, TFP in Singapore has shown stagnation since the 1990s.

One of the reasons for the current trend could be the massive inflow of unskilled immigrants from 2004 onwards which led to productivity stagnation. However, economists suggest that the country's over-reliance on migrant labor has affected incentives to invest, which may be the deep and systematic cause of the country's poor performance when compared to its own trading partners [6]. Overall, Singapore, as one of the Asian Tigers, has significantly higher average values in both labor productivity and TFP, which confirms the conclusion of Klenow and Rodriguez-Clare : The main cause of cross-country variations in economic growth rates is variations in productivity [7].

When evaluating the relationship between TFP and labor productivity, based on several existing literature, we concluded that there are many other macroeconomic variables that have an impact on TFP.

Human capital: Human capital refers to the knowledge and academic skills of employed workers, which has a significant positive impact on TFP.

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Trade openness: Miller and Upadhyay proposed that though human capital and trade policies are positively related to TFP, in the case of developing countries, human capital can affect TFP only after interacting with trade openness [8].

Unemployment: After India's liberalization of trade policies during the reform in the 1990s, unemployment has a positive relationship with TFP. This suggests that during the period with a high unemployment rate, present workers tend to be more productive due to the threat of losing a job, therefore workers motivate employees to put in their best effort, which eventually may boost productivity [9].

Efficient allocation of resources: Hsieh and Klenow examined the productivity change adjusted for the misallocation of resources at the firm level [10]. Setting aside the Romer model's assumptions and endogenous technological growth, they discover that India's TFP will increase by 30–60% if its labor and capital allocations are in line with those of the United States.

3. Real GDP and GDP per Capita

One way to evaluate India's economic growth is to look at its real GDP trend time path from 1960 to 2020, which illustrates an exponential rise in GDP during that time. To make the image more accurately depicts the percentage growth over time, we adopt the form of real GDP after taking natural log, where the convex quadratic trend of the change in the real GDP in the ln graph with an increasing slope represents that the rate of the change goes up along the time (Figure 3).

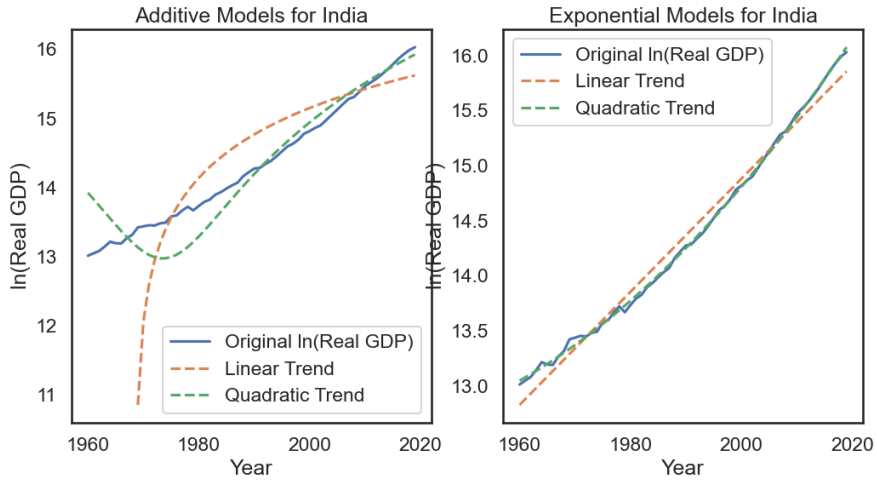

Figure 3: Real GDP trends of India after taking natural log.

The Solow model could be used to explain the increase in India's output, as there was a continuous rise in population. The Romer model of endogenous technological change could also illustrate this continuously positive growth, as indicated by the shift in the Indian government's policies, which attempted to emulate public education and promote labor participation in the R&D sector. A similar pattern, shown by a convex curve that indicates an increasing rate of change, can be seen in the real GDP per capita development in India (Figure 4).

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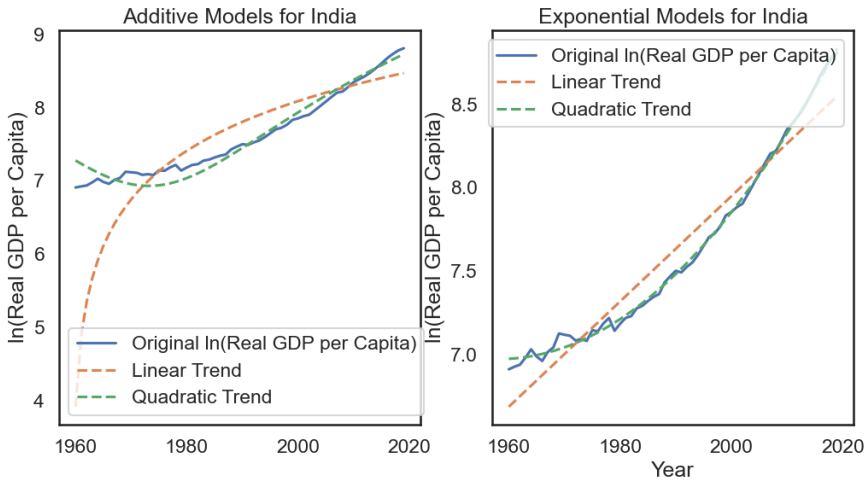

Figure 4: Real GDP per Capita of India.

