DRIVERS OF LABOUR PRODUCTIVITY GROWTH TRENDS IN SINGAPORE

Labour productivity grew by 2.5% per annum from 2009 to 2014

Shift-Share Analysis

Productivity improved within most sectors, but productivity growth of **domestically-oriented sectors** lagged behind that of **export-oriented sectors**

Sectors with highest productivity growth:
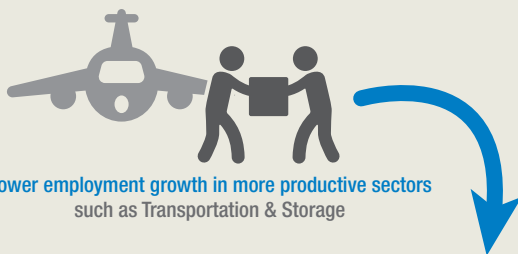
Biomedical Manufacturing

Precision Engineering

Transport Engineering

Overall labour productivity has been weighed down by a shift in employment towards **less productive sectors**

Lower employment growth in more productive sectors such as Transportation & Storage
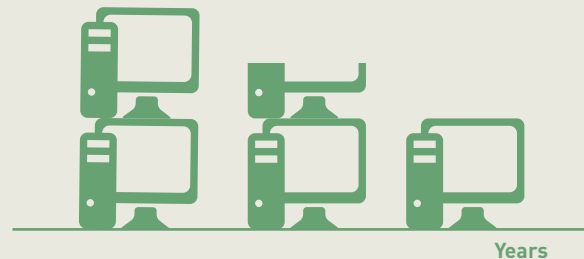
Higher employment growth in less productive sectors such as Food & Beverage Services and Construction
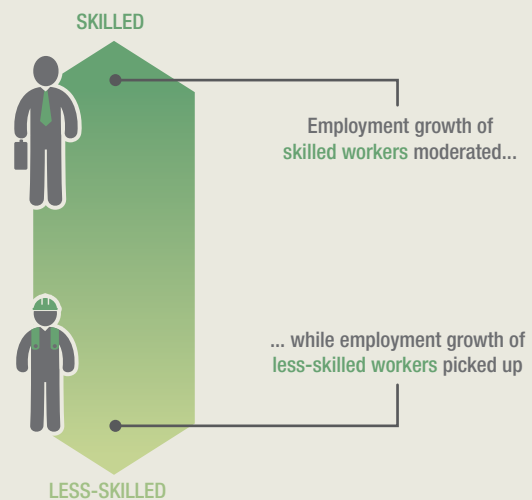
Growth Accounting Analysis

Capital intensity (i.e., capital per worker) and labour quality improvements supported productivity growth from 2009 to 2013

However, there are signs of a slowdown in **capital intensity** gains (e.g., in terms of machinery & equipment growth) in recent years

Years

Labour quality improvements also slowed

SKILLED

Employment growth of **skilled workers** moderated...

... while employment growth of **less-skilled workers** picked up

LESS-SKILLED

OVERVIEW

- This article examines the drivers of Singapore's labour productivity growth in recent years.

- <u>First</u>, using shift-share analysis, we find that Singapore's labour productivity growth from 2009 to 2014 was driven by productivity improvements in most sectors, especially export-oriented sectors. However, the gains were partially offset by a shift in employment towards less productive sectors, including Construction and Food & Beverage Services.

- <u>Second</u>, using growth accounting analysis, we find that capital intensity (i.e., capital per worker) and labour quality improvements supported productivity growth over the period of 2009 to 2013. However, there are signs of a slowdown in capital intensity gains (e.g., in terms of machinery & equipment growth), as well as labour quality improvements in more recent years.

The views expressed in this paper are solely those of the authors and do not necessarily reflect those of the Ministry of Trade and Industry or the Government of Singapore.

INTRODUCTION

Since 2010, the National Productivity Council (NPC) has spearheaded Singapore's productivity efforts, with the target of achieving productivity growth of 2 to 3 per cent per annum over the decade.[1] Between 2009 and 2014, overall productivity growth for the economy came in at a compounded annual growth rate (CAGR) of 2.5 per cent, although most of the gains can be attributed to the strong rebound in 2010 following the Global Financial Crisis (GFC). Excluding 2010, productivity growth has been lacklustre, at 0.3 per cent on a CAGR basis

This article examines the drivers of Singapore's productivity growth in recent years from two perspectives. The first is through a shift-share analysis to examine the extent to which Singapore's productivity growth was due to productivity changes within sectors, or shifts in employment across sectors with different productivity levels. The second is through a growth accounting analysis to examine how changes in capital intensity and labour quality have affected labour productivity growth.

