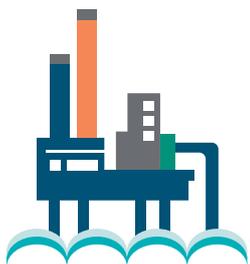


ECONOMIC SURVEY OF SINGAPORE

Third Quarter 2019



MTI MINISTRY OF TRADE
AND INDUSTRY
SINGAPORE



November 2019

Ministry of Trade and Industry
Republic of Singapore

website: www.mti.gov.sg

email: mti_email@mti.gov.sg

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanised, photocopying, recording or otherwise, without the prior permission of the copyright holder.

CONTENTS

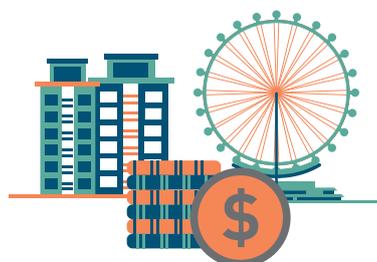
03

**MAIN INDICATORS
OF THE SINGAPORE ECONOMY**



06

**CHAPTER 1
The Singapore Economy**



18 **BOX 1.1**
Singapore's Corporate
Sector: Recent Trends
in Firm Formation and
Cessation



26

**CHAPTER 2
Sectoral Performance**

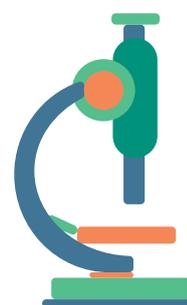
38

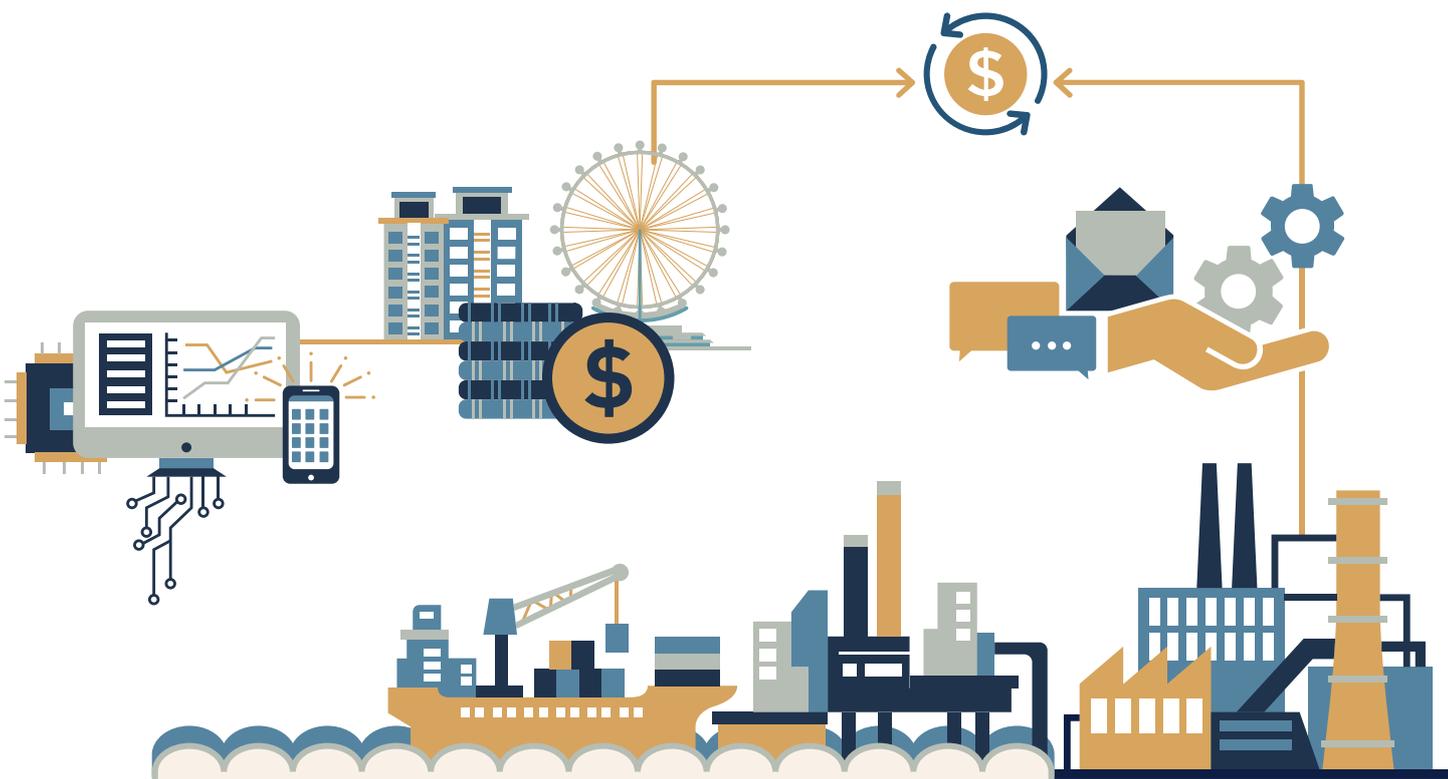
**CHAPTER 3
Economic Outlook**



42

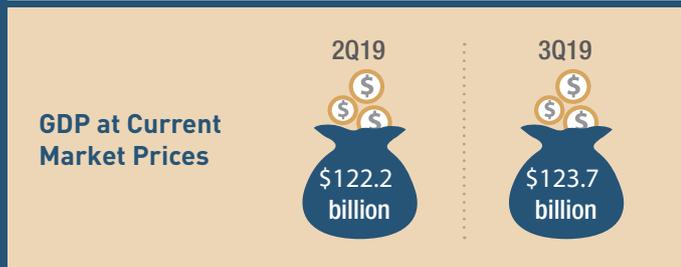
FEATURE ARTICLE
Returns to Research and
Development (R&D) Among
Firms in Singapore





MAIN INDICATORS OF THE SINGAPORE ECONOMY

OVERALL ECONOMY



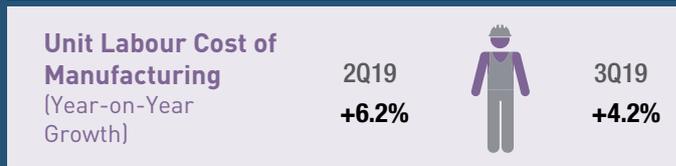
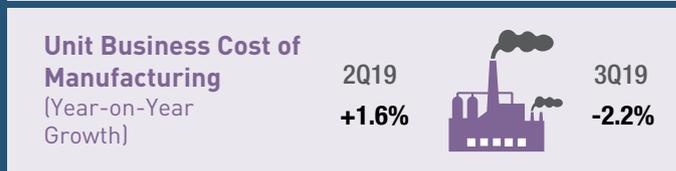
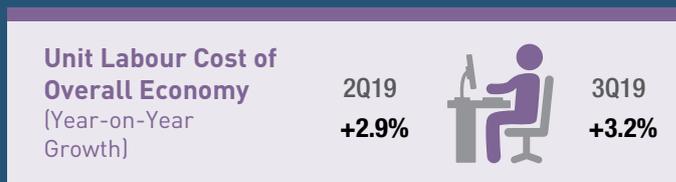
PRICES



LABOUR MARKET



COSTS



MERCHANDISE TRADE



SERVICES TRADE





Image courtesy of Ministry of Communications and Information



CHAPTER 1

THE SINGAPORE ECONOMY

CHAPTER 1

THE SINGAPORE ECONOMY

ECONOMIC PERFORMANCE

Real GDP grew by

0.5% in 3Q19



Quarterly Growth (Year-on-Year)



Main Drivers of Growth in 3Q19

Finance & Insurance



0.5%-point
contribution

Other Services Industries



0.3%-point
contribution

LABOUR MARKET

Resident
Unemployment Rate



3.2%
in 3Q19

Employment
(Q-0-Q Change)



+26,700
employed

Sectors with the Highest Employment Growth in 3Q19

+8,000
employed



Other Services
Industries

+6,500
employed



Business
Services

+5,300
employed



Construction

PRODUCTIVITY

Value-Added per Actual Hour
Worked declined by
1.1% in 3Q19



Sectors with the Highest Growth in Value-Added
per Actual Hour Worked in 3Q19

2.6%



Construction

0.8%



Finance & Insurance

COSTS

Overall Unit Labour Cost increased by

3.2% in 3Q19



Within the manufacturing sector



-2.2%



Unit Business Cost

4.2%



Unit Labour Cost

INTERNATIONAL TRADE

Total Merchandise Exports declined by 7.3% in 3Q19



-1.7%



Re-exports

-9.6%



Non-Oil Domestic Exports

-19.7%



Oil Domestic Exports

PRICES

The Consumer Price Index (CPI) rose by

0.4% in 3Q19



Categories with Price Increases

2.3%



Education

1.5%



Food

1.2%



Health Care

Quarterly Growth (Year-on-Year)

Total Services Exports declined by 0.6% in 3Q19



Services Export Growth was supported by...

0.8%-pt



Financial Services

0.6%-pt



Maintenance and Repair Services

0.2%-pt



Insurance Services

OVERVIEW

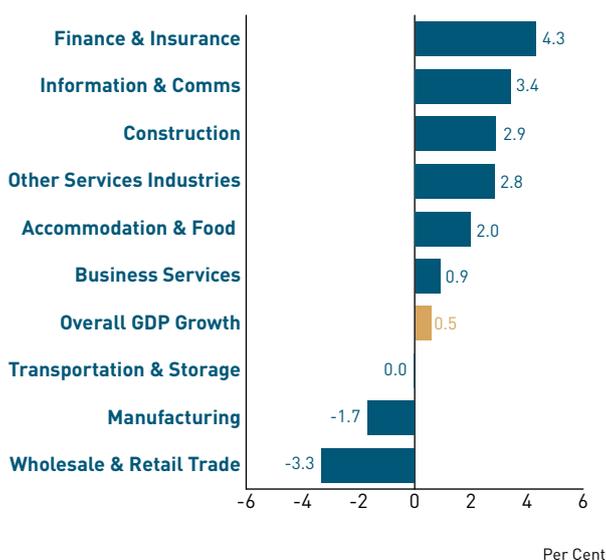
In the third quarter of 2019,

- The Singapore economy expanded by 0.5 per cent on a year-on-year basis. The sectors that contributed the most to GDP growth were the finance & insurance sector and “other services industries”.
- The seasonally-adjusted overall, resident and citizen unemployment rates rose slightly in September 2019 as compared to June 2019. Retrenchments in the third quarter were higher as compared to the second quarter but remained comparable to the same quarter a year ago.
- Total employment rose by 26,700 on a quarter-on-quarter basis, higher than the increase of 5,500 registered in the second quarter and the 19,300 recorded in the same quarter last year. Excluding foreign domestic workers, employment gains came in at 22,400 in the third quarter.
- The Consumer Price Index-All Items (CPI-All Items) rose by 0.4 per cent on a year-on-year basis, slower than 0.7 per cent increase in the previous quarter.

OVERALL PERFORMANCE

The Singapore economy grew by 0.5 per cent on a year-on-year basis in the third quarter, slightly higher than the 0.2 per cent growth in the previous quarter (Exhibit 1.1). On a quarter-on-quarter seasonally-adjusted annualised basis, the economy expanded by 2.1 per cent, a turnaround from the 2.7 per cent contraction in the preceding quarter.

Exhibit 1.1: GDP and Sectoral Growth Rates in 3Q 2019



The manufacturing sector shrank by 1.7 per cent year-on-year in the third quarter, moderating from the 3.3 per cent decline in the previous quarter. The contraction was due to a decline in output of the electronics cluster. All the other clusters in the sector expanded during the quarter, with the biomedical manufacturing cluster recording the strongest growth.

The services producing industries grew by 0.9 per cent year-on-year, easing from the 1.2 per cent growth in the previous quarter. The finance & insurance sector posted the fastest pace of growth (4.3 per cent), followed by the information & communications sector (3.4 per cent) and “other services industries” (2.8 per cent). The accommodation & food services and business services sectors also recorded positive growth of 2.0 per cent and 0.9 per cent respectively. By contrast, the wholesale & retail trade sector contracted by 3.3 per cent, while the transportation & storage sector posted flat growth in the third quarter.

The construction sector expanded by 2.9 per cent year-on-year, extending the 2.8 per cent growth in the preceding quarter. Construction output during the quarter was supported by an increase in both public sector and private sector construction works.

The sectors that contributed the most to GDP growth in the third quarter were the finance & insurance sector and the “other services industries” (Exhibit 1.2).

Exhibit 1.2: Percentage-Point Contribution to Growth in Real GDP in 3Q 2019 (By Industry)



SOURCES OF GROWTH

Total demand fell by 1.8 per cent on a year-on-year basis in the third quarter, extending the 0.4 per cent decline in the previous quarter (Exhibit 1.3). Total demand was weighed down by external demand, which dropped by 3.2 per cent year-on-year, a steeper decline as compared to the 1.2 per cent contraction in the preceding quarter.

On the other hand, domestic demand expanded by 1.8 per cent year-on-year, slightly higher than the 1.6 per cent growth in the previous quarter. This was due to a faster pace of increase in private consumption expenditure and private gross fixed capital formation (GFCF).

Within domestic demand, GFCF grew by 2.7 per cent year-on-year, reversing the 0.5 per cent contraction in the previous quarter. This came on the back of a 3.2 per cent expansion in private sector GFCF, which was in turn supported by higher investment spending on transport equipment and construction & works. Public sector GFCF registered a modest 0.5 per cent increase, supported by growth in investment spending in public construction & works.

Consumption expenditure grew by 4.1 per cent year-on-year, higher than the 3.0 per cent growth in the previous quarter. Growth during the quarter was largely driven by a 4.8 per cent increase in private consumption, while public consumption grew by a slower 1.6 per cent.

Exhibit 1.3: Changes in Total Demand*

	2018		2019		
	III	IV	I	II	III
Total Demand	3.3	0.9	-0.5	-0.4	-1.8
External Demand	4.2	1.4	-2.4	-1.2	-3.2
Total Domestic Demand	0.8	-0.2	3.9	1.6	1.8
Consumption Expenditure	2.3	2.5	4.8	3.0	4.1
Public	1.5	3.8	2.9	2.2	1.6
Private	2.6	2.2	5.4	3.2	4.8
Gross Fixed Capital Formation	-7.5	-4.4	0.2	-0.5	2.7
Changes in Inventories	1.5	-0.2	0.5	-0.1	-1.2

* For inventories, this refers to the contribution to GDP growth.

LABOUR MARKET

Unemployment and Retrenchment¹

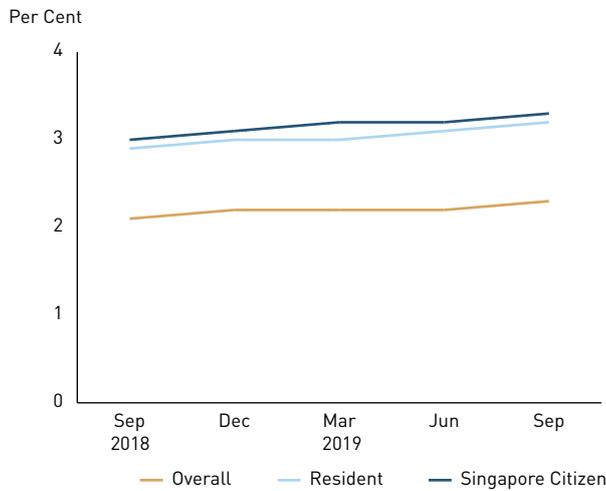
Compared to June 2019, the seasonally-adjusted unemployment rates inched up in September 2019 at the overall level (from 2.2 per cent to 2.3 per cent), and for residents (from 3.1 per cent to 3.2 per cent) and citizens (from 3.2 per cent to 3.3 per cent) (Exhibit 1.4).

In September 2019, an estimated 74,700 residents, including 65,000 Singapore citizens, were unemployed. These were higher than the number of unemployed residents (72,600) and citizens (64,200) in June 2019.²

¹ Retrenchment figures pertain to private sector establishments with at least 25 employees and the public sector.

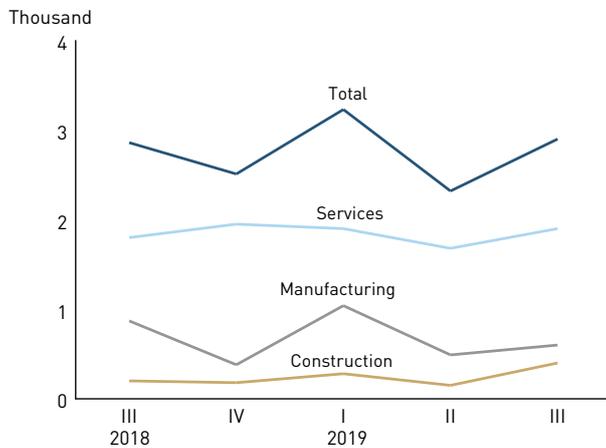
² Based on seasonally-adjusted data on the number of unemployed persons.

