Sri Lanka's Sources of Growth: The Application of Primal and Dual Total Factor Productivity Growth Accounting Approaches[*†]

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Abstract

Sri Lanka's high GDP growth performance since the opening of its economy in 1977 prompts the question of what have been the driving forces of its growth. Hence, this study aims to identify the sources of economic growth in Sri Lanka during 1980-2016 by calculating its Total Factor Productivity Growth (TFPG) using both Primal and Dual Growth Accounting Frameworks. This study is the first attempt in adopting the dual approach for Sri Lanka's data. Hence, it identifies the underlying reasons for the discrepancies in TFPG estimates between the two approaches. It also compares Sri Lanka's TFPG results with those of selected South and East Asian economies. Despite the limitations of growth accounting framework, the results show that the average annual primal TFPG for 1980-2016 is 2.3 percent, making up 45 percent of the 5.1 percent growth of total output. Alternatively, the corresponding dual TFPG is 3.6 percent. The results also show that both TFPG estimates follow a similar pattern. The higher dual TFPG is likely caused by market imperfections and government monopolies in Sri Lanka's economy. On the contrary, the lower primal TFPG is likely caused by inadequacies in estimating national accounts and an overestimation of the capital stock. Interestingly, Sri Lanka's TFPG estimates under both methods are higher than those in South and East Asian economies, except in Singapore and China. This study concludes that, Sri Lanka's growth has been driven by both productivity and capital accumulation. These findings will help Sri Lanka to formulate its future growth policies.

Keywords: Dual Approach, Growth Accounting, Primal Approach, Sources of Growth, Sri Lanka, Total Factor Productivity

JEL Classification Codes: D24, E22, E23, F43, O47

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1. Introduction

Sri Lanka has achieved a remarkable revival of economic growth after embarking on a series of economic reforms since early 1980s following the opening of the economy in late 1977. Its annual average real output grew at a rate of 4.7 percent during 1980 -1999 and, growth was even higher at 5.5 percent for the period 2000-2016 (World Bank, 2019). This is an impressive performance compared with the country's low economic growth during the first three decades following its independence in 1948 though Sri Lanka happened to be one of Asia's most promising economies (Kelegama, 2000).[3] Further, among its South Asian peers, Sri Lanka has recorded a high level of GDP per capita. This high performance prompts the question of what have been the driving forces of Sri Lanka's economic growth since 1980. It is also of relevance for the prospect of Sri Lanka's long-run economic growth. The related growth literature has identified two main sources of economic growth, namely, factor accumulation and productivity growth (Easterly & Levine, 2002; Iwata, Khan, & Murao, 2003; Klenow & Rodríguez-Clare, 1997; Pack & Page, 1994; Park, 2010; Sarel, 1997; Solow; 1956 Young, 1994a, 1994b). In this setting, this paper aims to identify the sources of economic growth in Sri Lanka in comparison to selected South and East Asian economies by calculating Total Factor Productivity Growth (TFPG) under both primal and dual growth accounting frameworks.

The conventional approach to decomposing the sources of economic growth of a country is the primal growth accounting framework which is closely related to the Solow growth model (Solow, 1957). The primal approach, also known as the production function approach, builds its growth accounting application on the theoretical construct of a production function. It consists of a set of calculations that decomposes output growth into growths of different inputs, mainly, growth arising from capital and labour inputs, and that from the residual, TFPG. The limitations of primal approach concern the need for making accurate measures of output, capital and labour quantities which may be difficult to obtain and the

[3] During the post-independence period until 1977, Sri Lanka had adopted a strictly closed economy policy dictated by a stringent system of exchange, import and export controls favouring import substitution (Kelegama, 2000). In late 1977, the country adopted an open economy policy with a flexible exchange rate system coupled with dismantling of most of the exchange and import controls (Lakshman, 1997; Rajapatirana, 1988). The economy underwent a structural transformation after it was opened from an agriculture-based economy to a manufacture and services-based economy (Athukorala, 2017). In 2010, the country officially progressed from a low-income country to a lower middle-income country (Central Bank of Sri Lanka, 2010) and then to an upper middle-income country in 2019 (World Bank, 2019).

assumptions in the model itself that assume full utilization of inputs, market perfections and constant returns to scale (CRS) which are hardly prevalent in a real market situation.

Alternatively, under the dual approach TFPG is calculated as the weighted growths of factor prices using the application of the national income identity assuming that there are no market imperfections. The advantage of the dual approach is that data on rental price of capital and wages are used instead of data on capital and labour stocks. According to the duality theory, dual and primal approaches should produce the same TFPG estimates (Jorgenson & Griliches, 1967). However, in reality they rarely give the same results as measurement errors and invalid assumptions distort their results. As each approach has its own strengths and weaknesses, it is useful to adopt both approaches and check for consistency, and more importantly identify the sources of their discrepancies. In the case of Sri Lanka, though previous studies have calculated the TFPG by using the primal approach (Duma, 2007; Fernandez, Erik, Davies, & Kock, 2005), there has not been an attempt at calculating TFPG by using the dual approach. Therefore, this paper fills the gap by using both primal and dual approaches to calculate Sri Lanka's TFPG for the period from 1980 to 2016 during which the country has had an open economy policy in place. The TFPG calculation helps a country to identify its existing growth drivers and decide the direction to which its economic policies should be aligned in the future.

The study finds that annual average primal TFPG for 1980-2016 has been 2.3 percent contributing for 45 percent of total output growth. Alternatively, corresponding dual TFPG estimate was 3.6 percent. It also finds the behaviour of both primal and dual estimates follow a similar pattern during 1980-2016, though dual TFPG exceeds primal by 1.3 percentage points. Further, study finds that the higher dual TFPG is likely due to two reinforcing effects. First, dual TFPG would have been overestimated by market imperfections and government monopolies present in Sri Lanka's economy. Second, the divergence would have been aggravated by an underestimation of the primal TFPG emanating from inadequacies in estimating national accounts specifically consequent to war, on the one hand, and an overestimation of the capital stock mainly due to corruptions, on the other. Results also show that two growth drivers in Sri Lanka for the last 35 year period have been productivity growth and capital accumulation at 2.3 percent and 2 percent, respectively. Additionally, after human capital is included, the annual average primal TFPG declines to 2 percent reflecting that human capital played a significant role in Sri Lanka's growth process. The findings also show that Sri Lanka's TFPG is higher than that of selected countries in South and East Asia except in Singapore and China. Finally, the sensitivity tests results show that the results remained unchanged even when using alternative factor shares in total income and different depreciation

rates of the physical capital stock. Overall, the results suggest that Sri Lanka's economic growth has been driven by both factor accumulation and TFPG during 1980-2016. Thus, the results obtained through this study will be useful for Sri Lanka to formulate appropriate resource allocation strategies in its future growth policies.

This paper contributes to the existing literature in three ways. First, this is the pioneering attempt at applying dual approach to Sri Lanka's data. Second, this study compares the estimated results of both primal and dual approaches and identifies underlying reasons for the divergence. Third, it compares Sri Lanka's TFPG estimates with that of other South and East Asian economies.

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature on TFPG. Section 3 presents the theoretical primal model and the estimation of input data. Section 4 is devoted to an analysis of the model and input data for calculating dual TFPG. Section 5 discusses the results whilst Section 6 adds extensions to the main study. Section 7 discusses the main conclusions in relation to policy guidance.

2. Literature Review

There are many noteworthy empirical studies on TFPG in the related literature. Some studies have focused on a single country, whilst others have concentrated on a selected group of countries. With the exception of a few studies that have used both the primal and dual approaches, most of them have used only the primal approach. In the case of Sri Lanka, all studies have been on primal and none on dual.

Covering a group of countries Park (2010) calculated TFPG in 12 selected Asian economies for the period 1970-2007. His results support two growth paradigms: The period 1970-2000 is found to be characterized by insignificant TFPG, supporting the view of 'accumulationists' that growth in these economies was mainly driven by factor accumulation. However, the subsequent period 2000-2007 is found to be characterized by high TFPG, supporting the view of 'assimilatonists' that growth in these economies was based on productivity growth. Thus, Park (2010) finds evidence of these economies transitioning from capital accumulation growth to technology assimilation growth.

