Manufacturing and Services in Singapore's Economy: Twin Engines of Growth and their Asymmetric Dependencies

Article · November 2017

CITATIONS
2

READS
579

1 author:

Ming Leong Kuan
University of Cambridge
8 PUBLICATIONS **54** CITATIONS

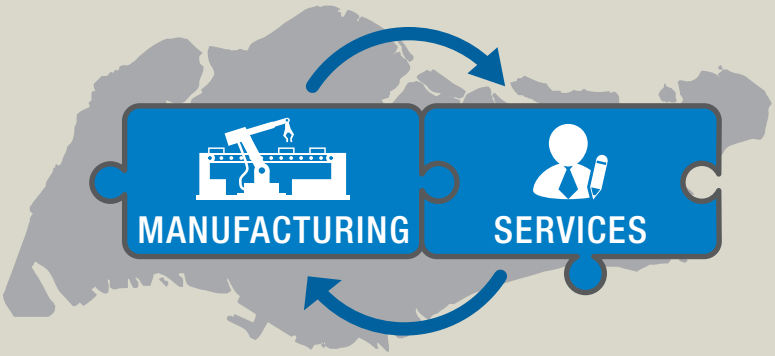
SEE PROFILE

FEATURE ARTICLE

MANUFACTURING AND SERVICES IN SINGAPORE'S ECONOMY: TWIN ENGINES OF GROWTH AND THEIR ASYMMETRIC DEPENDENCIES

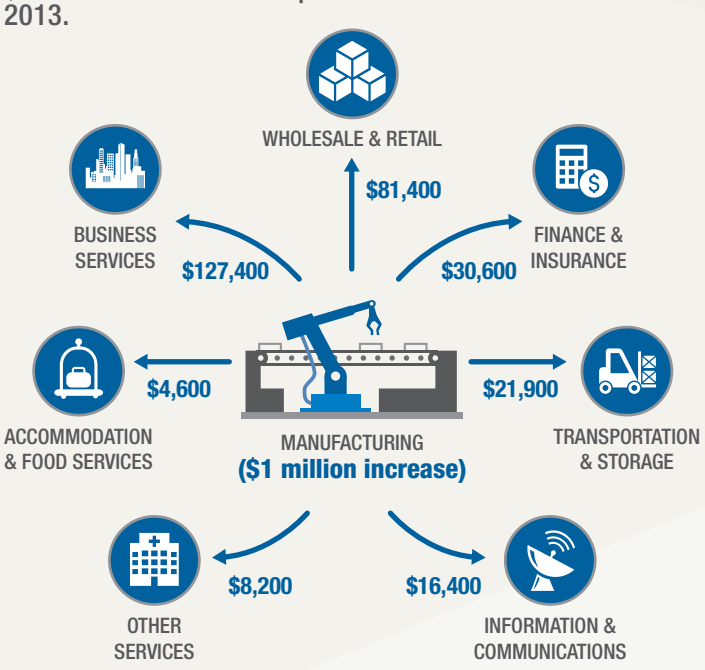
INTRODUCTION

Manufacturing and services are the twin engines of growth in the Singapore economy. Although they share a close, inter-dependent relationship, the development of services globally has historically depended more on the growth of the manufacturing sector than vice versa.

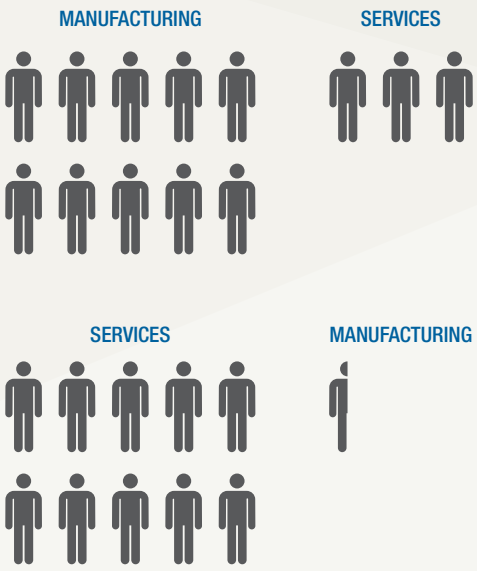


FINDINGS

The manufacturing sector was found to have stronger VA spillovers to the services sector than vice versa. For every $1 million of VA generated in the manufacturing sector, $0.29 million of VA were produced in the services sector in 2013.



Every 100 new manufacturing jobs were associated with 27 non-manufacturing jobs created. By contrast, every 100 new services jobs were associated with only 3 additional manufacturing jobs.



CONCLUDING REMARKS

In view of the manufacturing sector's strong backward linkages to the services sector, efforts to grow highly-productive modern services under the Government's Industry Transformation Maps will be supported by the concomitant development of a globally-competitive manufacturing sector.

EXECUTIVE SUMMARY

- Manufacturing and services are the twin engines of growth in the Singapore economy. Although they share a close, inter-dependent relationship, the development of services globally has historically depended more on the growth of the manufacturing sector than vice versa. This study examines whether the asymmetric dependencies between manufacturing and services hold in Singapore, and how this relationship has evolved over time.

- The manufacturing sector was found to have stronger value-added (VA) spillovers to the services sector than vice versa in 2013. Specifically, for every $1 million of VA generated in the manufacturing sector, $0.29 million of VA were produced in the services sector, particularly in knowledge-intensive professional services such as regional/international headquarters and engineering services, and wholesale trade. Notably, the chemicals and precision engineering clusters within the manufacturing sector contributed the most economic spillovers to the services sector. On the other hand, for every $1 million of services VA generated, $0.02 million of VA were produced in the manufacturing sector.

- Similarly, employment creation in the manufacturing sector was associated with greater employment creation in the services sector than vice versa. Specifically, every 100 new jobs in the manufacturing sector were associated with 27 jobs created in the services sector. Notably, jobs created in the biomedical manufacturing and chemicals clusters were associated with the most number of services jobs created, particularly in exportable services such as professional services and wholesale trade. By contrast, every 100 new services jobs were associated with only 3 new jobs in the manufacturing sector.

