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Sources of Singapore's Economic Growth, 1965–2008: Trends, Patterns and Policy Implications

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This article should be of interest to researchers and policy makers interested in economic development

Abstract: *This paper analyzes the sources of Singapore's GDP and labor productivity growth in 1965–2008 and reveals insights into related trends and patterns. The study documents four main findings. Firstly, both GDP and average labor productivity (ALP) growth in Singapore tended to decline during this period, and the contribution of ALP growth to GDP growth tended to decrease over time. Secondly, the contribution of labor to GDP growth was rather stable at approximately 1.5–2 percentage points per year, of which an increasing share came from foreign labor. Thirdly, total factor productivity growth improved substantially after the mid-1980s and has become a healthy source of GDP and ALP growth since that time. Finally, Singapore's ALP low growth and its declining trends have become notable recently, of which the main reason was a sharp decrease in the contribution of capital deepening. The study discusses the challenges facing Singapore's sharply declining ALP growth rate and proposes policy approaches that might help boost the country's ALP growth in the future.*

1. Introduction

The outstanding economic performance of Singapore and the other Asian "tiger economies" (Hong Kong, Korea, and Taiwan) during the past five decades has attracted a great deal of attention from researchers and policy-makers around the world. One way to gain insights into the performance of these economies is to decompose their growth into the contribution of productive factors (capital and labor) and the increase in total factor productivity (TFP). This makes it possible to capture the growth in combined productivity of production inputs and the contribution of unobservable factors.

Early studies of the sources of economic growth in "tiger economies" revealed shocking information about the East Asian growth model: TFP growth was found to be unusually low in comparison with output growth which was remarkably high. This paradox is particularly striking in the case of Singapore, where TFP growth was marginal even though output growth was well above 8% in the periods under study (Table 1).

Table 1. Singapore's output and TFP growth from selected studies

Unit: %

Study	Period	Output Growth	TFP Growth
Tsao (1985)*	1970–1979	8.3	0.08
Young (1995)	1966–1990	8.7	0.2
Kim and Lau (1994)	1964–1990	8.9	0.4

*Note: * This study was focused on the manufacturing sector*

Young (1995) concludes that whereas "the growth of output […] in the newly industrialized countries is virtually unprecedented, the growth of TFP in these economies is not." Kim and Lau (1994) argued that "the hypothesis that there has been no technical progress during the postwar period cannot be rejected for the four East Asian newly industrialized countries." Based on these results, Krugman (1994) adopts a bluntly pessimistic view of the East Asian growth model. He compares the growth patterns in these economies with those of the Soviet Union, which also achieved outstanding growth through rapid input accumulation for an extended period prior to a period of economic stagnation and its eventual collapse in 1991, and projected: "…from the perspective of the year 2010, current projections of Asian supremacy extrapolated from recent trends may well look almost as silly as 1960-vintage forecasts of Soviet industrial supremacy did from the perspective of the Brezhnev years." (Krugman, 1994, p. 78)

Interestingly, in 2010, Singapore's GDP growth peaked at 14.8%, having achieved among its best single-year performance figures from the past four decades. Although Krugman's projection has turned out incorrect, it calls for a better understanding of the pattern of Singapore's growth in the past and the challenges that Singapore is facing to maintain its high performance in the future. This study aims to perform these tasks, and toward that end, this paper will proceed as follows: Section 2 highlights the salient features of Singapore's economic growth since 1965 and the challenges the country is facing in sustaining its high performance. Section 3 introduces the framework used to decompose Singapore's sources of GDP and average labor

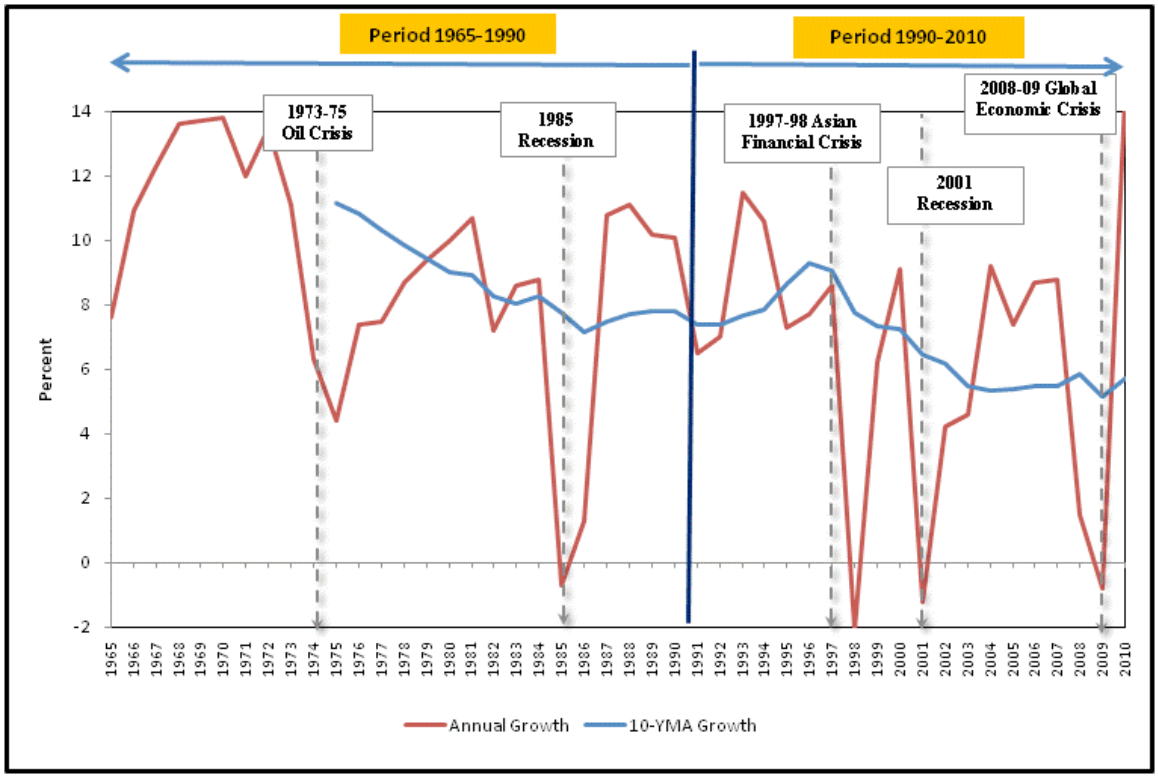
productivity (ALP) growth. Section 4 presents the results achieved along with relevant insights. Section 5 discusses policy issues and recommendations.

2. Singapore's economic growth, 1965–2010: salient features and challenges ahead

2.1. Salient features

Singapore's economic growth from 1965 to 2010 can be broadly understood by dividing that time-span into four shorter periods: 1965–1980, 1980–1990, 1990–2000, and 2000–2010 (Figure 1). The first two periods, 1965–1980 and 1980–1990, were characterized by government efforts to use export-led industrialization and rapid capital accumulation to promote quantitative growth. In the first period (1965–1980), the government's main policy objectives were to promote growth by attracting foreign direct investment (FDI), create jobs and expand productive capacity (Peebles and Wilson, 1996). During this period, Singapore achieved rapid growth. However, its economy was also affected by the worldwide recession of 1974–1975, which had been caused by the 1973 oil crisis. Singapore's growth in the second period (1980–1990) was shaped by government policies launched in the late 1970s and early 1980s to restructure industry by focusing on high-tech manufacturing and high value-added services.[1] A deep recession began in 1985 that was partly caused by a slump in global demand, especially from the US (Rigg, 1988).

Figure 1. Singapore's Annual and 10-Year Moving Average Growth, 1965–2010



Data source: Singapore Department of Statistics

The two periods after 1990 were influenced by the government's strategic plan to transform Singapore into a developed nation, which emphasized qualitative

[1] These policies were initiated in 1979 (Peebles and Wilson, 1996).

development.[2] These two periods, and especially the 2000–2010 period, were also affected by the accelerated pace of globalization, the rapid penetration of information technology, and increasing turbulence in the world economy. Factors that had a tremendous impact include the Asian financial crisis of 1997–1998, the global recession caused by the dot-com crash in 2000, the 9-11 terrorist attack in 2001, and the 2008–2009 global economic crisis (Figure 1).

