

Box 2.2 Sources of Singapore’s Productivity Growth: A Shift-Share Analysis

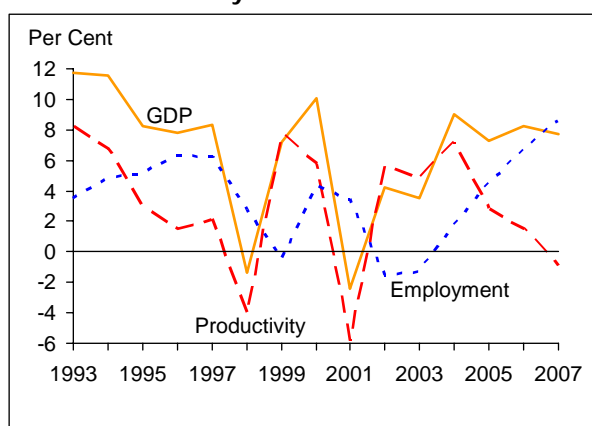
Productivity growth improves the long-term industrial performance and economic competitiveness of a country. Productivity growth has played an important role in helping Singapore to achieve strong economic growth and higher standards of living over the years. This article examines Singapore’s productivity performance during the period 1993-2007 using a “shift-share” analysis framework.

Singapore’s productivity growth generally follows a pro-cyclical pattern...

Singapore’s productivity growth generally follows a pro-cyclical pattern (Exhibit 1). It rises during recovery years due to the lag in hiring as firms boost output, and falls during recessions as firms tend to cut output before they reduce their workforce.

Given the effect that business cycles have on productivity trends, it is important to examine the longer term trends in productivity growth when assessing its impact on Singapore’s competitiveness. Based on a five-year annual average, Singapore’s productivity grew at 3.1 per cent during the period 2003-2007, which is lower than the 4.3 per cent achieved during the period 1993-1997. However, this is higher than the OECD average productivity growth rate of 1.6 per cent from 1993 to 2007.

Exhibit 1: Singapore’s GDP, Employment and Labour Productivity Growth



Understanding Singapore’s productivity growth using shift-share analysis...

To understand the sources of Singapore’s productivity growth since 1992, MOM and MTI used “shift-share” analysis to measure the contribution of various industries to overall productivity growth. This framework decomposes labour productivity gains into three components:

- (i) “Within Effect” - contribution of an individual sector’s labour productivity growth;
- (ii) “Static Shift Effect” - contribution via the shift in employment shares across sectors with different productivity levels; and
- (iii) “Dynamic Shift Effect” - contribution of relative employment shifts into sectors with different productivity growth.

The shift-share equation for productivity change, in level terms, can be represented as:

$$\Delta P_t = \sum_{i=1}^n (\Delta P_{i,t} \cdot l_{i,t-1}) + \sum_{i=1}^n (P_{i,t-1} \cdot \Delta l_{i,t}) + \sum_{i=1}^n (\Delta P_{i,t} \cdot \Delta l_{i,t}) \tag{1}$$

Or equivalently, in growth terms:

$$\dot{P}_t = \sum_{i=1}^n (\dot{P}_{i,t} \cdot y_{i,t-1}) + \sum_{i=1}^n \left(\frac{P_{i,t-1}}{P_{t-1}} \cdot \Delta l_{i,t}\right) + \sum_{i=1}^n \left(\frac{\Delta P_{i,t}}{P_{t-1}} \cdot \Delta l_{i,t}\right) \tag{1'}$$

where P is productivity (defined as value-added per worker); L is labour; Y is value-added (VA); i denotes sector; ΔP_t represents change in productivity in time t ; $\Delta l_{i,t}$ represents change in share of labour of sector i in time t ; and $y_{i,t-1}$ represents share of VA of sector i in time $t-1$.

The first term on the right hand side of equation (1') is the "within effect". This measures the contribution of productivity growth in individual sectors to overall labour productivity growth, and is derived by summing the productivity growth of individual sectors using their VA shares as weights.

The second term, called the "static shift effect", weighs the changes in labour shares of individual sectors by their relative levels of productivity. A net shift in labour share to sectors with higher labour productivity levels will have a positive static effect.

The third term, called the "dynamic shift effect", weighs the changes in labour shares of individual sectors by their respective labour productivity changes. A net shift in labour share to sectors with positive labour productivity growth will lead to a positive contribution.