SHIFT-SHARE ANALYSIS OF LABOUR PRODUCTIVITY GROWTH: AN UPDATE

An earlier shift-share analysis found that between 2008 and 2013, Singapore's productivity growth was supported by productivity growth within sectors, but weighed down by a shift in employment towards less productive sectors.[2] This section updates the analysis using the most recent data. In particular, we examine labour productivity growth over three 5-year periods: 1999-2004, 2004-2009 and 2009-2014.

Methodology

Using shift-share decomposition, overall labour productivity growth[3] in the economy may be expressed as the sum of three effects:

- <u>Within Effect</u>: the contribution of productivity growth within sectors to overall productivity growth;

- <u>Static Shift Effect</u>: the contribution of changes in the employment shares of sectors with *different productivity levels* to overall productivity growth; and

- <u>Dynamic Shift Effect</u>: the contribution of changes in the employment shares of sectors with *different productivity growth rates* to overall productivity growth.

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[1] *The target was set by the Economic Strategies Committee (ESC), and had the base year of 2009.*
[2] *See Goh (2014).*
[3] *It should be noted that in the shift-share analysis, labour productivity growth over a period is computed as annual averages, and not in CAGR terms. As such, the figures may not match the productivity growth figures reported in the first paragraph.*

In equation form, this can be represented as:

$$\frac{P_t - P_{t-1}}{P_{t-1}} = \sum_{i=1}^{n}\left[\left(\frac{P_{it}-P_{it-1}}{P_{it-1}}\right)\times\frac{Y_{it-1}}{Y_{t-1}}\right] + \sum_{i=1}^{n}\left[\left(\frac{P_{it-1}}{P_{t-1}}\right)\times\left(\frac{L_{it}}{L_t}-\frac{L_{it-1}}{L_{t-1}}\right)\right] + \sum_{i=1}^{n}\left[\left(\frac{P_{it}-P_{it-1}}{P_{t-1}}\right)\times\left(\frac{L_{it}}{L_t}-\frac{L_{it-1}}{L_{t-1}}\right)\right]$$

Where P_t is the productivity level of the economy in period t;

$Y_t = \sum_{i=1}^{n} Y_{it}$ is the total VA of the economy in period t;

$L_t = \sum_{i=1}^{n} L_{it}$ is the total employment of the economy in period t; and

$i = 1, \ldots, n$ is the ith sector in the economy.

Findings

Overall

From 2009 to 2014, Singapore's labour productivity grew by 2.6 per cent per year on average, reversing the decline of 1.0 per cent per year in the previous five years.[4] As shown in Exhibit 1, productivity growth was supported by higher productivity growth within sectors (i.e., positive Within Effect), but dampened by an increase in employment shares in less productive sectors relative to more productive sectors (i.e., negative Static Shift Effect):
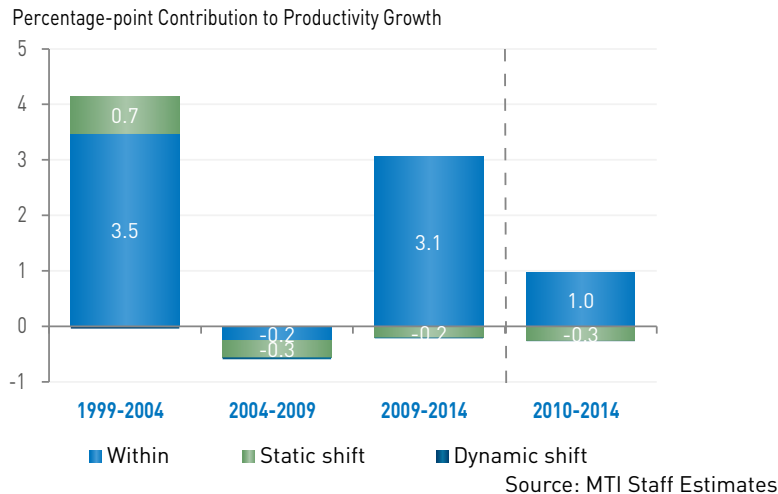
- Within Effect: Productivity improvements in the different sectors contributed 3.1 percentage-points to overall productivity growth each year on average over this period. This was a marked improvement from the previous 5-year period (-0.2 percentage-points each year), but still lower compared to the earliest 5-year period (+3.5 percentage-points each year).

- Static Shift Effect: The increase in employment shares of less productive sectors reduced overall productivity growth by 0.2 percentage-points each year on average in the last five years. While this was comparable to the Static Shift Effect of -0.3 percentage-points per year in the previous 5-year period, it was a reversal of the trend in the earliest 5-year period (+0.7 percentage-points each year).

- Dynamic Shift Effect: This effect was negative in all three 5-year periods, although the magnitude was very small (lower than -0.05 percentage-points each year).