Exhibit 1.4: Unemployment Rate (Seasonally-Adjusted)



Total retrenchments came in at around 2,900 in the third quarter, higher than the level recorded in the preceding quarter (2,320) but comparable to that observed in the same quarter last year (2,860) (Exhibit 1.5). Over the quarter, retrenchments increased in the construction (from 150 to 400), services (from 1,680 to 1,900) and manufacturing (from 490 to 600) sectors.

Exhibit 1.5: Retrenchments

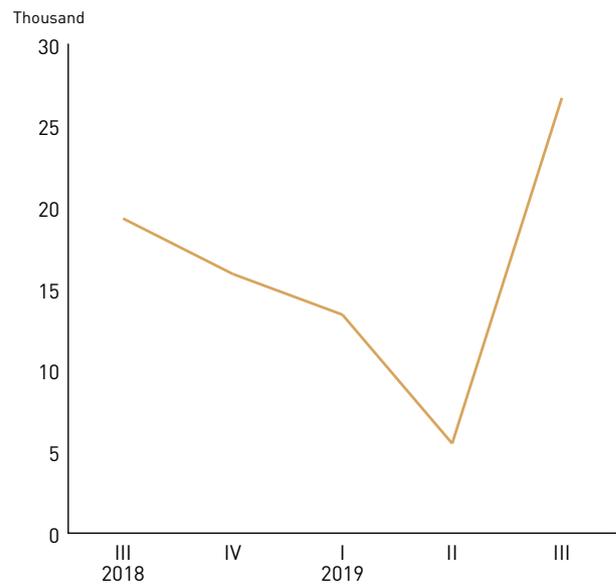


Employment³

Total employment rose by 26,700 on a quarter-on-quarter basis in the third quarter, higher than the increases in the second quarter (5,500) and the same quarter a year ago (19,300) (Exhibit 1.6). Excluding foreign domestic workers (FDWs), employment increased by 22,400. Total employment gains during the quarter came on the back of employment growth in all broad sectors.

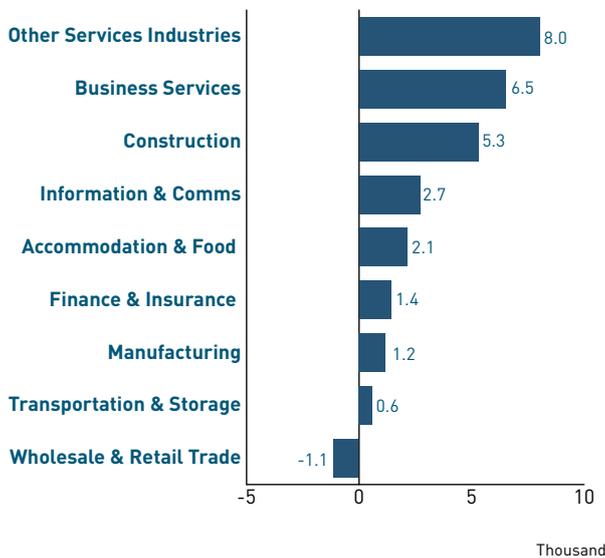
In the overall services sector, employment rose by 20,400 (16,100 excluding FDWs) in the third quarter, with the other services (8,000) and business services (6,500) sectors contributing the most to the increase (Exhibit 1.7). On the back of a pickup in construction activities, employment in the construction sector rose by 5,300, the highest since the first quarter of 2014 (6,300). Meanwhile, employment in the manufacturing sector rose by 1,200 after three consecutive quarters of decline.

Exhibit 1.6: Change in Total Employment, Quarter-on-Quarter



³ Based on preliminary estimates.

Exhibit 1.7: Changes in Employment by Industry in 3Q 2019



Hiring Expectations

According to EDB’s latest Business Expectations Survey for the Manufacturing Sector, hiring expectations in the sector remained subdued, with a net weighted balance of 3 per cent of manufacturers expecting to reduce hiring in the fourth quarter of 2019 as compared to the third quarter. Firms in the other electronics modules & components segment of the electronics cluster had the weakest hiring sentiments, with a net weighted balance of 42 per cent of firms in the segment expecting lower levels of hiring in the fourth quarter. By contrast, firms in the pharmaceuticals segment of the biomedical manufacturing cluster were the most positive, with a net weighted balance of 7 per cent of them expecting higher levels of hiring in the fourth quarter.

Hiring expectations for firms in the services sector were positive. According to DOS’ latest Business Expectations Survey for the Services Sector, a net weighted balance of 6 per cent of services firms expected to increase hiring in the fourth quarter of 2019 as compared to the third quarter. In particular, firms in the food & beverage services and retail trade industries were the most optimistic, with a net weighted balance of 29 per cent and 20 per cent of firms expecting to hire more workers in the fourth quarter respectively, likely because of the year-end holidays and festive season.

COMPETITIVENESS

Productivity

Overall labour productivity, as measured by real value-added per actual hour worked, declined by 1.1 per cent on a year-on-year basis in the third quarter (Exhibit 1.8).⁴ This was a smaller decline compared to the -3.2 per cent recorded in the previous quarter, in line with the modest uptick in GDP growth over the same period.

Among the sectors, the construction (2.6 per cent) and finance & insurance (0.8 per cent) sectors saw the strongest productivity growth in the third quarter. By contrast, the information & communications (-3.5 per cent) and wholesale & retail trade (-2.3 per cent) sectors experienced the largest declines in productivity.

Given the challenging external environment, outward-oriented sectors as a whole registered weaker productivity growth than domestically-oriented sectors in the third quarter. Specifically, the productivity of outward-oriented sectors fell by 1.7 per cent year-on-year in the third quarter, following the 4.7 per cent decline in the previous quarter.⁵ For domestically-oriented sectors, productivity fell by 0.4 per cent, after declining by 1.8 per cent in the preceding quarter.

Exhibit 1.8: Changes in Value-Added per Actual Hour Worked for the Overall Economy and Sectors in 3Q 2019



⁴ Overall labour productivity, as measured by real value-added per worker, fell by 1.0 per cent in the third quarter as compared to the 1.3 per cent decline in the preceding quarter. The slightly larger decline in real value-added per actual hour worked compared to real value-added per worker in the third quarter was due to a slight increase in the number of actual hours worked per worker.

⁵ 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 & beverage services, other business services and other services industries.

Unit Labour Cost and Unit Business Cost

Overall unit labour cost (ULC) for the economy rose by 3.2 per cent on a year-on-year basis in the third quarter, higher than the 2.9 per cent increase in the preceding quarter (Exhibit 1.9). The rise in the overall ULC was due to an increase in total labour cost per worker and a fall in labour productivity, as measured by real value-added per worker.

Exhibit 1.9: Changes in Unit Labour Cost in 3Q 2019



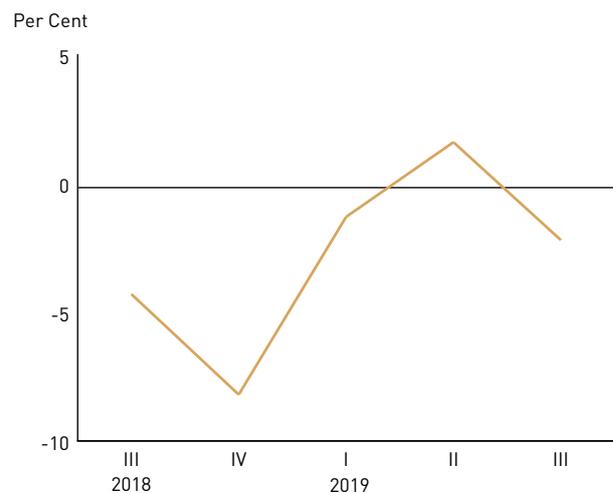
By sectors, the ULC for the manufacturing sector rose by 4.2 per cent year-on-year, moderating from the 6.2 per cent increase in the preceding quarter. This occurred on the back of a decline in productivity alongside an increase in total labour cost per worker in the sector.

In comparison, the ULC for services producing industries picked up by 3.3 per cent, faster than the 2.3 per cent increase in the previous quarter. Most services sectors saw an increase in their respective ULCs, with the exception of the finance & insurance sector. The ULC of the finance & insurance sector declined due to productivity gains and a fall in total labour cost per worker.

For the construction sector, ULC fell by 1.6 per cent, extending the 2.2 per cent decline in the previous quarter. The decline was driven by productivity gains in the sector, as total labour cost per worker remained unchanged.

Unit business cost (UBC) for the manufacturing sector declined by 2.2 per cent year-on-year in the third quarter, a turnaround from the 1.6 per cent increase in the previous quarter (Exhibit 1.10). The drop in the manufacturing UBC was mainly due to a 4.3 per cent fall in unit services cost (which includes royalties, utilities and other services costs such as professional and advertising fees), which outweighed the 4.2 per cent increase in manufacturing ULC.

Exhibit 1.10: Changes in Unit Business Cost for Manufacturing

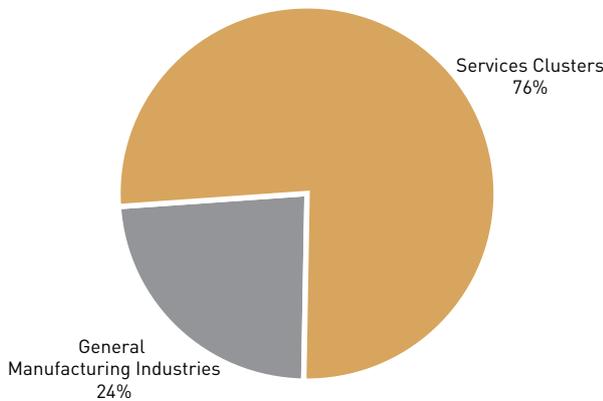


Investment Commitments

Investment commitments garnered by the Economic Development Board (EDB) in terms of Fixed Asset Investments (FAI) and Total Business Expenditure (TBE) amounted to \$180 million and \$751 million respectively in the third quarter (Exhibit 1.11 and Exhibit 1.12).

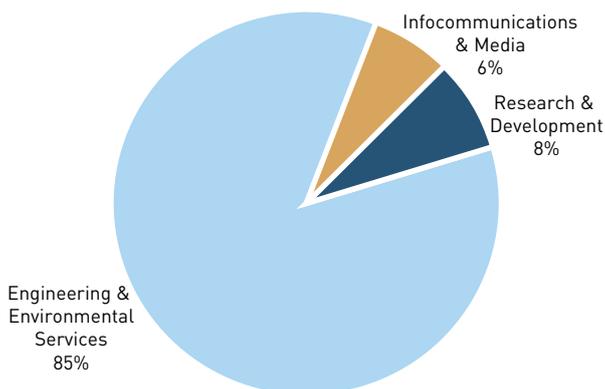
For FAI, the largest contribution came from the services clusters, which attracted \$137 million worth of commitments, mostly from the engineering & environmental services as well as research & development clusters. This was followed by the general manufacturing cluster, which garnered \$42 million of commitments. Investors from the United States contributed the most to total FAI, at \$97 million (54 per cent), followed by local investors, at \$79 million (44 per cent).

Exhibit 1.11: Fixed Asset Investments by Industry Cluster in 3Q 2019



For TBE, the engineering & environmental services cluster attracted the highest amount of commitments, at \$641 million. This was followed by the research & development and infocommunications & media clusters, at \$60 million and \$48 million respectively. Local investors were the largest source of TBE commitments, with commitments of \$627 million (84 per cent). They were followed by investors from the United States who contributed \$56 million of TBE commitments (7.4 per cent).

Exhibit 1.12: Total Business Expenditure by Industry Cluster in 3Q 2019



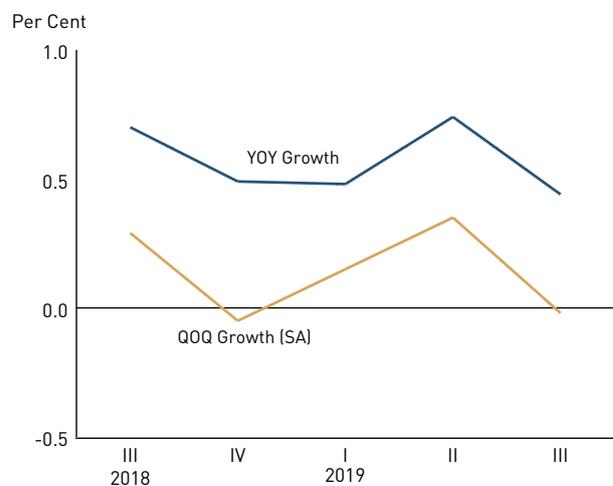
When fully realised, these commitments are expected to generate value-added amounting to \$610 million and more than 3,000 jobs.

PRICES

Consumer Price Index

The Consumer Price Index-All Items (CPI-All Items) rose at a slower pace of 0.4 per cent on a year-on-year basis in the third quarter, compared to the 0.7 per cent increase in the preceding quarter (Exhibit 1.13). On a quarter-on-quarter seasonally-adjusted basis, the CPI-All Items was unchanged in the third quarter, easing from the 0.4 per cent increase in the second quarter.

Exhibit 1.13: Changes in CPI-All Items



Among the CPI categories, food was the largest positive contributor to CPI-All Items inflation in the third quarter, with prices rising by 1.5 per cent on a year-on-year basis over this period due to an increase in the prices of food servicing services like hawker food and restaurant meals, as well as non-cooked food items such as vegetables and bread & cereals (Exhibit 1.14). Education costs went up by 2.3 per cent because of higher fees at commercial institutions, universities, kindergartens & childcare centres and polytechnics.

Meanwhile, transport costs rose by 0.9 per cent as an increase in car prices, bus & train fares and general repair & maintenance fees outweighed a fall in the prices of petrol and motorcycles & scooters. Healthcare costs picked up by 1.2 per cent as a rise in the costs of outpatient and hospital services more than offset a decline in the prices of medical products. Recreation & culture costs rose by 0.9 per cent on account of higher holiday travel expenses. The costs of household durables & services went up by 0.7 per cent due to an increase in the levy for foreign domestic workers as well as higher salaries for them. Prices of miscellaneous goods & services edged up by 0.2 per cent as a result of more expensive personal care items.

Exhibit 1.14: Percentage Changes in CPI over Corresponding Quarter of Previous Year

	Per Cent				
	2018		2019		
	III	IV	I	II	III
All items	0.7	0.5	0.5	0.7	0.4
Food	1.6	1.4	1.5	1.4	1.5
Clothing & Footwear	2.3	1.6	1.2	-0.9	-1.9
Housing & Utilities	-0.7	0.0	-0.4	-0.8	-1.4
Household Durables & Services	0.7	0.8	0.6	1.2	0.7
Health Care	2.0	1.7	1.6	1.2	1.2
Transport	-0.2	-2.0	-1.1	1.2	0.9
Communication	-1.0	-2.3	-2.1	-1.1	-1.2
Recreation & Culture	1.5	1.2	0.9	2.1	0.9
Education	2.6	3.2	2.8	2.6	2.3
Miscellaneous Goods & Services	1.1	1.3	0.8	0.2	0.2

The price gains in these CPI categories were in contrast to the declines in other categories. Clothing & footwear costs fell by 1.9 per cent on account of cheaper ready-made garments. Communication costs dipped by 1.2 per cent due to a fall in the prices of telecommunication services and equipment. Housing & utilities costs dropped by 1.4 per cent as lower costs of electricity and accommodation outweighed higher housing maintenance charges.

INTERNATIONAL TRADE

Merchandise Trade

Singapore's total merchandise trade declined by 6.7 per cent year-on-year in the third quarter, following the 2.2 per cent decrease in the preceding quarter (Exhibit 1.15). The fall in total merchandise trade was due to declines in both oil and non-oil trade. Total oil trade fell by 19 per cent in nominal terms, partly reflecting lower oil prices compared to a year ago, while non-oil trade declined by 3.5 per cent.

Exhibit 1.15: Growth Rates of Total Merchandise Trade, Merchandise Exports and Merchandise Imports (In Nominal Terms)

	Per Cent					
	2018			2019		
	III	IV	Ann	I	II	III
Merchandise Trade	14.7	9.2	9.2	2.1	-2.2	-6.7
Merchandise Exports	12.7	7.2	7.9	0.0	-4.5	-7.3
Domestic Exports	14.5	3.4	8.4	-6.5	-10.6	-13.1
Oil	28.9	12.1	17.1	-6.5	-2.9	-19.7
Non-Oil	8.0	-1.1	4.2	-6.4	-14.7	-9.6
Re-Exports	11.1	11.2	7.4	6.8	2.2	-1.7
Merchandise Imports	17.0	11.5	10.6	4.5	0.5	-5.9
Oil	30.9	16.9	18.9	-4.3	-9.6	-18.2
Non-Oil	13.4	9.9	8.3	7.3	3.7	-2.3

Total merchandise exports dropped by 7.3 per cent in the third quarter, extending the 4.5 per cent decrease in the preceding quarter. Within total exports, domestic exports declined by 13 per cent, while re-exports fell by 1.7 per cent during the quarter.