Hsieh (2002), using the dual approach, calculated TFPG for East Asian countries for the sample period 1966-1991. He finds that Korea and Hong Kong, both have similar dual and primal TFPG rates, but for Taiwan and Singapore, dual TFPG rates exceed primal TFPG rates by 1 percent and 2 percent, respectively. To resolve Singapore's productivity puzzle, Jayaram

and Lee (2010) calculated TFPG for Singapore and Hong Kong for the period 1997-2009 using an alternative dual approach. They find that Singapore's dual TFPG of 3.2 percent is much higher than its primal TFPG of 0.1 percent for the period 1997-2009. However, the divergence between dual and primal TFPG rates for Hong Kong is found to be small. In a country specific comparison, Islam, Dai, and Sakamoto (2006) find that primal TFPG in China is 4.1 percent and dual TFPG 3 percent for the period 1978-2002. Hloušek (2007) compares primal and dual TFPG rates for the Czech Republic and find that both approaches produce similar TFPG, suggesting that the national accounts are correct and dual approach is a useful alternative to primal growth accounting. Similarly, Céspedes and Ramírez-Rondán (2014) calculated the TFPG for the Peruvian economy from 2003 to 2012 by using both primal and dual approaches. Their results show that TFP grew at an annual average rate of 1.6 and 1.7 percent as per primal and dual approaches, respectively.

In a single approach country specific study, Gupta (2008), constructing data series from 1961 to 2004, finds that TFPG accounted for 35 to 70 percent of the total GDP growth in India. His accounting estimates, decomposition and period-wise trends showed that India's growth was being triggered by TFPG rather than by growth in factor accumulation. Later, Saha (2014) finds that on average TFPG was 1.5 in India during 1961-2008 but it was erratic in nature. His results further confirmed that the Indian economy had been experiencing a continuous rise in TFPG since the introduction of external economic reforms.

Studies on Indonesia by Baier, Dwyer Jr, and Tamura (2006), Sigit (2004) and Sutanto (2004), find a negative rate of TFPG for Indonesia during their respective sample periods from 1950 to 2002, indicating that Indonesia at that time relied solely on factor accumulation for its output growth. Covering Indonesia's long-term economic growth during 1880-2007, van der Eng (2008) found that for most of the period, the growth of the factors of production explained almost all of long-term output growth, and TFPG was marginal. Later, Alisjahbana and Pirmana (2015) find that TFPG started to pick up post economic crisis period, averaging at 1.3 percent during 2000-2013. Studying on Malaysia, Jajri (2007) argued that the low TFPG in Malaysian economy during 1971-2004 was due to the negative contribution from technical efficiency. Zaffrulla (2007) found that the annual average TFPG for Malaysia during 1997-2006 was 1.6 percent contributing to 29 percent to GDP growth. Bosworth (2005) found that the growth of the overall Thailand economy had been dominated by increases in capital and labour. Accordingly, TFPG during 1980-2002 in Thailand was 0.1 percent.

Covering the period from 1980 to 2010, López-Cálix, Srinivasan, and Waheed (2012) estimated a TFPG growth rate of 1.4 percent per annum for Pakistan contributing 28 percent

to average economic growth rate of 5 percent. In a later study, Amjad and Awais (2016) reviewed Pakistan's productivity performance over 1980-2015 and found that average annual TFPG for the period was 1.7 percent contributing 35 percent to the average economic growth rate of 4.8 percent.

Previous studies on calculating TFPG for Sri Lanka as standalone country studies are scarce. Initially, Sri Lanka had been included in studies that were conducted for assessing regional and country comparative analyses of sources of growth. Accordingly, Sri Lanka was included in a study done by Limam and Miller (2004) examining country comparative patterns of economic growth for 80 developed and developing countries. They decompose output growth into factor accumulation, TFPG, and production efficiency improvement, and find that factor accumulation growth, especially capital accumulation, is much more important than others in explaining output growth. Similarly, Bosworth and Collins (2003) included Sri Lanka in a study of measurement of growth accounting for 84 countries over the period 1960-2000. They find that both capital accumulation and efficiency gains are central to the growth process in countries in general. As a standalone study, Fernandez et al. (2005) calculated TFPG for Sri Lanka using the primal growth accounting framework, and found TFPG for the period 1978-2004 to be 1.1 percent. Based on this result, they have projected Sri Lanka's TFPG for 2005-2009 to be 1.9 percent. In a similar country study, Duma (2007) used the primal approach to investigate the main sources of growth in Sri Lanka between 1980 and 2006. He finds labour to be the most productive factor input in the 1980s, making the highest contribution to real output growth, but, over time, TFPG has taken it over from labour and become the most important source of growth. Previous researchers have employed only the primal approach to conduct country specific studies on Sri Lanka. Hence, the present study seeks to calculate both primal and dual TFPG for a longer time horizon for Sri Lanka. Accordingly, this is the first such attempt at using the dual approach to Sri Lanka's data.

3. The Primal Growth Accounting Approach

Under the growth accounting framework, real growth of an economy is disaggregated to identify the main contributors to growth. In this process, any unaccountable component is viewed as the contribution of all the factors combined, designated the TFPG. A long-term positive and significant TFPG implies an economy using its inputs more effectively to generate sustained economic growth. In the conventional growth accounting, the primal and dual approaches are used to calculate TFPG of an economy both at micro and macro levels.

The primal approach, also known as the production function approach, builds its growth accounting application on the theoretical construct of a production function. It consists of a set of calculations that decomposes output growth into growths of different inputs, mainly, growth arising from capital and labour inputs, and that from the residual, TFPG. This approach based on the Solow growth model (Solow, 1957) makes three major assumptions: a production function characterised by Constant Return to Scale (CRS), a factor market governed by perfect competition and the full utilization of inputs.

3.1 The Model

In this study a Cobb–Douglas type production function with CRS is used to decompose the sources of economic growth as follows:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}, \qquad (1)$$

where, Y_t is output, A_t is TFP (Total Factor Productivity) , K_t is capital, L_t is labour, α is the physical capital share of output and t is time. When logs are applied to Equation (1) and differentiated with respect to time, it expresses the growth rates as given in Equation (2).

$$\hat{Y}_t = \hat{A}_t + \alpha\hat{K}_t + (1-\alpha)\hat{L}_t, \qquad (2)$$

where, $\hat{Y}_t$, $\hat{A}_t, \hat{K}_t$ and $\hat{L}_t$ are the respective growth rates of output, TFP, physical capital stock and labour stock. From Equation (2), the growth rate of TFP can be derived as a residual of the observable variables as follows:

$$\hat{A}_t = \hat{Y}_t - \alpha\hat{K}_t - (1-\alpha)\hat{L}_{t.} \qquad (3)$$

TFPG calculated in Equation (3) is conditional upon the growth rates of output, physical capital and the labour stock. It also requires the respective shares of capital and labour in output to derive TFPG. Based on the assumption of competitive factor markets and CRS in production function, the capital share in total output s_K is equivalent to α and can be calculated by first multiplying the marginal product of capital (MPK) by the capital stock and then dividing it by total output.[4] Similarly, the labour share in total output s_L is equivalent to $(1-\alpha)$ and can be calculated by multiplying the marginal product of labour (MPL) by the labour force and then

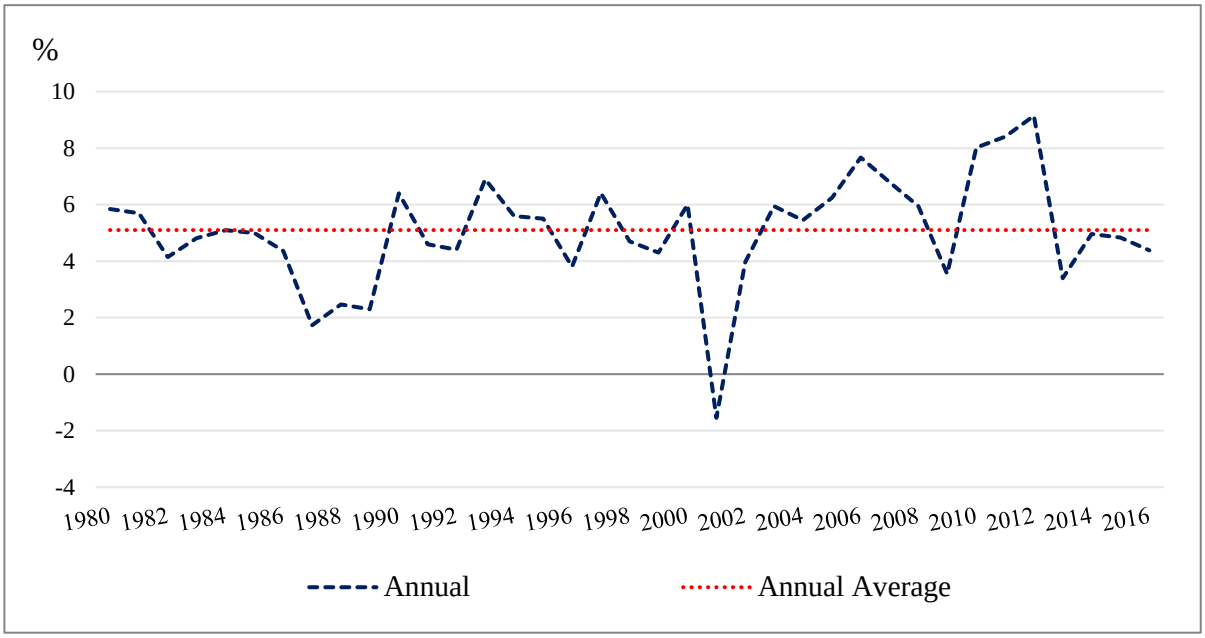
[4] $s_K = \frac{MPK.K}{Y} = \alpha$

dividing it by total output.[5] MPK and MPL can be obtained by differentiating Equation (1) with respect to capital and labour, respectively.[6]

3.2. Data

3.2.1 Output

Output used for TFPG calculation is the real Gross Domestic Product (GDP) reported in the World Development Indicators (WDI) (World Bank, 2019). The annual percentage growth rate of GDP based on constant local currency (LKR) for the period 1980-2016 is shown in Figure 1.