While the "within effect" considers the intra-sectoral productivity improvements, the shift (static and dynamic) effects consider the impact of inter-sectoral employment shifts on productivity.

"Within Effect" has been the predominant source of labour productivity growth...

The shift-share analysis shows that the "within effect" has been the predominant source of labour productivity growth in Singapore over the period 1993-2007 ([Exhibit 2](#)).

Exhibit 2: Decomposition of Labour Productivity Growth, 1993-2007

	Labour Productivity Growth	Within Effect	Static Shift Effect	Dynamic Shift Effect
1993-1997	4.3	5.1	-0.6	-0.1
1998-2002	1.9	1.5	0.4	0.0
2003-2007	3.1	2.8	0.3	0.0

Per Cent

The deceleration in productivity growth from the period 1993-1997 to the period 2003-2007 observed earlier can be attributed to a fall in the "within effect". This suggests that there has been a general slowdown in the productivity growth of various sectors of the economy, possibly due to factors such as a deceleration in technological improvements and/or capital deepening within the sectors.

On the other hand, the positive "static shift effect" during the periods 1998-2002 and 2003-2007 reflects net employment shifts into sectors with relatively higher productivity levels. This suggests that the effort to restructure our economy towards higher value-added sectors may be paying dividends.

With Manufacturing and Services sectors contributing the most to the "within effect"...

The Manufacturing and Services sectors were the main contributors to the 'within effect' for all three periods of study ([Exhibit 3](#)). The contributions of the Construction sector and Utilities and Other Goods Industries were small, reflecting their small VA shares in the economy.

Exhibit 3: Decomposition of the Within Effect, 1993-2007

	Total Within	Manufacturing	Construction	Utilities and Other Goods Industries	Services
1993-1997	5.1 (100)	1.9 (38)	-0.1 (-2)	0.1 (1)	3.2 (62)
1998-2002	1.5 (100)	1.3 (87)	-0.1 (-5)	0.0 (2)	0.2 (16)
2003-2007	2.8 (100)	0.9 (34)	0.0 (1)	0.0 (1)	1.8 (64)

Per Cent

Note: Figures in parentheses indicate sectors' share of the total "within-effect".

During the periods 1993-1997 and 2003-2007, the “within effect” of Services accounted for about 60 per cent of the overall “within effect” and hence, the bulk of overall productivity growth. This largely reflects the high VA share of the Services sector ([Exhibit 4](#)). The Manufacturing sector has also contributed significantly towards the “within effect” and hence productivity growth, despite its relatively smaller VA share. The fall in the overall “within effect” from the period 1993-1997 to the period 2003-2007, which dragged down overall productivity growth, was caused by the decline in the “within effects” for both the Manufacturing and Services sectors.

Exhibit 4: Key Indicators for Various Sectors, 1993-2007

	Manufacturing		Construction		Utilities and Other Goods Industries		Services	
	VA Share	Emp Share	VA Share	Emp Share	VA Share	Emp Share	VA Share ¹	Emp Share
1993-1997	24.2	24.0	6.9	13.1	2.0	0.8	66.9	62.1
1998-2002	23.6	20.2	6.3	14.0	2.1	0.7	67.9	65.1
2003-2007	25.3	20.4	3.8	10.5	1.9	0.7	69.0	68.5

¹ Includes ownership of dwellings.

There is therefore a need to improve the “within effects” of the Manufacturing and Services sectors...

The shift-share analysis shows that to arrest the decline in productivity growth, it is important to improve the “within effects” of the Manufacturing and Services sectors. This can be done by improving the productivity of individual industries within the sectors (e.g., through encouraging the adoption of technology or human capital development), as well as growing the VA share of higher productivity industries in our economy.

The Services sector should be the focus of our efforts to raise productivity growth in Singapore, given its large VA share and rising employment share. The continual restructuring of the Manufacturing sector towards higher technology and knowledge intensive activities would help to improve the sector’s “within effects” over time. However, to fully reap the productivity gains from such higher value activities, it is important for the restructuring efforts to be accompanied by strategies for industries to utilize technology more effectively, as well as to help workers acquire new and productive skills. In this regard, productivity-enhancing strategies should include training programmes for both employees and employers.

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