However, a further examination of the trends within the latest 5-year period (2009-2014) reveals that the positive Within Effect was mainly due to the productivity boost in 2010 on the back of the economic recovery from the GFC.[5] The Within Effect since 2010 was less positive (+1.0 percentage-point each year), even as the Static Shift Effect remained negative (-0.3 percentage-points each year) and continued to weigh on productivity growth.

[4] *The figures here refer to annual averages. Using CAGRs, the corresponding figures would be 2.5 per cent and -1.1 per cent over 2009-2014 and 2004-2009 respectively.*

[5] *Overall productivity improved by 11.6 per cent in 2010. From 2010 to 2014, overall productivity grew marginally, at an average rate of 0.3 per cent.*

Exhibit 1: Decomposition of Labour Productivity Growth[6]

Percentage-point Contribution to Productivity Growth

	Within	Static shift	Dynamic shift

Source: MTI Staff Estimates

Values shown in chart: 1999-2004: 3.5, 0.7; 2004-2009: -0.2, -0.3; 2009-2014: 3.1, -0.2; 2010-2014: 1.0, -0.3

Within Effects

Our key observations for the period from 2009 to 2014 are as follows:

• The Within Effect over the period was supported by productivity growth in most sectors, except for Retail Trade.

• Compared to the preceding five years, the average productivity growth of most sectors was higher. However, the picture is mixed when compared against the earliest 5-year period — while the average productivity growth of sectors like Biomedical Manufacturing, Precision Engineering, Transport Engineering and Finance & Insurance improved in the most recent five years, that of sectors like Electronics and Information & Communications was lower.

• The productivity performance of export-oriented and domestically-oriented sectors differed significantly over the period, with the productivity growth of domestically-oriented sectors (0.8 per cent per year on average) lagging behind that of export-oriented sectors (5.3 per cent per year average) (Exhibit 2).[7]

  – Excluding the rebound year of 2010, the trends remained the same. Between 2010 and 2014, the productivity of export-oriented sectors grew by 2.2 per cent per year on average, driven by the Biomedical Manufacturing, Precision Engineering and Transport Engineering sectors. By contrast, the productivity of domestically-oriented sectors fell by 0.1 per cent per annum on average, with the sharpest decline seen in the Retail Trade sector.

• The stronger productivity performance of the export-oriented sectors should not come as a surprise, as exporting firms have to constantly improve their products and processes in order to compete globally. Another possible reason is that firms which are able to expand to overseas markets are likely to be more productive in the first place.[8]

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[6] The Within Effect, Static Shift Effect and Dynamic Shift Effect do not sum up to overall productivity growth as they exclude the contribution of ownership of dwellings and taxes on products.

[7] The classification of a sector as export- or domestically-oriented is determined based on its export share of total output as estimated using the 2010 Input-Output tables and tourism receipts. This finding is similar to the results of an earlier analysis for the period from 2010 to 2013 (Economics Division, Ministry of Trade & Industry, 2014).