The fall in domestic exports was due to declines in both oil and non-oil domestic exports. In particular, oil domestic exports contracted by 20 per cent, partly reflecting lower oil prices compared to a year ago. In volume terms, oil domestic exports decreased by 9.2 per cent.

Meanwhile, non-oil domestic exports (NODX) declined by 9.6 per cent in the third quarter, following the 15 per cent decrease in the previous quarter. The drop in NODX was due to a fall in both electronics and non-electronics NODX.

Total merchandise imports contracted by 5.9 per cent in the third quarter, reversing the 0.5 per cent increase in the previous quarter. The contraction was due to a fall in both oil and non-oil imports. Specifically, oil imports declined by 18 per cent amidst lower oil prices compared to levels a year ago. At the same time, non-oil imports decreased by 2.3 per cent due to a decline in electronics imports, which outweighed the growth in non-electronics imports.

Services Trade

Total services trade dipped by 0.2 per cent on a year-on-year basis in the third quarter, a reversal from the 1.2 per cent growth recorded in the previous quarter (Exhibit 1.16). Services exports declined by 0.6 per cent year-on-year, a pullback from the 0.9 per cent increase in the preceding quarter. The fall in services exports was largely attributable to a decline in receipts from the use of intellectual property and exports of other business services. Meanwhile, services imports expanded by 0.3 per cent year-on-year, moderating from the 1.5 per cent increase in the previous quarter. The modest growth in services imports was mainly due to an increase in the imports of travel services and financial services.

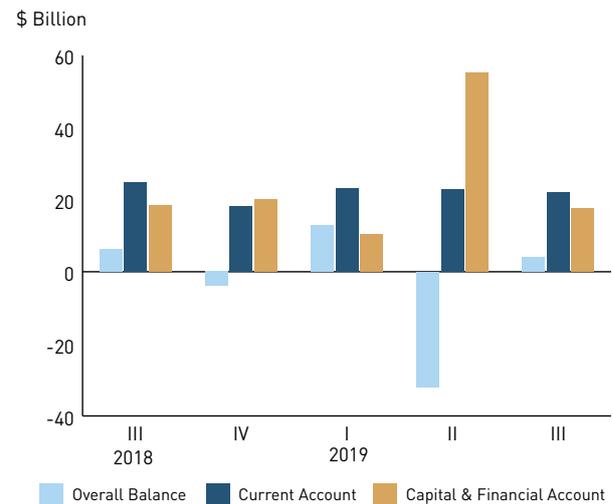
Exhibit 1.16: Growth Rates of Total Services Trade, Services Exports and Services Imports (In Nominal Terms)

	Per Cent					
	2018			2019		
	III	IV	Ann	I	II	III
Total Services Trade	2.1	0.8	2.1	-0.1	1.2	-0.2
Services Exports	4.3	2.1	3.9	-0.3	0.9	-0.6
Services Imports	-0.1	-0.5	0.3	0.1	1.5	0.3

BALANCE OF PAYMENTS

The overall balance of payments recorded a surplus of \$4.1 billion in the third quarter, a reversal from the deficit of \$32 billion in the previous quarter (Exhibit 1.17).

Exhibit 1.17: Balance of Payments



Current Account

The current account surplus edged down to \$22 billion in the third quarter, from \$23 billion in the second quarter. This was driven by a larger deficit in the primary income balance, which outweighed a smaller deficit in the services balance. Meanwhile, the surplus in the goods balance and deficit in the secondary income balance were almost unchanged.

The surplus in the goods balance was \$34 billion in the third quarter, comparable to the previous quarter, as goods exports and imports fell by similar magnitudes.

The deficit in the services balance narrowed to \$0.2 billion in the third quarter, from \$0.9 billion in the second quarter. Although net payments for other business services rose, they were more than offset by lower net payments for travel and telecommunications, computer & information services, as well as higher net receipts for financial and insurance services.

Meanwhile, the deficit in the primary income balance widened to \$9.5 billion in the third quarter, from \$7.9 billion in the preceding quarter, as primary income payments rose faster than receipts.

Capital and Financial Account⁶

Net outflows from the capital and financial account fell to \$18 billion in the third quarter, from \$55 billion in the second quarter. This was due to lower net outflows of portfolio investment as well as higher net inflows of direct investment, which outweighed an increase in the net outflows of financial derivatives and “other investment”.

Net outflows of portfolio investment decreased by \$59 billion to \$20 billion in the third quarter. This was partly due to lower net purchases of overseas securities by resident deposit-taking corporations.

Meanwhile, net inflows of direct investment rose to \$33 billion in the third quarter, from \$28 billion in the previous quarter, largely driven by an increase in foreign direct investment into Singapore.

In comparison, net outflows of financial derivatives surged to \$21 billion in the third quarter, from \$2.0 billion in the second quarter. At the same time, other investment recorded higher net outflows of \$10 billion in the third quarter, compared to \$1.6 billion in the preceding quarter. This was mainly due to a shift by the non-bank private sector from a net inflow to a net outflow position, which more than offset the switch from a net outflow to a net inflow position by deposit-taking corporations.

⁶ Net inflows in net balances are indicated by a minus (-) sign, and vice versa. For more details regarding the change in sign convention to the financial account, please refer to DOS's information paper on “Singapore's International Accounts: Methodological Updates and Recent Developments”.



BOX ARTICLE 1.1

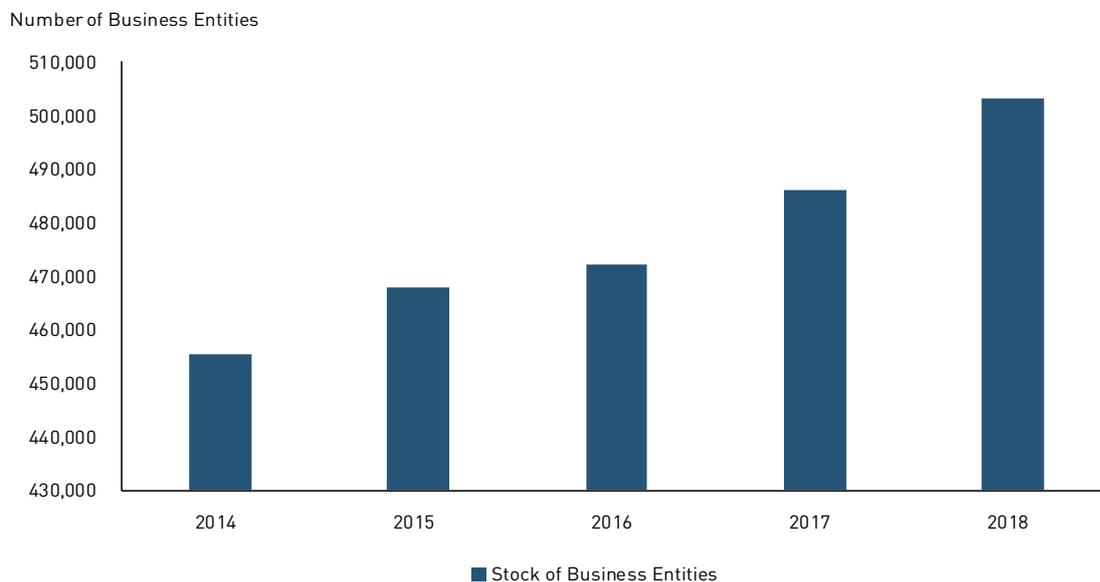
Singapore's Corporate Sector: Recent Trends in Firm Formation and Cessation

In 2017, MTI published an article on the formation and cessation trends of business entities in Singapore over the period of 2010 to 2016.¹ This article examines more recent data from the Accounting and Corporate Regulatory Authority (ACRA) in view of the slowdown in the Singapore economy, with a focus on the formation and cessation of companies and businesses,² which make up the vast majority of business entities in Singapore.³

The stock of business entities in Singapore grew between 2014 and 2018 on the back of strong net formation of business entities

The total number of business entities in Singapore increased between 2014 and 2018 on the back of strong net formation (i.e., formation minus cessation) of business entities. Over this period, the net formation of business entities averaged 16,520 per year. As a result, the stock of business entities rose from 455,280 in 2014 to 503,130 in 2018 (Exhibit 1).

Exhibit 1: Stock of Business Entities, 2014 – 2018



Source: ACRA

¹ "Singapore's Corporate Sector: Recent Trends in Firm Formation and Cessation", *Economic Survey of Singapore Second Quarter 2017*.

² A company is a business entity incorporated under the Companies Act consisting of at least (i) one director, (ii) one secretary and (iii) one member. On the other hand, a business is an entity formed either as a sole-proprietorship or partnership consisting of two to twenty members. In terms of liability, a company is a separate legal entity, which means that its directors and members are generally not personally liable for the debts and obligations incurred by the company. On the other hand, business owners are generally accountable for any obligations borne by the business. A more detailed comparison of the different types of business entities in Singapore can be found on ACRA's website.

³ As at end-2018, companies and businesses made up around 67% and 30% of total business entities respectively. The remaining business entities consisted of limited liability partnerships, limited partnerships and public accounting firms.

However, the net formation of business entities softened in the first three quarters of 2019

In line with slower economic growth, the net formation of business entities in the economy has weakened this year. Although still positive, the net formation of business entities was about 9,880 in the first three quarters of 2019, around a third lower than the 14,220 in the same period of 2018 and around a quarter lower than the average of 13,780 in the same period of 2014 – 2018.

The recent decline in the net formation of business entities comes amidst heightened uncertainties in the global economy and the resulting slowdown in the Singapore economy, which have led to a fall in the formation of business entities and an uptick in the cessation of business entities. The following sections describe the formation and cessation trends for companies and businesses in greater detail.

In the first three quarters of 2019, the number of new companies and new businesses formed in Singapore fell slightly

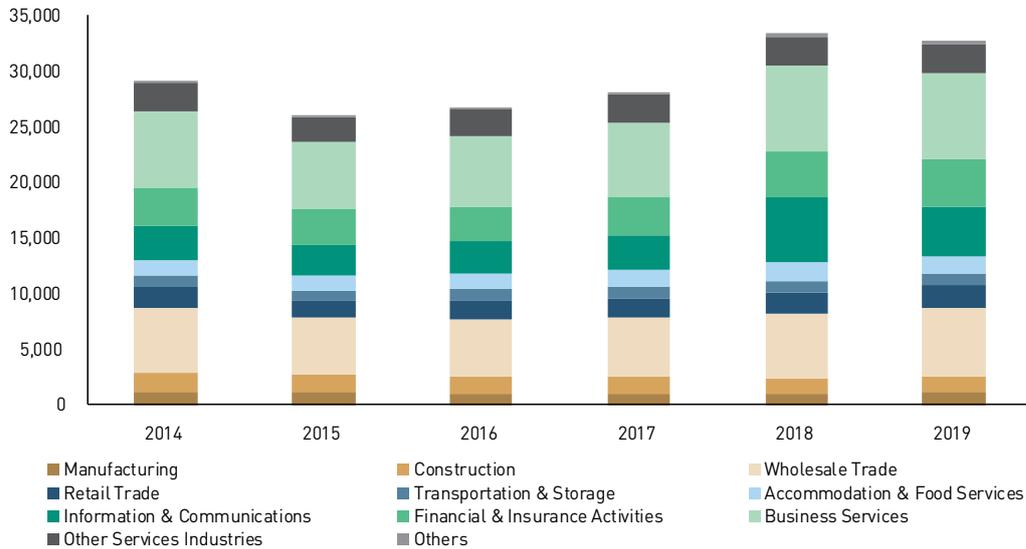
The formation of new business entities is an important indicator of economic health. In particular, the creation of new firms leads to the generation of new jobs and investments. A high level of firm entry may also reflect a vibrant start-up landscape. Conversely, a challenging economic environment is likely to dampen firm formation, as potential entrepreneurs may hold back from setting up new firms given the economic uncertainty and fewer potentially profitable business opportunities.

Against the backdrop of the current slowdown in the Singapore economy, the number of new companies formed came in at 32,650 in the first three quarters of 2019, slightly weaker than the 33,320 recorded in the same period of 2018 (Exhibit 2). However, if we look further back to the five years prior to 2019, the number of new companies formed in 2019 to-date remained larger than the average of 28,660 in the same period of 2014 – 2018. This suggests that overall company formation in the Singapore economy has remained resilient despite weaker economic conditions.

In terms of sectors, the information & communications sector was the main contributor to the on-year decline in company formation in the first three quarters of 2019. In turn, the comparatively weaker company formation in the sector can primarily be attributed to the surge in new companies formed in the IT & information services segment of the sector in the same period of 2018, particularly in areas related to the development of software and programming activities. However, notwithstanding the drop in formation, the 4,310 companies formed in the sector in 2019 to-date was still higher than the average of 3,530 clocked over the same period of 2014 – 2018, underscoring the increasing prominence of the digital economy.

Exhibit 2: Number of Companies Formed by Sectors (1Q – 3Q), 2014 – 2019

Number of Companies (1Q-3Q)



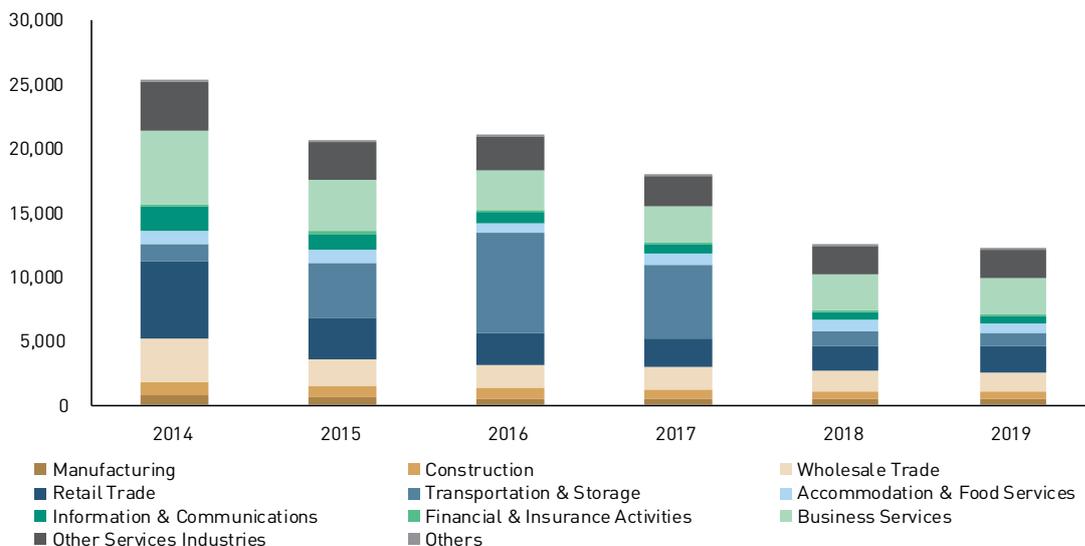
Source: ACRA

Note: The "Others" category includes activities not elsewhere classified, such as agriculture, mining and utilities.

As for businesses, the number of new businesses formed also dipped slightly to 12,160 in the first three quarters of 2019, from the 12,520 registered in the same period of last year (Exhibit 3). At a sectoral level, the wholesale trade sector was the key contributor to the decline. The fall in business formation in the wholesale trade sector can in turn be attributed to weak economic conditions in the sector.⁴

Exhibit 3: Number of Businesses Formed by Sectors (1Q – 3Q), 2014 – 2019

Number of Businesses (1Q-3Q)



Source: ACRA

⁴ Based on the Wholesale Trade Index, domestic wholesale sales volume fell by 4.6% and foreign wholesale sales volume contracted by 3.8% on a year-on-year basis in the first three quarters of 2019.

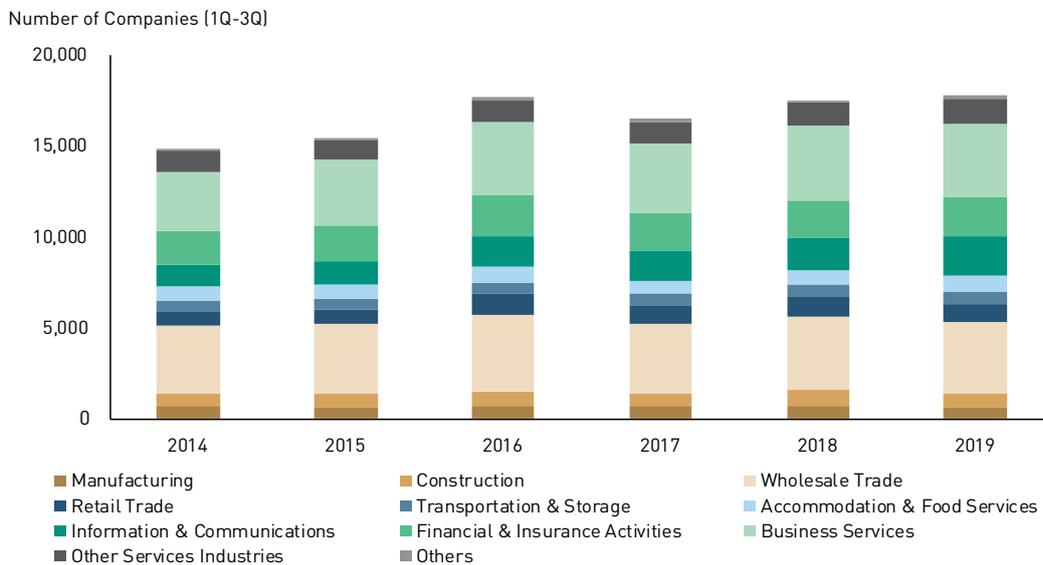
Compared to the last five years, the 12,160 new businesses formed in the first three quarters of 2019 was considerably lower than the average of 19,460 registered in the same period of 2014 – 2018. Although this decline was seen across all sectors, it was driven primarily by the transportation & storage sector. However, the drop in business formation in the transportation & storage sector should be seen in the context of the significant increase in business formation between 2015 and 2017 due to business registrations by drivers providing private car-hire services via platforms such as Uber and Grab. With the regulatory changes in late-2017 that did away with the need for such business registrations,⁵ business formation in the sector had fallen in tandem.