Source: World Development Indicators – 2019

Figure 1. GDP Growth in Sri Lanka 1980-2016

This growth pattern highlights several features. First, Sri Lanka's growth rate had not been high enough to elevate it to a higher middle-income country during the study period. Second, growth is erratic fluctuating widely around the average growth rate. Third, the country has not been able to sustain the high growth which it has recorded in certain years.

[5] $s_L = \frac{MPL.L}{Y} = (1\text{-}\alpha)$

[6] $MPK = \frac{\partial Y_t}{\partial K_t} = \alpha A_t \left(\frac{L_t}{K_t}\right)^{1-\alpha}$, and $MPL = \frac{\partial Y_t}{\partial L_t} = (1-\alpha) A_t \left(\frac{K_t}{L_t}\right)^{\alpha}$

3.2.2 Physical Capital Input

Since, the physical capital stock data are not readily available, the series was generated by employing the widely used Perpetual Inventory Method, suggested by Harberger (1978) using the Equation (4).

$$K_t = (1 - \delta)K_{t-1} + I_t \,, \qquad (4)$$

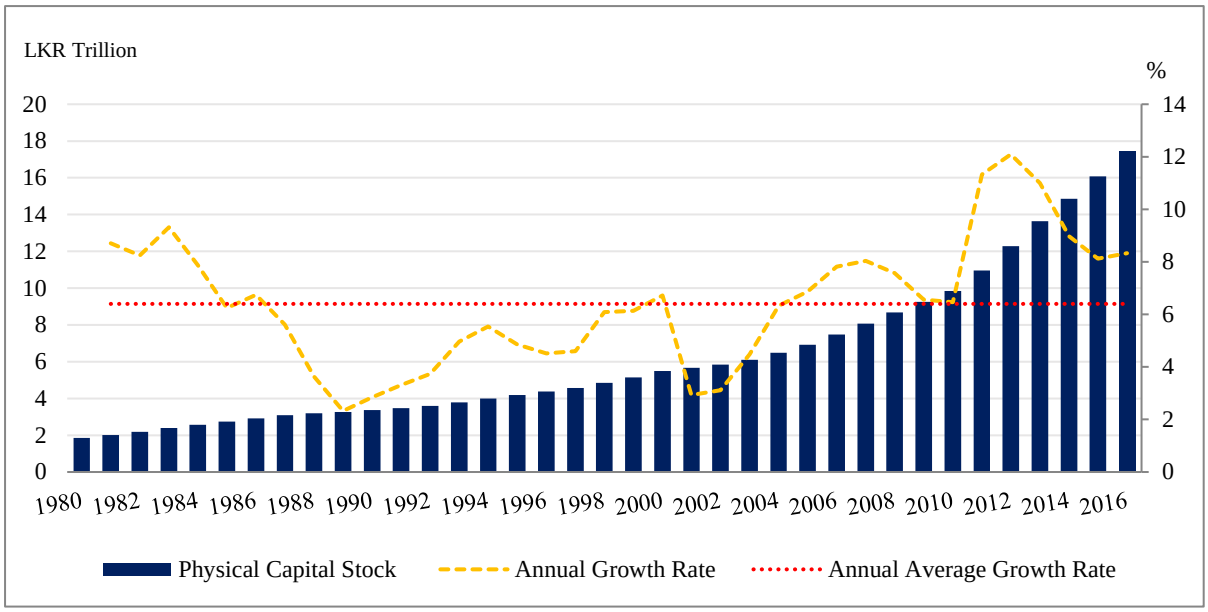
where K_t is the physical capital stock at time t, δ is the depreciation rate of capital and I_t is investment at time t. Accordingly, capital stock in the current year is equal to the previous year's capital stock adjusted for depreciation plus investments in the current year. The calculation of K_t requires the initial capital, K_{t-1}. Harberger (1978) employed the neoclassical growth theory to calculate initial capital given by Equation (5), assuming steady state in the economy with equal growth rates in output and capital.[7]

$$K_{t-1} = \frac{I_t}{g+\delta} \qquad (5)$$

where I_t is the current year investment, g is long-term annual average output growth and δ is the depreciation rate. When the economy is in equilibrium, the capital stock in the initial period can be calculated using data on current level of investments, depreciation rate and the growth rate of output. Following Equation (4), the physical capital stock is estimated by using a long term time series of gross fixed capital formation starting from 1960, the earliest data point available. Different depreciation rates are used in different time periods by considering the legal, economic, political and war conditions applicable to respective periods. Accordingly, the depreciation rate is 6.7 percent for the period before 1980, 10 percent from 1980 to 2009 and 6.7 percent.[8] During the war period 1980-2009 a higher depreciation rate at 10 percent was applied due to disruptions in capital formation such as attacks on the airport, Central Bank, Inland Revenue Department, major railway stations and many more strategically important places. After 2009, the depreciation rate of 6.7 percent is used to reflect the peaceful situation in the country. The estimated physical capital stock and its growth during 1980-2016 is given in Figure 2.

[7] As discussed by Berlemann and Wesselhöft (2014) at the steady state,
$GDP\ growth\ (g) = capital\ stock\ growth = \frac{K_t - K_{t-1}}{K_{t-1}} = \frac{I_t}{K_{t-1}} - \delta$

[8] Fernandez et al. (2005) used 8 percent depreciation rate for the whole period 1978-2004 whereas, Duma (2007) applied two depreciation rates (δ): before 1980s = 6.7 percent, 1980-2006 = 25 percent.



Source: Authors' own calculations

[a/] Authors' estimation based on WDI - 2018 data series and the stated assumption on δ.

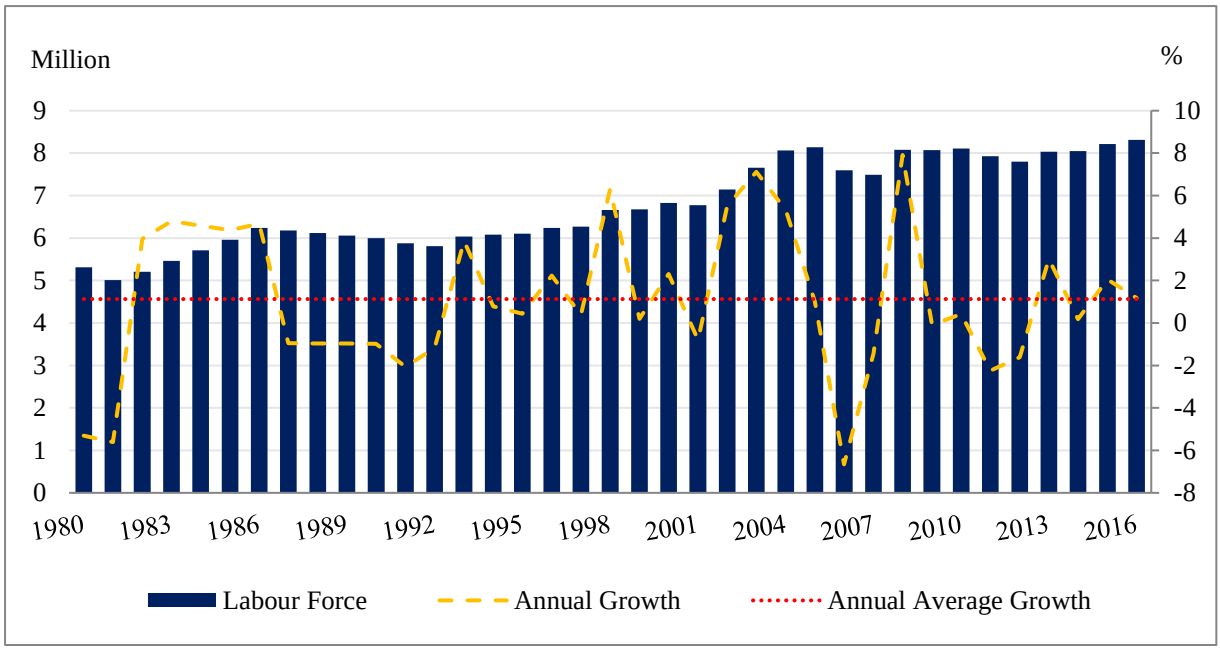
Figure 2. Estimated Physical Capital Stock in Sri Lanka and its Growth 1980 - 2016[a]

Though the capital stock has grown steadily during the period, its annual growth has been erratic ranging between 2 percent at the minimum and 12 percent at the maximum. This has generated an average of 6.4 percent for the entire period.

