

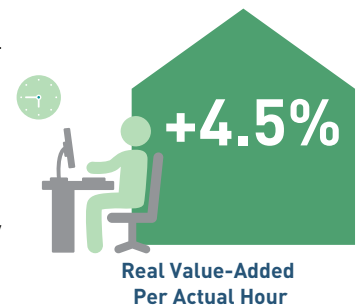
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# A Shift-Share Decomposition Analysis of Labour Productivity Growth in Singapore

## OVERVIEW OF SINGAPORE'S PRODUCTIVITY GROWTH

In 2017, Singapore's overall labour productivity, as measured by real value-added (VA) per actual hour worked (AHW), grew by 4.5 per cent, the highest recorded since the rebound year of 2010 following the Global Financial Crisis.

Singapore's economy has been increasingly driven by productivity growth rather than employment growth in recent years.

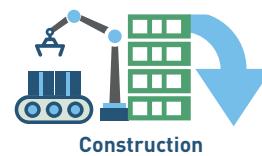


## DRIVERS OF PRODUCTIVITY GROWTH IN 2017

Productivity growth was primarily supported by productivity gains in outward-oriented sectors such as Manufacturing, Wholesale Trade and Finance & Insurance.



On average, more productive sectors increased their actual hours worked shares at the expense of less productive sectors like Construction.



## SUMMARY

To support productivity-led growth, it is important for Singapore to continue to press on with sectoral restructuring and transformation efforts such as through the implementation of the Industry Transformation Maps.



In 2017, Singapore's overall labour productivity, as measured by real value-added (VA) per actual hour worked<sup>1</sup> (AHW), grew by 4.5 per cent, the highest recorded since the rebound year of 2010 following the Global Financial Crisis.<sup>2</sup> This article examines the drivers of the strong productivity growth in 2017 using a shift-share analysis. It also traces the changes in the composition of Singapore's Gross Domestic Product (GDP) growth over the years, and compares our recent productivity performance with other advanced economies.

## GDP growth can be decomposed into productivity growth, employment growth and labour intensity growth

Broadly, output in an economy can grow either through an increase in labour input or through an improvement in the conversion rate of labour input to output (i.e., labour productivity):

$$\% \Delta \text{GDP} \approx \% \Delta \text{Labour Input} + \% \Delta \text{Labour Productivity}$$

Internationally, AHW is recognised to be the more accurate measure of labour input in an economy.<sup>3</sup> Concomitantly, VA per AHW is also accepted as the better measure of labour productivity. AHW can in turn be derived as the number of workers in the economy multiplied by the AHW per worker (i.e., labour intensity). This implies that GDP growth can be approximated by the summation of employment growth, labour intensity (i.e., AHW per worker) growth and labour productivity (i.e., VA per AHW) growth. The latter two terms will in turn approximately sum to VA per worker growth.

$$\begin{aligned} \% \Delta \text{GDP} &\approx \% \Delta \text{Employment} + \% \Delta \text{Labour Intensity} + \% \Delta \text{Labour Productivity (VA per AHW)} \\ &\approx \% \Delta \text{Employment} + \underbrace{\% \Delta \text{AHW per Worker} + \% \Delta \text{VA per AHW}}_{\% \Delta \text{VA per Worker}} \end{aligned}$$

For the rest of this article, labour productivity refers to VA per AHW unless otherwise stated.

## GDP growth has been increasingly driven by productivity growth in recent years

Excluding the rebound year of 2010, which saw a spike in productivity growth as the economy recovered strongly from the Global Financial Crisis, GDP grew by 3.9 per cent per annum (p.a.) over the period of 2010 (base year) to 2017, with the increase in productivity contributing 2.1 percentage-points to growth.