Singapore's economic growth throughout these four periods included three salient features: government intervention, vulnerability to external shocks, and resilience.

Government intervention: The government's interventionist policy has had a powerful effect on the dynamics of growth. Since achieving independence, the Singaporean government has adopted interventionist policies to promote economic growth and development. These policies range from attracting and cultivating FDI to promoting domestic businesses and from targeting strategic industries to upgrading the factor conditions. These policies have evolved over time and had a significant effect on Singapore's growth trajectory.

Vulnerability to external shocks: The Singapore economy is highly vulnerable to external shocks. Due to the characteristics of the economy (lack of natural resources, the legacy of dependence on entrepot trade[3]) and the government's development strategy, Singapore has a large and export-reliant manufacturing sector.[4] Its major industries, including electronics, petroleum, chemicals, and shipbuilding, are large scale and highly cyclical. As a result, any significant turmoil in the external environment can have severe adverse effects on Singapore's economy.

Resilience: Singapore's economy has demonstrated its excellent resilience with the ability to recover robustly from every of the five major shocks it has suffered: the 1973–1975 oil crisis, the 1985 global trade slowdown, the 1997–1998 Asian financial crisis, the 2000-2001 recession due to the consequences of the dotcom burst and the 9-11 terrorist attack, and the 2008-2009 global economic turmoil (Figure 1). Thanks to its sustained outstanding GDP growth over the past five decades, Singapore has become one the world's wealthiest nations in terms of gross national income per capita measured in purchasing power parity (PPP) terms.[5]

2.2. Challenges ahead

In spite of its remarkable economic growth, Singapore faces formidable challenges ahead in building sustainable prosperity. Some of these challenges are associated with the country's recent growth pattern, in which GDP growth has been driven strongly by employment expansion contributed by an influx of immigrant workers, while its labor productivity growth has been sluggish.

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[2] Ministry of Trade and Industry, *The Strategic Economic Plan Towards A Developed Nation*, Report of the Economic Planning Committee, 1991.
[3] For a detailed discussion, see Huff (1997).
[4] In 2007, the manufacturing sector's value added accounted for 25% of GDP in Singapore, whereas this figure was only 2.5% for Hong Kong (Source: World Development Indicators).
[5] In 2010, Singapore's GNI per capita was PPP$54,700, while this figure was 47,300 for Hong Kong, 47,020 for the United States, and 39,600 for Sweden. (Source: World Bank, available at http://siteresources.worldbank.org/DATASTATISTICS/Resources/GNIPC.pdf).

It is important to notice that labor productivity and its growth are important indicators of economic performance. On the theoretical ground, Jones (1997) pointed out that labor productivity is a more reliable measure compared to per capita income in capturing the wealth level of a nation. The labor productivity (measured as GDP or value-added per effective worker or man-hour) has been widely used in analyzing economic performance and the trend of convergence or divergence among countries.[6] While TFP growth remains an important indicator on technological progress and the economy's efficient use of production inputs, ALP growth is a practical measure that can be used to monitor the economy's progress toward higher value-added structures[7]. As Sargent and Rodriguez (2000, p. 43) pointed out, "In new growth models in which physical capital accumulation is the engine of growth, capital intensity drives TFP growth, not the other way around. Therefore trends in capital accumulation [which is captured by ALP growth] are more relevant for examining the growth process than are trends in TFP growth." In fact, ALP to some extent reflects the sophistication of an economy and its industries and it is a meaningful indicator of the pace of structural change and the vibrancy of innovation activities (Dowrick, 1989; Katz, 2000; O'Leary, 2003; and O'Mahony and Ark, 2003). In addition, Porter (2003) also showed that labor productivity is a determinant of prosperity and competitiveness.

On the practical ground, labor productivity has become a main priority and strategic focus of policy makers in many countries, especially the Organization for Economic Co-operation and Development (OECD) nations (Ahmad et al., 2003). In fact, governments across OECD countries are seeking to promote economic growth with policy reforms aimed at fostering labour productivity growth (OECD, 2008). It is also important to note that it is more practical and feasible to monitor and compare labor productivity level and growth across countries/sectors over time because the measurement of labor productivity is straightforward and its related data is timely available at all levels (economy, sector, sub-sector, and firm).

Concerning labor productivity, Singapore is facing two main challenges. The first challenge is related to Singapore's relative low labor productivity level. It average labor productivity (ALP) is still well below the corresponding US level, which is the typical benchmark used in economic growth literature. Taking the corresponding U.S. levels as 100, Singapore's ALP was around 60 or below for the economy level; the second challenge is Singapore's lack of robustness in catching up with the U.S. on ALP: Singapore's ALP relative to the US declined during 2001-2009 (Figure 2).

These two challenges are faced not only by the traditional sectors such as Manufacturing, Hotels and Restaurants, and Construction; but also by the advanced industries with high shares of skilled labor such as Information and Communications, and Financial Services (Figure 2). For example, the ALP of Singapore's Information and Communications sector relative to the US declined from below 50% in 2001 to below 35% in 2009 (Figure 2).

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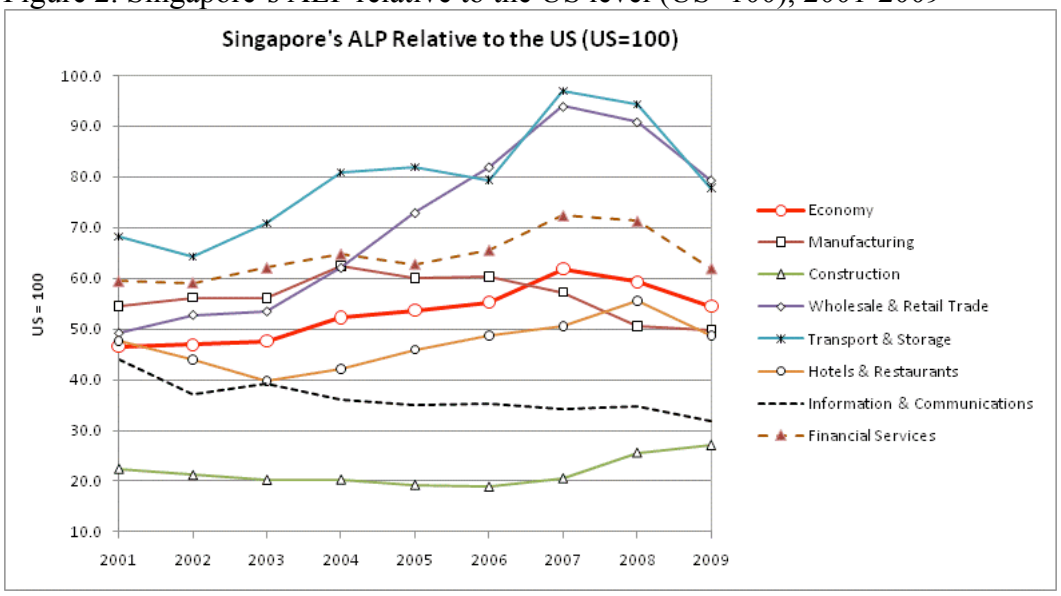
[6] The studies along this line include Abramovitz (1986), Baumol (1986), Dollar and Wolff (1988, 1993), Dowrick and Nguyen (1989), De Long (1992), Bernard and Jones (1995), Jones (1997), Hall and Jones (1997), Dunford and Smith (2000), Katz (2000), and McQuinn and Whelan (2007).

[7] It is worth noting that labor productivity has some limitations relative to the TFP measure. For example, it masks economies of scale while TFP growth can pick up on these issues (Mahadevan 2004).

