

Data Stewardship and Governance in the Singapore Department of Statistics

by Lim Yi Ding, Trusted Centre for Individual and Business Data Division
and Hya Ting Yu, Policy Planning / Prices Division
Singapore Department of Statistics

Introduction

In recent decades, advancements in technology have led to a data explosion and the enlargement of the data ecosystem. Concomitant with the digitalisation of systems and the internet of things, government administrative data, big data and private sector data have grown, giving rise to new types of data and data services. These data and data services can in turn facilitate deeper understanding of the economy and society and enhance decision-making by the public and the government.

National Statistical Offices (NSOs) can seize the opportunity presented by this evolving trend to assume an expanded role in data stewardship and governance for the larger data ecosystem. Currently, NSOs are performing this role to some extent through their coordination of the national statistical system¹, where the key objective is to ensure good coordination between statistical agencies within countries (Fundamental Principles of Official Statistics²).

In the 2023 report³ of the Conference of European Statisticians (CES) Task Force on Data Stewardship, data stewardship is described as the act of ensuring

the ethical and responsible creation, collection, management, use and reuse of data so that they are useful for the public good and benefit the full community of data users; and data governance is defined as a system of decision rights and accountabilities for the management of the availability, usability, integrity and security of the data and information, and the resulting regulations, policies and frameworks that provide enforcement.

In Singapore, the legal framework and initiatives for data use and data sharing were enhanced in recent years under the direction of the Smart Nation and Digital Government Office (SNDGO), via the enactment of the Public Sector (Governance) Act (PSGA), the release of the Government Data Strategy (GDS) and the introduction of the Government Data Architecture (GDA).

This article elaborates on the Singapore Department of Statistics (DOS)'s evolving role and functions in data stewardship and governance for the Singapore Public Sector. It describes the expansion of DOS's role from undertaking traditional statistical activities to becoming a Capability Centre of Individual and Business Data⁴ (CapCen).

1 The Organisation for Economic Co-operation and Development (OECD). (2002, p.220) The national statistical system (NSS) is the ensemble of units of statistical organisations and units within a country that jointly collect, process and disseminate statistics on behalf of the national government.

2 The United Nations Statistics Division (UNSD). (2014) United Nations Fundamental Principles of Official Statistics.

3 CES. (2023) "Data Stewardship and the Role of National Statistical Offices in the New Data Ecosystem".

4 Not housed under the Centre of Excellence for Infocomm Technology & Smart Systems (ICT&SS).

Landscape for Statistical Production in Singapore

Singapore has adopted a decentralised statistical system since 1973, with DOS headed by the Chief Statistician, performing the role of Singapore's NSO.

Statistics are collected and compiled by DOS alongside Research and Statistics Units (RSUs) in the Government. DOS and RSUs in some Ministries and Statutory Boards are gazetted under the Statistics Act 1973 to collect data under their subject matter purview for statistical purposes, ensuring they are fit for purpose. Non-gazetted RSUs in other Ministries and Statutory Boards may collect data under administrative regulations or Acts of their parent organisations.