A deeper analysis suggests that there has been a gradual shift in the drivers of GDP growth over this period, with GDP growth increasingly being productivity driven rather than employment driven (Exhibit 1). The key observations are as follows:

- In 2011, GDP growth came in at 6.4 per cent as the economy continued its recovery from the Global Financial Crisis. GDP growth was supported by both employment and productivity growth, which more than offset the drag posed by a decline in AHW per worker caused by a rise in the share of part-time workers in the economy.

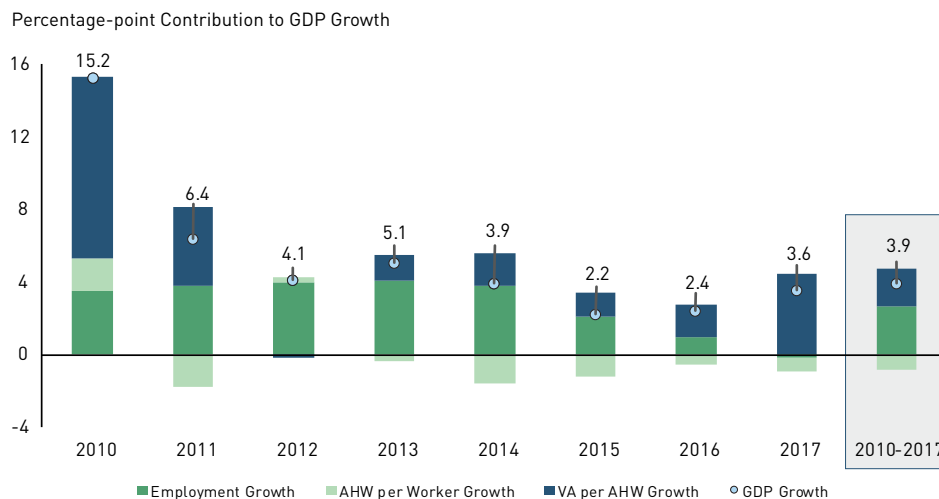
1 Actual Hours Worked is defined to be the number of hours that a person in paid or self-employment spends on work activities, proxied by Paid Hours Worked (PHW) for foreign employees and Usual Hours Worked (UHW) for local employees. See Goh and Lin (2015).

2 As measured by real VA per worker, productivity grew by 3.8 per cent in 2017.

3 For example, the International Labour Organisation (ILO) recommends the use of hours worked to measure labour input for the computation of productivity.

- From 2012 to 2013, GDP growth was largely supported by employment growth due to strong labour demand from firms as well as a continued increase in the supply of local workers on the back of a rise in the labour force participation rate. On the other hand, overall productivity performance was subdued, coming in at -0.2 per cent in 2012 and 1.4 per cent in 2013. At the same time, AHW per worker remained broadly unchanged.
- From 2014 to 2016, GDP growth weakened in line with a slowdown in the global economy. Along with increasing efforts to manage the inflow of foreign workers and restructure the economy towards more productive activities, employment growth started to moderate. Over this period, VA per AHW growth was stable at around 1.3 to 1.8 per cent, while AHW per worker declined.<sup>4</sup>
- In 2017, GDP growth rebounded on the back of a recovery in the global economy to 3.6 per cent. In turn, GDP growth was supported by a strong increase in productivity (4.5 per cent), even as employment (-0.2 per cent) and AHW per worker (-0.7 per cent) declined.<sup>5</sup> [See section on shift-share analysis for a deeper look at the drivers of productivity growth in 2017.]

Exhibit 1: Decomposition of GDP Growth, 2010-2017



Source: MTI Staff Estimates

Note: Growth in employment, AHW per worker and VA per AHW may not sum to GDP growth as the decomposition is based on an approximation approach.