While the number of company and business cessations rose in the first three quarters of 2019...

Firm cessation is an inherent part of economic restructuring, in which unproductive firms exit the market, thus freeing up capital and labour so that they can be put to better use. Changes in firm cessation may also be a reflection of the economic cycle, with firm exits increasing when economic conditions weaken.

Amidst the economic slowdown and ongoing economic restructuring, the cessation of companies registered a slight uptick to reach 17,720 in the first three quarters of 2019, from 17,490 in the same period of 2018. The uptick in company cessations was primarily driven by a higher number of company closures in the information & communications sector (Exhibit 4). The latter follows from a sharp increase in the number of start-ups formed in the IT & information services segment of the sector in recent years, some of which would have subsequently ceased operations.

Exhibit 4: Number of Companies Ceased by Sectors (1Q – 3Q), 2014 – 2019

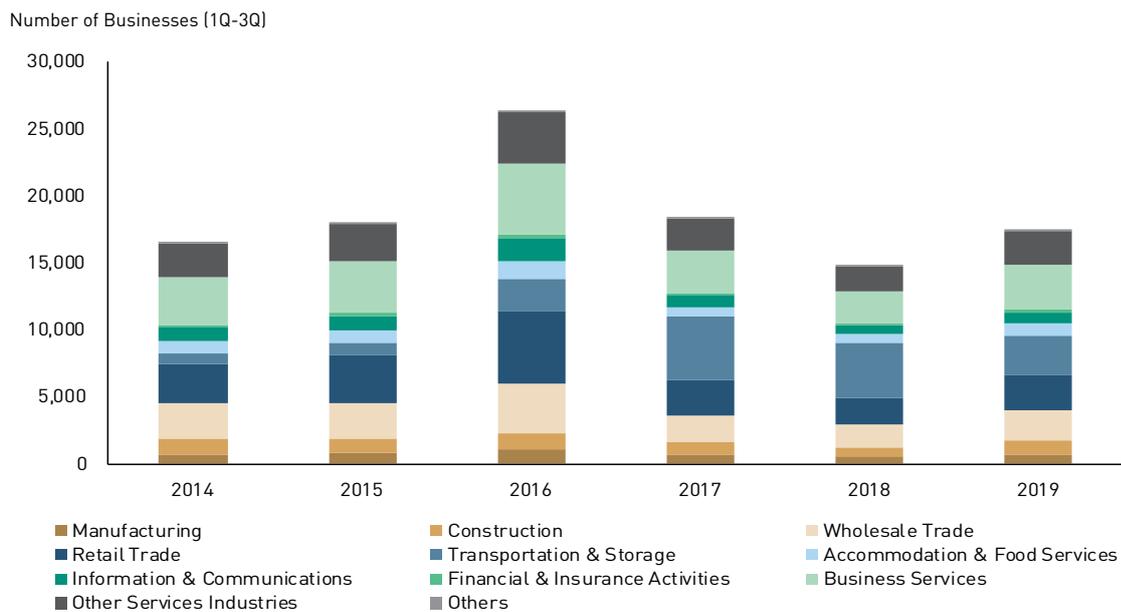


Source: ACRA

⁵ Since 1 October 2017, individuals who wish to own a private hire car are no longer required to register a business entity with ACRA.

Business cessations also rose in the first three quarters of 2019, coming in at 17,430 as compared to the 14,710 recorded over the same period of 2018. The rise in business cessations was broad-based, with all sectors experiencing an increase except for the transportation & storage sector (Exhibit 5). This likely reflects a more challenging environment facing businesses amidst the economic slowdown.

Exhibit 5: Number of Businesses Ceased by Sectors (1Q – 3Q), 2014 – 2019



Source: ACRA

... their cessation rates over a longer time horizon suggest that the overall health of companies and businesses has not deteriorated significantly

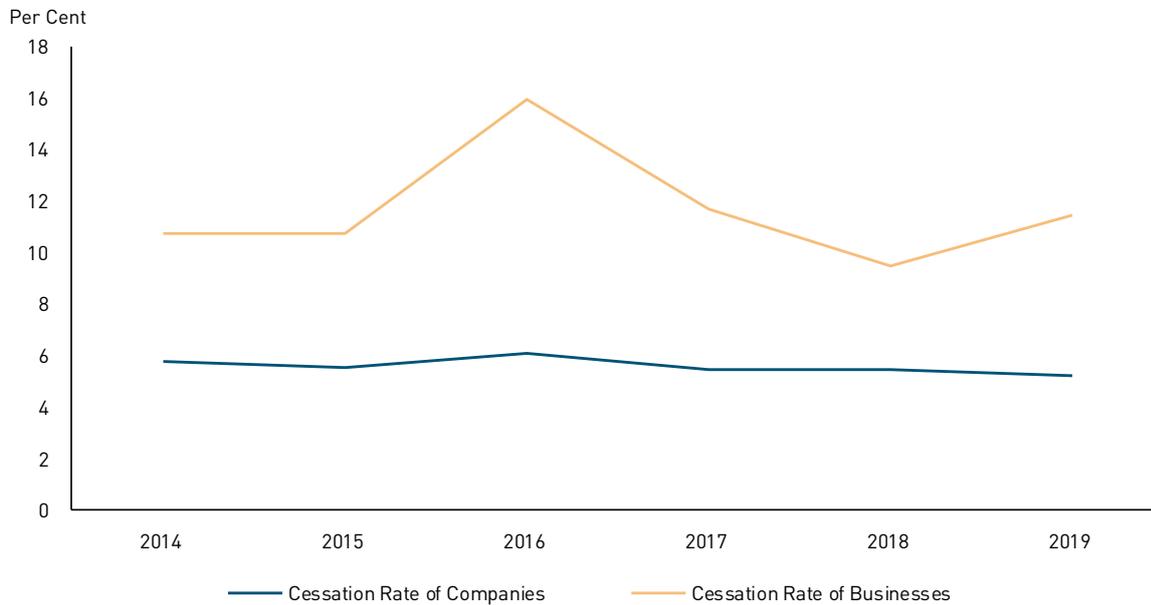
It is important to note that while the increase in company and business closures could be driven in part by the slowdown in economic activities this year, it could also partly reflect the rising stock of companies and businesses in the economy over time. To account for the latter, we compute the cessation rates⁶ of companies and businesses, and examine how they have changed over time.

From Exhibit 6, we can see that the cessation rate of companies came in at 5.3 per cent in the first three quarters of 2019, comparable to that in the same period of 2018 (5.5 per cent) but lower than the average seen in the same period of 2014 – 2018 (5.7 per cent). For businesses, the cessation rate picked up in the first three quarters of 2019 to 11.6 per cent, from 9.6 per cent in the same period of 2018. The uptick in the cessation rate of businesses (unlike the case for companies) suggests that businesses may be more vulnerable to economic slowdowns than companies, as they likely have weaker balance sheets and may lack access to financing to tide over a period of slower economic growth. Nevertheless, if we take a longer time horizon, the cessation rate of businesses in 2019 to-date remained comparable to the average of 11.8 per cent recorded over the same period of 2014 – 2018.⁷

⁶ In this article, cessation rate is defined as the number of firms that had ceased operations in the first three quarters of a particular year out of the total number of firms at the end of the preceding year.

⁷ Excluding 2016, the average cessation rate for businesses in the first three quarters of 2014-2018 was 10.8%.

Exhibit 6: Cessation Rates of Companies and Businesses (1Q – 3Q), 2014 – 2019



Source: ACRA, MTI estimates

Note: The sharp rise in the business cessation rate in 2016 was primarily due to a spike in business cessation in the retail trade and transportation & storage sectors. In turn, the former was because of sluggish retail (excluding motor vehicle) sales over this period, while the latter could be due to drivers providing private car-hire services exiting the industry.

Overall, the trends in cessation rates suggest that the overall health of companies and businesses has not deteriorated significantly despite the economic slowdown.

Conclusion

Given the economic slowdown amidst heightened global economic uncertainties, the net formation of business entities in the first three quarters of 2019 came in lower than that in the same period of last year, as the formation of business entities fell and the cessation of business entities rose. Although the number of company and business closures this year has inched up, the cessation rates of companies and businesses in the first three quarters of 2019 remained broadly comparable to their respective longer-term averages, suggesting that the overall health of firms has not deteriorated significantly. The Government will continue to monitor the situation closely, and stands ready to step up support for firms and workers if it becomes necessary, with a focus on building capabilities for the longer term.

Contributed by:

Mr Jonathan Lin
 Economist
 Economics Division
 Ministry of Trade and Industry



Image courtesy of Infineon Singapore



CHAPTER 2

SECTORAL PERFORMANCE

CHAPTER 2

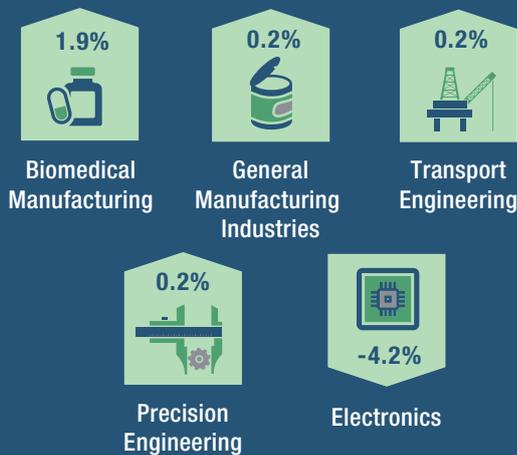
SECTORAL PERFORMANCE

MANUFACTURING

REAL GROWTH



CLUSTERS IN MANUFACTURING SECTOR %-POINT CONTRIBUTION IN 3Q19



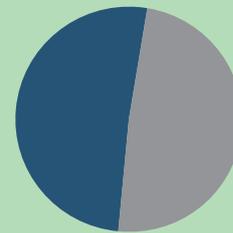
CONSTRUCTION

REAL GROWTH



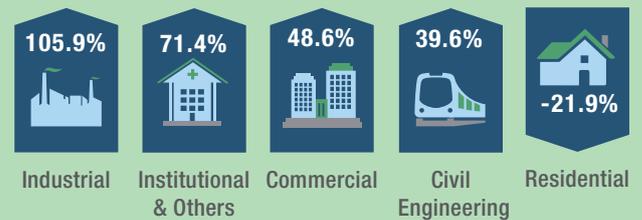
CERTIFIED PAYMENTS IN 3Q19

50.9%
Public



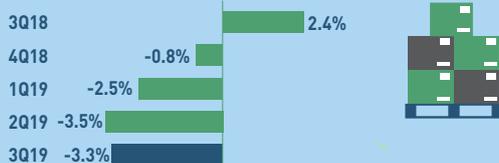
49.1%
Private

CONTRACTS AWARDED IN 3Q19



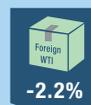
WHOLESALE & RETAIL TRADE

REAL GROWTH



WHOLESALE TRADE

Foreign Wholesale
Trade Index Growth



Domestic Wholesale
Trade Index Growth



RETAIL TRADE

Retail Sales Index Growth
(Non-Motor Vehicles)



Retail Sales Index Growth
(Motor Vehicles)



ACCOMMODATION & FOOD SERVICES

REAL GROWTH



ACCOMMODATION

Occupancy Rates of Hotels
(Y-O-Y Change)



Luxury
0.3%-pt



Upscale
0.2%-pt



Mid-Tier
2.5%-pt



Economy
1.7%-pt

FOOD SERVICES

F&B Sales Index Growth
(Y-O-Y Change)



Fast Food
7.8%



Restaurants
1.8%



Others
0.6%



Food Caterers
-1.6%

TRANSPORTATION & STORAGE

REAL GROWTH



Total Sea
Cargo Handled
Growth



Motor Vehicle
Population
Growth



Air
Passengers
Handled
Growth



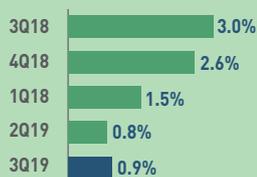
FINANCE & INSURANCE

REAL GROWTH



BUSINESS SERVICES

REAL GROWTH



PRIVATE RESIDENTIAL REAL ESTATE



Price Index
(Q-O-Q Change)

GROWTH OF BANK LOANS & ADVANCES TO NON-BANK CUSTOMERS IN 3Q19

Loans to
Businesses



Consumer
Loans



OVERVIEW

In the third quarter of 2019,

- The manufacturing sector contracted by 1.7 per cent, improving from the 3.3 per cent decline in the previous quarter. The sector was weighed down by a decline in the output of the electronics cluster, which more than offset the output increases in the remaining clusters.
- The construction sector grew by 2.9 per cent, slightly faster than the 2.8 per cent growth in the preceding quarter. The increase in construction output during the quarter was supported by both public sector and private sector construction activities.
- The wholesale & retail trade sector shrank by 3.3 per cent, extending the 3.5 per cent contraction in the previous quarter. The contraction of the sector was driven by both the wholesale trade and retail trade segments.
- The transportation & storage sector registered flat growth, easing from the 2.4 per cent expansion in the previous quarter. Within the sector, the air transport segment continued to expand, even as the water transport segment contracted.
- Growth in the accommodation & food services sector accelerated to 2.0 per cent, from 1.2 per cent in the preceding quarter. Both the accommodation and food services segments expanded during the quarter.
- The finance & insurance sector grew by 4.3 per cent, extending the 5.1 per cent growth in the previous quarter, underpinned by firm demand for payments-related activities.
- The business services sector posted growth of 0.9 per cent, comparable to the 0.8 per cent recorded in the previous quarter, driven by healthy growth in the professional services segment.

MANUFACTURING

The manufacturing sector shrank by 1.7 per cent year-on-year in the third quarter, improving from the 3.3 per cent decline in the preceding quarter (Exhibit 2.1). The sector's performance was dragged down by a decline in the output of the electronics cluster. The other clusters of the sector all recorded output expansions (Exhibit 2.2).

Exhibit 2.1: Manufacturing Sector's Growth Rate

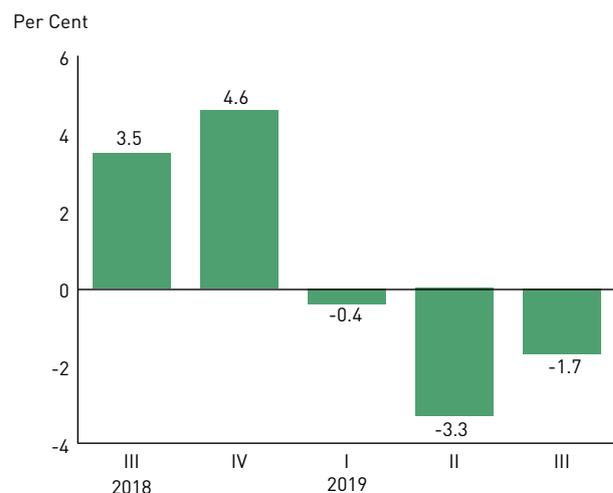
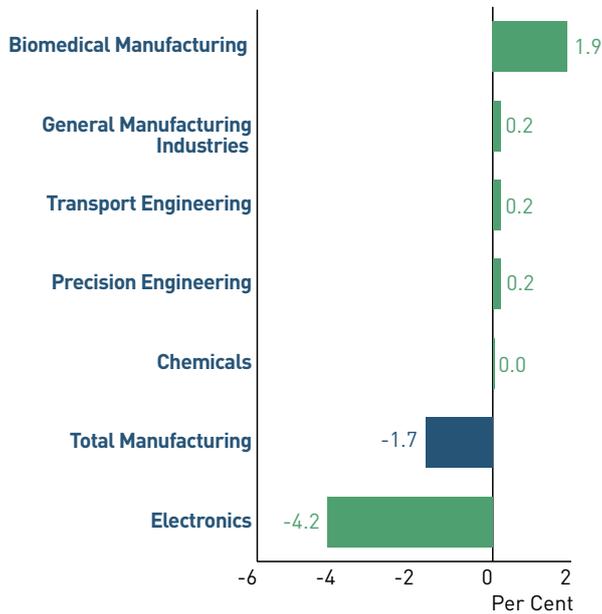


Exhibit 2.2: Percentage-Point Contribution to Manufacturing Sector's Growth in 3Q 2019



The biomedical manufacturing cluster's output rose by 10 per cent in the third quarter, supported by robust output expansions in both the pharmaceuticals and medical technology segments. In the pharmaceuticals segment, output rose by 11 per cent due to a higher level of production of active pharmaceutical ingredients. As for the medical technology segment, output increased by 9.2 per cent on the back of higher export demand for medical devices.