[8] See Bernard and Jensen (2004), and Clerides, Lach and Tybout (1998).
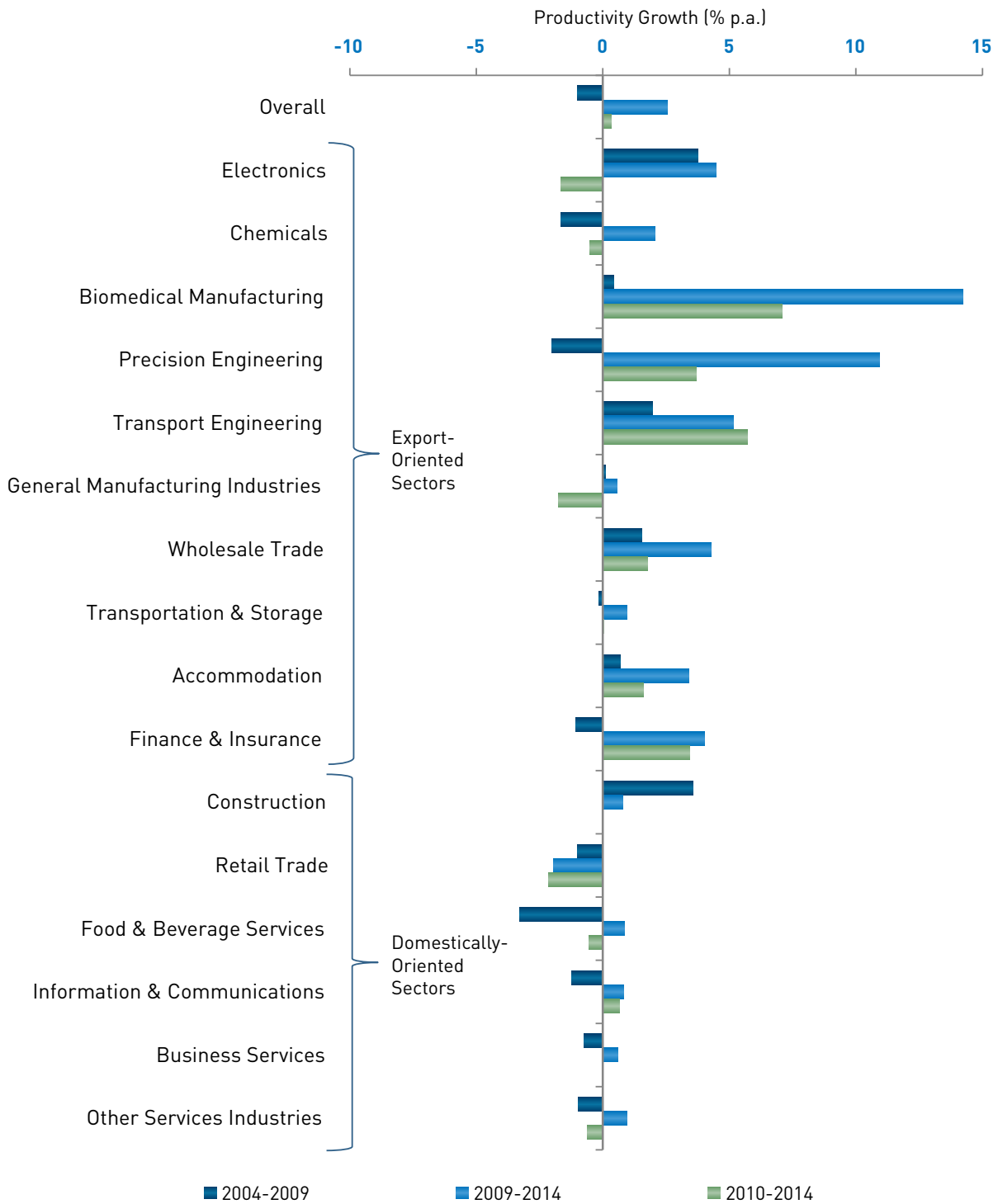
Source: Singapore Department of Statistics and MTI Staff Estimates

Static Shift Effects

- From 2009 to 2014, the share of workers employed in less productive, domestically-oriented sectors generally increased relative to that in the more productive, export-oriented sectors, thus weighing down overall productivity growth (Exhibit 3). In particular, we observe the following:

- Export-oriented sectors that were more productive than the overall economy like Transportation & Storage, Wholesale Trade, Electronics and Chemicals saw a decline in their employment shares. While most of these sectors saw employment growth over the period, their employment gains were insufficient to offset the employment growth in the less productive sectors, thus resulting in a shift in employment share towards the latter.

- On the other hand, there was an increase in the employment share of domestically-oriented sectors that were less productive than the overall economy like Construction, Food & Beverage Services and Other Services Industries. There could be a few reasons for this. First, employment growth in the Construction sector was strong due to the ramp-up in building and infrastructural works in recent years (e.g., public housing and new MRT lines). Second, more previously economically-inactive older, as well as less-educated locals have entered the workforce in recent years,[9] possibly incentivised by schemes such as the Workfare Income Supplement (WIS) scheme.[10] As the barriers to entry in some of the less productive sectors (e.g., Food & Beverage Services) are lower, it may have been easier for these workers to enter these sectors. Third, to cater to the needs of our population, the healthcare and social services sectors (classified under Other Services Industries) have seen an expansion of their manpower needs.

Excluding 2009, the trends highlighted above remain similar for the period of 2010-2014.