- Over time, the economic spillovers by both the manufacturing and services sectors have risen on the back of a strengthening of their backward linkages with other sectors within the domestic economy. Between 2000 and 2013, the indirect VA generated by the manufacturing sector rose by 2.2 per cent per annum, while that generated by the services sector increased by 0.2 per cent per annum. Within the manufacturing sector, the chemicals cluster saw the largest improvement in backward linkages (8.6 per cent per annum increase in VA spillovers), followed by the precision engineering (4.6 per cent per annum) and transport engineering (1.4 per cent per annum) clusters.

- In view of the manufacturing sector's strong backward linkages to the services sector, efforts to grow highly-productive modern services such as professional services, wholesale trade and finance & insurance under the Government's Industry Transformation Maps will be supported by the concomitant development of a globally-competitive manufacturing sector.

The views expressed in this paper are solely those of the author and do not necessarily reflect those of the Ministry of Trade and Industry or the Government of Singapore.[1]

1. INTRODUCTION

Manufacturing and services are the twin engines of growth in the Singapore economy (see ECS, 1986; EPC, 1991; CSC, 1998; ERC, 2003; ESC, 2010; CFE, 2017). With services accounting for 69.4 per cent of its Gross Domestic Product (GDP) in 2016, Singapore is a predominantly services economy. Nonetheless, it continues to have a strong manufacturing base.[2] Over the medium term, the Government remains committed to maintaining a globally-competitive manufacturing sector that contributes to around 20 per cent of the economy.

[1] *The author would like to thank Yong Yik Wei for her useful comments, as well as the Department of Statistics (DOS), Economic Development Board (EDB) and International Enterprise (IE) Singapore for their inputs to the study. All remaining errors belong to the author.*

[2] *In 2016, the manufacturing sector comprised 19.6% of Singapore's economy. As a comparison, the share of manufacturing in GDP was smaller in other advanced economies such as the United States (11.7% in 2016) and United Kingdom (9.7%) (BEA, 2017; World Bank, 2017). Developed countries that maintained a sizeable manufacturing presence in their economies included Ireland (36.7% of GDP in 2016), South Korea (29.3%) and Germany (22.6%).*

Traditionally, manufacturing and services share a close, inter-dependent relationship (see Britton, 1990; Illeris, 1996; Daniels & Bryson, 2002; Kuan, 2016). However, their dependencies have also historically been asymmetric – i.e., the development of services depends more on the growth of the manufacturing sector than vice versa.

This study examines whether the asymmetric dependencies between manufacturing and services hold in Singapore, and how this relationship has evolved over time. With the cluster approach adopted under the Government's Industry Transformation Maps (ITMs) (see CFE, 2017), it is also important to understand the nature and extent of inter-sectoral linkages in order to maximise synergies across sectors.

The rest of the paper is organised as follows. Section 2 provides an overview of the literature on the relationship between manufacturing and services, with a focus on their asymmetric dependencies. Section 3 highlights the data sources and empirical methodology used to analyse manufacturing-services linkages in this study. Section 4 examines the inter-dependencies between manufacturing and services, in terms of the value-added (VA) and employment spillovers, at the broad sectoral level (i.e., manufacturing vs. services) as well as for the more detailed manufacturing clusters and services industries. Section 5 discusses broad policy implications and also provides concluding remarks.

2. LITERATURE REVIEW

The manufacturing sector has historically been viewed as having an important role in an economy because of its strong inter-sectoral linkages that stimulate development in the rest of the economy (Cornwall, 1977; Myint, 1980). This arises through backward linkages to sectors that the manufacturing sector draws inputs from, and forward linkages to sectors that the manufacturing sector supplies inputs to (Hirschman, 1958). Using input-output (IO) tables, Cornwall (1977) showed that the manufacturing sector had strong backward linkages through its purchases of inputs from other sectors in the economy, and also strong forward linkages given its role as a supplier of capital goods and new technologies to other sectors. Drawing on IO analysis of France, Pilat and Wölfl (2005) estimated that 29 per cent of manufacturing workers contributed indirectly to the production of non-manufacturing output (i.e., intermediate inputs to the rest of the economy). As a comparison, 13 per cent of services workers contributed indirectly to the production of non-services output.

While manufacturing and services share a close relationship, their inter-dependencies have been noted to be asymmetric. Early work by Galenson (1963) highlighted that the growth of manufacturing employment generated a much larger employment in the services sector than vice versa. Subsequent extensions by Park (1989) and Park and Chan (1989) showed that sustained employment and output growth in services depended on the contemporaneous development of manufacturing activities. In a study of six advanced economies (France, Germany, Netherlands, Spain, United Kingdom and United States) in the late 1990s, Gregory and Russo (2007) illustrated that 24 to 31 per cent of employment created from an injection of demand in the manufacturing sector flowed to the services sector.[3] By contrast, services retained most of the employment gains from an increase in demand in the services sector, with only 6 to 11 per cent of new jobs going to the manufacturing sector. In general, the employment intensity (i.e., the number of economy-wide jobs created from final demand) in the manufacturing sector was similar to that in the services sector, with some countries (e.g., United States and United Kingdom) creating more jobs in the overall economy from manufacturing demand than services demand. In Sweden, Andersson (2006) examined regional employment data and found that even as manufacturing and services shared a propensity to co-locate, knowledge-intensive manufacturing industries had a stronger influence on anchoring knowledge-intensive producer services employment than vice versa. With manufacturing being a major purchaser of inputs from highly-productive modern services, Guerrieri and Meliciani (2005) and Felipe et al. (2013) concluded that the ability of countries to develop these services sectors was tied to the presence and structure of the manufacturing base.

[3] *In Gregory and Russo's (2007) study, a broader definition of manufacturing that included agriculture, mining and quarrying, public utilities and construction was adopted.*

In Singapore's context, Thangavelu and Tan (2008) studied employment linkages in the economy and found that employment spillovers from manufacturing to services were more significant than in the reverse direction. For the same increase in final demand, manufacturing created 1.6 times as many jobs as services in the combined manufacturing and services sectors. Notably, the petrochemicals and electronics industries were found to have high employment spillovers to the services sector. Within the services sector, commerce activities, including marketing and wholesale & retail trade, benefited the most from an increase in final demand in the manufacturing sector.