The general manufacturing cluster expanded by 2.4 per cent in the third quarter. Growth was driven by the miscellaneous industries segment, which grew by 5.9 per cent due to a higher level of production of metal tanks & containers and wearing apparel, as well as the food, beverage & tobacco segment, which expanded by 1.7 per cent on account of an increase in the output of beverage products. By contrast, output in the printing segment continued to decline.

Output in the transport engineering cluster increased by 1.5 per cent in the third quarter, supported by a 21 per cent and 9.1 per cent expansion in output in the aerospace and land transport segments respectively. In particular, the robust performance of the aerospace segment was due to a higher volume of engine repair and maintenance work from commercial airlines. On the other hand, the marine & offshore engineering segment declined by 17 per cent on account of a lower level of offshore and shipbuilding & repairing activities.

In the third quarter, output in the precision engineering cluster rose by 1.3 per cent, bolstered by strong growth in the precision modules & components segment. Specifically, the segment grew by 9.6 per cent on the back of an increase in the output of optical products. By contrast, the machinery & systems segment contracted by 4.3 per cent as the output of semiconductor foundry equipment and refrigeration systems fell.

Output of the chemicals cluster increased by 0.5 per cent in the third quarter, supported by the other chemicals segment which expanded by 9.6 per cent on account of a higher level of output of fragrances. On the other hand, the cluster's growth was weighed down by output declines in the petrochemicals, specialty chemicals and petroleum segments, mainly due to scheduled maintenance shutdowns in some plants.

The electronics cluster contracted by 11 per cent in the third quarter. The poor outturn of the cluster was largely due to a 13 per cent fall in the output of the semiconductors segment on the back of soft global semiconductor demand. The latter was in turn due to weak demand conditions in key end-markets such as the smartphone and PC markets, which had been exacerbated by the uncertainty caused by the US-China trade tensions. Similarly, the computer peripherals and other electronic modules & components segments recorded output declines of 12 per cent and 13 per cent respectively. By contrast, the data storage and infocomms & consumer electronics segments grew by 14 per cent and 3.8 per cent respectively.

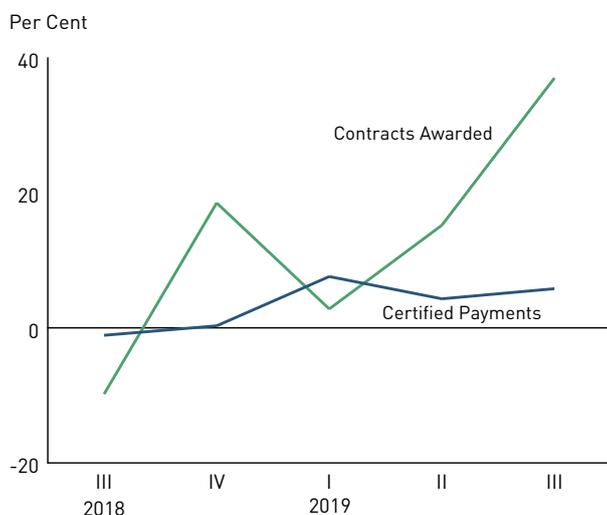
CONSTRUCTION

The construction sector grew by 2.9 per cent year-on-year in the third quarter, extending the 2.8 per cent growth in the previous quarter. Both public sector and private sector construction activities increased during the quarter.

In the third quarter, nominal certified progress payments (a proxy for construction output) rose by 5.8 per cent, faster than the 4.3 per cent increase in the previous quarter (Exhibit 2.3). The rise in construction output was partly supported by public certified progress payments (5.4 per cent), which was in turn driven by an expansion in public civil engineering works (11 per cent) and public industrial building works (34 per cent). Private certified progress payments also rose (6.3 per cent) during the quarter, largely due to an increase in private industrial building works (26 per cent) and private residential building works (8.1 per cent).

Meanwhile, construction demand in terms of contracts awarded expanded at a faster pace of 37 per cent in the third quarter, compared to the 15 per cent increase in the previous quarter (Exhibit 2.3). The expansion in overall construction demand was due to stronger public sector construction demand (116 per cent), which was in turn led by a surge in demand for public industrial building works (5,316 per cent) such as JTC's Integrated Business Park Development at Punggol Digital District, and institutional & others building works (78 per cent) such as SIT's centralised campus in Punggol. By contrast, private sector contracts awarded declined (-26 per cent) due to weaker demand for private residential building works (-36 per cent) and private industrial building works (-52 per cent).

Exhibit 2.3: Changes in Contracts Awarded and Certified Payments



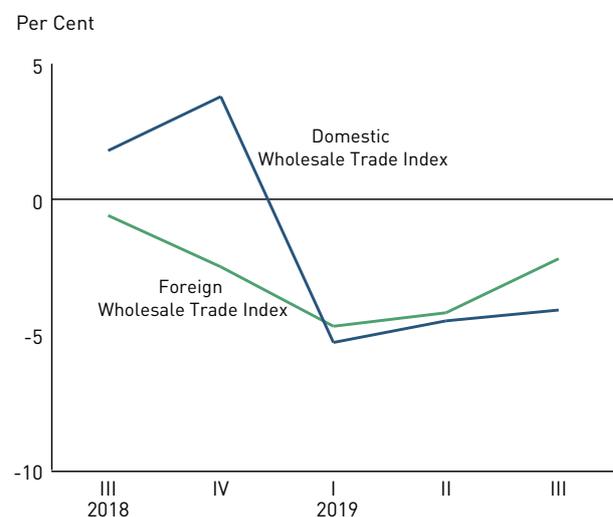
WHOLESALE & RETAIL TRADE

The wholesale & retail trade sector shrank by 3.3 per cent year-on-year in the third quarter, extending the 3.5 per cent decline in the previous quarter. Both the wholesale trade and retail trade segments within the sector contracted during the quarter.

The wholesale trade segment was weighed down by foreign wholesale trade sales volumes (Exhibit 2.4), which declined by 2.2 per cent in the third quarter, extending the 4.2 per cent contraction in the previous quarter. The fall in foreign wholesale trade sales volumes was due to lower sales volumes of electronic components (-11 per cent), telecommunications & computers (-3.9 per cent) and "other wholesale trade"¹ (-12 per cent), which outweighed an increase in the sales volume of metals, timber & construction materials (7.3 per cent).

Likewise, domestic wholesale trade sales volumes shrank by 4.1 per cent in the third quarter, following the 4.5 per cent contraction in the previous quarter. The decline was largely due to lower sales volumes of electronic components (-37 per cent), metals, timber & construction materials (-11 per cent) and chemicals & chemical products (-8.2 per cent).

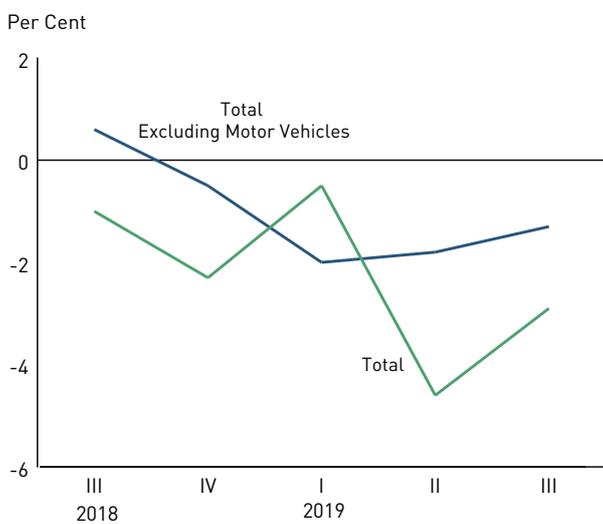
Exhibit 2.4: Changes in Changes in Wholesale Trade Index at Constant Prices



¹ The "other wholesale trade" segment consists of a diverse range of products that include agricultural raw materials and live animals, tropical produce, personal effects and medicinal and pharmaceutical products, among others.

For the retail trade segment, overall retail sales volume declined by 2.9 per cent in the third quarter, moderating from the 4.6 per cent drop in the previous quarter. Overall retail sales volume was weighed down by an 11 per cent fall in motor vehicle sales on the back of lower COE quotas. Non-motor vehicle retail sales volume also contracted by 1.3 per cent, led by a fall in the sales volumes of watches & jewellery (-15 per cent) and furniture & household equipment (-6.3 per cent).

Exhibit 2.5: Changes in Retail Sales Index at Constant Prices

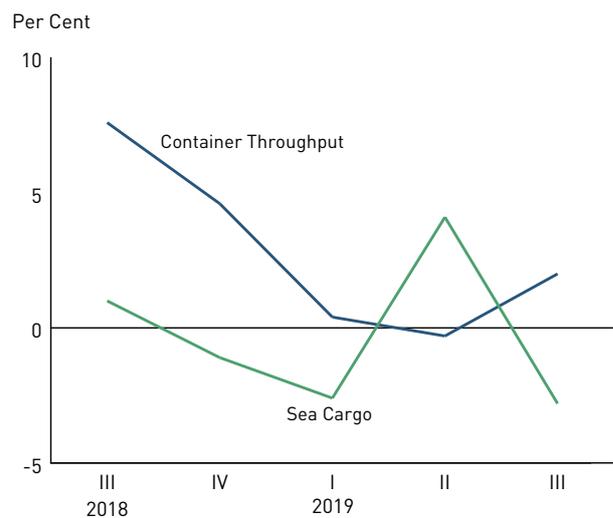


TRANSPORTATION & STORAGE

The transportation & storage sector registered flat growth year-on-year in the third quarter, easing from the 2.4 per cent growth in the previous quarter. Within the sector, the air transport segment continued to expand, even as the water transport segment contracted.

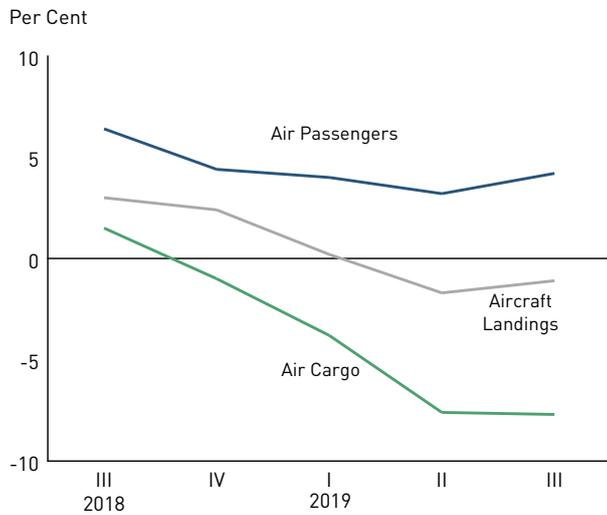
The water transport segment was weighed down by a fall in the volume of sea cargo handled. Specifically, the volume of sea cargo handled declined by 2.8 per cent in the third quarter, a reversal from the 4.1 per cent expansion recorded in the previous quarter (Exhibit 2.6). The lower volume of sea cargo handled was in turn due to a 7.8 per cent decline in the volume of oil-in-bulk cargo handed at Singapore's ports, which more than offset a 2.0 per cent expansion in container throughput over the same period.

Exhibit 2.6: Changes in Container Throughput and Sea Cargo Handled



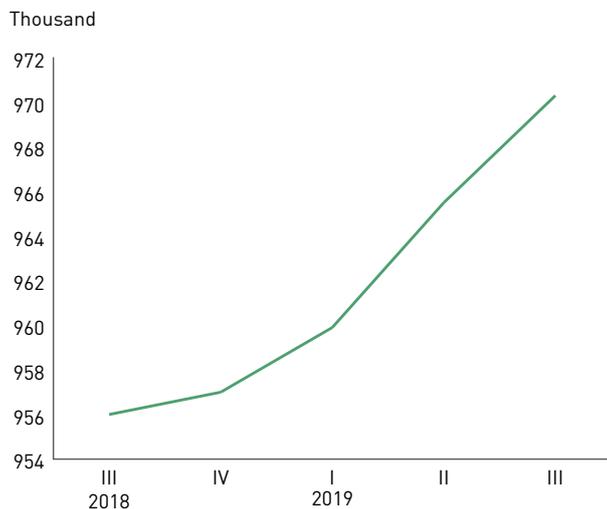
On the other hand, the air transport segment was bolstered by a 4.2 per cent increase in the volume of air passenger traffic handled at Changi Airport, which was higher than the increase of 3.2 per cent posted in the previous quarter (Exhibit 2.7). The rise in air passenger traffic volume was underpinned by robust growth on routes to and from Changi Airport's key markets, including South-East Asia, China, Japan and Oceania. Meanwhile, total air cargo shipments handled at Changi Airport fell by 7.7 per cent in the third quarter, extending the 7.6 per cent contraction in the preceding quarter, likely due to the weakness in electronics exports. The number of aircraft landings also fell by 1.1 per cent to reach 47,966 in the third quarter, extending the 1.7 per cent decline in the previous quarter.

Exhibit 2.7: Changes in Air Transport



As of September 2019, the total number of motor vehicles registered with the Land Transport Authority was 970,344, representing a 1.5 per cent increase from a year ago (Exhibit 2.8). These comprised 555,823 private and company cars, 75,079 rental cars, 18,772 taxis, 19,598 buses, 139,741 motorcycles and scooters, and 161,331 goods vehicles & other vehicle types.

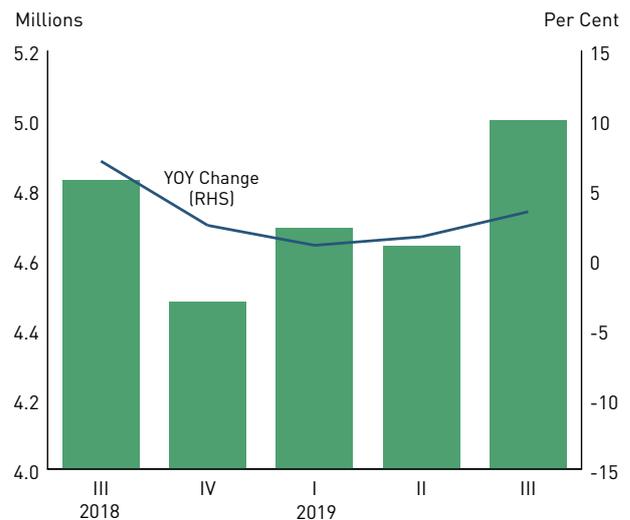
Exhibit 2.8: Motor Vehicles Registered



ACCOMMODATION & FOOD SERVICES

Growth in the accommodation & food services sector came in at 2.0 per cent year-on-year in the third quarter, higher than the 1.2 per cent in the preceding quarter. The sector's expansion was supported by both the accommodation and food services segments.

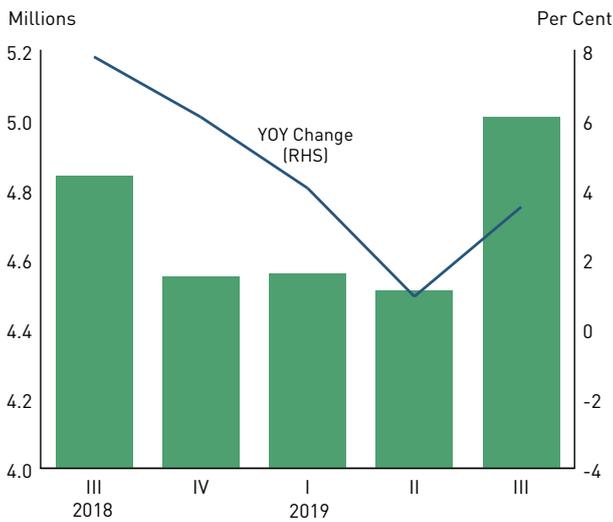
Exhibit 2.9: Visitor Arrivals



Total visitor arrivals rose by 3.5 per cent in the third quarter, faster than the 1.7 per cent growth in the previous quarter (Exhibit 2.9). The increase in visitor arrivals was led by inbound markets such as China, Indonesia and the United States, which recorded growth of 5.5 per cent, 7.6 per cent and 17 per cent respectively.