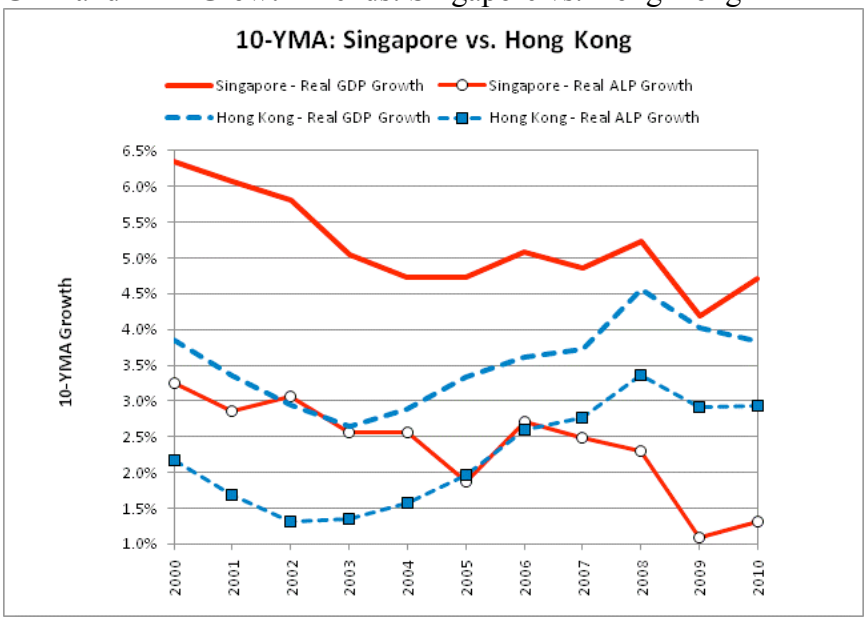
Figure 2. Singapore's ALP relative to the US level (US=100), 2001-2009



Data sources: Singapore Department of Statistics (for Singapore); Bureau of Economic Analysis (for the US).

In comparisons to its peer, Singapore paled beside Hong Kong in recent decades. In terms of the long-term growth trend based on the 10-Year Moving Average (10-YMA)[8] growth, Hong Kong overtook Singapore on ALP since 2007 and this gap has widened since then. At the same time, Singapore's 10-YMA GDP growth has a downward trend, while that of Hong Kong has shown notable improvement. These comparisons suggest that Singapore should rethink its current growth model to sustain its high economic performance in the long-term.

Figure 3. GDP and ALP Growth Trends: Singapore vs. Hong Kong



Data source: Total Economy Dataset, Conference Board

3. Decomposition Framework

[8] The 10-YMA of variable X at year *t* is computed as $(X_t + X_{t-1} + X_{t-2} + ... + X_{t-9})/10$.

This section investigates the sources of Singapore's economic growth since 1965. Because the detailed data such as capital investment flows is not available for 2009 and 2010, the investigation focuses on the 1965-2008 timeframe.

This exercise uses the standard growth decomposition framework employed by the Organization for Economic Co-operation and Development (OECD) for measuring aggregate and industry-level productivity growth, which is elaborated in OECD (2001). The methodology was introduced by Solow (1957, 1960) and developed considerably by Dale Jorgenson, Zvi Griliches, and Erwin Diewert (OECD, 2001, p. 18).[9] Assume that the aggregate production function takes the form

$$Y = A.X(K_{BS}, K_{TE}, K_{ME}, L), \qquad (1)$$

where gross domestic product Y is produced from aggregate factor input X, which incorporates capital services K and labor employed L. K is rendered using three types of capital assets: nonresidential business structures (K_{BS}), transport equipment (K_{TE}), and machinery and equipment (K_{ME}). Productivity is represented as the Hicks-neutral augmentation of aggregate input (A). It is important to note that this decomposition framework is more advanced than the traditional approach based on the simple Cobb-Douglas function. As elaborated in Appendix 2, this method uses the concept of capital services, which takes into account the user's costs of capital for different asset types to estimate the contribution of capital to growth.

Under the neoclassical assumptions of competitive markets and constant returns to scale, Equation 1 can be transformed into a growth accounting decomposition as follows:

$$\Delta \ln Y = \bar{v}_{K_{BS}} \Delta \ln K_{BS} + \bar{v}_{K_{TE}} \Delta \ln K_{TE} + \bar{v}_{K_{ME}} \Delta \ln K_{ME} + \bar{v}_L \Delta \ln L + \Delta \ln A, \qquad (2)$$

where $\bar{v}$ is the average percentage of total factor income represented by the subscripted input over the two periods of the change. All variables are expressed in logarithmic first differences ($\Delta \ln$) to indicate their growth rates. The assumption of constant returns to scale of the aggregate input function implies that

$$\bar{v}_K = \bar{v}_{K_{BS}} + \bar{v}_{K_{TE}} + \bar{v}_{K_{ME}} = 1 - \bar{v}_L. \qquad (3)$$

Equation 2 implies that GDP growth is driven by three main sources:

- Capital input ($\bar{v}_{K_{BS}} \Delta \ln K_{BS} + \bar{v}_{K_{TE}} \Delta \ln K_{TE} + \bar{v}_{K_{ME}} \Delta \ln K_{ME}$)
- Labor input ($\bar{v}_L \Delta \ln L$), and
- TFP growth ($\Delta \ln A$).

Combining Equations (2) and (3) creates a framework for decomposing the sources of average labor productivity (ALP) growth, $y = Y / L$, as

$$\Delta \ln y = \bar{v}_{K_{BS}} \Delta \ln k_{BS} + \bar{v}_{K_{TE}} \Delta \ln k_{TE} + \bar{v}_{K_{ME}} \Delta \ln k_{ME} + \Delta \ln A, \qquad (4)$$

where $k_i = K_i / L$ is referred to as capital deepening in capital assets i ($i \in \{BS; TE; ME\}$)

[9] While there are other frameworks for decomposing the sources of growth such as those based on the Constant Elasticity of Substitution (CES) and Transcendental Logarithmic (translog) functions, the method adopted by OECD has proved to be a consistent and well-founded approach, which effectively integrates the production function theory with national accounts (OECD, 2001).

Equation (4) shows that ALP growth is driven by two main sources:
The contribution of capital deepening ($\bar{v}_{K_{BS}} \Delta \ln k_{BS} + \bar{v}_{K_{TE}} \Delta \ln k_{TE} + \bar{v}_{K_{ME}} \Delta \ln k_{ME}$) and TFP growth ($\Delta \ln A$).

Equations (2), (3), and (4) also imply that

$$\Delta \ln Y = \Delta \ln y + \Delta \ln L. \quad (5)$$

That is, GDP growth is driven by two sources: ALP growth ($\Delta \ln y$) and the contribution of employment expansion ($\Delta \ln L$). The share of labor productivity growth in GDP growth computed as $\Delta \ln y / \Delta \ln Y$ indicates the extent to which GDP growth is driven by labor productivity growth, which is associated with improvements in a nation's competitiveness and standards of living. If this percentage declines, it implies that GDP growth is increasingly driven by employment expansion.

Growth decomposition based on the frameworks presented above requires an estimation of the percentage of income driven by labor and capital inputs, capital stock and capital services. The details of these estimation procedures are provided in the Appendices at the end of this paper.

4. Growth Decomposition Results

4.1. The sources of growth by period

The results indicating the sources of Singapore' economic growth in its four periods of development — 1965–1980, 1980–1990, 1990–2000, and 2000–2008 — are shown in Table 2.