## Singapore's productivity performance in recent years compares favourably with other advanced economies

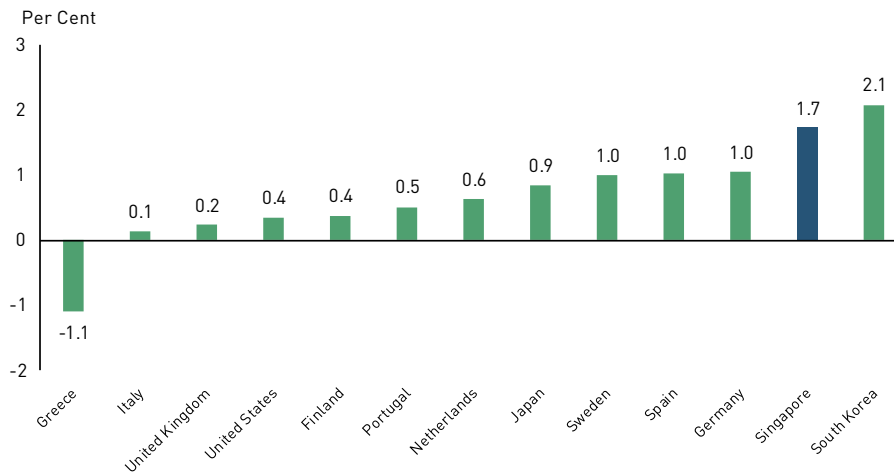
Exhibit 2 presents the compound annual growth rate (CAGR) of productivity (as measured by VA per AHW) for several advanced economies between 2010 and 2016.<sup>6</sup> With the exception of Greece, most of the economies experienced positive, though subdued, productivity growth following the Global Financial Crisis. Among these economies, productivity growth ranged from 0.1 per cent p.a. (in Italy) to 2.1 per cent p.a. (in South Korea). Comparatively, Singapore's productivity growth of 1.7 per cent p.a. was higher than that in most of the economies compared.

<sup>4</sup> In a downturn, employers are likely to cut the number of hours worked per worker before they let go of the workers. Hence, it is not surprising to see AHW per worker decline during an economic slowdown.

<sup>5</sup> AHW per worker fell primarily due to a reduction in the average number of hours worked by full-time workers.

<sup>6</sup> VA per AHW data for 2017 is not available for most of these countries, with the exception of Singapore and Germany. Between 2010 and 2017, VA per AHW grew by 2.1 per cent p.a. in Singapore and 1.0 per cent p.a. in Germany.

Exhibit 2: Productivity (VA per AHW) Growth of Selected Advanced Economies, 2010-2016



Source: MTI Staff Estimates, OECD

## Using shift-share analysis to derive a deeper understanding of the drivers of productivity growth in Singapore in 2017...

Given Singapore's strong productivity growth in 2017, we further examine its underlying drivers using a shift-share decomposition approach. Here, productivity growth (as measured by VA per AHW) is expressed as the sum of three components (see Annex A for more details on the empirical methodology):

- **Within Effect:** the contribution of productivity growth within sectors to overall productivity growth;
- **Static Shift Effect:** the contribution of changes in the AHW shares of sectors with different productivity levels to overall productivity growth; and
- **Dynamic Shift Effect:** the contribution of changes in the AHW shares of sectors with different productivity growth rates to overall productivity growth.

## ...we find that productivity growth in 2017 was supported by a strong Within Effect as well as a positive Static Shift Effect

A previous shift-share analysis (see Fan & Teo, 2016) found that Singapore's productivity growth was largely supported by the productivity growth of outward-oriented sectors (i.e., a large positive Within Effect due to outward-oriented sectors).<sup>7</sup> However, this was weighed down by a negative Static Shift Effect as less productive, domestically-oriented sectors increased their AHW shares at the expense of more productive, outward-oriented sectors.

Similar to the previous analysis, a strong Within Effect was found to be the primary driver of overall productivity growth in 2017 (Exhibit 3).<sup>8</sup> However, unlike in previous years, we find that the Static Shift Effect also contributed positively to overall productivity growth in 2017.