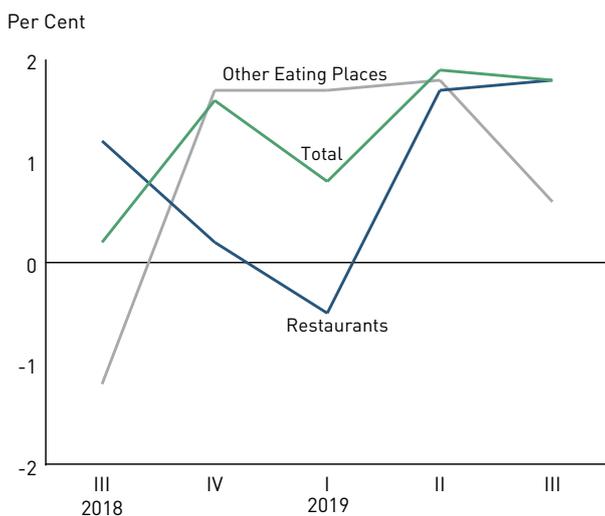
In tandem with the higher number of visitor arrivals, gross lettings at gazetted hotels rose by 3.5 per cent in the third quarter, accelerating from the 0.9 per cent growth in the preceding quarter (Exhibit 2.10). As the increase in gross lettings outpaced the 1.9 per cent growth in available room-nights over the same period, the average occupancy rate of gazetted hotels edged up by 1.4 percentage-points on a year-on-year basis to reach 91.4 per cent in the third quarter.

Exhibit 2.10: Gross Lettings at Gazetted Hotels



The food services segment expanded in the third quarter, as food & beverage sales volume rose by 1.8 per cent, extending the 1.9 per cent growth in the second quarter (Exhibit 2.11). Higher sales volume was seen for fast food outlets (7.8 per cent), restaurants (1.8 per cent) and other eating places² (0.6 per cent) during the quarter. On the other hand, the sales volume of food caterers declined by 1.6 per cent over the same period.

Exhibit 2.11: Changes in Food & Beverage Services Index at Constant Prices

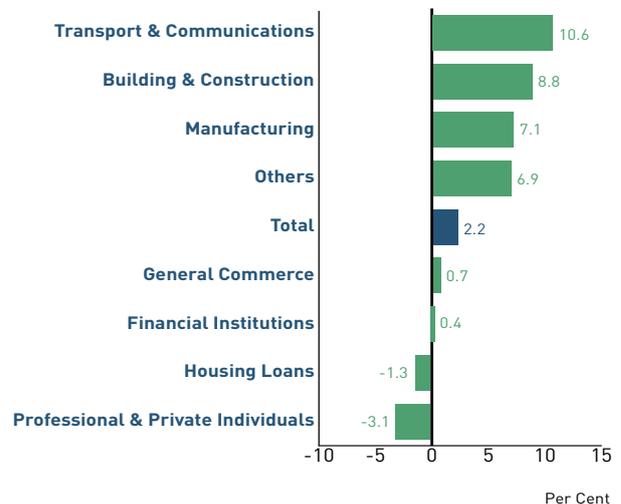


FINANCE & INSURANCE

The finance & insurance sector grew by 4.3 per cent year-on-year in the third quarter, extending the 5.1 per cent growth in the preceding quarter. Growth was largely driven by robust demand for payment processing services amidst a steady expansion in e-commerce activities and rising consumer preferences for cashless transactions. Financial intermediation activity also picked up further, while growth in the insurance segment continued to moderate.

In the financial intermediation segment, Asian Currency Unit (ACU) non-bank lending grew by 5.6 per cent year-on-year in the third quarter, supported by a lift in demand from Asia, which more than offset the weakness in the Americas. Growth of Domestic Banking Unit (DBU) non-bank lending edged higher to 2.2 per cent in the third quarter, from the 2.1 per cent registered in the preceding quarter, helped by a pickup in loans to businesses (Exhibit 2.12). Notably, growth in loans to the transport, storage & communication and building & construction sectors remained firm, more than offsetting the contractions seen in loans to professional & private individuals and consumer loans.

Exhibit 2.12: Growth of DBU Loans & Advances to Non-Bank Customers by Industry in 3Q 2019



Meanwhile, sentiment-sensitive segments such as security dealing and foreign exchange trading found firmer footing from the accommodative policies of central banks, which supported the risk appetite of investors. Elsewhere, growth in the insurance segment was lacklustre, against the backdrop of a series of natural disaster events, as well as softer domestic and regional demand for insurance services.

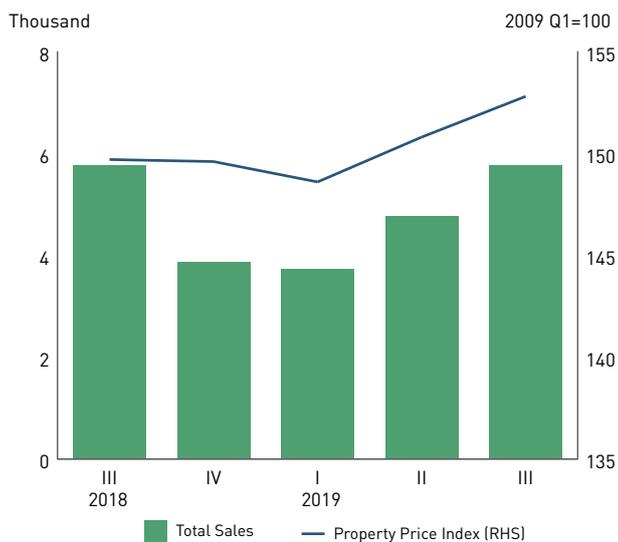
² Other eating places include cafes, coffee houses, food courts, food kiosks, pubs and canteens.

BUSINESS SERVICES

The business services sector grew by 0.9 per cent year-on-year in the third quarter, extending the 0.8 per cent growth in the preceding quarter. Growth was primarily driven by the professional services segment, which expanded on account of the sustained demand for its services domestically and in the region.

On the other hand, the real estate segment contracted slightly in the third quarter on the back of lacklustre sales transactions of private residential units (-0.03 per cent). Private residential property prices rose by 1.3 per cent on a quarter-on-quarter basis in the third quarter, slightly slower than the 1.5 per cent increase in the previous quarter (Exhibit 2.13).

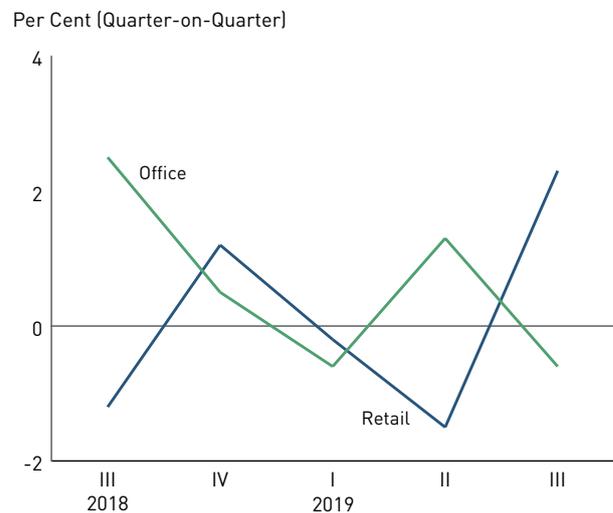
Exhibit 2.13: Total Sales Transactions for Private Residential Units and Private Residential Property Price Index



For the private retail space market, rentals rose by 2.3 per cent on a quarter-on-quarter basis in the third quarter, reversing the 1.5 per cent decline in the previous quarter (Exhibit 2.14). Meanwhile, the average occupancy rate of private retail space held steady at 91 per cent in the third quarter, similar to the preceding quarter.

By contrast, rentals for private office space fell by 0.6 per cent on a quarter-on-quarter basis in the third quarter, a reversal from the 1.3 per cent increase in the previous quarter. The average occupancy rate of private office space came in at 89 per cent during the quarter, inching up from the 88 per cent in the second quarter.

Exhibit 2.14: Changes in Rentals of Private Sector Office and Retail Spaces



The private industrial space market remained stable in the third quarter. Industrial rentals were unchanged on a quarter-on-quarter basis, easing from the 0.1 per cent growth in the second quarter. The occupancy rates for private sector multiple-user factory space and private sector warehouse space stood at 89 per cent and 88 per cent respectively in the third quarter, comparable to the previous quarter's rates of 89 per cent and 89 per cent respectively.

Exhibit 2.15: Occupancy Rate and Rental Growth of Private Sector Industrial Space

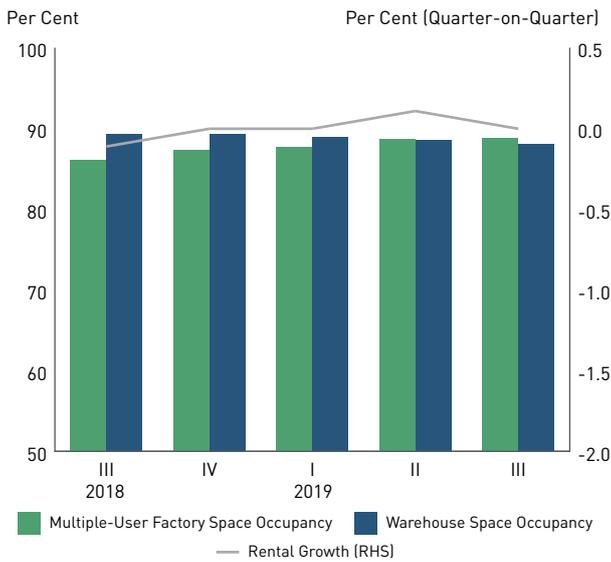




Image courtesy of Singapore Tourism Board



CHAPTER 3

ECONOMIC OUTLOOK

CHAPTER 3

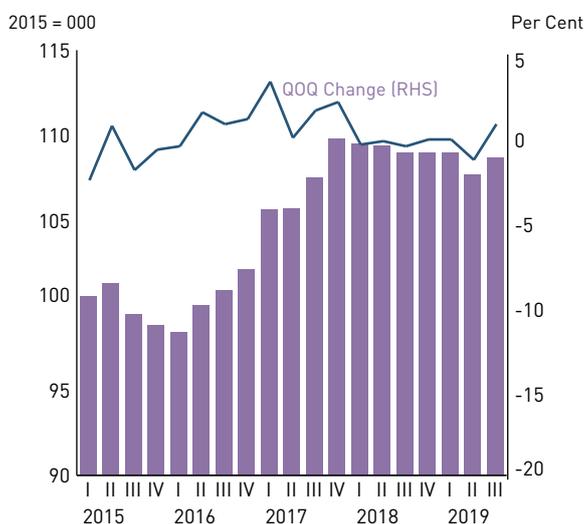
ECONOMIC OUTLOOK

LEADING INDICATORS

On a quarter-on-quarter basis, the composite leading index (CLI) increased by 0.9 per cent in the third quarter, a reversal from the 1.2 per cent decline in the previous quarter (Exhibit 3.1).

Of the nine components in the CLI, four of them increased on a quarter-on-quarter basis, namely stock of finished goods, new companies formed, non-oil sea cargo handled and money supply. By contrast, domestic liquidity, stock price, non-oil retained imports and the US Purchasing Managers' Index declined compared to a quarter ago. There was no change in the wholesale trade component.

Exhibit 3.1: Composite Leading Index Levels and Growth Rate



OUTLOOK FOR 2019

Since the last Economic Survey of Singapore in August, there are signs of stabilisation in the global economy even though global growth remains weak. Domestically, the manufacturing sector performed better than expected in the third quarter on the back of robust expansions in the biomedical manufacturing cluster and the aerospace segment of the transport engineering cluster, even though the electronics cluster continued to contract.

For the remaining quarter of the year, MTI expects the performance of the manufacturing sector and trade-related services sectors such as wholesale trade to remain subdued in view of the ongoing downswing in the global electronics cycle. However, sectors such as construction, information & communications, finance & insurance, and education, health & social services are projected to continue to post steady growth.

Taking into account the performance of the Singapore economy in the first three quarters of the year and the outlook for the fourth quarter, the 2019 GDP growth forecast for Singapore is narrowed to **“0.5 to 1.0 per cent”**, from “0.0 to 1.0 per cent”.

OUTLOOK FOR 2020

For 2020, global growth is projected to see a modest pickup, led by an improvement in the growth outlook for emerging market and developing economies. However, growth in several of Singapore's key final demand markets such as the US and China is expected to ease.

In the US, GDP growth is projected to moderate in 2020 as investment growth is expected to continue to slow amidst prolonged trade tensions and policy uncertainty. Nonetheless, private consumption should provide some support to growth as labour market conditions remain healthy. Meanwhile, the Eurozone economy is expected to expand at a slightly faster pace, with continued support coming from domestic demand. Labour market conditions are likely to remain firm, while borrowing costs should stay low given a more accommodative monetary policy stance adopted by the European Central Bank.

In Asia, China's growth is projected to slow in the year ahead as investment growth is expected to decelerate following financial reforms to curb shadow lending. Existing US tariffs are also likely to continue to weigh on China's exports. Nonetheless, stable household consumption growth and accommodative macroeconomic policies should lend some support to the Chinese economy. At the same time, growth in the key ASEAN economies is expected to remain resilient. While merchandise exports are likely to remain subdued, consumer sentiments should stay firm and hence supportive of private consumption.

At the same time, uncertainties in the global economy remain. First, notwithstanding the resumption of trade talks and the announcement of a partial trade deal, US-China trade tensions remain a source of risk as existing tariffs are still in place and additional tariffs may be imposed. There is also a possibility that tensions could escalate again. Second, a steeper-than-expected slowdown of the Chinese economy could be precipitated by additional tariffs imposed by the US and sharper-than-anticipated tightening of financial conditions due to domestic deleveraging efforts. This could in turn lead to a sharp fall in Chinese import demand and negatively affect the region's growth. Third, Brexit-related uncertainties remain given upcoming elections in the UK and the decision to further delay Brexit. Moreover, there continues to be the risk of a "no-deal" Brexit. Fourth, ongoing uncertainties in Hong Kong and geopolitical tensions in the Middle East could lead to financial market volatility, and have negative spillover effects on the region and Singapore.

On balance, given the growth outlook for Singapore's key final demand markets, and the projected recovery in the global electronics cycle in the year ahead, MTI expects growth in the Singapore economy to pick up modestly in 2020 as compared to 2019.

In particular, the manufacturing sector is expected to return to positive growth, led by a gradual recovery in the electronics and precision engineering clusters. Improved conditions in these clusters is also likely to support growth in related sectors such as wholesale trade. At the same time, growth in the information & communications and finance & insurance sectors is expected to remain healthy, bolstered by firms' healthy demand for IT and digital solutions and sustained demand for payment processing services respectively. Meanwhile, the education, health & social services segment should remain resilient as operations in healthcare facilities continue to ramp up. The construction sector is also projected to see sustained growth in the coming year.

Taking into account the global and domestic economic environment, the Singapore economy is expected to grow by **"0.5 to 2.5 per cent"** in 2020.



Image courtesy of Singapore Tourism Board



**FEATURE
ARTICLE**

FEATURE ARTICLE

RETURNS TO RESEARCH AND DEVELOPMENT
(R&D) AMONG FIRMS IN SINGAPORE

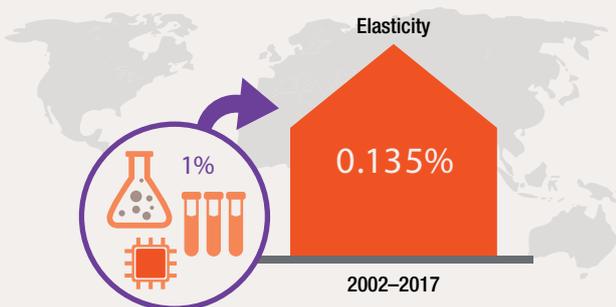
INTRODUCTION

Research and Development (R&D) plays a key role in Singapore's ambitions to be an innovation-driven and value-creating economy. At the macroeconomic level, apart from enhancing the competitiveness of existing industries, R&D lays the foundation for Singapore to develop new capabilities in industries of the future. At the sectoral and firm levels, R&D investments can stimulate innovations in product offerings and production processes. These innovations can in turn raise productivity, thereby supporting sustainable economic and wage growth.

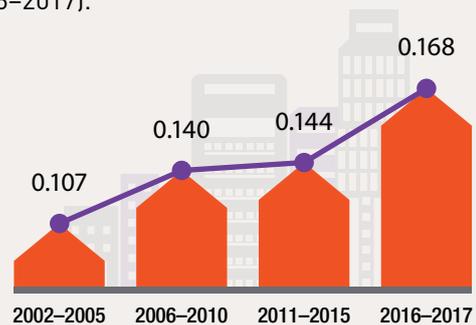


FINDINGS

Over the period of 2002 to 2017, a 1 per cent increase in R&D stock raised firm-level productivity by 0.135 per cent on average, which compares favourably with that found in other advanced economies.

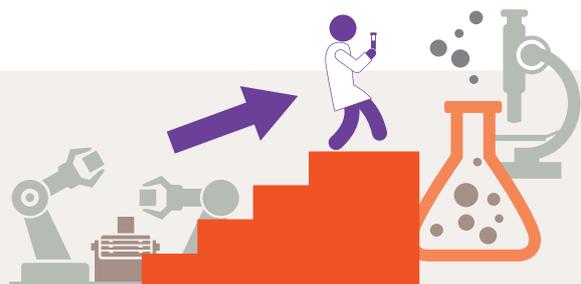


The elasticity of R&D has increased over time, from 0.107 for Science & Technology Plan 2005 (2002-2005) to 0.168 for the first two years of Research, Innovation and Enterprise Plan 2020 (2016-2017).