Table 2. Sources of GDP and ALP growth, 1965–2008

	1965-1980	1980-1990	1990-2000	2000-2008
GDP Growth (% points)				
GDP growth (I)	9.7	7.2	7.3	4.7
Contribution of capital	7.9	3.8	3.8	2.3
Contribution of labor	1.9	1.4	2.1	1.9
TFP growth	−0.1	2.0	1.4	0.5
Structure (%)				
Real GDP growth	100.0	100.0	100.0	100.0
Contribution of capital	81.1	52.8	52.4	48.4
Contribution of labor	20.1	19.8	28.4	41.0
TFP growth	−1.2	27.4	19.2	10.6
ALP Growth (% points)				
ALP growth (II)	5.9	4.4	3.4	0.9
Capital deepening	6.0	2.4	2.0	0.4
TFP growth	−0.1	2.0	1.4	0.5
Structure (%)				
ALP growth	100.0	100.0	100.0	100.0
Capital deepening	102.0	54.9	59.2	43.8
TFP growth	−2.0	45.1	40.8	56.2
Share of ALP Growth in GDP Growth (%)				

(II)/(I)	61.2	60.9	47.1	18.9

During the first period (1965–1980), Singapore achieved an outstanding GDP growth rate of 9.7%, of which 81.1% was due to capital accumulation. The contribution of labor was 1.9%, accounting for 20.1% of GDP growth. In contrast, TFP growth averaged −0.1% (Table 2) despite Singapore's outstanding GDP growth, and this discrepancy has sparked concerns regarding Singapore's degree of technological progress (Tsao, 1982, 1985; Kim and Lau, 1994). Although TFP growth was negligible, ALP growth during this period was strong at 5.9% and was totally driven by robust capital deepening (6%). During this period, ALP growth accounted for 61.2% of GDP growth (Table 2), which means that economic growth was largely driven by improvements in labor productivity.

In the second period (1980–1990), the government policies launched in the late 1970s and early 1980s to restructure industry with a focus on high-tech manufacturing and high value-added services produced encouraging results. The GDP grew 7.2%, with a significant contribution from TFP growth (2% or a 27.4% share). ALP growth was 4.4% and accounted for nearly 61% of GDP growth (Table 2). Furthermore, ALP growth was driven almost equally by capital deepening (2.4%) and TFP growth (2.0%). These results are consistent with those of Toh and Ng (2002) and Akkemik (2007), who found that TFP growth was negligible in the early stages of Singapore's development but that it has substantially increased since the late 1980s. Chongvilaivan (2012), who examined Singapore's manufacturing sector during 1976-2004, showed that learning effects and high-tech capital deepening contributed significantly to TFP growth and the contribution of the former was larger than the latter. On the other hand, the heavy capital accumulation in the previous period, which built the foundation for long-term growth, might also have contributed to this improvement in performance.

In the third period (1990–2000), GDP growth was nearly the same as in the second period at 7.3%. However, relative to the second period, GDP growth in the third period was driven more by employment expansion (with 2.1% or a 28.4% share) and less by TFP growth (with 1.4% or a 19.2% share). Furthermore, the ALP growth rate was 3.4%, 1% point below the rate in the second period (Table 2). This gap was caused by both the lower contribution of capital deepening (which fell from 2.4% to 2.0%) and the lower level of TFP growth (which fell from 2.0% to 1.4%). It is also important to note that the contribution of ALP growth to GDP growth in 1990–2000 fell to 47.1% from 60.9% in 1980–1990 (Table 2).

GDP growth in the fourth period (2000–2008) experienced a sharp drop, falling to 4.7%. This slowdown was largely caused by the sharp decreases in the capital contribution (from 3.8% in 1980–1990 and 1990–2000 to 2.3% in 2000–2008) and TFP (from 2.0% in 1980–1990 and 1.4% in 1990–2000 to 0.5% in 2000–2008). Conversely, the contribution of labor remained high at 1.9%, whereas ALP growth in this period fell considerably to 0.9%, to which capital deepening contributed only 0.4% (Table 2). Furthermore, the contribution of ALP growth to GDP growth during this period was surprisingly small (18.9%).

The sources of Singapore's GDP and ALP growth as presented above indicate three important trends that will pose a challenge to Singapore's growth in the coming years. First, ALP growth, especially the share of ALP growth in GDP growth, declined. ALP

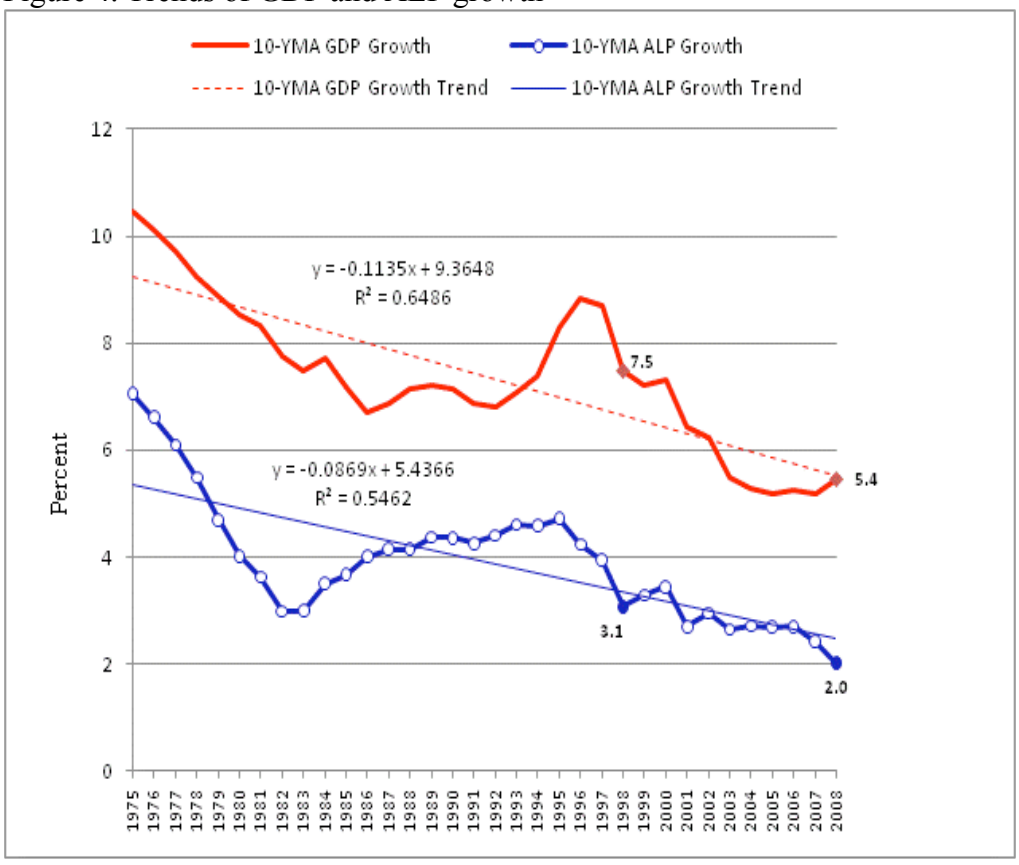
growth fell from 5.9% in 1965–1980 to 4.4%, 3.4%, and 0.5% in 1980–1990, 1990–2000, and 2000–2008, respectively. The contribution of ALP to GDP growth also fell sharply, especially in the last two periods, with a decrease from approximately 61% in the first two periods to 47.1% in 1990–2000 and 18.9% in 2000–2008. Secondly, the contribution of capital deepening to ALP growth declined over time: from 6.0% points in 1965–1980 to 2.4%, 2.0%, and 0.4% in 1980–1990, 1990–2000, and 2000–2008, respectively. Thirdly, Singapore tried to maintain a large share of labor contribution to GDP growth by increasingly relying on cheap foreign labor. (Table 2)

Subsection 4.2 examines the trends and patterns in GDP and ALP growth and their sources using the 10-YMA measure. This examination provides further insight into the policy challenges complicating the question of Singapore's future growth.

4.2. Driving factors of GDP and ALP growth trends

Both GDP and ALP growth followed downward-sloping trends. Their trend lines exhibit high predictive power (R^2=0.65 for GDP growth and 0.55 for ALP growth) and a large negative slope β (β=−0.11 for GDP growth and −0.09 for ALP growth). These figures indicate that on average, 10-YMA growth decreased by 1.1% points for GDP and 0.9% points for ALP. (Figure 4).