3.2.3 Labour Input

Labour input is measured by the number of workers in the labour force. The labour force data from 1990-2016 are sourced from Department of Census and Statistics and the series from 1980 to 1989 was interpolated by using data reported in Central Bank of Sri Lanka (2000). Figure 3 shows the estimated labour stock and its growth in Sri Lanka during 1980-2016.

A sharp decline in the labour force in 2006 and 2007 is due to unreliability of the labour force data collected in 2006 and 2007 from conflict areas in the North and the East. Data for 2005, 2006 and 2007 were presented excluding those provinces. (Central Bank of Sri Lanka, 2007).



Sources: Central Bank of Sri Lanka

Department of Census and Statistics of Sri Lanka

Figure 3. Labour Force in Sri Lanka and its Growth 1980 – 2016

3.2.4 Capital Share

In this study, the production function is assumed to be CRS Cobb-Douglas, $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$, with $\alpha = 0.3$ as in the related literature. Aiyar and Dalgaard (2005) found evidence to suggest that the Cobb-Douglas production function with a constant capital share of one-third satisfies more general conditions, and in particular it is a very good approximation to countries that have different production functions. Also, most comparative studies which attempted to benchmark productivity performance across countries have imposed constant factor shares, typically with a capital share equals to 0.3 or 0.35 (Crafts, 2003).

3.2.5 Labour Share

The assumption of CRS necessitates to calculate the labour share as the residual$(1 - \alpha)$. The assumed capital share of 0.3 generates a labour share of 0.7 which is consistent with the literature. Guerriero and Sen (2012) used national income tables for 178 countries to construct a dataset of labour share in national income, and found that it varied between 0.65 and 0.72 across countries during 1970-2010. This 0.7 share is also supported by a 15 year average of labour share of income for Sri Lanka until 2014 as given in PWT.9 (Lederman, Lesniak, Feenstra, Inklaar, & Timmer, 2017).

4. The Dual Growth Accounting Approach

The primal approach may produce erroneous TFPG due to measurement errors of output and capital and labour stocks. The dual approach however uses factor prices instead of factor quantities. Those prices are a better measure since they can be observed directly in the market. The dual TFPG can be calculated from the basic national income identity where output is exhausted by payments to factors if CRS prevails and the market is free from imperfections.

4.1 The Model

The dual approach uses the national income identity in which the sum of the payments received by each factor, capital (K_t) and labour (L_t), is presented in Equation (6) as in Hsieh (2002).

$$Y_t = r_t K_t + w_t L_t, \tag{6}$$

where Y_t is the aggregate income, r_t is the real return to physical capital and w_t is the real return to labour. By differentiating Equation (6) with respect to time and dividing it by Y_t, Equation (7) can be derived.

$$\hat{Y}_t = s_K \hat{r}_t + s_K \hat{K}_t + s_L \hat{w}_t + s_L \hat{L}_t, \tag{7}$$

where $\hat{r}_t$ and $\hat{w}_t$ are the growth rates of real returns to capital and labour, respectively. s_K and s_L are capital and labour factor shares of income, respectively, as same as in primal approach.[9]

Equation (7) can be rearranged by placing growth rate of factor quantities on the left-hand side to yield the following:

$$\hat{Y}_t - s_K \hat{K}_t - s_L \hat{L}_t = s_K \hat{r}_t + s_L \hat{w}_t \tag{8}$$

Equation (8) shows the duality between the primal and dual TFPG calculations. The left-hand side of Equation (8) is the primal TFPG calculated by subtracting the weighted growth rates of factor quantities from the output growth rate, which is the same as Equation

[9] In this setting $s_K + s_L = 1$

(3). The right-hand side of Equation (8) represents the dual TFPG, the weighted growth of factor prices. The dual TFPG thus is given by Equation (9) as follows:

$$\hat{A}_t = s_K \hat{r}_t + s_L \hat{w}_t \qquad (9)$$

4.2 Data

The evolution of dual TFPG is influenced by the market structure in which the interest rates and wages are determined. Since a continuous series of data for the rental rate of capital and wages are not available, all the input data for calculating TFPG under the dual approach are estimated.

4.2.1 Return to Physical Capital – The Real Rental Rate

For physical capital, its earning is indicated by the real rental rate of capital. In the TFP literature, the rental price of capital good j is based on the Jorgenson and Griliches (1967) rental price formula:

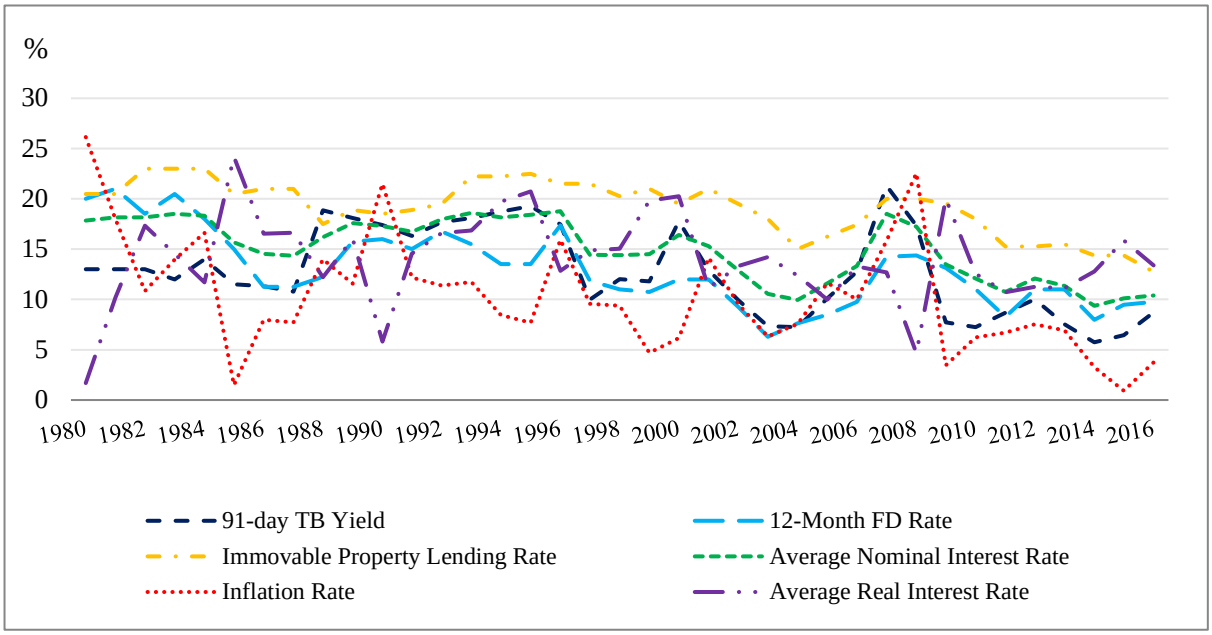
$$\frac{r_j}{p} = \frac{p_j^k}{p}(i - \hat{P}_k + \delta_j), \qquad (10)$$

where $\frac{p_j^k}{p}$ is the relative price of capital, $\hat{P}_k$ the inflation rate and δ_j the depreciation rate of capital type j capital, and i is the nominal interest rate. This equation states that the real rental price of capital j is equal to the product of its relative price and the real interest rate plus depreciation rate. Equation (10) can be simplified by using the ratio of investment goods deflator to GDP deflator as a measure of the relative price of capital as in Hsieh (2002). In this analysis, the relative price ratio is assumed to be equal to one due to data limitations relating to investment goods deflator. Thus the real rental price of capital is equivalent to the real interest rate plus the depreciation rate as in Equation (11).

$$r_t = (i_t - \Delta p_t + \delta_t) \qquad (11)$$

The estimated nominal interest rate (i_t) for the aggregate economy is measured by the three-year moving average of the real lending rate of immovable properties. Data is sourced from Central Bank of Sri Lanka (2017). The data on CPI inflation rate are extracted from World

Bank (2019), whilst the depreciation rates (δ_t) are the same that had been used for primal calculation. The evolution of the different types of interest rates and the inflation rates in Sri Lanka are in Figure 4.