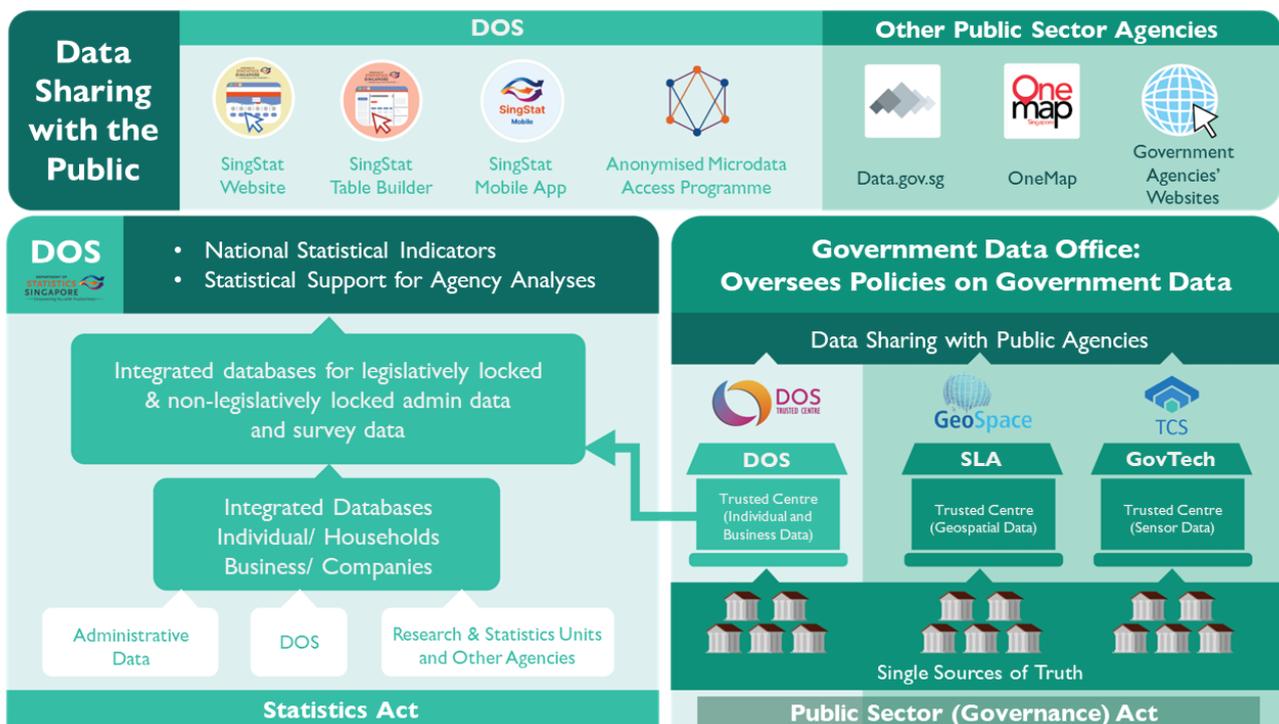
DOS, as the National Statistical Coordinator, works closely with RSUs and administrative data producers to minimise duplication of statistical activities and surveys, reduce respondent burden and improve data quality. Regular meetings with RSUs are held to discuss statistical coordination matters and promote an environment of learning and cross-sharing of best practices on statistical activities across the data value chain.

Trusted Centre for Individual and Business Data at DOS

In 2019, DOS was designated by SNDGO as the Trusted Centre for Individual and Business Data (DOS TC) to support the implementation of Singapore's GDS. DOS TC shares individual and business data within the government on a need basis under the PSGA, to facilitate the use of data for policy analysis and service delivery. This appointment is testimony to DOS's forte in working with data on individuals and businesses, including DOS's domain knowledge and competence in data management, integration, quality, security and confidentiality.