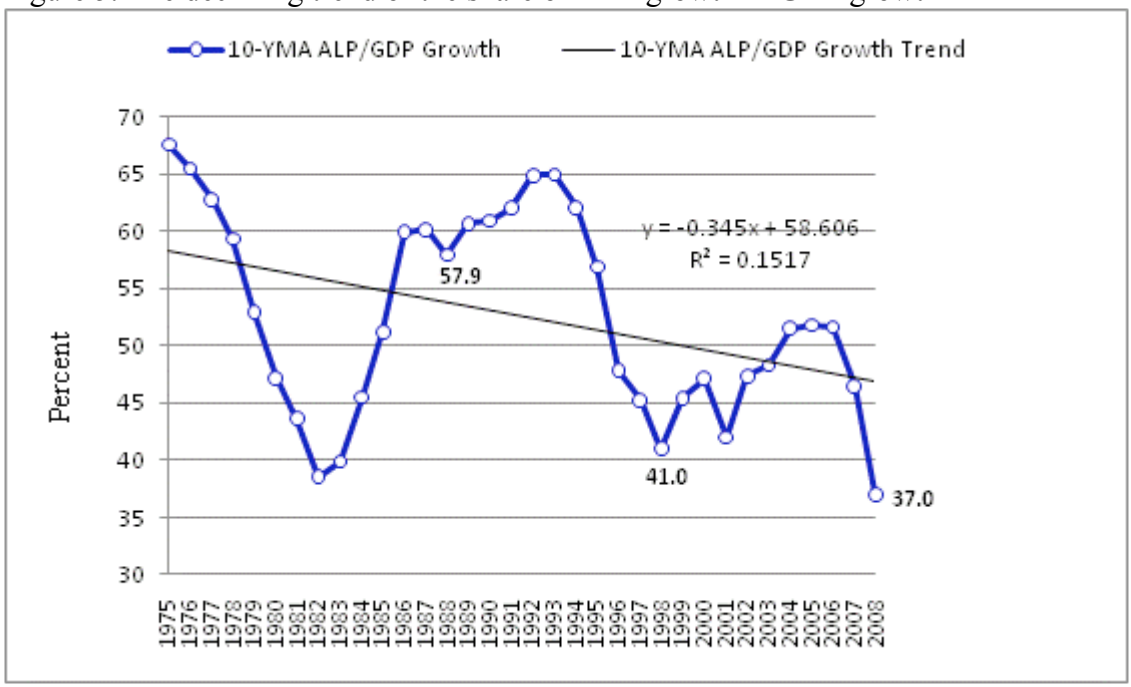
Figure 4. Trends of GDP and ALP growth



The declining trends in GDP and ALP growth have been particularly pronounced over the past two decades. 10-YMA GDP growth fell from 7.5% in 1998 to 5.4% in 2008, whereas 10-YMA ALP growth declined from 3.1% in 1998 to 2.0% in 2008. The decreasing trend in GDP and ALP growth in Singapore is consistent with the "convergence effect" found in the economic growth literature: nations tend to grow

more slowly as their wealth increases.[10] Although decreasing trends in GDP and ALP growth are unavoidable, ALP growth has tended to decline more rapidly than GDP growth. In fact, the contribution of ALP growth to GDP growth (using the 10-YMA measure) declined from 57.9% in 1988 to 41% in 1998 and 37% in 2008. These figures indicate that Singapore's GDP growth was increasingly dependent on employment expansion during this interval (Figure 5).

Figure 5. The declining trend of the share of ALP growth in GDP growth



It is also important to note that GDP and ALP growth (based on the 10-YMA measure) did not steadily fall over time. Instead, there were some periods of resurgence. 10-YMA GDP growth was stable and surged from 1986 to 1996 (Figure 4, Table 3a), whereas 10-YMA ALP growth increased from 1983–1996 (Figure 4, Table 3b). These observations suggest that policy initiatives and external factors also played an important role in Singapore's economic performance.

The remainder of this section investigates the changes in the sources of GDP and ALP growth. This analysis will elucidate the factors driving the declining trends and periodic resurgence in GDP and ALP growth.

Figure 6a. The sources of GDP growth

[10] Barro (1991) and Barro and Sala-i-Martin (1995) estimate that per capita incomes tend to converge to their steady-state levels at a rate of approximately 2% per year.

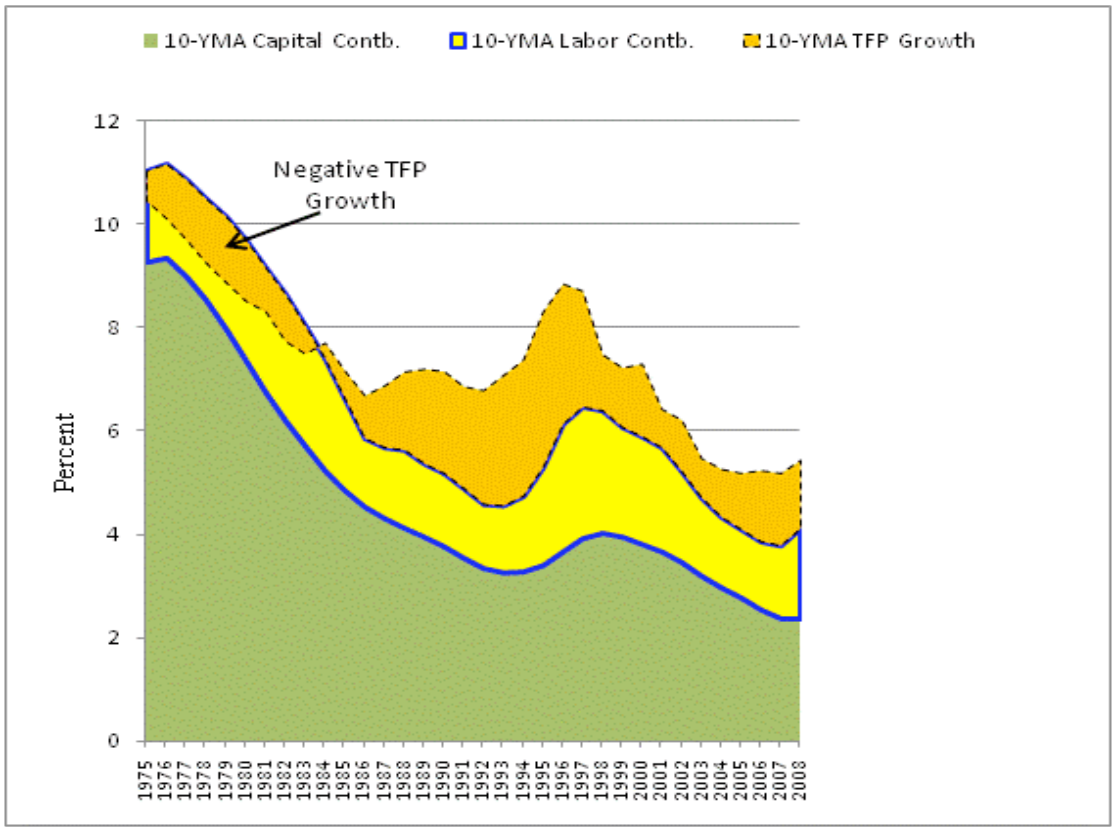

10-YMA Capital Contb.
10-YMA Labor Contb.
10-YMA TFP Growth
Negative TFP Growth
Percent
12
10
8
6
4
2
0
1975
1976
1977
1978
1979
1980
1981
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Table 3a. The sources of GDP growth