3. DATA AND EMPIRICAL METHODOLOGY

This study examines manufacturing-services linkages using the Department of Statistics' (DOS) Singapore IO Tables 2000, 2005, 2010 and 2013. Employment statistics are sourced from the Ministry of Manpower (MOM).

Broadly, Singapore's IO Tables illustrate inter-sectoral linkages in the economy, and follow the notion that a sector's output is obtained by consuming inputs from other sectors. In turn, the output of the sector can also serve as inputs to other sectors. In notational form, output X in Singapore can be expressed as the following:

$$X = \begin{pmatrix} M \\ S \\ Z \end{pmatrix} = \begin{pmatrix} a_{mm} & a_{ms} & a_{mz} \\ a_{sm} & a_{ss} & a_{sz} \\ a_{zm} & a_{zs} & a_{zz} \end{pmatrix} \begin{pmatrix} M \\ S \\ Z \end{pmatrix} + \begin{pmatrix} f_m \\ f_s \\ f_z \end{pmatrix} = AX + F$$

where manufacturing, services and others (i.e., agriculture & fishing, construction and utilities) are denoted by M, S, and Z respectively, and f encapsulates the final demand generated by households and the government, exports of goods and services, gross fixed capital formation and changes in inventories. The technical coefficients in matrix A represent the amount of inputs from other sectors that is required by a sector in order to produce a unit of the latter's output. As an illustration, a_{sm} refers to the intermediate services input that flows to the manufacturing sector to support the production of one unit of manufacturing output.

Re-ordering the above notation gives the following expression:

$$X = (I - A)^{-1}F$$

where I is the identity matrix, and $(I - A)^{-1}$ is the Leontief Inverse Matrix where each coefficient in the matrix denotes the total output that is generated from an increase in final demand in a sector in matrix X.

VA multipliers for the various sectors are then derived by multiplying the Leontief Inverse Matrix with the ratio of total VA to total output for each sector. Similarly, the Leontief Inverse Matrix is multiplied with the ratio of total employment to total output for each sector to obtain the employment multipliers for the various sectors.

An increase in final demand in a sector can generate VA and create employment within the sector (directly or indirectly[4]), as well as in other sectors of the economy that it sources intermediate inputs from (i.e., through backward linkages). In the subsequent analysis, the indirect VA multiplier of sector x is estimated as the VA that is generated in other sectors (i.e., outside sector x) for an increase in VA (direct and indirect) in sector x.[5]

[4] *Second- and subsequent-order effects exist in the IO analysis of economic multipliers. For instance, an increase in final demand for sector x stimulates production in sector y if the latter provides the former with intermediate inputs. This in turn further raises output in sector x if sector y draws inputs from it.*

[5] *The increase in the VA (direct and indirect) of sector x in turn arises through an increase in its final demand.*

4. RESULTS

Analysis at Broad Sectoral Level

Based on the 2013 IO Tables, the manufacturing sector was found to have stronger VA spillovers to the services sector than vice versa (Exhibit 1). Specifically, for every $1 million of VA generated in the manufacturing sector, $0.29 million of VA were produced in the services sector and another $0.04 million in the other sectors of the economy (i.e., construction, utilities, and other goods producing industries). Conversely, for every $1 million of VA generated in the services sector, $0.02 million of VA were generated in the manufacturing sector and another $0.01 million in the other sectors of the economy.

Exhibit 1: VA spillovers generated for a $1 million increase in manufacturing/ services VA, 2013

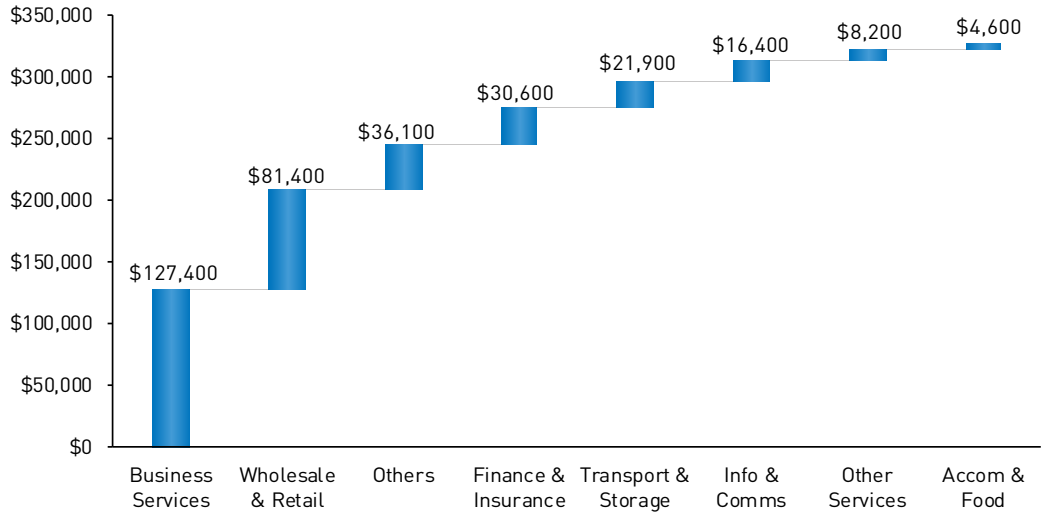
Increase in VA:	Manufacturing	Services	Others
Manufacturing	$1m	$290,500	$36,100
Services	$20,900	$1m	$14,100

Source: Estimates based on the Singapore IO Tables 2013

Notes: The increase in VA arises from an increase in final demand. The "Others" category includes construction, utilities and other goods producing industries.