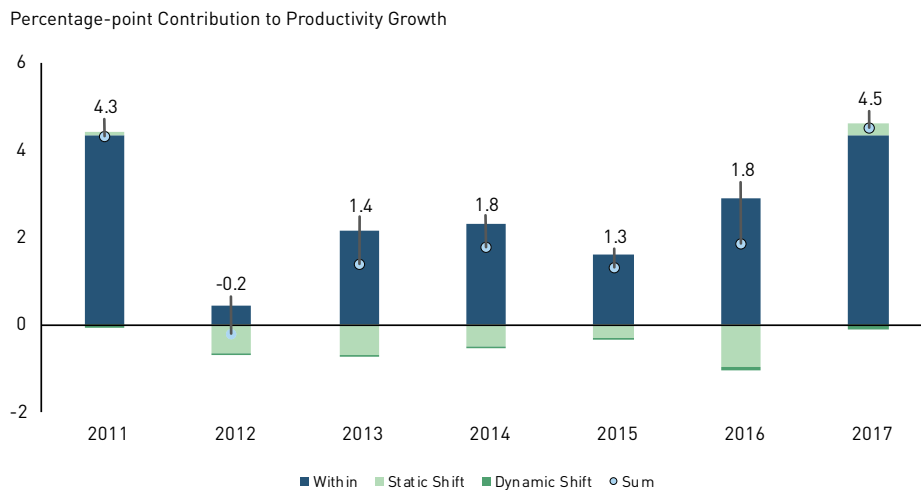
<sup>7</sup> The classification of a sector as outward- or domestically-oriented is determined by its direct and indirect export share of total output as estimated using the latest Input-Output tables and tourism receipts. Outward-oriented sectors refer to Manufacturing, Wholesale Trade, Transportation & Storage, Accommodation, Information & Communications, Finance & Insurance, and Professional Services. Domestically-oriented sectors refer to Construction, Retail Trade, Food Services, Other Business Services, and Other Services Industries.

<sup>8</sup> Annex B presents a decomposition of VA per worker growth. This decomposition obtains largely similar results.

The salient observations are as follows:

- **Within Effect:** In 2017, overall productivity grew by 4.5 per cent, with productivity improvements within sectors contributing 4.3 percentage-points to overall productivity growth.
- **Static Shift Effect:** The Static Shift Effect contributed positively to overall productivity growth in 2017. Specifically, the shift in total AHW towards more productive sectors and away from less productive sectors contributed 0.3 percentage-point to overall productivity growth.
- **Dynamic Shift Effect:** Similar to past results, overall productivity growth was weighed down by a negative, though negligible, Dynamic Shift Effect (-0.1 percentage-point).

Exhibit 3: Decomposition of Labour Productivity (VA per AHW) Growth, 2011-2017



Source: MTI Staff Estimates

Note: The Within, Static Shift and Dynamic Shift Effects may not sum to the overall productivity growth due to rounding.

## Outward-oriented sectors were the main contributors to the positive Within Effect and hence overall productivity growth in 2017