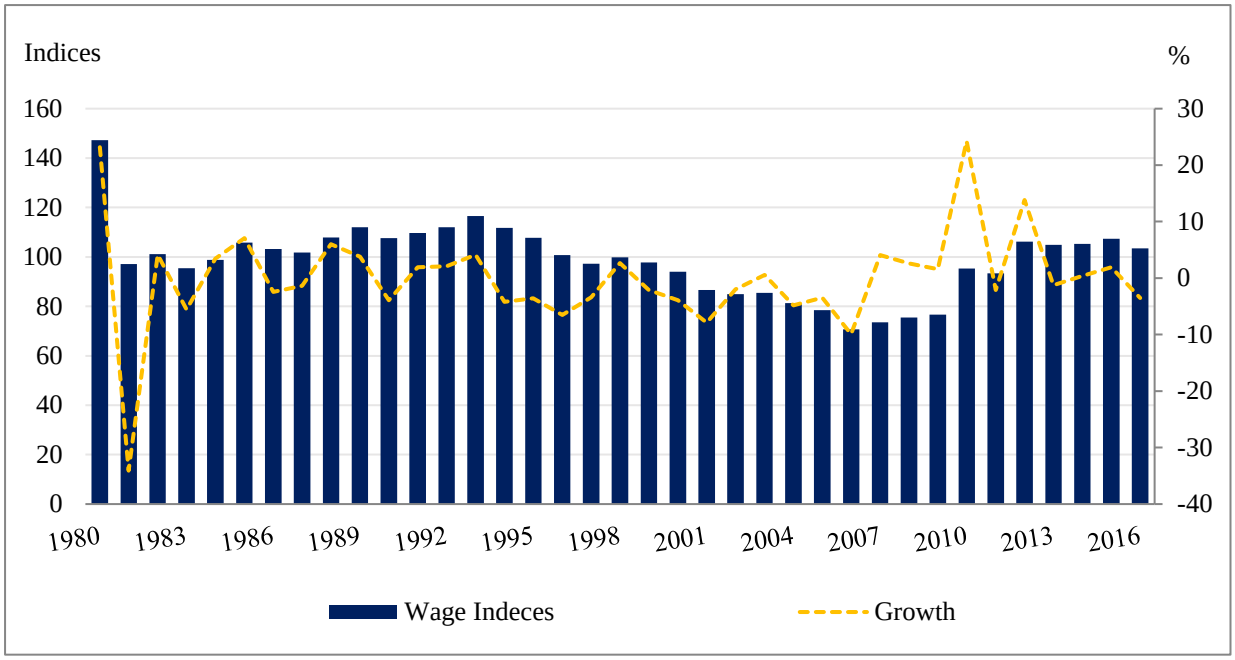


Sources: Central Bank of Sri Lanka
World Development Indicators - 2019

Figure 4. Movement of Interest Rates and Inflation Rate in Sri Lanka 1980-2016

4.2.2 Return to Labour - Real Wages

In Sri Lanka, the average nominal wage data series is not available even at the aggregate level. Therefore, the estimation was made by using Real Wage Rate Indices (Workers in Wages Boards Trades) published by Central Bank of Sri Lanka in its different Annual Reports. Real Wage Indices and their growth rates from 1980 to 2016 are in Figure 5.Both the wage indices and their growth rates have more or less followed the same pattern during the period under consideration except in 1981 when the inflation rate had peaked. After the end of the war in 2009, the wage indices have recorded a high growth rate since the growing economic conditions permitted the payment of high wages to employees.



Source: Central Bank of Sri Lanka

Figure 5: Evolution of Real Wage Rate Indices and their Growth in Sri Lanka 1980-2016

4.2.3 Factor Shares

Factor shares are assumed to be the same as those of the primal approach. Accordingly, the capital share, s_K is 0.3 and labour share, s_L is 0.7.

5. Results and Discussions

5.1 Results of the Primal Approach

The primal results are decomposed by sources of growth into two time segments: the entire sample period 1980-2016 and eight segments identified based on specific economic policy regimes and changes in socio-political atmosphere in the country in Table 1.

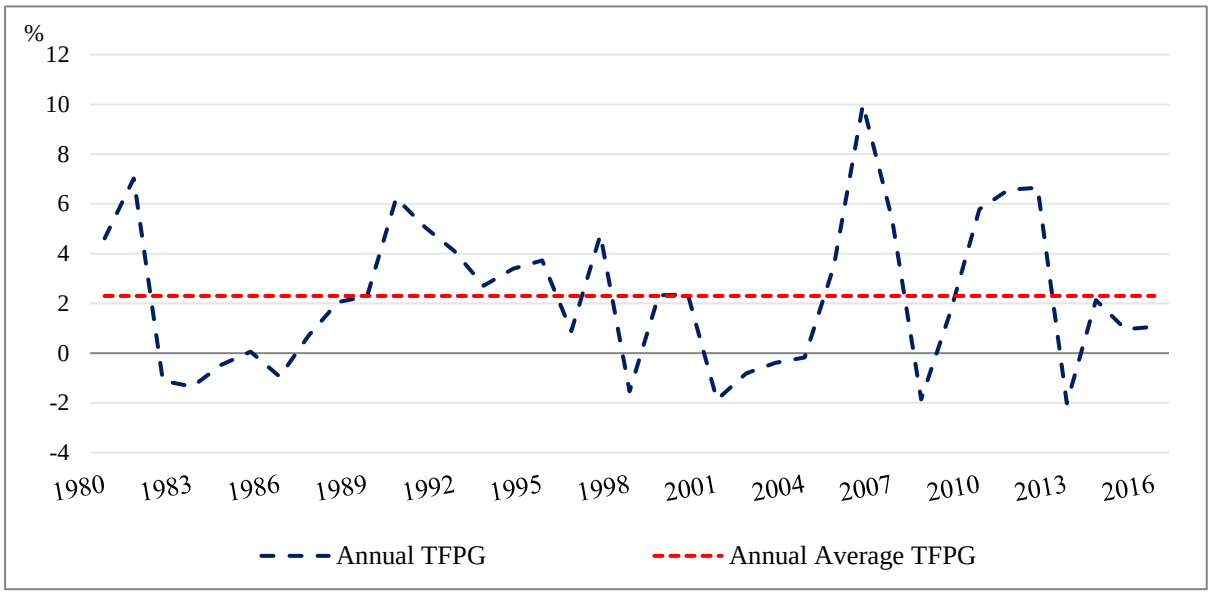
The annual average output growth rate for the entire period 1980-2016 is 5.1 percent. That is comprised of 2 percent, 0.8 percent and 2.3 percent growth rates of capital, labour and TFP, respectively. Thus, TFPG accounts for 45 percent of the output growth for the entire sample period 1980-2016, and the remaining 55 percent is be attributed to the growth of factor inputs. Although TFPG is high for Sri Lanka, it is highly volatile ranging from -2 percent in 2013 to 10 percent in 2006 as depicted in Figure 6. The high volatility is demonstrative of the

failure of Sri Lanka to sustain TFPG at an even level due to changes in policy regimes, internal conflicts or external shocks.

Table 1. Decomposition of Growth in Sri Lanka (1980-2016) – Primal (Baseline) Approach

Period	Rationale	GDP Growth	Capital Growth	Labour Growth	TFP Growth
			%		
1980-1984	Open economy/War	5.1	3.0	0.3	1.7
1985-1989	JVP insurrection/War	3.2	1.5	0.9	0.8
1990-1994	Multi Fibre Agreement/War	5.6	1.2	0.1	4.3
1995-1999	War	4.9	1.6	1.3	2.0
2000-2004	Global recession/Cease fire	4.0	1.4	2.7	-0.2
2005-2009	Infrastructure Investments/War	6.0	2.2	0.1	3.7
2010-2014	Infrastructure Investment/Peace	6.8	3.0	0.0	3.8
2015-2016	Social Market Economy	4.6	2.5	1.1	1.0
1980-2016	37 Years	5.1	2.0	0.8	2.3

Source: Authors' own calculations



Source: Authors' own calculations

Figure 6. Movement of TFPG in Sri Lanka: Primal Approach 1980-2016

The Results in Table 1 show that the contributions of capital and labour to growth have shifted from one time period to another. In 1980-84, capital was the main contributor to growth.

This could be explained by the significant capital inflow to the country immediately after opening the economy in late 1977 in the form of concessionary loans and aid grants mainly from Western Europe, the United States, Japan, and multilateral lending institutions. Since then, the country could not maintain the same capital inflows with escalation of violence due to war and ultra-left political movement, Janatha Vimukthi Peramuna (JVP). These conflicts, significantly decelerated both economic growth and capital growth and TFPG fell substantially to 0.8 percent during 1985-89.