Exhibit 2 shows a more detailed breakdown of the VA spillovers to the various sectors generated by a $1 million increase in VA in the manufacturing sector. As can be seen, growth in the manufacturing sector generated significant spillovers to the business services (particularly knowledge-intensive professional services such as regional/international headquarters[6] and engineering services) ($127,400), and wholesale & retail trade ($81,400) industries.[7]

Exhibit 2: Indirect VA generated for a $1 million increase in manufacturing VA, 2013



Source: Estimates based on the Singapore IO Tables 2013

Note: The "Others" category includes construction, utilities and other goods producing industries.

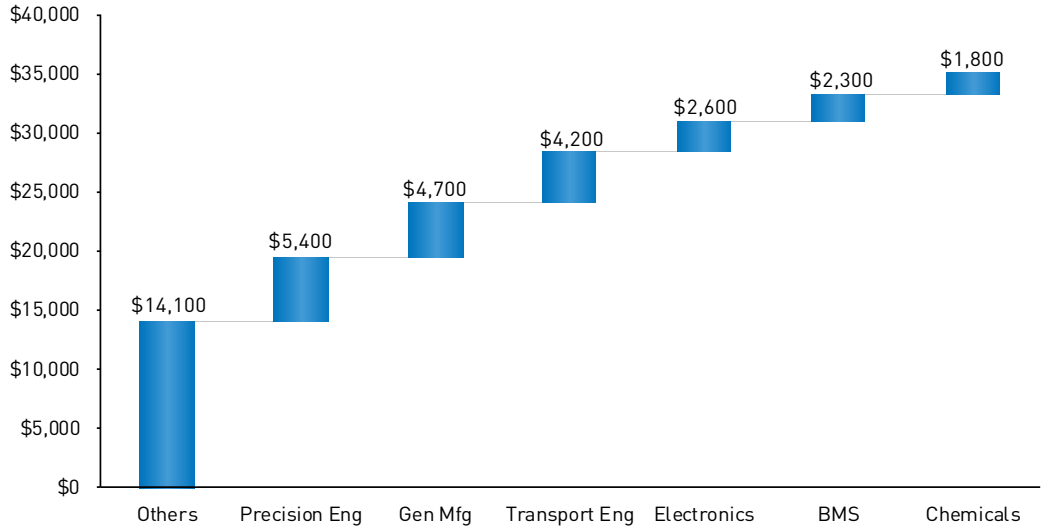
Similarly, Exhibit 3 shows a breakdown of the indirect VA generated by a $1 million increase in VA in the services sector. Notably, the most significant spillovers were observed in the "Others" category which comprised the utilities ($8,600 of indirect VA) and construction ($5,400) industries.[8] Of the $20,900 of VA spillovers to the manufacturing sector, the precision engineering cluster derived the greatest benefit ($5,400), followed by the general manufacturing ($4,700) and transport engineering ($4,200) clusters.

[6] In 2013, 19.6% of the output of business representative offices and headquarters activities was tied to Singapore's domestic manufacturing sector.

[7] Spillovers to the wholesale & retail trade industry were largely driven by the wholesale trade segment. In 2013, Singapore's manufacturing sector demanded $10.2 billion of intermediate output from the wholesale trade segment, over 100 times the intermediate output sourced from the retail trade segment ($99 million).

[8] Nonetheless, for the same $1 million increase in VA, the manufacturing sector generated more indirect VA in the utilities ($28,100) and construction ($7,300) industries in 2013.

Exhibit 3: Indirect VA generated for a $1 million increase in services VA, 2013



Source: Estimates based on the Singapore IO Tables 2013

Note: The "Others" category includes construction, utilities and other goods producing industries.

In terms of employment, job creation in the manufacturing sector was associated with greater job creation in the services sector than vice versa (Exhibit 4). For every 100 new jobs in the manufacturing sector, 31 non-manufacturing jobs were created in the overall economy, of which 27 were services jobs. By contrast, every 100 new services jobs were associated with only 5 additional non-services jobs in the economy, of which 3 were manufacturing jobs.

Exhibit 4: Employment creation associated with an increase in 100 manufacturing/ services jobs, 2013

Increase in Jobs:	Manufacturing	Services	Others
Manufacturing	100	27	4
Services	3	100	2

Source: Estimates based on the Singapore IO Tables 2013

Notes: The increase in 100 jobs arises from an increase in final demand. The "Others" category includes construction, utilities and other goods producing industries.

Analysis at Detailed Manufacturing Clusters and Services Industries

Given that the manufacturing and services sectors are highly heterogeneous, it is important to disaggregate the two broad sectors to better understand the extent to which individual manufacturing clusters and services industries within the broad sectors generate economic spillovers and create jobs outside their clusters and industries.

Reflecting the diversity in Singapore's manufacturing sector, economic spillovers differed across the clusters within the sector (Exhibit 5). Among the manufacturing clusters, chemicals produced the most VA spillovers in the economy, with $1 million of chemicals VA associated with a $1.2 million increase in VA in the rest of the economy. Notably, the indirect VA generated across the various services industries ($967,500) was nearly as large as the VA produced in the chemicals cluster, with wholesale trade being a key beneficiary.[9] The precision engineering ($515,300), transport engineering ($372,000), general manufacturing ($364,000) and electronics ($275,800) clusters also generated healthy VA spillovers to the other industries in the economy. By contrast, biomedical manufacturing had weaker linkages within the domestic economy, with most of the economy-wide VA generated from its growth (91.1 per cent) retained within the cluster.[10]

[9] Wholesale trade accounted for half of total intermediate services inputs to the chemicals cluster. The refineries and petrochemical plants in the chemicals cluster are supported by crude oil and chemicals trading, where trading companies are engaged to competitively source feedstock and efficiently market the cluster's end-products to customers.

[10] Most of the inputs to the production of pharmaceuticals and biological products in the biomedical manufacturing cluster are imported. Additionally, as the products are primarily produced for export, with a smaller proportion of the products being used as intermediate inputs to other manufacturing clusters, there are fewer second- and subsequent-order effects on the economy as compared to the other manufacturing clusters.