Exhibit 3: Static Shift Effects by Sectors[11]
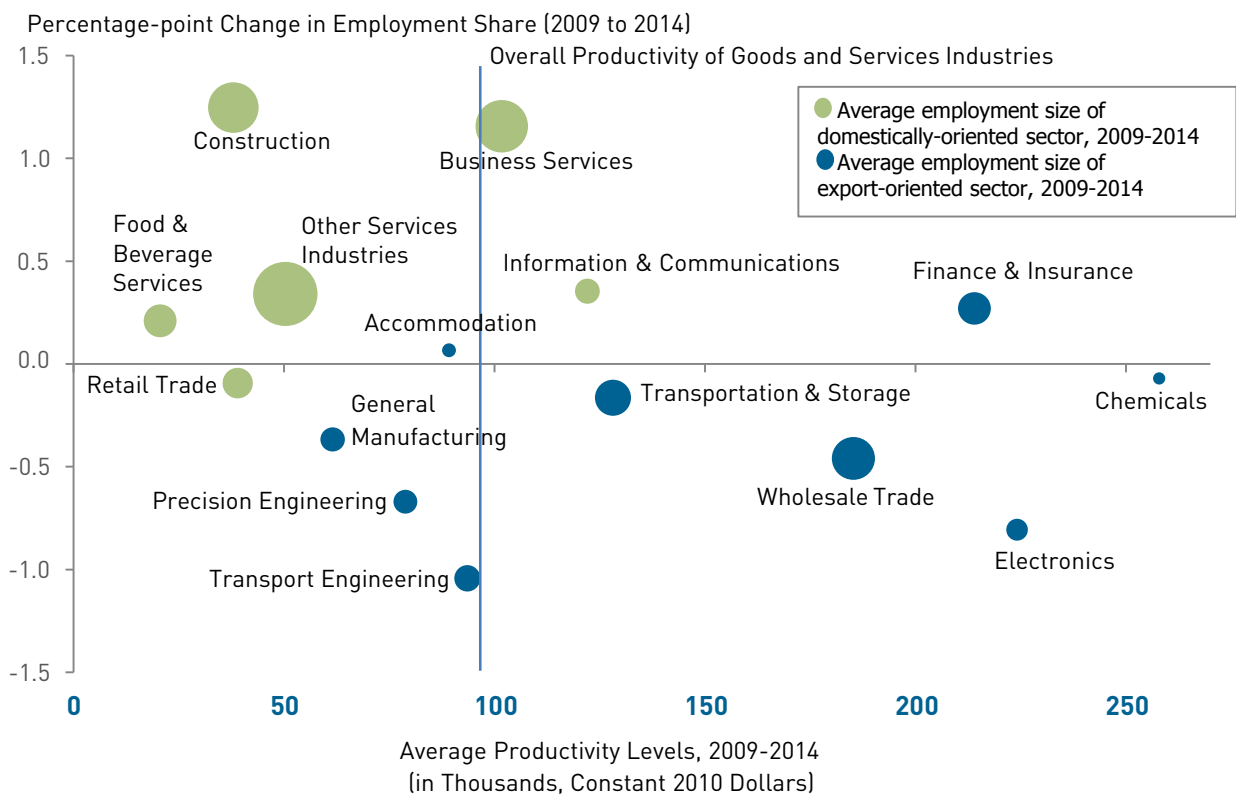
Source: MTI Staff Estimates

[9] Between 2009 and 2014, the labour force participation rate of residents aged 25 to 64 increased from 79.9 per cent to 82.3 per cent, while that of residents aged 65 and above increased from 17.2 per cent to 25.2 per cent.

[10] An earlier study by Leong et al (2014) found that WIS encouraged less-educated Singaporeans, especially those who were older, to enter the workforce between 2007 to 2010. The WIS was subsequently enhanced in 2013.

[11] The Biomedical Manufacturing sector is not shown to improve readability as its average productivity level (2009-2014) exceeded that of other sectors by a large amount. Its change in employment share from 2009 to 2014 was marginal.

Summary

Singapore experienced higher labour productivity growth between 2009 and 2014, as compared to the earlier period of 2004 to 2009. Overall productivity growth was supported by productivity growth in most sectors, with the export-oriented sectors experiencing higher productivity growth than the domestically-oriented ones. However, overall productivity growth was dampened by a shift in employment share towards less productive sectors such as Construction.

Our findings have two broad policy implications. First, to boost overall productivity growth, there is a need for the Government to continue to drive productivity improvements within the sectors, especially the domestically-oriented ones. Second, the Government should continue with efforts to restructure our economy towards more productive sectors, and to equip Singaporeans with the skills to enter these sectors, in order to arrest the negative shift effect.

GROWTH ACCOUNTING ANALYSIS OF LABOUR PRODUCTIVITY GROWTH

Capital intensity and labour quality are important determinants of labour productivity growth. A higher level of capital intensity means that each worker has more machines and technology to work with, thereby enabling them to be more productive. A higher quality workforce is also more productive as better trained workers may be more efficient and are also able to produce higher value-added products.

These two factors are also pertinent in our current push towards productivity-driven growth. At the firm level, the Government has introduced several tax incentives and grants since 2010 to encourage firms to innovate and make more capital investments. At the worker level, the Government is investing heavily in pre-employment and continuing education & training (CET) to upskill the quality of the workforce.

In this section, we use a growth accounting approach to examine changes in capital intensity (i.e., capital per worker) and labour quality in the economy in recent years, and determine how they have affected labour productivity growth

Methodology

We adopt a traditional growth accounting approach to analyse labour productivity growth over two decades from 1993 to 2013.[12] Productivity growth is decomposed into contributions from capital intensity, labour quality and Total Factor Productivity (TFP). TFP - which can be taken as a measure of the impact of the use of more efficient technologies and business practices on productivity growth - is computed as a residual in our analysis.