During 1990-1994, textile and garment industry flourished as a result of the Multi Fibre Agreement that attracted 'quota-hopping' foreign direct investments into the country.[10] Consequently, growth accelerated to 5.6 percent due mainly to investments in sophisticated garment factories. It resulted in the acceleration of TFPG to 4.3 percent, the highest ever during all the sub periods under consideration. It accounted for 77 percent of the output growth. During 1995-1999, there were many acts of large scale violence, including the bombing of the Central Bank in 1996. Consequently, economic growth decelerated to 4.9 percent and TFPG fell to 2 percent. Accordingly, its share in GDP growth declined to 41 percent. GDP growth further declined to 4 percent during 2000-2004 with the escalation of violence at the beginning of the period and unfavourable global economic condition in 2001. A major casualty was the Colombo International Airport which came under attack by LTTE in mid-2000. In 2002, the government entered a cease fire agreement with LTTE allowing normal economic relations to take place between the conflict-driven northern Sri Lanka and the southern parts of the country. As a result, the economy which had recorded a negative growth of 1.5 percent in 2001 began to recover after 2003. Economic growth accelerated to 5.9 percent in that year, followed by 5.4 percent in 2004. However, because of the negative economic growth of 1.5 percent in 2001, the average economic growth during 2000-2004 fell to 4 percent. During this period, economic growth came mainly from labour growth. TFPG fell to negative 0.2 percent, reflecting the low productivity level of the labour force.

During 2005-2009 Sri Lanka was hit by both war and a rise in global energy prices. Yet, economic growth accelerated to 6 percent that lifted TFPG to 3.7 percent representing 62 percent of GDP growth. This was the result of an increase in gross domestic capital formation from 22 percent of GDP in the previous five year period to 24 percent in the period under reference. This in turn contributed to an increase in the rate of growth in the capital stock that

[10] Multi-Fibre Agreement was an international trade agreement that was in force from 1974 to 2004 setting quotas on the textiles and clothing which developing countries could export to developed countries.

grew below its period average of 6.4 percent during 2000-2004 to above the period average in the succeeding five year period.

During 2010-2014, capital formation continued to grow still faster reaching 29 percent of GDP in 2012 and 2013. This was mainly made up of a large number of infrastructure projects completed by the government in ports, airports, electricity generation and highways. This high capital formation resulted in an improvement in TFPG, creating a positive loop and pushing up economic growth to a higher level compared to the previous period. Accordingly, economic growth during that period amounted to 6.8 percent with a TFPG of 3.8 percent that accounted for a 56 percent of the growth attained during that period.

During 2015-2016, Sri Lanka failed to harness its growth potential due to economic and political uncertainty, unfavourable weather conditions, slowdown in growth of demands for its traditional export markets, while a strengthening US economy prompted short term capital outflows (Central Bank of Sri Lanka, 2015; 2016). This was further reinforced by the slowdown in adopting complex technology to its production system (Wijewardena, 2018). Subsequently, the exchange rate came under stress and Sri Lanka had to seek for the assistance of International Monetary Fund for much needed corrections. Consequently, during 2015-2016, economic growth contracted to 4.6 percent with a consequential fall in TFPG to 1 percent and the contribution of capital and labour to 2.5 percent and 1.1 percent, respectively.

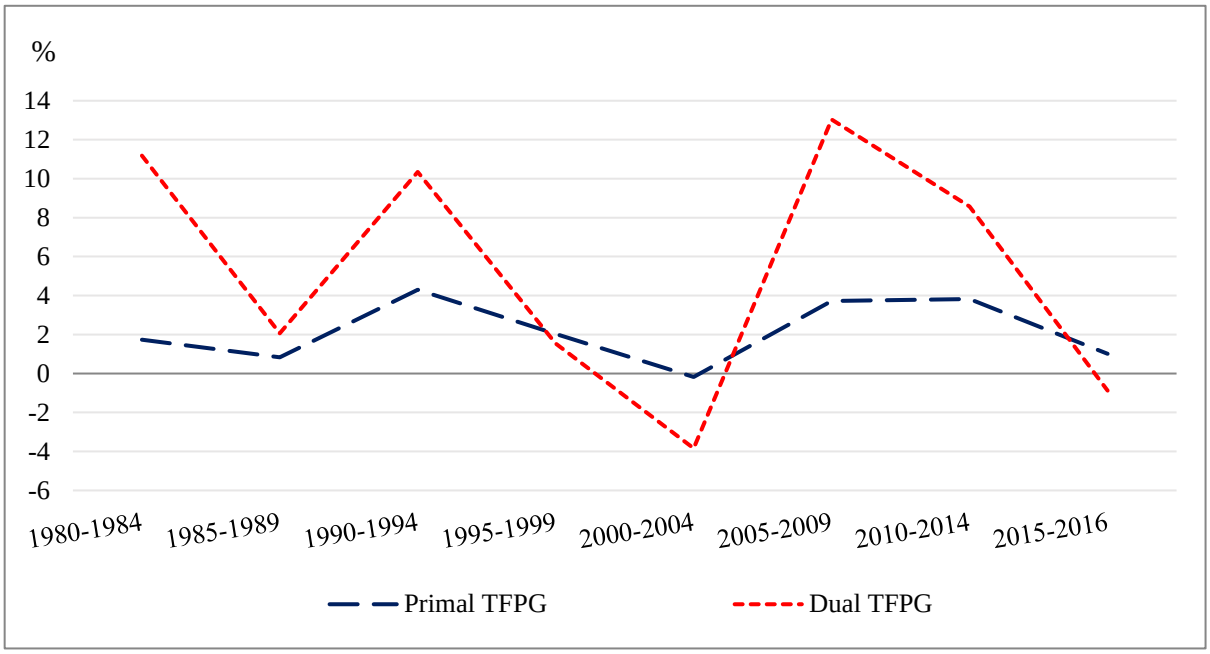
5.2 Results of the Dual Approach

The estimated annual average TFPG under the dual approach is 3.6 percent for the period 1980-2016 as in Table 2. There is a wide variation of estimated TFPG numbers among sub time horizons -3.7 during 1995-1999 being the lowest and 9.4 during 1980-1984 being the highest. During 1980-1984 there was a high interest rate regime which led to higher property lending rates. This is along with the very low inflation rates increased the real rate of capital. Similarly, there were historically high wage indices during that period positively contributing to TFPG. Contrastingly, both nominal property lending rates and wage indices were comparatively low during 2000-2004 leading to negative TFPG consequent to internal and external economic shocks prevailed during that period. Overall, the dual TFPG fluctuations have been mainly due to wide fluctuations in the real interest rate and real wage indices. Since the immovable property lending rate has been fairly stable over the period, it is the large changes in the inflation rate that have led to the fluctuations in real return on capital. Similarly,

the fluctuations in real return on labour or the real wage rate indices have reinforced the dual TFPG fluctuations, as the labour share in total output has accounted for 0.7.

5.3 The Assessment of the Results of Primal and Dual Approaches

The results show that primal and dual TFPG estimates for Sri Lanka during the period follow similar trends as in Figure 7.