Year	10-YMA				GDP Growth=100		
	GDP Growth (%)	Contribution (% points)			Contribution Share (%)		
		Capital	Labor	TFP	Capital	Labor	TFP
1975	10.4	9.3	1.8	−0.6	88.7	16.9	−5.6
1976	10.1	9.3	1.8	−1.1	92.5	18.0	−10.4
1977	9.7	9.0	1.9	−1.2	92.6	19.3	−12.0
1978	9.2	8.5	2.0	−1.2	92.3	21.2	−13.4
1979	8.9	8.0	2.2	−1.3	89.9	24.5	−14.4
1980	8.5	7.4	2.3	−1.2	86.6	27.3	−13.9
1981	8.3	6.8	2.4	−0.9	81.3	28.9	−10.2
1982	7.7	6.2	2.4	−0.9	80.2	31.6	−11.8
1983	7.5	5.7	2.3	−0.5	76.3	30.9	−7.2
1984	7.7	5.2	2.2	0.3	68.0	28.1	3.9
1985	7.2	4.9	1.8	0.5	67.8	24.8	7.4
1986	6.7	4.5	1.3	0.8	67.9	19.8	12.3
1987	6.9	4.3	1.4	1.2	62.8	19.9	17.3
1988	7.2	4.1	1.5	1.5	57.9	21.1	21.1
1989	7.2	4.0	1.4	1.8	55.0	19.6	25.3
1990	7.2	3.8	1.4	2.0	52.8	19.8	27.4
1991	6.9	3.6	1.3	2.0	51.8	19.6	28.6
1992	6.8	3.4	1.2	2.2	49.5	18.2	32.3
1993	7.1	3.3	1.3	2.5	46.3	18.2	35.5
1994	7.4	3.3	1.5	2.6	44.7	19.7	35.6
1995	8.3	3.4	1.9	3.0	41.1	22.8	36.1
1996	8.8	3.7	2.5	2.7	41.6	27.8	30.6
1997	8.7	3.9	2.5	2.2	45.2	29.2	25.6
1998	7.5	4.0	2.4	1.1	54.0	31.6	14.4
1999	7.2	4.0	2.1	1.1	54.9	29.3	15.8
2000	7.3	3.8	2.1	1.4	52.4	28.4	19.2
2001	6.4	3.7	2.0	0.7	57.2	31.3	11.5
2002	6.2	3.5	1.8	1.0	55.9	28.2	15.9
2003	5.5	3.2	1.5	0.8	58.6	27.6	13.8
2004	5.3	3.0	1.4	0.9	56.6	25.9	17.5
2005	5.2	2.8	1.3	1.1	53.8	25.4	20.8
2006	5.2	2.6	1.3	1.4	48.8	25.0	26.1
2007	5.2	2.4	1.4	1.4	46.1	27.1	26.8
2008	5.4	2.4	1.7	1.3	43.8	32.0	24.2

Changing patterns in the sources of GDP growth

The three sources of GDP growth (based on the 10-YMA measure) are graphed in Figure 6a. Although the contribution of capital declined, that of labor was essentially stable, and that of TFP growth exhibited decisive improvement after 1984. The contribution of capital to growth (based on the 10-YMA measure) fell from 9.3% in 1975 to 4.9%, 3.4%, 2.8%, and 2.4% points in 1985, 1995, 2005, and 2008, respectively (Table 3a). Meanwhile, during the same years, the contribution of labor was 1.8%, 1.8%, 1.9%, 1.3%, and 1.7%, and that of TFP growth was −0.6%, 0.5%, 3.0%, 1.1%, and 1.3% (Table 3a). This examination thus shows that the decline in capital contribution was the sole cause of the decline in GDP growth.

Figure 6b. The sources of ALP growth

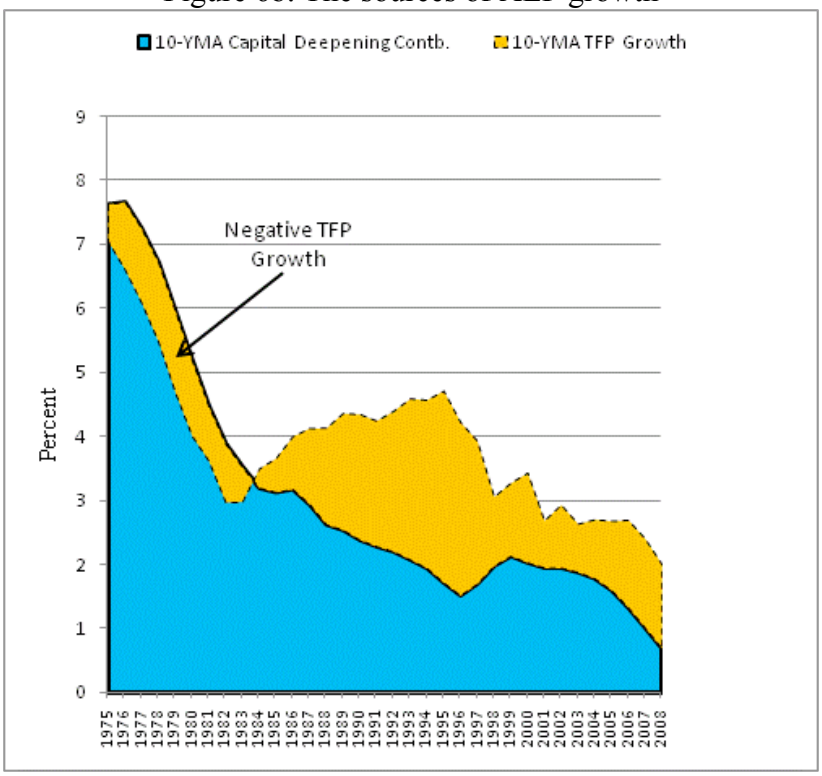

Table 3b. The sources of ALP growth

Year	10-YMA			ALP Growth=100	
	ALP Growth (%)	Contribution (% points)		Contribution Share (%)	
		Capital Deepening	TFP	Capital Deepening	TFP
1975	7.1	7.6	−0.6	108.3	−8.3
1976	6.6	7.7	−1.1	116.0	−16.0
1977	6.1	7.3	−1.2	119.1	−19.1
1978	5.5	6.7	−1.2	122.6	−22.6
1979	4.7	6.0	−1.3	127.2	−27.2
1980	4.0	5.2	−1.2	129.5	−29.5
1981	3.6	4.5	−0.9	123.5	−23.5
1982	3.0	3.9	−0.9	130.6	−30.6
1983	3.0	3.5	−0.5	118.1	−18.1
1984	3.5	3.2	0.3	91.5	8.5
1985	3.7	3.1	0.5	85.6	14.4
1986	4.0	3.2	0.8	79.5	20.5
1987	4.1	3.0	1.2	71.3	28.7
1988	4.1	2.6	1.5	63.6	36.4
1989	4.4	2.5	1.8	58.3	41.7
1990	4.4	2.4	2.0	54.9	45.1
1991	4.3	2.3	2.0	53.9	46.1
1992	4.4	2.2	2.2	50.2	49.8
1993	4.6	2.1	2.5	45.4	54.6
1994	4.6	2.0	2.6	42.7	57.3
1995	4.7	1.7	3.0	36.5	63.5
1996	4.2	1.5	2.7	36.1	63.9
1997	3.9	1.7	2.2	43.4	56.6
1998	3.1	2.0	1.1	64.8	35.2
1999	3.3	2.1	1.1	65.2	34.8
2000	3.4	2.0	1.4	59.2	40.8
2001	2.7	2.0	0.7	72.7	27.3
2002	2.9	2.0	1.0	66.5	33.5
2003	2.6	1.9	0.8	71.5	28.5
2004	2.7	1.8	0.9	66.0	34.0
2005	2.7	1.6	1.1	59.8	40.2
2006	2.7	1.3	1.4	49.4	50.6
2007	2.4	1.0	1.4	42.3	57.7
2008	2.0	0.7	1.3	34.7	65.3

Changing patterns in the sources of ALP growth
Figure 6b depicts the sources of ALP growth. It is obvious that the contribution of capital deepening severely declined, whereas TFP growth became a major source of ALP growth after the mid-1980s. The contribution of capital deepening (based on the 10-YMA measure) fell from 7.6% in 1975 to 3.1%, 1.7%, 1.6%, and 0.7% in 1985, 1995, 2005, and 2008, respectively, whereas the contribution of TFP to ALP growth in the same years was −8.3%, 14.4%, 63.5%, 40.2%, and 65.3% (Table 3b). These results indicate that the decreased contribution of capital deepening was the major factor in the declining trend of ALP growth.