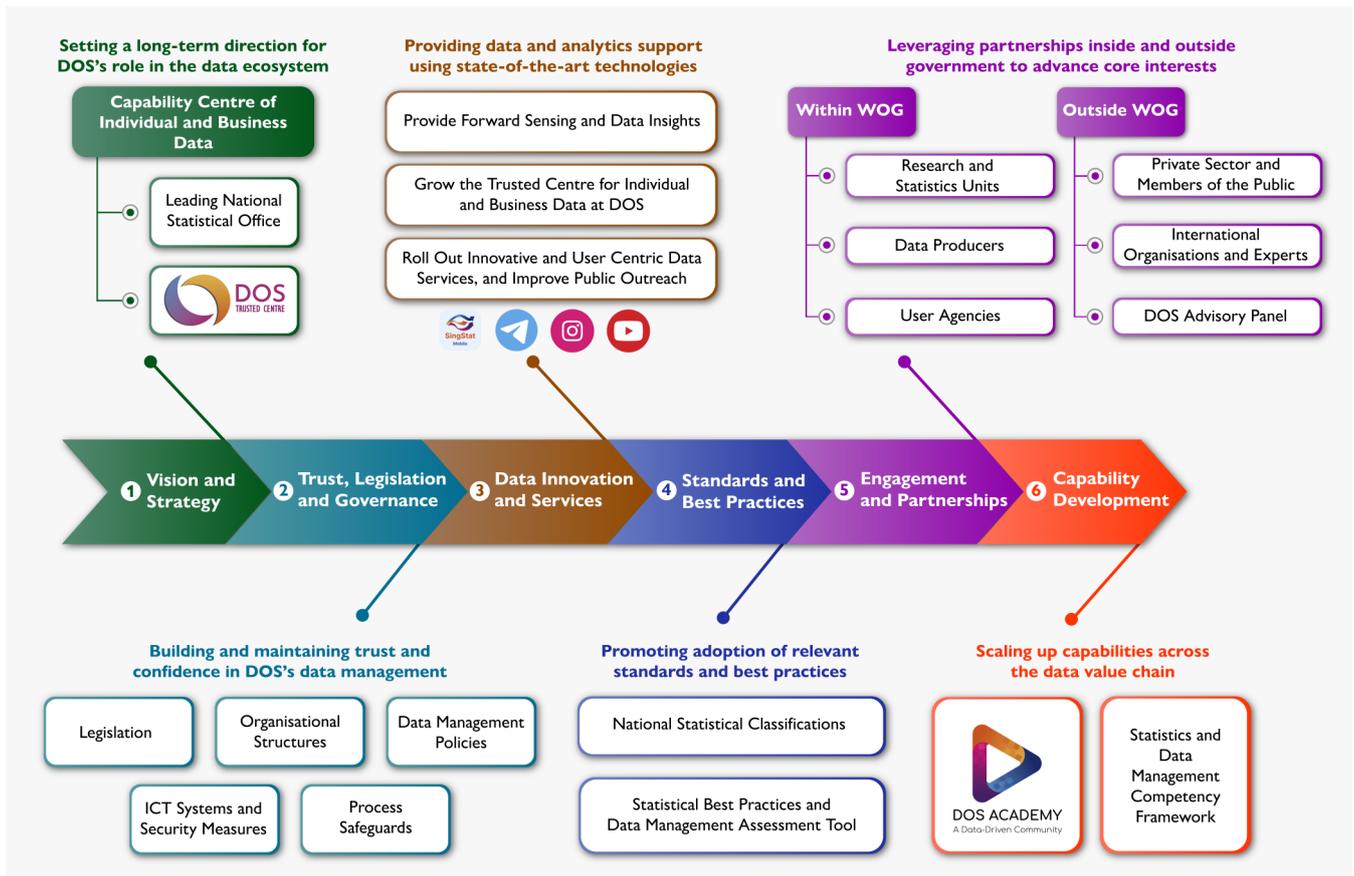
DOS TC's role has significant synergy with DOS being the NSO, resulting in DOS being the first stop for users to obtain data and data services⁵. Two other Trusted Centres for geospatial data and for sensor data were established in the Singapore Land Authority (SLA) and Government Technology Agency of Singapore (GovTech), respectively. Figure 1 illustrates the expanded data landscape in Singapore, encompassing the National Statistical System, and the broader data ecosystem, including integrated national databases under the Trusted Centres.

FIGURE 1 EXPANDED DATA LANDSCAPE IN SINGAPORE



⁵ Data services including data fusion, anonymisation, sampling, analytics, standards and data lab services etc.

FIGURE 2 DOS'S APPROACH TO DATA STEWARDSHIP AND GOVERNANCE



Data Stewardship and Governance in DOS

As the National Statistical Coordinator, DOS has been engaged in data stewardship and data governance with respect to the role of producing quality statistics, developing of national statistical standards and coordinating of statistical activities.

As DOS develops from the traditional role of a NSO to a CapCen, DOS's expanded role in data stewardship for the public service ensures the strategic use of data and information in making data-driven decisions and providing services for the public.

DOS took reference from the 2022 report on data stewardship by the CES Task Force and mapped the best practices against DOS's CapCen strategies to form a list of data stewardship functions that apply in DOS's context today (Figure 2).

Each component of the framework will be elaborated in the subsequent sections.

Vision and Strategy - Setting a Long-Term Direction for DOS's Role in the Data Ecosystem

As the NSO, DOS's vision is to develop and maintain a national statistical service of quality, integrity, and expertise.