Exhibit 5: VA spillovers generated for a $1 million increase in manufacturing VA by manufacturing cluster, 2013

Manufacturing Cluster	Own Cluster	Rest of Economy	Rest of Manufacturing	Services	Others
Electronics	$1m (78.4%)	$275,800 (21.6%)	$26,200 (2.1%)	$210,100 (16.5%)	$39,500 (3.1%)
Chemicals	$1m (44.7%)	$1.2m (55.3%)	$94,900 (4.2%)	$967,500 (43.2%)	$177,000 (7.9%)
Biomedical Manufacturing	$1m (91.1%)	$97,500 (8.9%)	$6,300 (0.6%)	$84,300 (7.7%)	$6,800 (0.6%)
Precision Engineering	$1m (66.0%)	$515,300 (34.0%)	$50,600 (3.3%)	$437,000 (28.8%)	$27,700 (1.8%)
Transport Engineering	$1m (72.9%)	$372,000 (27.1%)	$49,900 (3.6%)	$301,700 (22.0%)	$20,400 (1.5%)
General Manufacturing	$1m (73.3%)	$364,000 (26.7%)	$27,900 (2.0%)	$294,800 (21.6%)	$41,400 (3.0%)

Source: Estimates based on the Singapore IO Tables 2013

Notes: The "Others" category includes construction, utilities and other goods producing industries. The numbers in parenthesis denote the share of VA that is generated in the overall economy from an increase in VA in the manufacturing cluster. The figures for "Rest of Manufacturing", "Services" and "Others" may not sum to that of "Rest of Economy" due to rounding.

In terms of jobs, the manufacturing clusters also generated healthy spillovers to the rest of the economy, particularly in the various services industries (Exhibit 6). The creation of 100 jobs in each manufacturing cluster was associated with the creation of 19 (for general manufacturing) to 117 (for biomedical manufacturing[11]) jobs in the broader economy. Notably, job creation in the biomedical manufacturing, chemicals and electronics clusters was associated with a significant number of jobs created in the various services industries (94, 58 and 38 services jobs respectively for every 100 manufacturing jobs). These included jobs in the business services and wholesale & retail trade industries.

Exhibit 6: Employment creation associated with an increase in 100 manufacturing jobs by manufacturing cluster, 2013

Manufacturing Cluster	Own Cluster	Rest of Economy	Rest of Manufacturing	Services	Others
Electronics	100 (64.4%)	55 (35.6%)	8 (5.3%)	38 (24.5%)	9 (5.7%)
Chemicals	100 (56.8%)	76 (43.2%)	9 (5.2%)	58 (32.8%)	9 (5.2%)
Biomedical Manufacturing	100 (46.0%)	117 (54.0%)	11 (5.3%)	94 (43.4%)	12 (5.3%)
Precision Engineering	100 (75.8%)	32 (24.2%)	4 (2.8%)	26 (19.4%)	3 (2.1%)
Transport Engineering	100 (79.4%)	26 (20.6%)	5 (4.0%)	19 (14.9%)	2 (1.7%)
General Manufacturing	100 (83.8%)	19 (16.2%)	2 (1.6%)	15 (12.4%)	3 (2.2%)

Source: Estimates based on the Singapore IO Tables 2013

Notes: The increase in 100 manufacturing jobs arises from an increase in final demand in the manufacturing cluster. The "Others" category includes construction, utilities and other goods producing industries. The numbers in parenthesis denote the share of employment that is generated in the overall economy in line with an increase in 100 jobs in the manufacturing cluster. The figures for "Rest of Manufacturing", "Services" and "Others" may not sum to that of "Rest of Economy" due to rounding.

[11] The biomedical manufacturing cluster generated weaker VA spillovers as previously illustrated. Nonetheless, as the cluster is highly productive (i.e., requiring fewer workers per unit of VA generated), when normalised by jobs created in the cluster, each biomedical manufacturing job was associated with a larger number of jobs created in the overall economy. In 2016, nominal VA per worker in the biomedical manufacturing cluster was $732,100, much higher than that in the overall economy ($111,800).

As for services, much of the economic spillovers generated was found to accrue more to the various services industries rather than to the manufacturing sector (Exhibit 7). In particular, manufacturing only accounted for 0.5 per cent (finance & insurance) to 4.6 per cent (accommodation & food services) of the economy-wide VA that was generated from the growth of the different services industries. Among the services industries, the accommodation & food services industry had the largest VA spillovers to the rest of the economy ($556,100) for a $1 million increase in VA, as it drew significant inputs from the real estate, food manufacturing and wholesale trade segments. This was followed by the transportation & storage ($409,300), other services ($325,700), wholesale & retail trade ($312,800), information & communications ($267,700), business services ($186,600) and finance & insurance ($126,200) industries.

Exhibit 7: VA spillovers generated for a $1 million increase in services VA by services industry, 2013

Services Industry	Own Industry	Rest of Economy	Rest of Services	Manufacturing	Others
Wholesale & Retail Trade	$1m (76.2%)	312,800 (23.8%)	290,800 (22.2%)	12,500 (1.0%)	9,500 (0.7%)
Accommodation & Food Services	$1m (64.3%)	556,100 (35.7%)	429,700 (27.6%)	71,600 (4.6%)	54,800 (3.5%)
Transportation & Storage	$1m (71.0%)	409,300 (29.0%)	330,900 (23.5%)	58,400 (4.1%)	20,000 (1.4%)
Information & Communi-cations	$1m (78.9%)	267,700 (21.1%)	216,700 (17.1%)	36,600 (2.9%)	14,500 (1.1%)
Finance & Insurance	$1m (88.8%)	126,200 (11.2%)	116,400 (10.3%)	5,400 (0.5%)	4,400 (0.4%)
Business Services	$1m (84.3%)	186,600 (15.7%)	141,800 (12.0%)	23,300 (2.0%)	21,400 (1.8%)
Other Services	$1m (75.4%)	325,700 (24.6%)	257,000 (19.4%)	40,000 (3.0%)	28,700 (2.2%)

Source: Estimates based on the Singapore IO Tables 2013

Notes: The "Others" category includes construction, utilities and other goods producing industries. The numbers in parenthesis denote the share of VA that is generated in the overall economy from an increase in VA in the services industry. The figures for "Rest of Services", "Manufacturing" and "Others" may not sum to that of "Rest of Economy" due to rounding.