5. Policy challenges and recommendations

5.1. Policy issues

As presented in Section 2, labor productivity is a key measure of economic performance, which determines a country's international competitiveness and living standards. While Singapore's economic performance over the past 4-5 decades is miraculous, its challenges associated with labor productivity remain formidable. It appears that it will take a long way for Singapore to catch up with the US on the ALP level. One can estimate that if the two countries maintain their 1998–2008 ALP growth rates, it will take more than 120 years for Singapore to catch up with the US on this measure.[11] Therefore, ALP growth should be the primary focus of Singapore's economic policy in the coming years.

The analyses in Section 4 provide several policy insights that should help Singapore to boost its ALP growth. First, it is imperative that Singapore reverses the sharply declining trend in the contribution of capital deepening. Secondly, Singapore must maintain and strengthen its fairly healthy level of TFP growth.

The declining trend in the contribution of capital deepening was driven by the decrease in the rate of capital accumulation in Singapore, especially after the 1997–1998 Asian financial crisis, although the economy maintained a high rate of employment expansion. There are three possible factors in these dynamics. Firstly, businesses in Singapore appeared to find it more profitable to substitute labor for capital because they had good access to inexpensive labor. In fact, the number of foreign workers rose from 21,000 (3.2% of the workforce) in 1970 to 120,000 (7.4%) in 1980, 248,000 (16.1%) in 1990, and 612,000 (29.2%) in 2000. The majority of these individuals were low-skilled workers[12] (Yeoh, 2007). At the same time, Singapore's trend of underinvestment relative to its employment expansion has become increasingly evident since 2005 (Figure 7).

Figure 7: Trends of Singapore's Investment Intensity and Employment Growth

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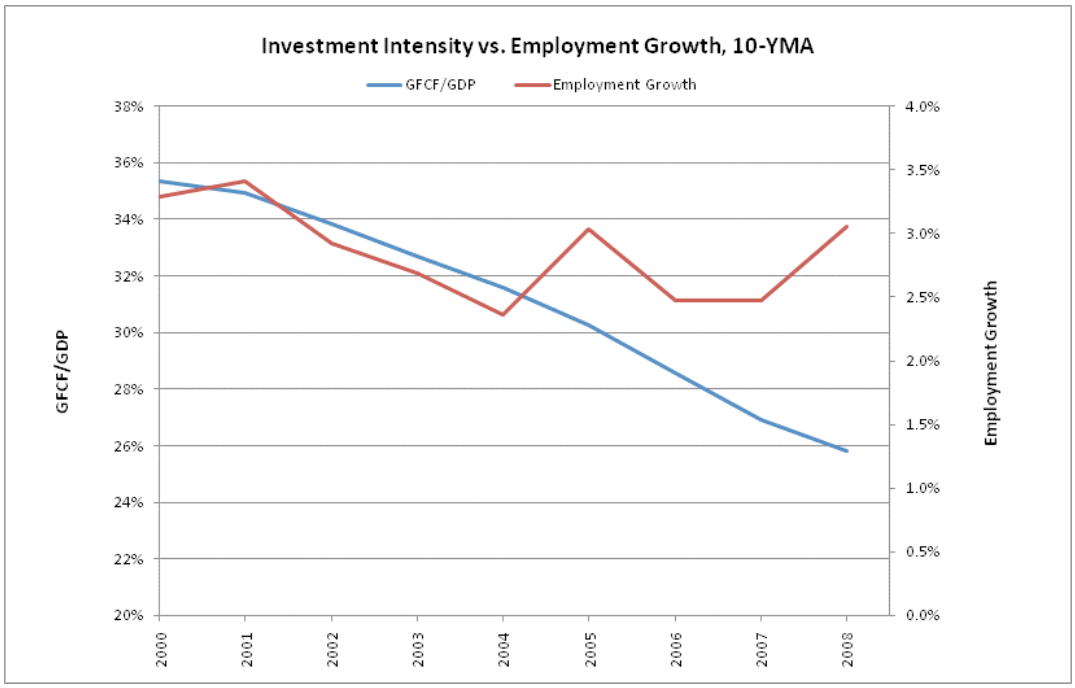
[11] For country X (with productivity x_0 in year 0 and ALP growth rate g_X) to catch up with country Y (with productivity y_0 in year 0 and ALP growth rate g_Y), it takes $k = \ln(\frac{y_0}{x_0}) : \ln(\frac{1+g_X}{1+g_Y})$ years. Over 1998-2008, Singapore's ALP growth was around 2.0%, while this rate was 1.6% for the US.

[12] In 2006, 86.6% of 670,000 foreign workers in Singapore were low-skilled (Yeoh, 2007).



Secondly, the government may have prioritized GDP growth at the cost of ALP growth. Because GDP growth is an important performance indicator that affects the pay that government officials receive (Blöndal, 2006), the government tends to have a strong incentive to promote GDP growth. As a result, the government may have encouraged employment expansion at the cost of ALP growth. Thirdly, because of the accelerated rate of globalization that occurred with the rise of Asia, firms may have been able to achieve higher returns on capital investment elsewhere outside of Singapore.

The next subsection suggests policy approaches that may help Singapore to effectively address the challenges to its ALP growth as presented above.

5.2. Policy recommendations

Any policy that helps Singapore enhance its long-term economic performance must focus on ALP growth in addition to TFP growth and help the economy to constantly transition into higher value-added activities.
The endeavor to promote ALP growth in Singapore should center on three approaches: i) eliminating policies biased towards business expansion at the cost of ALP growth; (ii) establishing an effective mechanism for monitoring ALP growth in every industry and economic sector; and (iii) utilizing a strategic framework to launch policies and initiatives intended to boost ALP growth.

Removing the policies that may dampen ALP growth

There are several policies that can encourage businesses to expand at the cost of ALP growth. One such policy is heavy reliance on simple measures such as increases in value-added, revenues, employment, or exports as key performance indicators, which

can attract attention at the expense of ALP growth. These methods of performance measurement may encourage businesses to achieve growth through employment expansion or by shifting towards lower value-added activities. Another policy bias is the provision of easy access to immigrant workers without labor productivity performance monitoring.

Establishing an effective system for monitoring ALP growth in the sector

To boost ALP growth, the government and business associations need to establish an effective system for monitoring ALP growth in every industry. This system should include a productivity database based on international benchmarks and regular surveys and roundtable discussions intended to improve comprehension of the dynamics of ALP growth in every industry and every economic sector. This system should provide insights and evidence that will assist in the introduction and monitoring of policy initiatives intended to foster ALP growth.