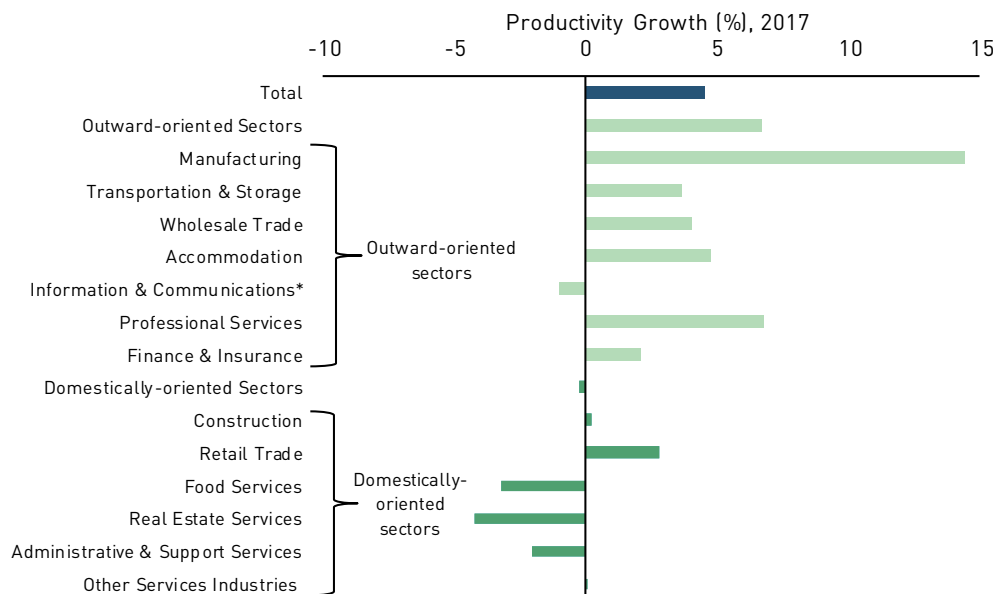
The large Within Effect in 2017 was mainly driven by productivity growth in outward-oriented sectors such as Manufacturing, Wholesale Trade and Finance & Insurance, but was weighed down by the weaker productivity performance of domestically-oriented sectors such as Food Services, Real Estate and Administrative & Support Services. Specifically, productivity in outward-oriented sectors surged by 6.7 per cent in 2017, while that in domestically-oriented sectors fell by 0.2 per cent (Exhibit 4).<sup>9</sup> Correspondingly, outward-oriented sectors contributed 4.2 percentage-points to overall productivity growth, while domestically-oriented sectors contributed -0.5 percentage-point.

Outward-oriented sectors saw strong productivity growth in 2017 in part due to the pickup in the external environment. More generally, firms in outward-oriented sectors are also incentivised to optimise operations and seek efficient production methods to remain competitive in the face of global competition.

<sup>9</sup> Notably, productivity in the Manufacturing sector grew by a robust 14.4 per cent in 2017. This came on the back of strong VA growth in the sector, primarily supported by output expansions in the Electronics, Precision Engineering and Chemicals clusters. At the same time, total AHW in the sector fell, driven mainly by the shedding of workers in the Marine & Offshore Engineering segment of the Transport Engineering cluster.

On the other hand, there remains scope to raise the productivity of domestically-oriented sectors. To this end, the Government will continue to press on with sectoral restructuring and transformation efforts such as through the implementation of the Industry Transformation Maps. Firms in the domestically-oriented sectors are also encouraged to step forward to tap on the various Government schemes available (e.g., the Capability Development Grant) to raise their productivity.

Exhibit 4: Sectoral Productivity (VA per AHW) Growth, 2017



Source: Singapore Department of Statistics and MTI Staff Estimates

\* Productivity in the Information & Communications sector fell in 2017, as total AHW (4.4 per cent) rose at a faster pace than VA (3.3 per cent). In turn, the stronger-than-usual increase in AHW was due to a rise in the number of self-employed individuals who generally worked longer hours. Over a longer time period (2010-2017), productivity growth in the sector was positive, at 0.9 per cent p.a..

### At the same time, overall productivity growth was boosted by a positive Static Shift Effect, with more productive sectors raising their AHW shares