POLICY TAKEAWAY

These findings suggest that the government should continue to leverage R&D investments, along with other efforts under the Industry Transformation Maps, to raise the productivity of firms and industries in Singapore. Our efforts to raise the R&D and innovative capacity of our firms will be key to the transformation of our industries and Singapore's next phase of growth.



EXECUTIVE SUMMARY

- ▶ Leveraging a panel dataset from the Agency for Science, Technology and Research's (A*STAR) annual R&D survey, this study provides an overview of Singapore's R&D landscape. It also examines the impact of R&D investments on firm-level productivity in Singapore, and how this impact has changed across the various Science and Technology (S&T) and Research, Innovation and Enterprise (RIE) Plans.
- ▶ Our study finds that there are positive returns to firm-level productivity from R&D investments. Over the period of 2002 to 2017, a 1 per cent increase in R&D stock in a firm led to a 0.135 per cent increase in productivity on average. In dollar terms, a \$1 increase in R&D stock raised productivity in a median firm (defined as having a median value-added to R&D stock ratio) by \$0.24. The elasticity and dollar impact of R&D have also increased across the S&T and RIE Plans. Specifically, the elasticity rose from 0.107 for S&T Plan 2005 (2002-2005) to 0.168 for the first two years of RIE Plan 2020 (2016-2017). Meanwhile, the dollar impact rose from \$0.20 in 2002-2005 to \$0.28 in 2016-2017.
- ▶ These findings suggest that the government should continue to leverage R&D investments, along with other efforts under the Industry Transformation Maps, to raise the productivity of firms and industries in Singapore. Our efforts to raise the R&D and innovative capacity of our firms will be key to the transformation of our industries and Singapore's next phase of growth.

*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 (MTI), A*STAR or the Government of Singapore.¹*

1. INTRODUCTION

Research and Development (R&D) plays a key role in Singapore's ambitions to be an innovation-driven and value-creating economy. At the macroeconomic level, apart from enhancing the competitiveness of existing industries, R&D lays the foundation for Singapore to develop new capabilities in industries of the future. At the sectoral and firm levels, R&D investments can stimulate innovations in product offerings and production processes. These innovations can in turn raise productivity, thereby supporting sustainable economic and wage growth.

In view of the important role of R&D in the Singapore economy, this study examines the impact of R&D on the multi-factor productivity – productivity henceforth – of firms that conduct R&D, and how this impact has changed across the Science and Technology (S&T) and Research, Innovation and Enterprise (RIE) Plans over the years.

The rest of the paper is organised as follows. Section 2 provides an overview of R&D in the Singapore economy. Section 3 briefly reviews the literature related to the impact of R&D on firm-level productivity. Section 4 outlines the data source and empirical methodology used to estimate the impact of R&D on firms' productivity. Section 5 presents the results, and the final section concludes.

2. OVERVIEW OF R&D IN THE SINGAPORE ECONOMY

Against the backdrop of rapid technological advancements, it is critical for Singapore to invest in R&D in order to build up our S&T capabilities, and support our development as a knowledge-intensive and innovative economy. Reflecting Singapore's commitment to do so, the National Science and Technology Board (NSTB), subsequently renamed as the Agency for Science, Technology and Research (A*STAR), was established in 1991.²

¹ We would like to thank Ms Yong Yik Wei for her useful suggestions and comments. We would also like to acknowledge the statistical support from A*STAR's Research and Statistics Unit.

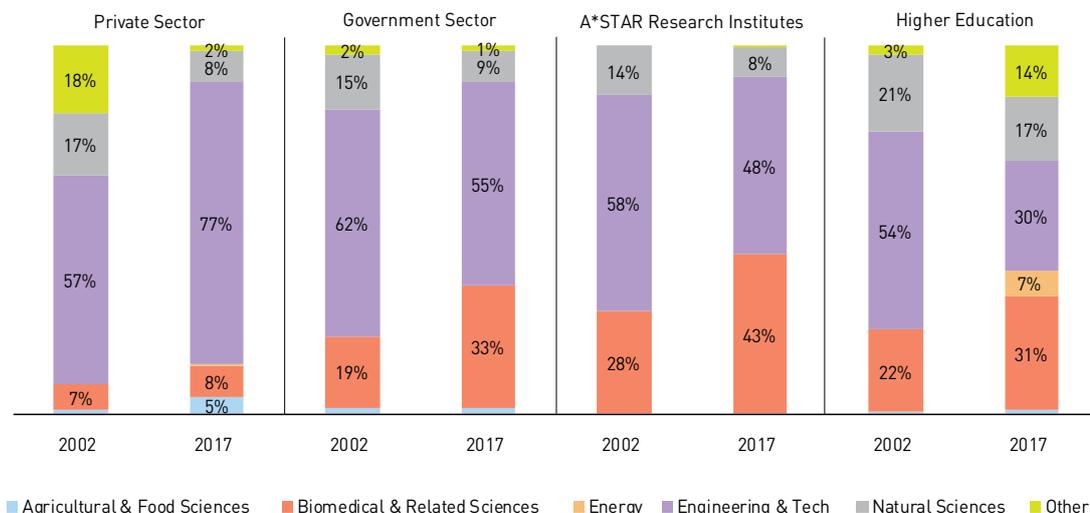
² For more details on the NSTB and A*STAR, see Hang et al. (2016), Thampuran (2017) and Yeoh (2017).

Concomitantly, the government's investment in R&D has increased over the years. The first National Technology Plan (1991-1995) had a budget of \$2 billion, which doubled to \$4 billion in the second National S&T Plan (1996-2000). In the four most recent S&T and RIE Plans, the funding continued to increase, to \$6 billion in S&T Plan 2005 (2001-2005), \$13.5 billion in S&T Plan 2010 (2006-2010), \$16 billion in RIE Plan 2015 (2011-2015), and \$19 billion in RIE Plan 2020 (2016-2020).

In tandem with the government's efforts to promote R&D, Gross Expenditure on R&D (GERD) in Singapore rose from \$0.8 billion in 1991 to \$9.1 billion in 2017, representing a compounded annual growth rate (CAGR) of 10.0 per cent. The increase in GERD was supported by growth in both Business Expenditure on R&D (BERD) and Public Expenditure on R&D (PUBERD)³. The former rose from \$0.4 billion to \$5.4 billion (or 10.1 per cent per annum) over the same period, while the latter increased from \$0.3 billion to \$3.7 billion (or 9.9 per cent per annum). As a share of Gross Domestic Product (GDP), GERD (BERD) climbed from 0.96 per cent (0.56 per cent) to 1.94 per cent (1.16 per cent) between 1991 and 2017. By 2017, BERD accounted for around 60 per cent of GERD.

Given Singapore's capabilities in the manufacturing sector (e.g., electronics, precision engineering, aerospace and marine), a sizeable share of R&D expenditure in the private sector (or BERD) has remained in Engineering and Technology (Exhibit 1).⁴ Similarly, Engineering and Technology remains a key focus of PUBERD (i.e., R&D expenditure in the government sector, A*STAR research institutes and higher education), although the share of PUBERD in Biomedical & Related Sciences has also seen a significant increase over the years. The latter reflects the government's efforts to develop the Biomedical Sciences (BMS) sector as a new engine of growth.⁵ At the same time, within the higher education sector, new areas of research such as Energy have also become more prominent in recent years.⁶

Exhibit 1: R&D Expenditure by Areas of Research and Institutional Sector, 2002 and 2017



Source: A*STAR R&D Survey

Note: The "Others" category includes research which does not fall within the core areas, including research on education and supply chain management.

In terms of the strategic focus areas, R&D expenditure in the private and government sectors has mostly focused on Experimental Development and Applied Research, while that in the A*STAR research institutes and higher education sector has been more diverse (Exhibit 2). The focus of the private and government sectors on more downstream research (i.e., Experimental Development and Applied Research) is aligned with their aim to operationalise R&D.

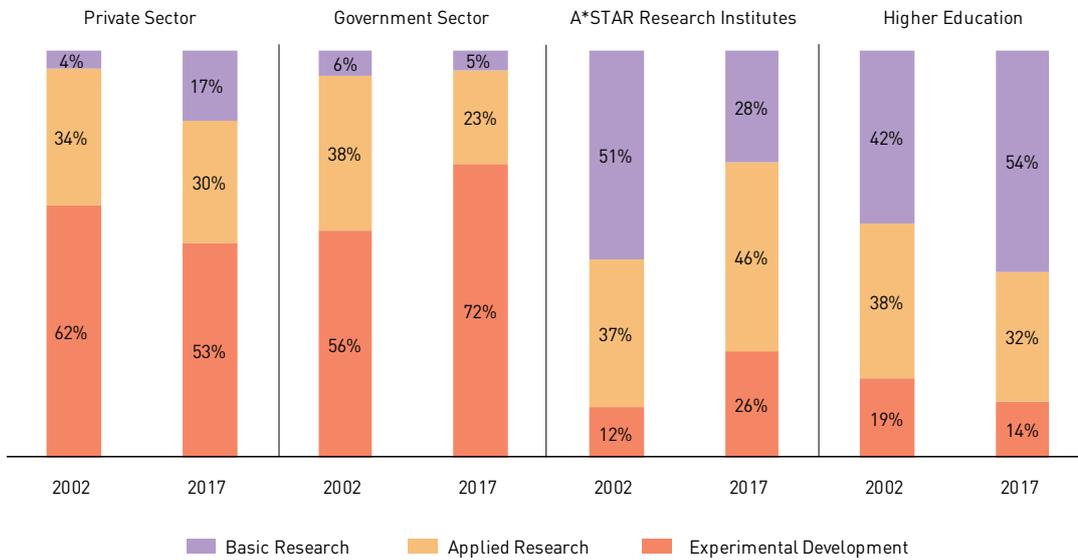
³ PUBERD comprises R&D spending by the universities, A*STAR research institutes and the government sector.

⁴ Data with detailed breakdown into the various segments of R&D spending is only available from 2002 onwards.

⁵ In 2000, the government launched the BMS initiative, with a budget of \$1.48 billion, to create a conducive innovation ecosystem with research infrastructure and top scientists (see Thampuran & Kong, 2016; Thampuran, 2017). In the same year, the Biomedical Research Council (BMRC) was established to promote public sector R&D and nurture Singapore's talent base in the BMS sector. Reflecting the aim to grow BMS research in Singapore, new research institutes, including the Genome Institute of Singapore (first known as the Singapore Genomics Programme in 2000), the Bioinformatics Institute (2001), and the Institute of Bioengineering and Nanotechnology (2003) were formed in the initial years.

⁶ To support R&D in the energy sector, research institutes were set up in the universities, including the National University of Singapore's Solar Energy Research Institute of Singapore (SERIS) in 2008 and the Nanyang Technological University's Energy Research Institute (NTU-ERI@N) in 2010.

Exhibit 2: R&D Expenditure by Strategic Focus Areas and Institutional Sector, 2002 and 2017

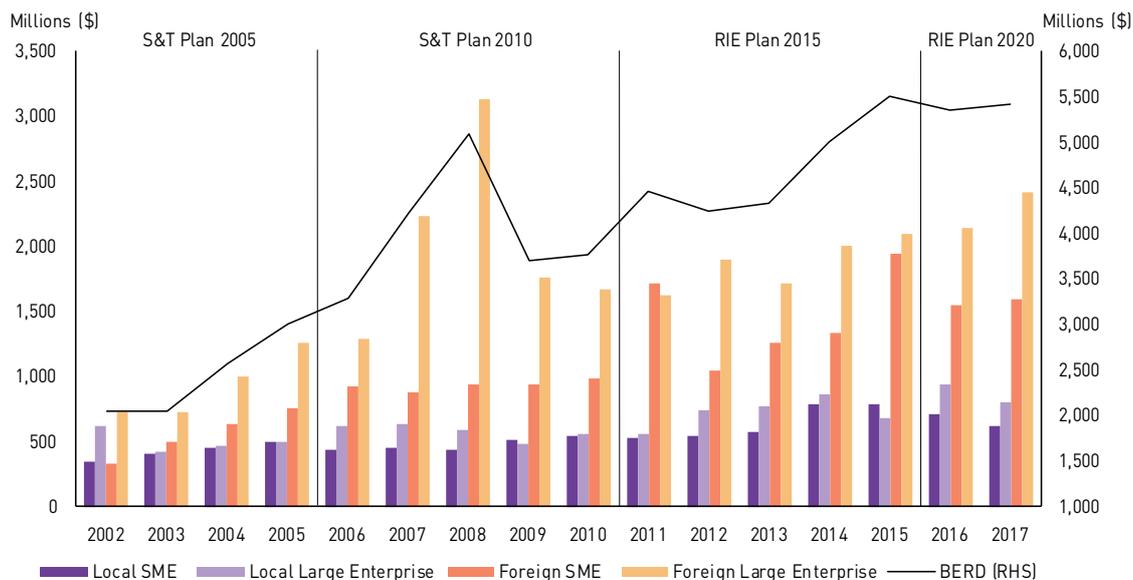


Source: A*STAR R&D Survey

Note: Basic research is defined as that which advances knowledge, or/and produces a broad base of knowledge likely to form the basis of the solution to problems. Applied research refers to original investigation directed primarily towards a specific practical objective, and aims to give operational form to ideas. Experimental development draws on knowledge gained from research to produce new or improve existing products/processes.

Focusing on R&D spending in the private sector, it can be seen that the increase in BERD over the years was supported primarily by higher R&D spending by foreign enterprises (Exhibit 3). Between 2002 and 2017, BERD for foreign small and medium-sized enterprises (SMEs) and foreign large enterprises increased by 10.9 per cent per annum and 8.3 per cent per annum respectively. While the BERD of local enterprises also rose during this period, it was at a slower pace of 3.8 per cent per annum for local SMEs and 1.6 per cent per annum for local large enterprises.

Exhibit 3: BERD by Firm Type, 2002-2017

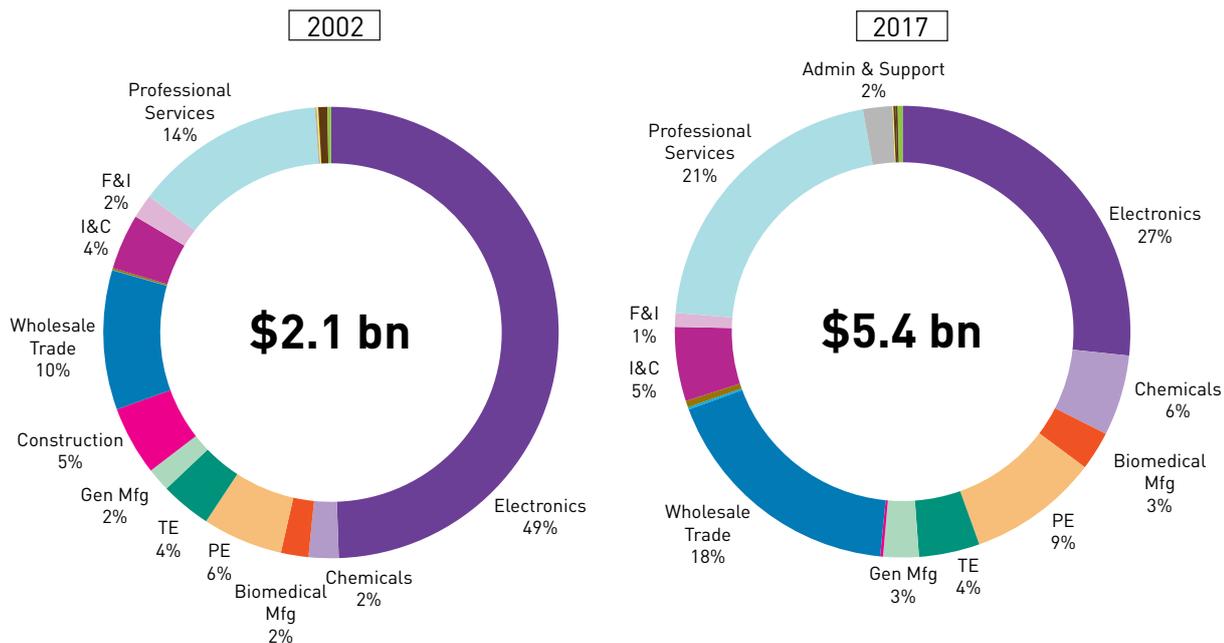


Source: A*STAR R&D Survey

Note: Exhibit 3 draws on firm-level data from A*STAR's annual R&D survey between 2002 and 2017. As such, it only captures the last four years of S&T Plan 2005 and the first two years of RIE Plan 2020.