We model the economy using a Cobb-Douglas production function with constant returns to scale:

$$Y = A \cdot \prod_i L_i^{b_i} \cdot \prod_j K_j^{c_j}$$

Where Y = real output;
A = Total Factor Productivity (TFP);
L_i= employment of ith type of labour;
b_i= share of output of the ith type of labour;
K_j= net stock of jth type of capital;
c_j= share of output of jth type of capital; and
$\sum_i b_i + \sum_j c_j = 1$ (i.e., constant returns to scale)

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[12] *We are not able to analyse productivity growth in 2014 as capital stock data for 2014 is not available yet. Capital stock data for earlier years may also be revised when 2014 capital stock data is available.*

Under the standard neoclassical assumptions of competitive markets where inputs are paid their marginal products, output growth will be approximately a function of the weighted growth in inputs and TFP growth:

$$\Delta Y \approx \sum_i b_i \Delta L_i + \sum_j c_j \Delta K_j + \Delta A$$

Labour productivity growth can then be decomposed into the three components as represented in the equation below:

$$\Delta \frac{Y}{L} \quad \approx \quad S_L \cdot \sum_i (s_i - l_i)\Delta L_i \quad + \quad \sum_j c_j \left(\Delta \frac{K_j}{L} \right) \quad + \quad \Delta A$$

| Productivity growth | $\approx$ | Contribution from changes in labour quality | $+$ | Contribution from changes in capital intensity | $+$ | Contribution from TFP |

Where S_L = total wage share of output;
s_i = wage share of ith type of labour out of total wages; and
l_i = employment share of ith type of labour

In this study, we examine the contributions from five types of capital, *viz*, Machinery & Equipment, Computer Software, Research & Development (R&D), Transport Equipment, and Construction & Works. As the focus of the study is on capital stock used by firms for production, residential buildings are excluded from Construction & Works. Correspondingly, the imputed ownership of residential dwellings is also removed from the productivity computation. To estimate the share of output of the different capital types, we compute their user costs based on their respective market values, depreciation rates and the relevant prevailing cost of financial capital.

For labour quality, we categorise labour into skilled and less-skilled labour based broadly on their occupation types. The quality for each type of labour is proxied by its average wage. When the number of skilled workers increases faster than that of less-skilled workers, overall labour quality improves, contributing positively to labour productivity growth. Conversely, if the number of less-skilled workers rises faster than the number of skilled workers, labour quality deteriorates and dampens productivity growth.

### Decomposition of overall labour productivity growth

We find that from 2009 to 2013, capital intensity, labour quality as well as TFP all contributed positively to productivity growth (Exhibit 4):

- Capital intensity improvements contributed an average of 0.7-percentage points to productivity growth each year from 2009 to 2013, compared to the downward drag of 0.6 percentage-points each year in the earlier five years. Nonetheless, this was still lower than the contributions seen in the mid-1990s to mid-2000s, when growth in capital intensity contributed an average of 2.1 to 2.6 percentage-points to productivity growth each year.

- Labour quality improvements contributed an average of 0.2 percentage-points to productivity growth per year from 2009 to 2013. This was similar to the contribution of labour quality in the earlier five years (+0.3 percentage-points).[13]

- TFP is estimated to have contributed an average of 2.3 percentage-points to productivity growth per year over this period, higher than its contribution in the preceding 5-year period (-0.5 percentage-points). This suggests that technological progress and improvements in processes and business practices may have been a key driver of productivity growth in the latest period.

[13] *We are not able to estimate the impact of labour quality in the earlier years as data is not available. The effects of labour quality were hence subsumed under TFP in the first two five-year periods (1994 – 2004).*

Exhibit 4: Contributions from Capital Intensity and Labour Quality to Labour Productivity Growth[14]

Percentage-point Contribution to Labour Productivity Growth

Source: MTI Staff Estimates
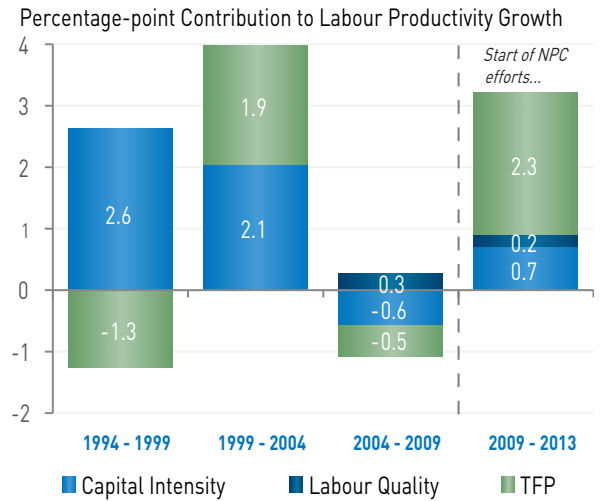
Contribution from capital intensity

Next, we delve deeper into the contribution of capital intensity by different capital types. Looking at the latest period from 2009 to 2013 (Exhibit 5), we find that the results differed across the various types of capital:

• Contributions from Machinery & Equipment (M&E) and Construction & Works (excluding residential buildings) improved in the latest period as compared to the previous 5-year period. In particular, the rebound in the contribution from Construction & Works (excluding residential buildings) was in line with the step-up in infrastructure projects in recent years.