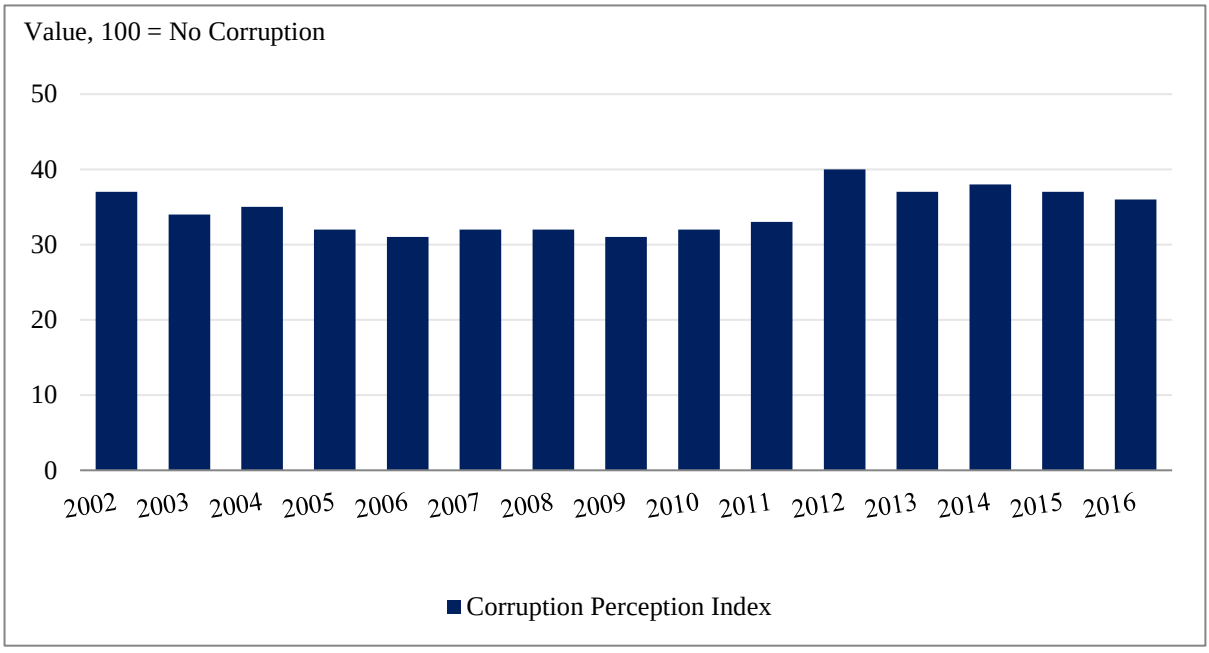
Source: Authors' own calculations

Figure 7. Movement of TFPG in Sri Lanka: Primal and Dual Approaches 1980-2016

However, dual estimates exceed primal by 1.3 percentage points. This divergence is due to understatement of primal or overstatement of dual TFPG or a combination of both. Theoretically, under the perfect conditions, both dual and primal approaches should produce similar results (Jorgenson & Griliches, 1967) as in Equation (8). However, it may not necessarily happen in practice due to the violations of assumptions, namely, perfect market competition, full capacity utilization and CRS. Also, omitted factors of production, measurement errors or the inconsistencies in national account data and inappropriate factor shares and depreciation rates can contribute to the discrepancies between primal and dual TFPG estimates. The related literature discusses some reasons for such deviations pertaining to other countries.

Discussing the omitted factors of production in an East Asian country analysis, Hsieh (2002) explained that TFPG under primal exceeds the dual when the national income exceeds the payments to capital and labour. He also explained that in Singapore during 1966-1991 dual TFPG rate exceeded its primal rate by 2 percent, due to the higher rate of market capital accumulation not explained by market imperfections. Céspedes and Ramírez-Rondán (2014) found that in the Peruvian economy during 2003-2012 TFP grew at an annual average rate of 1.6 percent and 1.7 percent as per primal and dual approaches, respectively. They listed the causes for market imperfections such as taxes, mark-ups, labour unions, minimum wages and credit rationing, which lead to erroneous calculation of TFPG under dual approach. In a TFP analysis on the post-reform Chinese growth, Islam et al. (2006) has discussed the inherent problem in national income accounts that lead to overstate the primal TFPG. They found that during 1978-2002 dual TFPG in China is approximately 1.1 percent less than that of primal.

In the case of Sri Lanka, dual TFPG exceeds primal by 1.3 percentage points during 1980-2016. Primal TFPG is underestimated due to the underestimation of the national accounts of the country resulted from inadequate coverage of the conflict areas on one side and unrecorded SMEs on the other. This would have been aggravated by the existence of a comparatively higher level of corruption as in Figure 8. Corruption overprices capital projects leading to an overestimation of the country's capital stock causing primal TFPG to be understated.



Source: Transparency International

Figure 8. Sri Lanka's Corruption Perception Index 2002 to 2016

In contrast, there is an overestimation of dual TFPG due to market imperfections.[11] In Sri Lanka, these imperfections take a number of forms. There have been product market regulations restricting the size and the entry of firms, especially the government monopolies in the railways, electricity, water supply and petroleum distribution. In the capital market, the largest savings bank and superannuation funds are government monopolies. The financial sector has been highly regulated. In lending, extremely high property lending rates even in low inflation regimes have been prevailed. In some selected years, these high lending rates had led to high real rental rates on capital on one side, and subsidies, taxes and capital controls across the economy on the other. The labour market had been characterised by minimum wages in gazetted industries. There had been stringent regulations with respect to termination of employment thereby making any market adjustment to lean years difficult. Thus, the employment protection measures in force may have distorted labour pricing. In addition, upward stickiness in wages may also have distorted the dual TFPG estimates.

Though there is a divergence between the primal and dual TFPG estimates for Sri Lanka, dual method can be used as an alternative complementary method to the primal approach. The appropriate method of estimating TFPG varies depending on the country, sector or industry involved, the period under consideration and availability of reliable input data. Since each method has its own merits and demerits, it is advisable to undertake the estimation of TFPG by using both approaches and compare their results for consistency and reliability.

6. Extensions to the main Study

In this section further extensions were considered to the main study to test the robustness of the results.

6.1 Inclusion of Human Capital as the Third Factor of Production

Since inclusion of human capital as a factor of production is relevant in the current context, primal TFPG is calculated by modifying the original Cobb-Douglas production function to include human capital as the third factor of production as in Equation (12).

$$Y_t = A_t {K_t}^{\alpha} (HL)_t^{1-\alpha} \quad , \qquad (12)$$

[11] For details of market imperfections, see, Restuccia and Rogerson (2017).

where H_t is the human capital and $(1-\alpha)$ is the factor share of human capital and labour. By dividing Equation (12) by the labour input, production function per worker is obtained in Equation (13).

$$y_t = A_t {k_t}^{\alpha} {h_t}^{1-\alpha} \quad (13)$$

After differentiating the per worker production function, growth function with respect to per worker can be derived as below.

$$\hat{y}_t = \hat{A}_t + \alpha\hat{k}_t + (1-\alpha)\hat{h}_t \quad (14)$$

When the Equation (14) is rearranged, TFPG can be obtained as given below.

$$\hat{A}_t = \hat{y} - \alpha\hat{k}_t(1-\alpha)\hat{h}_t, \quad (15)$$

where the TFPG is the residual after deducting the respective growth rates of capital per worker and human capital per worker from the output per worker. The indicator used to proxy the human capital in this study is the education sub-category of the human development index (UNDP, 2016). Human capital data series is available with five year intervals from 1980 to 2005 and annually from 2006 to 2013. Therefore, a continuous annual series from 1980 -2016 was generated by linearly interpolating data for the missing years.

When human capital is included in the model, annual average primal TFPG declined to 2 percent during 1980-2016 indicating that human capital plays an important role in Sri Lanka's growth process. The government provides free education from grade one to university level in Sri Lanka and the annual budgetary allocation for education is 2 percent of GDP (Central Bank of Sri Lanka, 2016). Those public policies have resulted in significantly high performance in Sri Lanka's educational indicators such as the literacy rate standing at around 93 percent, student/teacher ratio at government schools of 18 and eligibility to university admission of 51.4 percent of Advanced Level students (Central Bank of Sri Lanka, 2016).

6.2 Comparison of Alternative Estimates

Primal calculations including human capital are almost identical with the TFP annual average growth rate as per PWT 9.0 at constant national prices 2014 (Lederman et al., 2017). This series has calculated TFPG of 2 percent in Sri Lanka for 1980-2014 (PWT 9.0). Table 2

compares the estimated results of baseline primal approach, primal approach with human capital, dual approach and PWT 9.0 TFPG estimates.

Table 2. Comparison of Different TFPG Results

Period	Primal Baseline	Primal with HC	Dual	TFPG% PWT[a]
1980-1984	1.7	1.9	9.4	0.8
1985-1989	0.8	0.0	1.2	-0.7
1990-1994	4.3	3.6	6.0	3.7
1995-1999	2.0	1.3	-0.5	1.5
2000-2004	-0.2	-0.9	-3.7	0.8
2005-2009	3.7	4.1	9.3	3.8
2010-2014	3.8	3.6	4.7	4.0
2015-2016	1.0	1.6	-1.9	n/a
1980-2014	2.3	2.0	3.9	2.0
1980-2016	2.3	2.0	3.6	n/a

Source: Authors' own calculations

a/ Author calculated the simple average annual TFPG rate for Sri Lanka for 1980-2014, by using the annual TFP data published at constant national prices (2011 = 1) in PWT 9.0.

6.3 Comparative Country TFPG

Figure 9 presents TFPG for Sri Lanka in comparison to some selected peer counties in Asia as calculated in the related literature.