Over time, the composition of firms' R&D spending by industry has become more diversified (Exhibit 4). In line with the strategic technology domains proposed in recent RIE Plans (e.g., Services and Digital Economy, Urban Solutions and Sustainability) (see Low, 2017), firms in selected services have contributed more to BERD over the years. Notably, between 2002 and 2017, the share of BERD increased significantly for firms in the professional services (14 per cent to 21 per cent) and wholesale trade (10 per cent to 18 per cent) sectors. By contrast, the contribution to BERD by firms in the electronics cluster fell from 49 per cent to 27 per cent over the same period.⁷

Exhibit 4: BERD by Industry, 2002 and 2017



Source: A*STAR R&D Survey

Note: The following abbreviations were used in Exhibit 4 – Finance & Insurance (F&I), Information & Communications (I&C), General Manufacturing Industries (Gen Mfg), Transport Engineering (TE), Precision Engineering (PE), and Biomedical Manufacturing (Biomedical Mfg).

3. LITERATURE REVIEW

Internationally, studies have found that R&D investments have a positive impact on firms' productivity, although the estimated returns vary across economies, industries and time periods examined. For instance, a 1 per cent increase in R&D stock was estimated to increase the productivity of UK manufacturing firms by 0.02 per cent in 1990-2000 (Griffith et al., 2006), US firms by 0.06 per cent in 1964-1990 (Hall, 1993), and German manufacturing firms by 0.09 per cent in 1979-1989 (Harhoff, 1998). More recent work estimated that a 1 per cent increase in R&D stock led to a 0.15 per cent increase in productivity on average among firms in the OECD in 2006-2007 (Kancs & Siliverstovs, 2016).

For Singapore, Fan et al. (2015) found that R&D conducted by firms had a positive and significant impact on firm-level productivity. Specifically, they estimated that a 1 per cent increase in R&D stock raised firm-level productivity by 0.13 per cent on average over the period of 2002 to 2013. In dollar terms, a \$1 increase in R&D stock in a firm with a median value-added (VA) to R&D stock ratio increased productivity by \$0.35. Across the S&T and RIE Plans, they found that the elasticity of productivity with respect to changes in R&D stock rose, from 0.10 per cent in 2002-2005, to 0.13 per cent in 2006-2010, and 0.15 per cent in 2011-2013.⁸ The dollar impact of R&D also followed a similar trend, increasing from \$0.29 in 2002-2005, to \$0.37 in 2006-2010, and \$0.40 in 2011-2013.

⁷ In absolute levels, BERD by firms in the electronics cluster continued to increase, from \$1.02 billion in 2002 to \$1.45 billion in 2017 (or 2.4 per cent per annum).

⁸ Due to data availability, Fan et al.'s (2015) study only covered the last four years of S&T Plan 2005 and the first three years of RIE Plan 2015.

4. DATA AND EMPIRICAL METHODOLOGY

To update earlier estimates of the impact of R&D on the productivity of firms that conduct R&D in Singapore, this study uses an anonymised unbalanced panel dataset compiled from A*STAR's annual National Survey of R&D over the period of 2002 to 2017. The dataset contains information on firms' R&D expenditure, profits, net fixed asset investments, employment and industry classification, among others.

Our sample for the study covers 1,724 private firms which conducted in-house R&D for at least two years during the period of analysis. Similar to the approach by Fan et al. (2015), we excluded R&D service providers (i.e., firms classified under SSIC2015 72) from the analysis as their R&D expenditure would have directly contributed to the bulk of their VA.⁹

Consistent with other firm-level studies, a Cobb-Douglas production function, augmented with R&D capital stock (which represents knowledge capital), is assumed for each firm¹⁰:

$$Y = AL^\alpha K^\beta S^\gamma \quad (1)$$

Where Y = Firm's VA
 A = Efficiency parameter (proxy for technological progress)
 L = Labour
 K = Physical capital stock
 S = R&D capital stock

A fixed effects regression is then run, based on the logarithmic form¹¹ of equation 1:

$$\log Y_{it} = \beta_s \log S_{it} + \beta_L \log L_{it} + \beta_K \log K_{it} + \beta_X X_{it} + c_i + \sum_t \theta_t d_t + \varepsilon_{it} \quad (2)$$

Where Y_{it} is the VA of firm i at time t
 S_{it} is the R&D stock of firm i at time t
 L_{it} and K_{it} are the labour and physical capital stock¹² respectively in firm i at time t
 X_{it} is a set of control variables comprising dummies for the area of research and industry, as well as interactions of year and industry dummies for firm i at time t
 c_i is the fixed effects term for firm i
 d_t is a dummy for year t
 ε_{it} is an error term associated with firm i at time t

The regression controls for both observable (e.g., labour and physical capital stock) and time-invariant unobservable (e.g., management practices) characteristics of firms, as well as macroeconomic (e.g., economic cycles) and industry-specific (e.g., fixed asset requirements) factors that could affect VA across firms. As such, β_s , which measures the average impact of a firm's R&D stock on its VA, can also be interpreted as the average impact of the R&D stock on its productivity.¹³ The dollar impact of R&D for a median firm (defined as one with a median VA to R&D stock ratio) is then estimated by multiplying β_s and the VA to R&D stock ratio of the firm.¹⁴

We also allow R&D to have varying effects on firm productivity across the four S&T and RIE Plans in 2002-2017:

$$\log Y_{it} = \sum_j \beta_{sj} \log S_{it} \times \text{Plan}_j + \sum_j \beta_{Lj} \log L_{it} \times \text{Plan}_j + \sum_j \beta_{Kj} \log K_{it} \times \text{Plan}_j + \beta_X X_{it} + c_i + \sum_t \theta_t d_t + \varepsilon_{it} \quad (3)$$

In addition to the variables defined in equation 2, Plan_j is a dummy for each S&T or RIE Plan j , where j = S&T Plan 2005 (2002-2005), S&T Plan 2010 (2006-2010), RIE Plan 2015 (2011-2015) or RIE Plan 2020 (2016-2017).¹⁵

⁹ Firms with negative values for VA, non-R&D fixed assets and employment were excluded from the analysis.

¹⁰ See Annex A for the computation of the variables Y_{it} , S_{it} , L_{it} and K_{it} .

¹¹ In line with the literature, we assume that the log of efficiency parameter ($\log A$) is the sum of a firm-specific effect (c_i), a time effect (d_t) and other effects stemming from areas of research and industry.

¹² In line with the literature, R&D employment and R&D capital stock are excluded from the computation of labour and physical capital stock to avoid double counting R&D inputs.

¹³ The impact on VA from an increase in R&D stock can be considered as the impact on multi-factor productivity as other factor inputs used in the production process (e.g., capital and labour) are already controlled for in the regression.

¹⁴ The dollar impact estimates are in chained 2015 dollars, with the latest GDP deflators used to deflate nominal VA.

¹⁵ As the analysis draws on firm-level data from A*STAR's annual R&D survey for the period of 2002-2017, it can only capture the last four years of S&T Plan 2005 and the first two years of RIE Plan 2020.

5. RESULTS

Our findings suggest that there are positive and significant returns to firm-level productivity from conducting R&D (Exhibit 5). Specifically, we estimate that a 1 per cent increase in R&D stock raised firms' productivity by 0.135 per cent on average over the period of 2002-2017. In dollar terms, a \$1 increase in R&D stock in a firm with a median VA to R&D stock ratio raised productivity by \$0.24. Our elasticity estimate compares favourably with that found in other advanced economies.

Exhibit 5: Impact of R&D Stock on Firm-level Productivity

	2002-2017
β_s	0.135**
Dollar impact (\$)	\$0.24

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Additionally, we find that the impact of R&D on firms' productivity increased across the four most recent S&T and RIE Plans (Exhibit 6). In particular, the estimated elasticity rose from 0.107 for S&T Plan 2005 (2002-2005), to 0.140 for S&T Plan 2010 (2006-2010), 0.144 for RIE Plan 2015 (2011-2015), and 0.168 for the first two years of RIE Plan 2020 (2016-2017). For a firm with a median VA to R&D stock ratio, the dollar impact of R&D followed a similar trend, rising from \$0.20 in 2002-2005, to \$0.24 in 2006-2010 and 2011-2015, and \$0.28 in 2016-2017.

Exhibit 6: Impact of R&D Stock on Firm-level Productivity over the S&T and RIE Plans

	2002-2005	2006-2010	2011-2015	2016-2017
β_s	0.107***	0.140***	0.144***	0.168***
Dollar impact (\$)	\$0.20	\$0.24	\$0.24	\$0.28

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

6. CONCLUSION

In summary, our study finds that R&D investments have been beneficial in improving firms' productivity. The estimated elasticity of productivity with respect to R&D stock is positive and significant, and compares favourably with that found in other advanced economies. The elasticity and dollar impact of R&D on productivity has also increased, in line with the focus on R&D with economic outcomes across the S&T and RIE Plans. In particular, the increase in government funding across the tranches, together with the growing emphasis on public-private partnerships (see Low et al., 2016), may have strengthened private firms' R&D capabilities and enabled their R&D investments to reap higher returns over time.

These findings also suggest that the government should continue to leverage R&D investments, along with other efforts under the Industry Transformation Maps, to raise the productivity of firms and industries. To encourage firms to grow their capabilities through R&D, the government has in place initiatives such as A*STAR's Growing Enterprises through Technology Upgrade (GET-Up) programme, and the Economic Development Board's Research Incentive Scheme for Companies. Firms, particularly SMEs, can also tap on laboratory facilities, technology consultancy, testing services and training courses in the Centres of Innovation to grow new innovative capabilities. Our efforts to raise the R&D and innovative capacity of our firms will be key to the transformation of our industries and Singapore's next phase of growth.

Contributed by:

Ms Marsha Teo, Economist
Mr Alex Loo, Economist
Dr Kuan Ming Leong, Lead Economist
Economics Division
Ministry of Trade and Industry

REFERENCES

- Fan, S. L., Foo, X. Y., & Goh, K. (2015). Impact of Research & Development on Productivity. *Economic Survey of Singapore Second Quarter 2015*, 42-49.
- Griffith, R., Harrison, R., & Van Reenen, J. (2006). How Special is the Special Relationship? Using the Impact of U.S. R&D Spillovers on U.K. Firms as a Test of Technology Sourcing. *The American Economic Review*, 96(5), 1859-1875.
- Hall, B. H. (1993). Industrial Research During the 1980s: Did the Rate of Return Fall? *Brookings Papers on Economic Activity: Microeconomics*, 2, 289-330.
- Hall, B. H., Mairesse, J., & Mohnen, P. (2010). Measuring the Returns to R&D. In B. H. Hall, & N. Rosenberg (Eds.), *Handbook of the Economics of Innovation, Volume 2* (pp. 1033-1082). Amsterdam: Elsevier B. V.
- Hang, C. C., Low, T. S., & Yeoh, K. C. (2016). Shifting Gear Into Research. In C. C. Hang, T. S. Low, & R. Thampuran (Eds.), *The Singapore Research Story* (pp. 25-54). Singapore: World Scientific.
- Harhoff, D. (1998). R&D and Productivity in German Manufacturing Firms. *Economics of Innovation and New Technology*, 6(1), 29-50.
- Kancs, D., & Siliverstovs, B. (2016). R&D and Non-Linear Productivity Growth. *Research Policy*, 45(3), 634-646.
- Low, T. S. (2017). National Research Foundation. In B. T. Tan, H. Lim, & K. K. Phua (Eds.), *50 Years of Science in Singapore* (pp. 51-75). Singapore: World Scientific.
- Low, T. S., Thampuran, R., & Yeoh, K. C. (2016). Partnering Multinational Corporations in R&D. In C. C. Hang, T. S. Low, & R. Thampuran (Eds.), *The Singapore Research Story* (pp. 165-187). Singapore: World Scientific.
- Thampuran, R. (2017). Science, Technology and Open Innovation - The A*STAR Journey. In B. T. Tan, H. Lim, & K. K. Phua (Eds.), *50 Years of Science in Singapore* (pp. 39-50). Singapore: World Scientific.
- Thampuran, R., & Kong, H. L. (2016). The Biomedical Sciences: Research for Better Health. In C. C. Hang, T. S. Low, & R. Thampuran (Eds.), *The Singapore Research Story* (pp. 101-133). Singapore: World Scientific.
- Yeoh, F. (2017). R&D in Singapore - The Early Years of NSTB. In B. T. Tan, H. Lim, & K. K. Phua (Eds.), *50 Years of Science in Singapore* (pp. 23-38). Singapore: World Scientific.

ANNEX A: COMPUTATION OF VARIABLES

Following Fan et al. (2015), the key variables are defined as follows:

Value-added (VA) (Y_{it})

Nominal VA is the sum of net operating profit after taxes, indirect taxes, expenditure on manpower and depreciation of fixed assets. This is then deflated using GDP deflators by industry from the Department of Statistics (DOS) to obtain real VA.

R&D Stock (S_{it})

For real R&D expenditure, nominal R&D expenditure is deflated using the Gross Fixed Capital Formation (GFCF) deflator. This deflator is obtained by dividing GFCF at current market prices by GFCF in chained (2015) dollars. Both series are available from DOS.

Consistent with the academic literature, the perpetual inventory method is used to compute the R&D capital stock (S_{it}) (equations 4 and 5). We assume a depreciation rate (δ) of 15 per cent in line with the literature (e.g., Hall et al., 2010; Fan et al., 2015) and a growth rate (g) of 19 per cent. The latter is the estimated growth rate of real BERD from 1990 to 2001.

$$S_{it} = S_{it-1} \times (1-\delta) + E_{it} \quad (4)$$

Where S_{it} is the R&D capital stock for firm i at time t
 δ is the depreciation rate of R&D capital stock which is assumed to be 15 per cent
 E_{it} is the real R&D expenditure for firm i at time t

$$S_{it=0} = \frac{E_{it=0}}{g+\delta} \quad (5)$$

Where $S_{it=0}$ is the R&D capital stock for firm i when it first entered the dataset
 $E_{it=0}$ is the real R&D expenditure for firm i when it first entered the dataset
 g is the growth rate of real R&D expenditure which is assumed to be 19 per cent

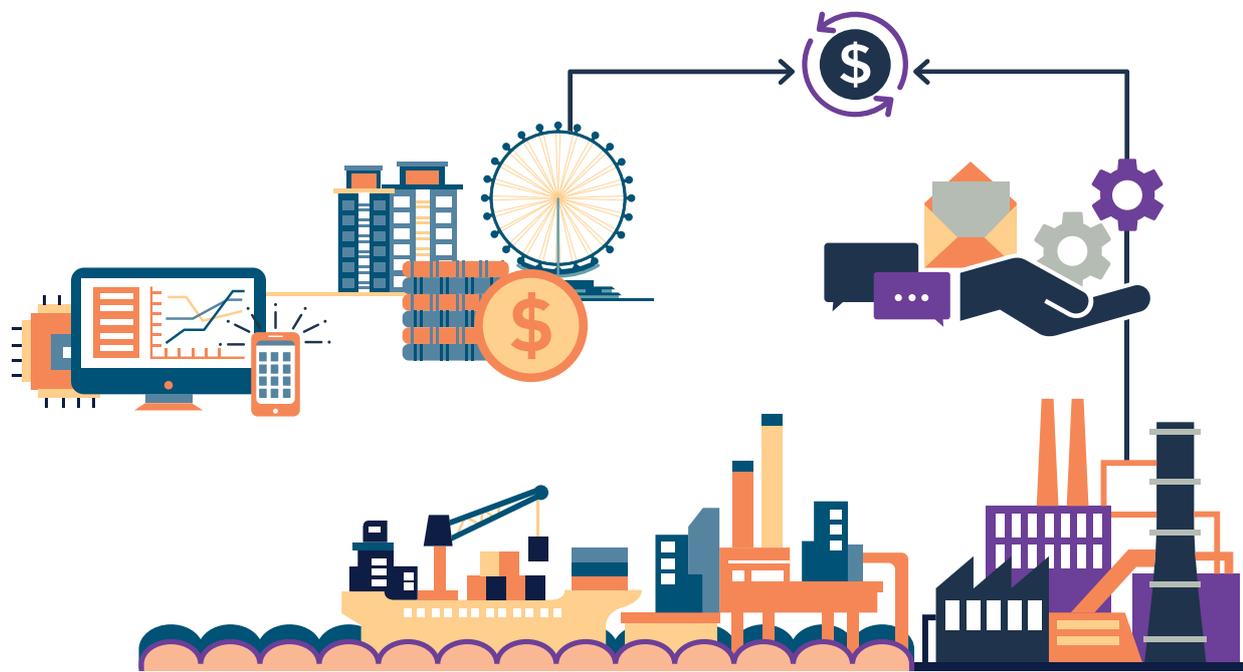
Physical Capital Stock (K_{it})

Total physical capital stock is proxied using the net book value of fixed assets. This is deflated using the net capital stock deflator to obtain real total physical capital stock. The net capital stock deflator is the ratio of net capital stock at current market prices to net capital stock in chained (2015) dollars. Both series are available from DOS.

The physical capital stock (K_{it}) used in the analysis excludes the physical capital stock used for R&D purposes to avoid double counting the R&D physical capital stock.

Labour (L_{it})

Similarly, the labour stock (L_{it}) used in the analysis is total employment less R&D workers to avoid double counting R&D workers (as their remuneration is typically already captured under R&D expenditure).





MINISTRY OF TRADE AND INDUSTRY

100 High Street, #09-01 The Treasury
Singapore 179434

ISSN 2382-6541