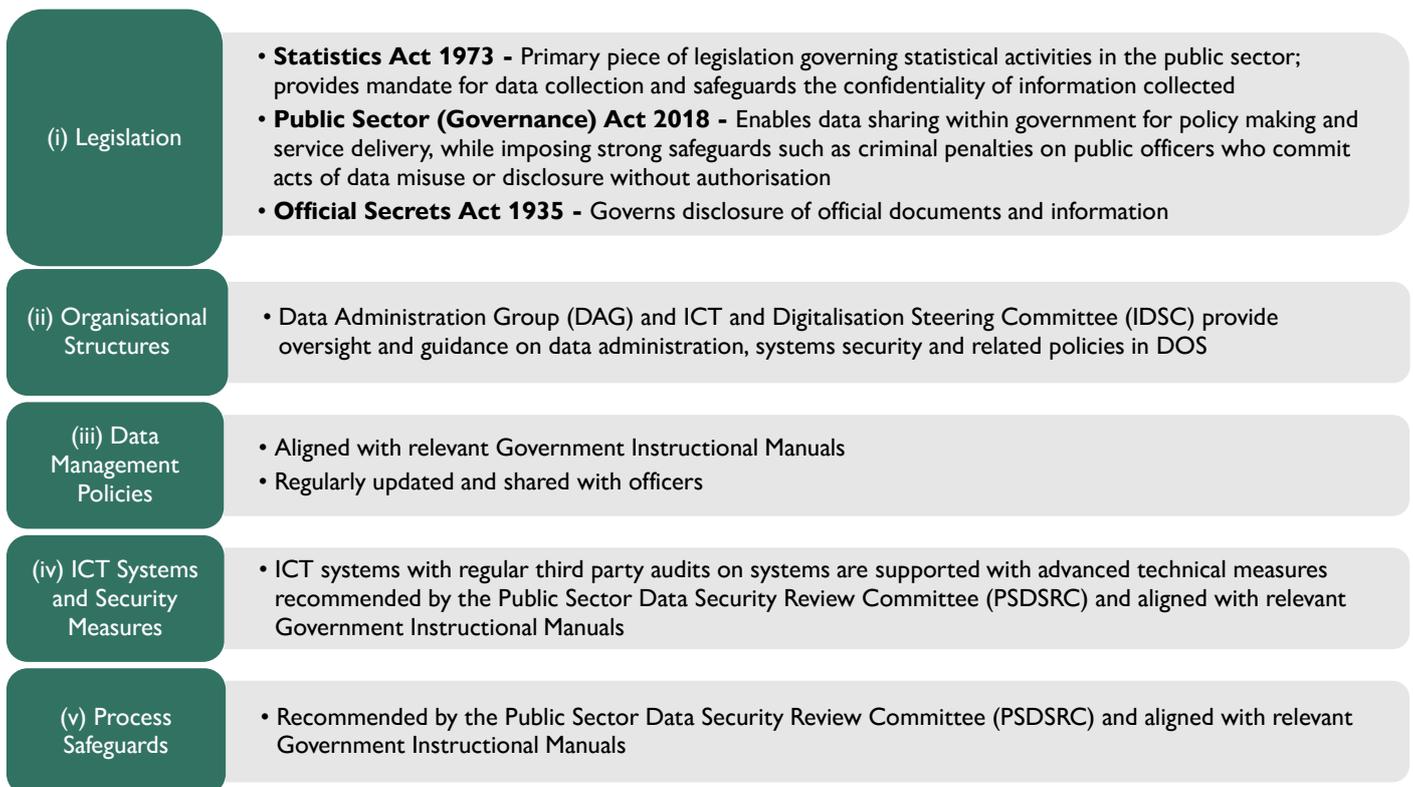
DOS's mission is to deliver insightful statistics and trusted services that empower decision making. Following DOS's appointment as a Trusted Centre, DOS embarked on the next bound of transformation as the CapCen (Figure 3) to:

- (i) stay relevant in the constantly changing economic and social landscape;
- (ii) keep up with ever-increasing data flows and new technologies; and
- (iii) unlock value and empower data-driven insights in support of evidence-based policy formulation and seamless service delivery to benefit residents and businesses in Singapore.

FIGURE 3 DOS AS CAPABILITY CENTRE OF INDIVIDUAL AND BUSINESS DATA (CAPCEN)

- (i) **Leading National Statistical Office:**
DOS compiles and disseminates national statistical indicators, provides statistical analyses with integrated data from diverse sources including administrative and survey data, develops national statistical standards and classifications, and coordinates and advises on statistical matters
- (ii) **Trusted Centre for Individual and Business Data at DOS:**
DOS enables Whole-of-Government (WOG) data sharing for policy analysis and planning, as well as agency operations and service delivery purposes

FIGURE 4 DOS'S DATA GOVERNANCE FRAMEWORK



Trust, Legislation and Governance - Building and Maintaining Trust and Confidence in DOS's Data Management

Maintaining high levels of public trust and confidence in DOS is critical to ensure continued public support for data sharing and uninterrupted flow of data from the public. DOS adopts a data governance framework with five main pillars, to protect and preserve the trust in DOS's management of data (Figure 4).