In terms of employment, growth in the various services industries also primarily supported employment creation within the services sector, with limited spillovers to the manufacturing sector (Exhibit 8). For every 100 jobs that were created in each services industry through an increase in final demand, the number of manufacturing jobs created through spillovers ranged from 1 (for finance & insurance) to 8 (for transportation & storage) jobs. Employment creation in the transportation & storage industry was associated with the most jobs created in the broader economy (45 jobs for every 100 transportation & storage jobs). This was followed by the wholesale & retail trade (34), information & communications (29), business services (26), finance & insurance (25), accommodation & food services (17) and other services (13) industries.

Exhibit 8: Employment creation associated with an increase in 100 services jobs by services industry, 2013

Services Industry	Own Industry	Rest of Economy	Rest of Services	Manufacturing	Others
Wholesale & Retail Trade	100 (74.4%)	34 (25.6%)	31 (22.9%)	2 (1.5%)	2 (1.2%)
Accommodation & Food Services	100 (85.8%)	17 (14.2%)	11 (9.5%)	4 (3.2%)	2 (1.5%)
Transportation & Storage	100 (69.0%)	45 (31.0%)	34 (23.7%)	8 (5.5%)	3 (1.7%)
Information & Communi-cations	100 (77.3%)	29 (22.7%)	23 (17.6%)	4 (3.5%)	2 (1.6%)
Finance & Insurance	100 (79.7%)	25 (20.3%)	23 (18.1%)	1 (1.1%)	1 (1.0%)
Business Services	100 (79.1%)	26 (20.9%)	16 (12.8%)	4 (3.1%)	6 (5.0%)
Other Services	100 (88.4%)	13 (11.6%)	10 (8.7%)	2 (1.6%)	1 (1.3%)

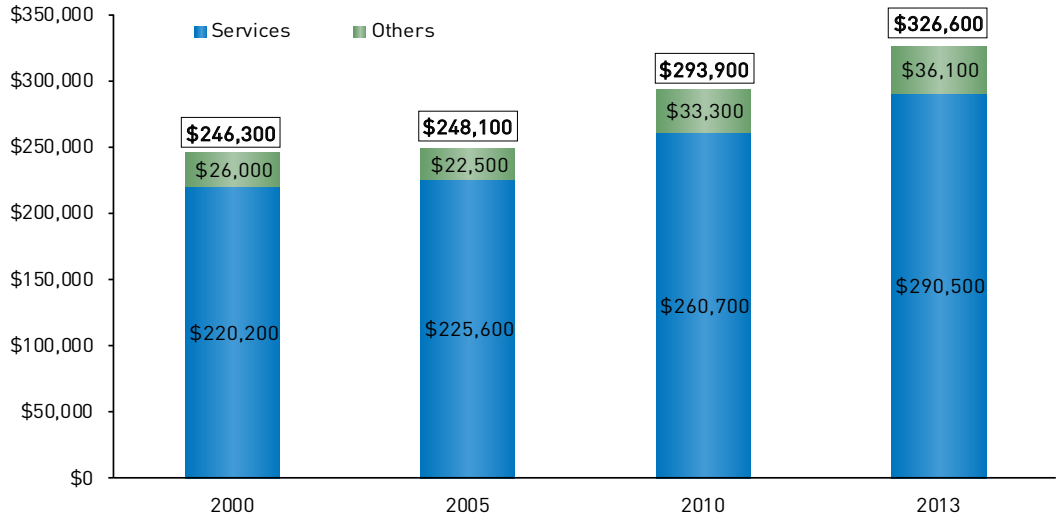
Source: Estimates based on the Singapore IO Tables 2013

Notes: The increase in 100 services jobs arises from an increase in final demand in the services industry. The "Others" category includes construction, utilities and other goods producing industries. The numbers in parenthesis denote the share of employment that is generated in the overall economy in line with an increase in 100 jobs in the services industry. The figures for "Rest of Services", "Manufacturing" and "Others" may not sum to that of "Rest of Economy" due to rounding.

Analysis of Inter-Sectoral Linkages Over Time

Over time, economic spillovers generated by both manufacturing and services have risen on the back of a strengthening of their backward linkages with other sectors within the domestic economy (Exhibits 9 and 10).[12] Between 2000 and 2013, indirect VA generated in the rest of the economy by the manufacturing and services sectors rose by 2.2 per cent per annum (p.a.) and 0.2 per cent p.a. respectively. Notably, the manufacturing sector has deepened its backward linkages with several individual services industries in the economy such as business services. Between 2000 and 2013, the indirect VA generated in the business services industry from a $1 million increase in manufacturing VA rose by 4.1 per cent p.a. (from $75,700 to $127,400).

Exhibit 9: Indirect VA associated with a $1 million increase in manufacturing VA, 2000-2013