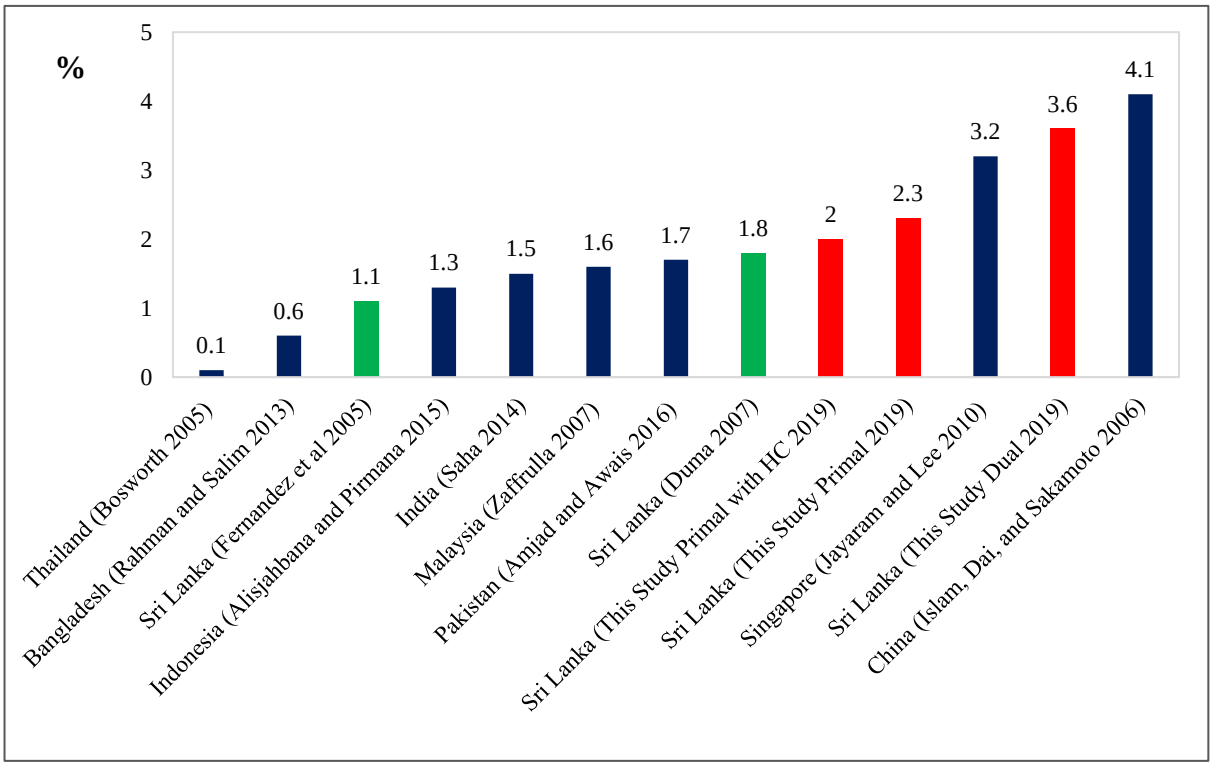


Figure 9. TFPG in Sri Lanka and Selected Asian Countries in Related Studies

Sri Lanka's TFPG estimates are comparatively higher than that of many South and East Asian countries, except for Singapore and China. South Asian countries such as Sri Lanka, India and Pakistan, have reported a fairly higher TFPG at around 2 percent, but the only outlier to the lower side is Bangladesh. Though, Indonesia and Sri Lanka follow a similar Per Capita GDP growth path[12], Sri Lanka's TFPG estimates are higher than that of Indonesia.

6.4 Sensitivity analysis

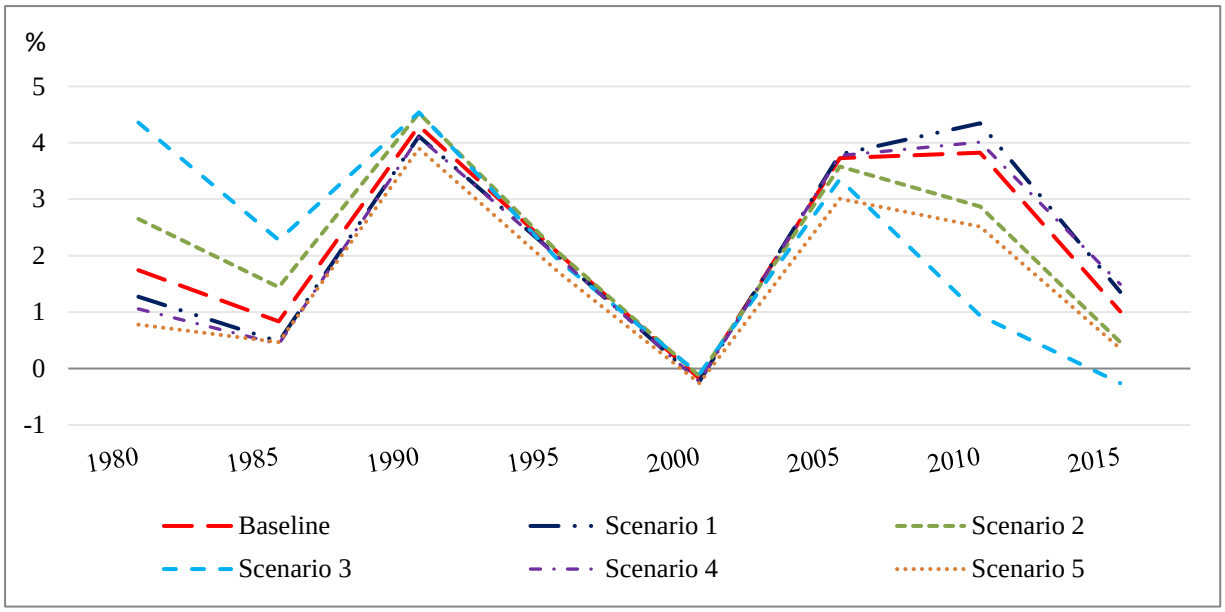
The estimated TFPG results in primal approach could be sensitive to the assumptions made on the physical capital share of output (α) and the depreciation rate (δ). Therefore, the alternative capital stocks were generated by adjusting the depreciation rate and capital share as per the specifications given in Table 3 and the TFPG results of all scenarios during 1980 to 2016 for sub time periods are depicted in Figure 10.

Table 3. Specifications of the Baseline Scenario and Five Alternative Scenarios - Primal

Period	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				%		
		$\alpha = 0.3$				$\alpha = 0.4$
				δ		
Before 1980s	6.7	6.7	6.7	6.7	8.0	6.7
1980-2009	10.0	7.5	15.0	25.0	8.0	10.0
After 2009	6.7	6.7	6.7	6.7	8.0	6.7

The results indicate that the annual average TFPG estimate in different scenarios under primal approach during 1980-2016 has ranged between 1.7 percent and 2.4 percent and all estimates follow a similar trend. Therefore, it is clear that TFPG results of this study are robust to using different values of capital share and depreciation rate.

[12] Both Sri Lanka and Indonesia were in the lower-middle income group during the study period according to the World Bank's country income classification. Also, both countries have very similar growth rate of per capita real output between 1980 and 2016 with Sri Lanka slightly higher at 4 percent per annum compared to Indonesia's 3.5 percent per annum (World Bank, 2019).



Source: Authors' own Calculations

Figure 10. Movement of TFPG Results under Different Assumptions - Primal

7. Conclusions and Recommendations

The study finds that annual average primal TFPG for 1980-2016 has been 2.3 percent contributing for 45 percent of total output growth of 5.1 percent. Alternatively, corresponding dual TFPG estimate was 3.6 percent. It also finds the behaviour of both primal and dual estimates follow a similar pattern during 1980-2016, though dual TFPG exceeds primal by 1.3 percentage points. This divergence is due to the combined effect of overestimating dual TFPG by market imperfections and underestimating primal TFPG as a result of an underestimation of national accounts and an overestimation of the capital stock. The study also finds that relative importance of factor accumulation and the efficiency improvements in the GDP growth deviated alternatively during the period under consideration. The past growth record for the 37 year period from 1980-2016 shows that the two growth drivers in Sri Lanka have been productivity growth and capital accumulation at 2.3 percent and 2 percent, respectively. The results also show that Sri Lanka's TFPG under both methods has been higher than some East Asian countries, except for Singapore and China. Different sensitivity checks show that the baseline results are robust enough to make those conclusions. These results will be useful for Sri Lanka to adopt appropriate resource allocation strategies and production technologies in its future growth policies.

Sri Lanka's long term economic development crucially depends on its ability to undertake an economy-wide reforms along with technological advancements and converting

its labour force to a pool of critical capital. As per the national accounts main growth drivers in Sri Lanka have been industry and services and not agriculture. This is obvious since agriculture that employs a third of the labour force contributes only 8 percent to GDP denoting low productivity and under-employment. Therefore, economic policies could be designed to reallocate those underemployed workers to more productive industry and services to minimise misallocation losses and increase TFPG. Even in the services sector, it is important that the expansion should take place in internationally tradable areas, namely, tourism, healthcare and education. Policies should also be designed to reduce the excess workers in the public sector. Despite heavy investment in physical infrastructure, its contribution to the total output has been less than expected. Hence, the results of the study show that in future, policies should be designed to improve the productivity of such infrastructure projects.

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