Before 1990, India's GDP grew slowly but fluctuated a lot, due to the pressure of international debt and the balance of payments deficit highly restricted India's development. However, India has experienced a sharper increase in its real GDP since 1991 which is impacted by the economic reforms, also known as "Liberalization, Privatization, and Globalization" (LPG) reforms [11]. The Romer formulation could help explain that India's reforms helped improve investor confidence and productivity as well as efficiency in several sectors due to competition and innovation, which in turn led to greater output.

The real GDP per capita in Singapore over that period is much greater than that in India. The reason why Singapore was in a more favorable position is due to its affiliation with the British Empire as a former colony [12]. However, even though the real GDP per capita in Singapore is far away ahead of India, the rate of the percentage increase in Singapore is worse than that in India since Singapore's trendlines of the change in the real GDP per capita after taking logs show a concave shape whereas India has two convex trendlines (Figure 5).

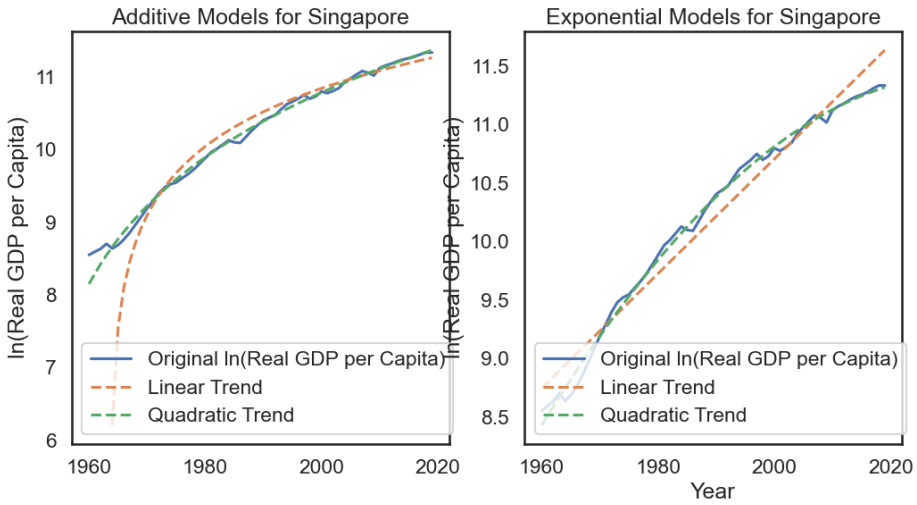

Figure 5: Real GDP per Capita of Sigapore.

When looking at the ln graphs of Singapore, we can see that, from the 1960s to 1970s, Singapore experienced rapid economic growth. This was driven by its industrialization and export-oriented policy, supported by the Hechsher-Ohlin trade theory [13]. After that, even though Singapore's real

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GDP growth rate fluctuated a bit, most of the time, the curve kept being above the trend line, until 2008. The clear drop in Singapore's real GDP growth rate shown in the ln graph was mainly caused by the global financial crisis. Although it recovered relatively quickly after that time, it still lasted below the linear trend line.

Even though the overall trends of the real GDP growth among both countries look similar, the development of Singapore's economy was not as smooth as that of India, as reflected by those kinks in the curve. Since 1965, Singapore has experienced five major external shocks, which are the 1973-5 oil crisis, the 1985 global trade slowdown, the 1997-8 Asian financial crisis, and the 2008-9 global economic turmoil respectively, which could be observed on the diagram where there are clear drops in GDP in those corresponding periods [14]. However, the resilience of Singapore's economy is remarkable, and it can recover robustly from each shock.

4. Contribution to Economic Growth

4.1. Growth Accounting Framework

Growth accounting is a quantitative tool for analyzing how specific factors contribute to economic growth. It gives a better understanding of the economic growth of Singapore and India. To build up the framework, we first start with the Cobb-Douglas production function:

$$Y_t = A_t {K_t}^{\alpha} (H_t L_t)^{1-\alpha} \tag{1}$$

After taking log of the production function, we get:

$$log(Y_t) = log(A_t) + \alpha log(K_t) + (1-\alpha) log(H_t) + (1-\alpha) log(L_t) \tag{2}$$

Then repeating this for t+1 time:

$$log(Y_{t+1}) = log(A_{t+1}) + \alpha log(K_{t+1}) + (1-\alpha) log(H_{t+1}) + (1-\alpha) log(L_{t+1}) \tag{3}$$

By approximating the difference:

$$\%\Delta Y_t = \%\Delta A_t + \alpha \%\Delta K_t + (1-\alpha)\%\Delta H_t + (1-\alpha)\%\Delta L_t \tag{4}$$

The growth accounting is composed of three main components, where ΔY is the GDP growth rate, ΔA is the growth rate of TFP, ΔK is the growth rate of capital, ΔH represents the human capital growth rate and ΔL is the growth rate of labor.