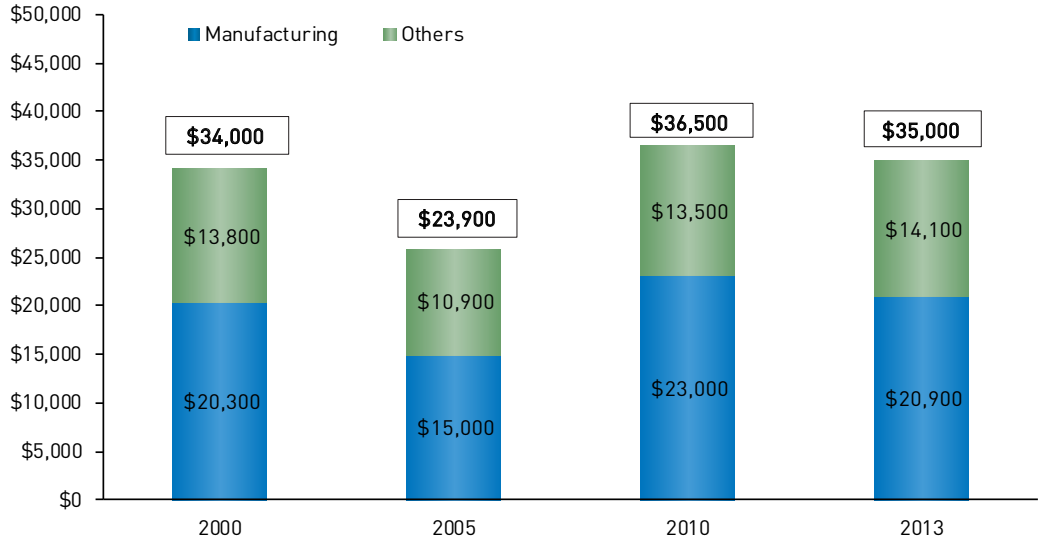


Source: Estimates based on the Singapore IO Tables 2000, 2005, 2010 and 2013

Notes: The "Others" category includes construction, utilities and other goods producing industries. The numbers may not sum to the total due to rounding.

[12] *Changes in economic spillovers over time could also be influenced by changes in prices and the make-up of the IO industries, as well as methodological updates.*

Exhibit 10: Indirect VA associated with a $1 million increase in services VA, 2000-2013

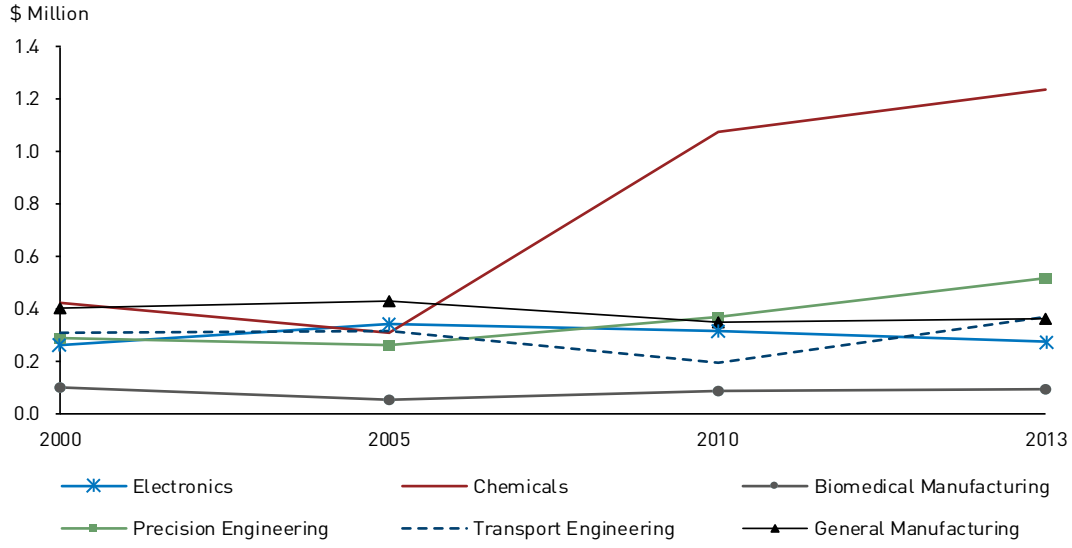


Source: Estimates based on the Singapore IO Tables 2000, 2005, 2010 and 2013

Notes: The "Others" category includes construction, utilities and other goods producing industries. The numbers may not sum to the total due to rounding.

Within the manufacturing sector, the chemicals cluster saw the largest improvement in backward linkages in the domestic economy (Exhibit 11). Between 2000 (when Jurong Island[13] was officially opened) and 2013, the VA spillovers from the chemicals cluster to the rest of the economy rose by 8.6 per cent p.a., supported by increases in VA spillovers to other manufacturing clusters (10.9 per cent p.a.) and the services sector (8.9 per cent p.a.).[14] During this period, VA spillovers from the precision engineering and transport engineering clusters to the rest of the economy also increased by 4.6 per cent p.a. and 1.4 per cent p.a. respectively.[15] On the other hand, VA spillovers from the electronics, biomedical manufacturing and general manufacturing clusters have remained fairly stable over time.

Exhibit 11: Indirect VA associated with a $1 million increase in manufacturing VA by manufacturing clusters, 2000-2013



Source: Estimates based on the Singapore IO Tables 2000, 2005, 2010 and 2013

[13] Using a model of 'state-enabled industry integration' (see Chan, 2011), Singapore established a specialised 33km² cluster of chemical activities on Jurong Island to harness scale economies and linkages between firms.

[14] VA spillovers from the chemicals cluster to the construction, utilities and other goods producing industries also rose by 6.6% p.a. between 2000 and 2013.

[15] Between 2000 and 2013, the precision engineering cluster's VA spillovers to services (5.4% p.a.) and the other manufacturing clusters (2.2% p.a.) rose, while VA spillovers to the construction, utilities and other goods producing industries remained stable. For the transport engineering cluster, there was an increase in VA spillovers to services (1.7% p.a.) and the construction, utilities and other goods producing industries (0.4% p.a.), while VA spillovers to the other manufacturing clusters remained at similar levels between 2000 and 2013.

5. CONCLUDING REMARKS

In recent years, the rapid growth of services worldwide has led to views that countries can pursue services-centric pathways of development (e.g., Bhagwati, 2010; Romer, 2012; Ghani & O'Connell, 2014). Indeed, such views are supported by several characteristics of the services sector (e.g., its strong intra-sectoral linkages and capacity to generate employment opportunities), as well as the attractiveness of modern services.

However, the manufacturing sector continues to retain many important engine-of-growth properties (see Haraguchi et al., 2017). Arising from their asymmetric dependencies, manufacturing development anchors services activities, but services growth may not stimulate the development of manufacturing activities. As such, the loss of manufacturing capabilities is harder to restore as the sector does not benefit significantly from a thriving services-centric economy. The manufacturing sector's strong inter-sectoral linkages, particularly backward linkages to the services sector, offer countries the opportunity to undertake complementary approaches to develop both the manufacturing and services sectors.