• Contributions from Computer Software and R&D fell when compared to the previous 5-year period, but remained positive. On the other hand, the contribution from Transport Equipment remained negative in the latest period.

Exhibit 5: Contribution from Capital Intensity to Labour Productivity Growth, 1994 – 2013

Percentage-point Contribution to Labour Productivity Growth
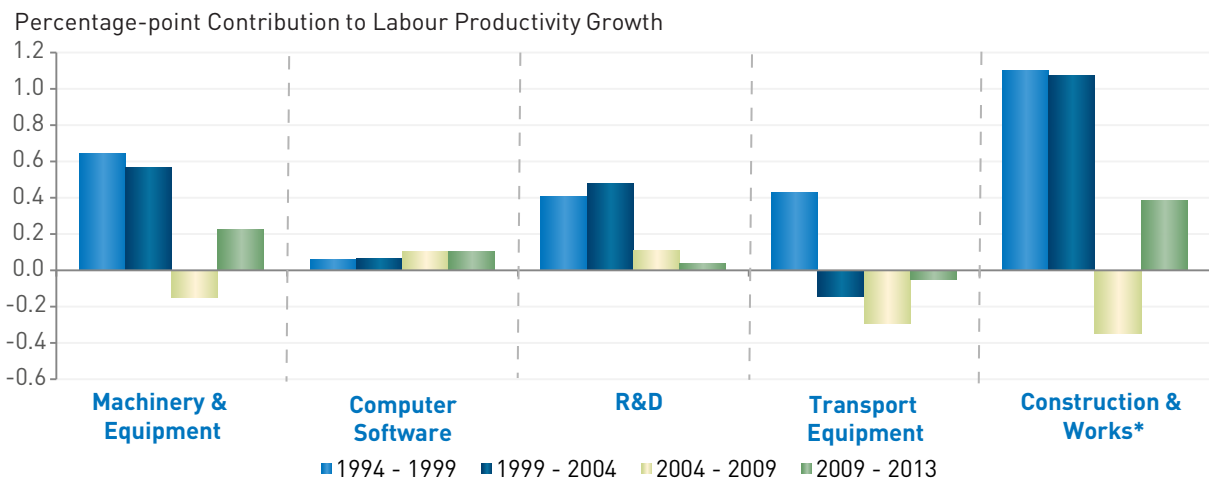
Source: MTI Staff Estimates
*Residential buildings are excluded

[14] The contributions from three components – capital intensity, labour quality and TFP – will not sum up to productivity growth for the overall economy as ownership of residential dwellings has been removed from the productivity computation.

However, examining the trends within the latest period (2009-2013) in greater detail, we observe a decline in the contribution from M&E, as the growth in M&E capital stock moderated from 6.1 per cent in 2010 to 4.3 per cent in 2013.

The moderation in the growth of the M&E capital stock may have been caused by firms becoming more cautious due to uncertainties in the global economy. Globally, we note that there has also been a slowdown in capital expenditure in M&E. For example, in the US, real private investments in M&E fell from 9.0 per cent in 2010 to 4.7 per cent in 2013; while in Germany, it fell from 10.1 per cent to -1.9 per cent. Similarly, Standard & Poor's has reported a decline in the growth of global non-financial corporate capital expenditure, from 10 per cent in 2011 to 6 per cent in 2012 and -1 per cent in 2013.[15] Slower growth in investments and corporate expenditure may have occurred as firms cut down on investments on the back of lower expectations of future profits. In Singapore, the presence of government schemes to help firms invest in machinery and equipment may have helped to offset in part the negative impact of uncertainties on firms' investments.
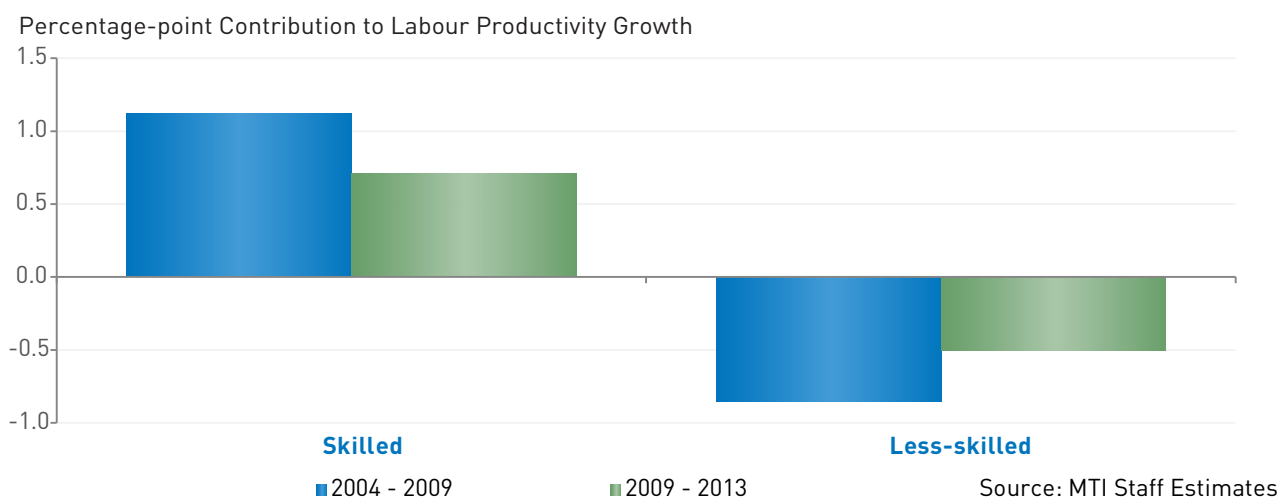
Contribution from labour quality