4.2. Empirical Analysis of India and Singapore

Figure 6 depicting GDP growth contributions from 1980 to 2020 under alpha=0.3 shows a generally stable trend with notable fluctuations for Singapore in 1985, 1998, 2001, and 2009. In 1985, Singapore's TFP rose by 2%, while capital and labor contributions fell by 4% and 3%, respectively. Similar situation happened again in 1998 and 2001. The year 2009 marked a substantial increase with over 20% in labor contribution and 10% in capital contribution, against an 18% decrease in TFP contribution, indicating a period of increasing labor and capital efficiency. The spike in labor contribution can be explained by the data provided by the migration policy institute. Despite the increasing share of PRs among the resident population, which itself rose from 8.8 percent of the total population in 2000 to 14.3 percent in 2010 [15].

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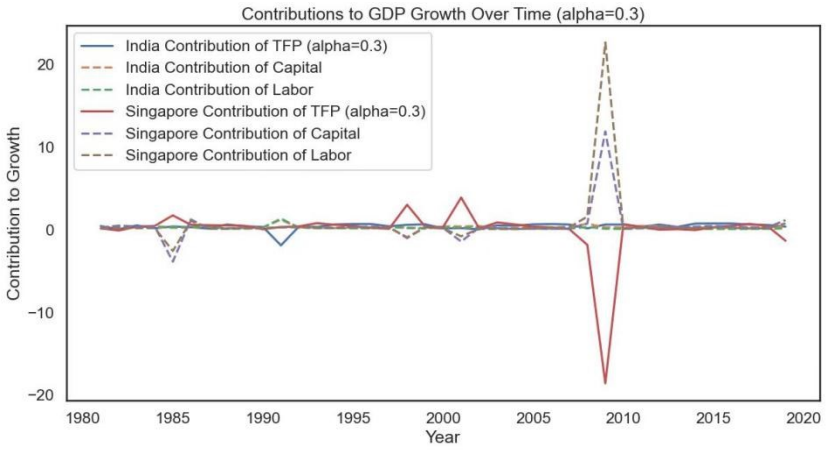

Figure 6: Contribution of Each Input to GDP Growth

For India, TFP and capital contributions mostly varied within a narrow margin of 0.5%, except in 1991 when the Indian economy underwent a significant economic and political transformation. They have transformed the way India as an economy works and opened the country up to the world for trade and commerce.

In the 1990s, Singapore made significant progress in technological innovation and manufacture. For example, electronics manufacturing, particularly the production of semiconductors and electronic components is becoming the top in the market. Additionally, due to Singapore's small population base and chronically low fertility rate, the government imposed a lot of policies to improve the skills and education of its workforce and implements immigration policies to boost labor force growth, which aimed to attract labor from all over the world to help improve academic research and technology levels. But at the same time, the flood of unskilled immigrants also decreased labor productivity, which is what caused labor input to negatively affect economic growth in the 1990s [16].

In 1991, India faced a severe economic crisis resulting from a balance of payment deficit. To boost the economy, the government dismantled the License Raj, a system that required businesses to obtain licenses for various activities. Some believed that the Licence Raj was obstructing economic progress and keeping the Indian economy from achieving its full potential. They argued that extensive government intervention was suppressing economic activity and hindering the economy's growth and development [17]. This move aimed to promote a more open and competitive business environment. Meanwhile, as for the information technology sector, India experienced rapid growth; the scale of India's IT and ITeS industry grew from US$100 million in 1990 to US$1 billion in 1996, which changed the course of development of this country forever. Agricultural industry is also very important for India economy. After the 1991 liberalization, the economic reforms had a profound impact on Indian agriculture, affecting production patterns, market integration, and the overall performance of the industry. According to the Solow model, the increase in capital investment in IT and agriculture industry will make a catch-up growth for India.

In conclusion, India has emphasized capital accumulation as a cornerstone of its economic development strategy, while Singapore has focused more on TFP growth. Both capital accumulation and TFP growth are important for economic development, but their relative importance can vary depending on the country's stage of development. For developing country like India, capital accumulation is in the first place in the early stages of development. When the economy becomes mature, the returns on additional capital investments tend to diminish, and then the focus should shifts towards enhancing TFP. For developed country like Singapore, TFP growth is more crucial because it already reach high level of capital stock, TFP will help to reach higher production potential.

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5. Conclusion

This paper analyzes the growth trends, dynamics and possible relationships of real GDP, TFP and labor productivity in India and Singapore over the period 1960-2020, and also demonstrates the different factors influencing the economic growth in different periods with the growth accounting method. Based on the impact of changes in inputs on GDP brought about by the past policies and historical background of the two countries, we analyze that although changes in capital accumulation and population have been a long-standing policy for developing countries like India, the combination of Romer's theory and Singapore's past performance suggests that an increase in TFP is the main factor that can lead to higher and more stable economic growth.

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