Similar to the observations in other economies, this study highlights that there are also asymmetric dependencies between manufacturing and services in Singapore, a predominantly services economy with a manufacturing base. Linkages are strong from manufacturing to services, but comparatively weaker in the opposite direction. As such, growth in the manufacturing sector results in more significant spillovers to the services sector, in terms of VA generated and jobs created, than vice versa.

The cluster approach under the ITMs is undertaken in recognition of the increasingly complex linkages across sectors in the economy. In view of their synergies, efforts to grow highly-productive modern services such as professional services, wholesale trade, and finance & insurance under the ITMs will be supported by the concomitant development of a globally-competitive manufacturing sector.

Contributed by:

Dr Kuan Ming Leong
Lead Economist
Economics Division
Ministry of Trade and Industry

REFERENCES

Andersson, M. (2006). Co-Location of Manufacturing and Producer Services: A Simultaneous Equations Approach. In C. Karlsson, B. Johansson, & R. R. Stough (Eds.), *Entrepreneurship and Dynamics in the Knowledge Economy* (pp. 94-124). New York: Routledge.

BEA (Bureau of Economic Analysis, United States). (2017). *BEA Interactive Database*. Washington, DC: BEA.

Bhagwati, J. N. (2010). *The Manufacturing Fallacy*. Retrieved November 21, 2017, from Project Syndicate: http://www.project-syndicate.org/commentary/the-manufacturing-fallacy

Britton, S. (1990). The Role of Services in Production. *Progress in Human Geography*, 14(4), 529-546.

CFE (Committee on the Future Economy). (2017). *Report of the Committee on the Future Economy: Pioneers of the Next Generation*. Singapore: CFE.

Chan, C. B. (2011). How Singapore Became a Newly Industrialised Economy. In C. B. Chan (Ed.), *Heart Work 2: EDB and Partners: New Frontiers for the Singapore Economy* (pp. 12-22). Singapore: Straits Times Press.

Cornwall, J. (1977). *Modern Capitalism: Its Growth and Transformation*. Oxford: Martin Robertson.

CSC (Committee on Singapore's Competitiveness). (1998). *Committee on Singapore's Competitiveness. Singapore*: Ministry of Trade and Industry.

Daniels, P. W., & Bryson, J. R. (2002). Manufacturing Services and Servicing Manufacturing: Knowledge-Based Cities and Changing Forms of Production. *Urban Studies*, 39(5-6), 977-991.

ECS (Economic Committee of Singapore). (1986). *Report of the Economic Committee: The Singapore Economy: New Directions. Singapore*: Ministry of Trade and Industry.

EPC (Economic Planning Committee of Singapore). (1991). *The Strategic Economic Plan: Towards a Developed Nation. Singapore*: SNP Publishers.

ERC (Economic Review Committee of Singapore). (2003). *Report of the Economic Review Committee: New Challenges, Fresh Goals - Towards a Dynamic Global City*. Singapore: Ministry of Trade and Industry.

ESC (Economic Strategies Committee of Singapore). (2010). *Report of the Economic Strategies Committee: High Skilled People, Innovative Economy, Distinctive Global City*. Singapore: ESC.

Felipe, J., Briones, R., Brooks, D. H., Mehta, A., & Verspagen, H. (2013). *Asia's Economic Transformation: Where to, How, and How Fast?: Key Indicators for Asia and the Pacific 2013 Special Chapter*. Manila: Asian Development Bank.

Galenson, W. (1963). Economic Development and the Sectoral Expansion of Employment. I*nternational Labour Review*, 87(6), 506-519.

Ghani, E., & O'Connell, S. D. (2014). *Can Service Be a Growth Escalator in Low Income Countries?* World Bank Policy Research Working Paper No. 6971. Washington, DC: World Bank.

Gregory, M., & Russo, G. (2007). Do Demand Differences Cause the U.S.-European Employment Gap? In M. Gregory, W. Salverda, & R. Schettkat (Eds.), *Services and Employment: Explaining the U.S.-European Gap* (pp. 81-108). Princeton, NJ: Princeton University Press.

Guerrieri, P., & Meliciani, V. (2005). Technology and International Competitiveness: The Interdependence Between Manufacturing and Producer Services. *Structural Change and Economic Dynamics*, 16(4), 489-502.

Haraguchi, N., Cheng, C. F., & Smeets, E. (2017). The Importance of Manufacturing in Economic Development: Has This Changed? *World Development*, 93, 293-315.

Hirschman, A. O. (1958). *The Strategy of Economic Development*. New Haven and London: Yale University Press.

Illeris, S. (1996). The Service Economy: *A Geographical Approach*. Chichester: John Wiley and Sons.

Kuan, M. L. (2016). Does Manufacturing Colocate with Intermediate Services? Analyzing the World Input-Output Database. In A. Noman, & J. Stiglitz (Eds.), *Efficiency, Finance, and Varieties of Industrial Policy: Guiding Resources, Learning and Technology for Sustained Growth* (pp. 447-482). New York: Columbia University Press.

Myint, H. (1980). *The Economics of the Developing Countries*. London: Hutchinson.

Park, S.-H. (1989). Linkages Between Industry and Services and their Implications for Urban Employment Generation in Developing Countries. *Journal of Development Economics*, 30(2), 359-379.

Park, S.-H., & Chan, K. S. (1989). A Cross-Country Input-Output Analysis of Intersectoral Relationships between Manufacturing and Services and their Employment Implications. *World Development*, 17(2), 199-212.

Pilat, D., & Wölfl, A. (2005). *Measuring the Interaction Between Manufacturing and Services*. OECD Science, Technology and Industry Working Papers 2005/05. Paris: OECD Publishing.

Romer, C. D. (2012). *Do Manufacturers Need Special Treatment?* Retrieved November 21, 2017, from The New York Times: http://www.nytimes.com/2012/02/05/business/do-manufacturers-need-special-treatment-economic-view.html

Thangavelu, S. M., & Tan, Z. L. (2008). Employment Linkages and Structural Changes in Singapore. *Economic Survey of Singapore 2007*, 131-145.

World Bank. (2017). *World Development Indicators Database*. Washington, DC: World Bank.