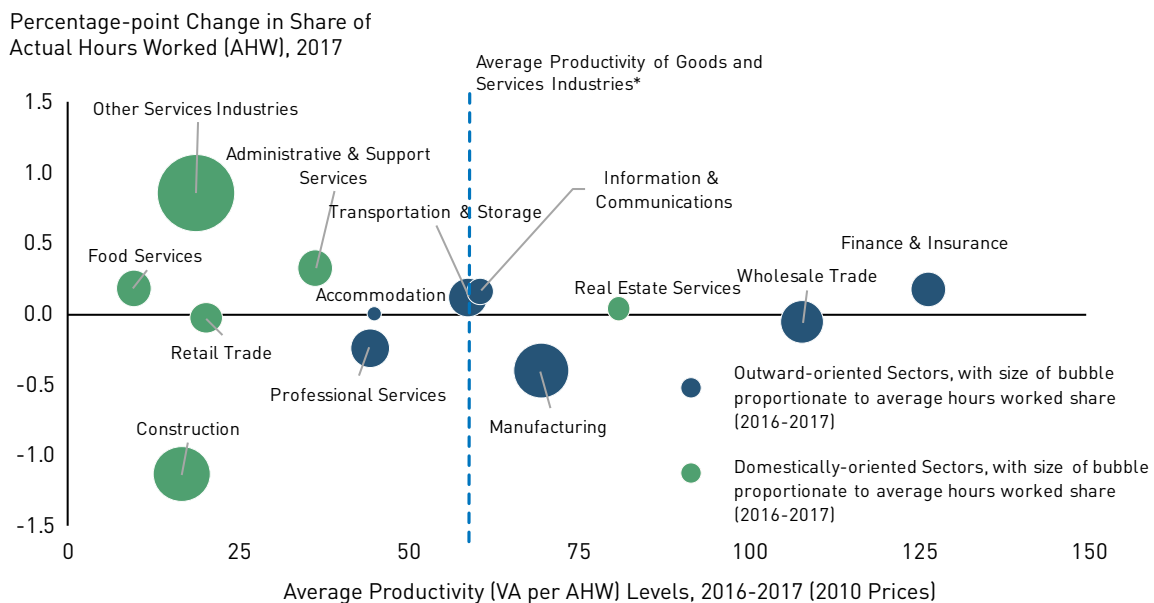
At the overall economy level, more productive sectors increased their AHW shares at the expense of less productive sectors, resulting in a positive Static Shift Effect (0.3 percentage-point) in 2017. These changes in AHW shares were mostly driven by changes in employment shares.<sup>10</sup>

Exhibit 5 presents the change in AHW share and the average productivity level of each sector. The Static Shift Effect is positive when the AHW shares of more productive sectors increase at the expense of less productive sectors. Notably, Construction, a sector with lower productivity levels, saw a decline in its AHW share. This was driven partly by a decline in the sector's employment share, as construction firms shed foreign workers in view of weak demand. Meanwhile, the productive Finance & Insurance sector increased its AHW share, supported by an increase in employment share.

<sup>10</sup> The AHW share of a sector can increase if the employment share of the sector increases holding the AHW per worker constant across sectors, or if the AHW per worker in the sector increases relative to other sectors and there is no change in employment across the sectors. Conversely, the AHW share of a sector can fall if the employment share of the sector falls or if the AHW per worker in the sector falls relative to other sectors.

However, these Static Shift gains were partly offset by gains in the AHW shares of some less productive, domestically-oriented sectors. For instance, the Other Services Industries continued to hire workers on the back of expansions in healthcare facilities. In addition, a fall in the AHW shares of productive sectors such as Manufacturing also weighed on the Static Shift Effect. Over the years, the Manufacturing sector's share of AHW has fallen steadily in line with stronger productivity gains in the sector, as it benefited from greater scope for automation compared to other sectors in the economy (e.g., personal services).

Exhibit 5: Change in Hours Worked Share vs. Average Productivity Levels by Sector, 2016-2017



Source: MTI Staff Estimates

\* Excludes ownership of residential dwellings and taxes on products

## Summary

Singapore's economic growth in recent years has been productivity-led rather than employment-led. In particular, overall productivity registered strong gains of 4.5 per cent in 2017, outpacing GDP growth of 3.6 per cent. Based on a shift-share analysis, Singapore's productivity growth in 2017 was found to be primarily due to a large Within Effect, which was in turn driven by productivity gains in outward-oriented sectors such as Manufacturing, Wholesale Trade and Finance & Insurance, on the back of an upturn in the global economy. Overall productivity growth was also supported by a positive Static Shift Effect as more productive sectors such as Finance & Insurance gained AHW shares at the expense of less productive sectors such as Construction.