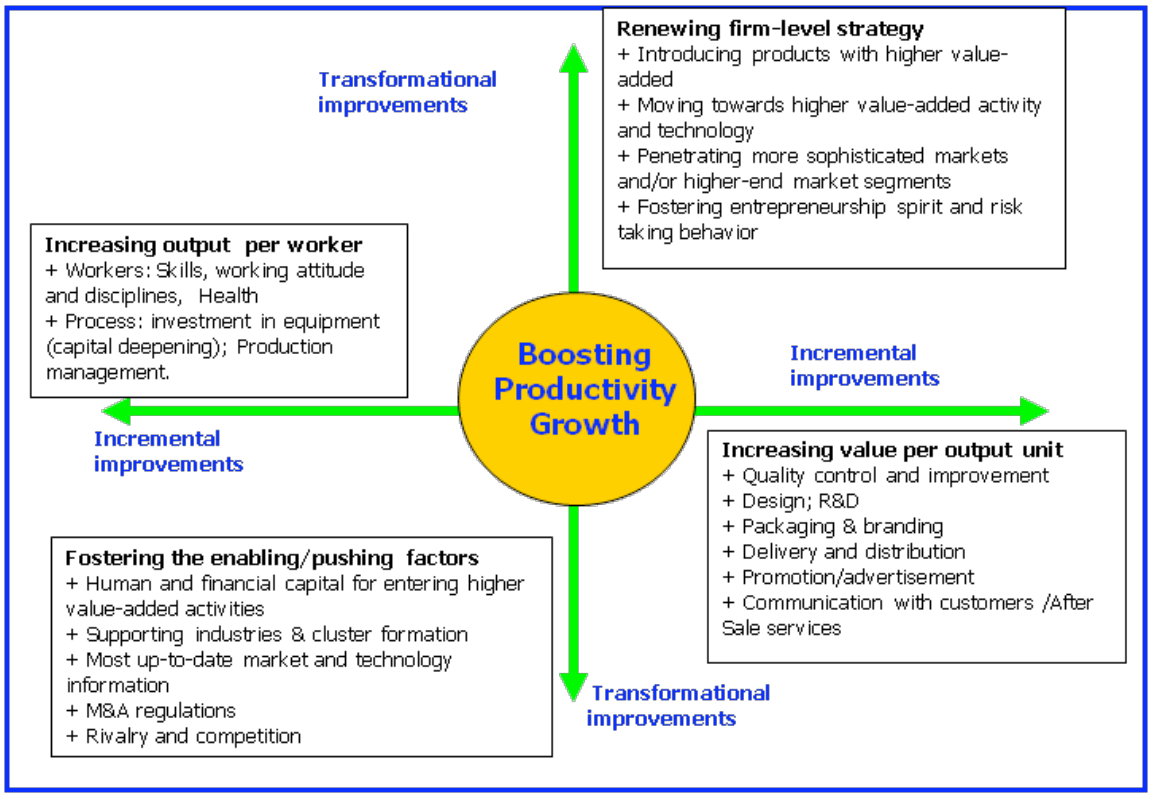
Utilizing a strategic framework for formulating policy initiatives to boost ALP growth

Figure 8 provides a strategic framework for designing policy initiatives to boost ALP growth in a given industry. This framework consists of two major dimensions. One dimension aims to help firms make incremental improvements to increase ALP, and the other seeks to enable firms to undertake transformational efforts to boost their ALP.

There are two measures of incremental improvement: increase in output per worker and increase in value per unit of output. The set of policy initiatives that aims to help firms increase output per worker should include provisions for training and worker reallocation across firms and industries. In addition, this set of policy initiatives should help firms to upgrade their production equipment and management through tax incentives or through the diffusion of technology information and best practices. The set of policy initiatives that aims to assist firms in increasing the value generated per unit of output should be more closely related to innovation and competition policy.

To encourage firms to transition into higher value-added activities, policy initiatives should focus on exhorting firms to revise their business strategies and on addressing the factors that facilitate business transformation. Firms should be incentivized to revise business strategies in order to increase ALP growth and move toward higher value-added activities. There should also be support available for local firms to expand globally. Policy initiatives that help to facilitate the transition into higher value-added activities might include those that increase the availability of labor skills and capital for such activities, provide better access to up-to-date market and technology information, and revise regulations to facilitate merger and acquisition (M&A) activities and foster competition.

Figure 8: A strategic framework for policy initiatives intended to boost ALP growth



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Appendices

Appendix 1: Income shares of labor and capital inputs

Let us begin with the national income identity (from Singapore's Annual Yearbook of Statistics):

$$Y = CE + GOS + GOSO + TPI + SD \qquad \text{(A1)}$$

where Y is the GDP, CE represents 'Employee Compensation', GOS is 'Gross Operating Surplus', $GOSO$ is the 'Gross Operating Surplus of Others',[13] TPI is 'Taxes on Production & Imports', and SD represents 'Statistical Discrepancies'. Assume that the contribution of labor income to the three ambiguous items — $GOSO$, TPI, and SD — is the same as its contribution to the overall economy v_L. Equation (A1) implies that the total contribution of labor input to GDP is

$$v_L Y = CE + v_L(GOSO + TPI + SD) \qquad \text{(A2)}$$

Equation (A2) can be rewritten to estimate the labor income share as

$$v_L = \frac{CE}{Y - GOSO - TPI - SD} \qquad \text{(A3)}$$

Under the neoclassical assumption of constant returns to scale, the income share of capital can simply be computed as $v_K = 1 - v_L$.

Appendix 2: Capital Stocks and Capital Services

Capital Stocks

The quantity of capital stock for asset type i is determined using the 'perpetual inventory method' as follows:

$$S_{i,T} = S_{i,T-1}(1-\delta_i) + I_{i,T} = \sum_{t=0}^{\infty}(1-\delta_i)^t I_{i,T-t} \qquad \text{(A4)}$$

where $S_{i,T}$ is the capital stock in year T for capital asset type i, δ_i is the constant rate of geometric depreciation,[14] and $\delta_i = 0.028$ for $i = BS$ (nonresidential business structures), $\delta_i = 0.191$ for $i = TE$ (transport equipment), and $\delta_i = 0.125$ for $i = ME$ (machinery and equipment). $I_{i,T-t}$ is the constant price investment flow in year $T - t$.

Capital Services

The procedure used to estimate the capital services rendered by a given type of capital asset was presented by Jorgenson, Ho, and Stiroh (2005). The procedure requires the estimation of the quantity of capital services, the rental price of those capital services, the contribution of the capital asset to income, and the ex-post nominal rate of return.

The quantity of capital services rendered by capital asset type *i* in year *T* is defined as the average capital stock between years T and T-1:

$$K_{i,T} = \frac{(S_{i,T} + S_{i,T-1})}{2} \qquad \text{(A5)}$$

The rental price $c_{i,T}$ of capital services from capital asset type i in period T is obtained using the assumption that the typical investor in period $T-1$ who invests in

[13] The 'Others' category here includes unincorporated firms and nonprofit institutions.

[14] These geometric depreciation rates originally appeared in Jorgenson, Ho, and Stiroh (2005) and Timmer, Ypma, and Ark (2003).

this capital asset at price $p_{i,T-1}$ will obtain a return rate that will justify the nominal rate of return r_T observed for the economy and the market price of the remaining value of the asset in year T. Under the market equilibrium condition, this assumption implies that

$$p_{i,T-1}(1+r_T) = c_{i,T} + (1-\delta_i)p_{i,T} \qquad \text{(A6)}$$

Equation (A6) suggests the formula for computing the rental price $c_{i,T}$

$$c_{i,T} = r_T p_{i,T-1} + \delta_i p_{i,T} - \pi_{i,T} p_{i,T-1} \qquad \text{(A7)}$$

where $\pi_{i,T} = (p_{i,T} - p_{i,T-1}) / p_{i,T-1}$ is the asset's price change over the period.

The contribution to income $v_{i,T}$ of capital services rendered by capital good *i* in year *T* is computed as

$$v_{i,T} = \frac{K_{i,T}}{Y_T} c_{i,T} \qquad \text{(A8)}$$

where Y_T is the GDP in current prices in year T.

The nominal rate of return r_T is determined as follows. The contribution to income of aggregate capital input is the sum of the contributions of all capital asset types as follows:

$$v_K = \sum_i v_{i,T} \qquad \text{(A9)}$$

Combining Equations (A7), (A8), and (A9) yields

$$v_K = \sum_i \frac{K_{i,T}}{Y_T} (r_T p_{i,T-1} + \delta_i p_{i,T} - \pi_{i,T} p_{i,T-1}) \qquad \text{(A10)}$$

Therefore, the nominal rate of return r_T (based on the ex-post approach), can be estimated using Equation (A10) as follows:

$$r_T = \frac{\left\{ v_K Y_T + \sum_i K_{i,T} \pi_{i,T} p_{i,T-1} - \sum_i K_{i,T} \delta_i p_{i,T} \right\}}{\sum_i K_{i,T} p_{i,T-1}} \qquad \text{(A11)}$$