Turning to labour quality, we find that for the period from 2009 to 2013, the contribution from labour quality to productivity growth was positive, at around 0.2 percentage-points per year. The improvement in labour quality over the period came about in spite of a slowdown in the employment growth of skilled workers, as the employment growth of less-skilled workers had slowed down by more (Exhibit 6).

However, examining the trends within the period in greater detail, we observe that the rate of improvement in labour quality has declined. This was due to a pick-up in the employment growth of less-skilled workers in more recent years, even as the employment growth of skilled workers moderated.

The increase in less-skilled workers in recent years may in part be due to the manpower needs of the construction sector, as well as the entry of less-skilled Singaporeans into the workforce. Specifically, the construction sector expanded substantially in the last few years with the step-up in building and infrastructure projects. This led to an expansion in the number of less-skilled foreign workers in the workforce. At the same time, as mentioned earlier in the shift-share analysis, less-educated Singaporeans have also been encouraged to enter the workforce amidst a tight labour market, possibly incentivised by schemes such as the WIS.

Exhibit 6: Contribution from Labour Quality to Labour Productivity Growth, 2004 – 2013

Percentage-point Contribution to Labour Productivity Growth

■ 2004 - 2009   ■ 2009 - 2013   Source: MTI Staff Estimates

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[15] *See Standard & Poor's Rating Services (2014). Figures in the report are rounded to the nearest whole number.*

Summary

Using growth accounting analysis, we find that improvements in capital intensity, labour quality and TFP contributed positively to overall labour productivity growth between 2009 and 2013. However, delving more deeply into the trends within the period, we find that contribution from capital intensity, especially in terms of M&E capital, has declined in more recent years. The weakness in M&E mirrors the trends seen globally, and could be partly attributed to global economic uncertainties. In this climate, Government schemes to encourage firms to invest in machinery and equipment may be even more pertinent.

Similarly, contributions from labour quality improvements have declined in more recent years, in part due to the strong growth in less-skilled workers in the construction sector, even as the growth in skilled workers in the economy tapered. However, as the construction sector presses ahead with efforts to raise its productivity, and the skills profile of Singaporeans improves with our pre-employment and CET efforts, we expect labour quality to improve over time.

CONCLUSION

Between 2009 and 2014, productivity growth has come in within the 2-3 per cent target set by the Economic Strategies Committee. However, excluding the 2010 rebound, productivity growth in the most recent four years from 2010 to 2014 has been lacklustre. This article suggests four reasons for this:

- First, productivity of domestically-oriented sectors has remained weak, lagging behind that of externally-oriented sectors.

- Second, productivity has been weighed down by a shift in employment towards less productive sectors, with higher employment growth in sectors like Construction relative to more productive sectors like Transportation & Storage.

- Third, capital intensity growth has slowed in more recent years, weighed down in particular by the slowdown in M&E capital growth.

- Lastly, improvements in labour quality may have also fallen in more recent years, due to faster growth in the number of less-skilled workers in the economy relative to skilled workers. The former was in turn partly due to an increase in the workforce of the Construction sector.

To improve our overall productivity, we must press on with efforts to restructure the economy towards more productive sectors. We also need to continue to equip our workforce with the skills needed to take on higher value-added jobs in the economy, while helping companies to invest in capital and improve their technological and business process capabilities.

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