To support productivity-led growth, there continues to be a need to press on with sectoral restructuring and transformation efforts. To this end, the implementation of the Industry Transformation Maps, particularly for less productive domestically-oriented sectors, is expected to help boost overall productivity growth in the years ahead. The emphasis on life-long learning and skills training under the SkillsFuture initiatives will also equip workers with the necessary skills to move into more productive sectors.

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Goh, K., & Lin, T. (2015). Trends in Actual Hours Worked and Implications for Labour Productivity. *Economic Survey of Singapore Second Quarter 2016*, 16-23.



## Annex A: Shift-Share Decomposition Analysis of Growth in Value-Added (VA) per Actual Hour Worked (AHW)

Productivity growth can be expressed as the sum of the Within Effect, the Static Shift Effect and the Dynamic Shift Effect.

In equation form, growth in productivity, in terms of VA per AHW, can be represented as:

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

Where  $P_t$  is the productivity level (VA per AHW) of the economy in period  $t$ ;

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

$H_t = \sum_{i=1}^n H_{it}$  is the total AHW of the economy in period  $t$ ; and

$i = 1, \dots, n$  is the  $i^{\text{th}}$  sector in the economy.

## Annex B: Shift-Share Decomposition Analysis of Growth in Value-Added (VA) per Worker

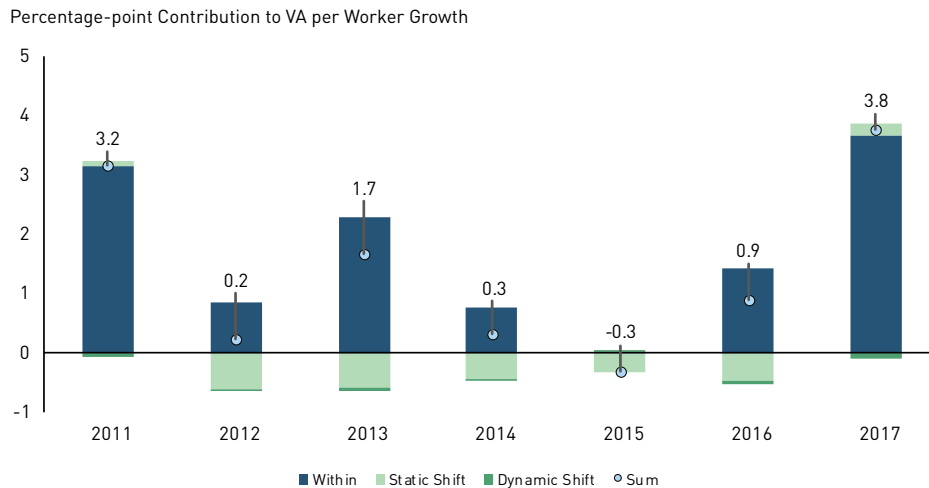
Growth in productivity, in terms of VA per worker, can be similarly decomposed into the summation of Within, Static Shift and Dynamic Shift Effects. In equation form, this can be represented as:

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

Where  $P_t$  is the productivity level (VA per worker) 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 labour of the economy in period  $t$ ; and  
 $i = 1, \dots, n$  is the  $i^{\text{th}}$  sector in the economy.

The results of the shift-share analysis using VA per worker are provided in Exhibit B-1. In general, the findings are similar to that found using VA per AHW. Specifically, we find a positive and large Within Effect, which contributed 3.7 percentage-points to the overall VA per worker growth of 3.8 per cent in 2017. Overall VA per worker growth was also supported by a positive Static Shift Effect (0.2 percentage-point), but was weighed down by a negative, but small, Dynamic Shift Effect (-0.1 percentage-point).

Exhibit B-1: Decomposition of Real VA per Worker Growth, 2011-2017



Source: MTI Staff Estimates

Note: The Within, Static Shift and Dynamic Shift Effects may not sum to the overall productivity growth due to rounding.