Data Innovation and Services - Providing Data and Analytics Support Using State-of-the-Art Technologies

DOS furnishes a wide range of economic and social data as well as data services to provide insights for

analyses and decision making by diverse user groups. DOS provides support to public sector agencies in in-depth policy evaluation by leveraging DOS's Integrated Databases viz. Business, Individual and Household Databases which are integrated with longitudinal data from administrative, survey and big data sources. To facilitate effective use of the integrated databases, DOS provides a comprehensive suite of statistical and research services e.g., shaping problem statements, providing advice on data selection, modelling, and interpretation and reporting of findings.

DOS TC ingests and processes a wide range of non-legislatively locked administrative core data on individuals and businesses from data custodians. With this integrated national database, the core data are distributed to the public agencies securely, on a need

basis under the PSGA, for them to carry out their analyses and service delivery.

As DOS's main public fronting communication and dissemination platform, the [SingStat Website](#) provides general users with a wide range of open data, statistical information and resources. DOS's e-Service – the [SingStat Table Builder](#) – facilitates access to over 2,200 data tables from 70 public sector agencies across economic and socio-demographic domains. More detailed data were made available on the SingStat Table Builder over the years. Likewise, more infographics, interactive dashboards and videos were released on the SingStat Website for the public to understand data and explore data trends. Curated content are placed in the Students' Corner on the SingStat Website and DOS engages academic institutions to raise students' awareness of DOS's data and data services through various publicity platforms.

To cater to a population with high usage of smartphones and social media, DOS developed the [SingStat Mobile App](#) and has presence on **social media channels** viz. Telegram, Instagram, YouTube and LinkedIn. The SingStat Mobile App provides users with fast, free and easy access to the latest key statistics while on-the-go and offers charting functions to visualise the data. The social media channels facilitate outreach in different ways to the social media generation.

In support of businesses, DOS developed the [Data for Businesses](#) webpage that provides a business performance benchmarking tool for firms to evaluate their business performance, as well as dashboards which provide firms with curated and contextualised data to address questions on their customers and industry. During the development of these business tools, DOS engaged the relevant public sector agencies and private sector users to obtain feedback on product features and content before the final launch.

DOS made available access to selected anonymised microdata through DOS's [Anonymised Microdata Access Programme](#) (AMAP), which enables researchers commissioned by government agencies and academic researchers from local Autonomous Universities to conduct deep-dive studies in approved data exploitation environments such as the **DOS Data Lab**. Many researchers have conducted studies on various economic, social and manpower topics using the anonymised microdata from DOS.

DOS TC supports [TRUST](#), a national platform that enables anonymised health-related research and real-world data to be brought together, accessed and used in an expeditious and secure manner. The platform supports health data analytics and innovation between public institutions, and between the public and private sectors to improve health outcomes.

Standards and Best Practices - Promoting Adoption of Relevant Standards and Best Practices

As the National Statistical Coordinator, DOS coordinates statistical activities across public sector agencies, develops the national statistical classifications (e.g., Singapore Standard Industrial Classification, Singapore Standard Occupational Classification), standards and statistical best practices, and promotes their adoption by public agencies.

The [Statistical Best Practices](#) (SBP) handbook guides public agencies in conducting surveys and utilising data from administrative sources. It serves as a useful resource for private sector organisations seeking to improve data quality. In addition, a Data Management Assessment Tool (DataMAT) is available for public agencies to assess the strengths and weaknesses of their statistical processes against the best practices in the SBP handbook.

Engagement and Partnerships - Leveraging Partnerships Inside and Outside Government to Advance Core Interests

DOS extensively engages data users in the Singapore Public Sector, RSUs and data producers in the administrative data source agencies, through WOG platforms and on a bilateral basis, to coordinate, synergise and prioritise cross-cutting data requirements, with the aim of reducing respondent burden.

Outside of the Singapore government, DOS establishes public-private partnerships by collaborating with private sector companies to advance common interests in data-related topics, such as the application of artificial intelligence, machine learning and privacy preservation, through bilateral sharing sessions and talent attachment programmes.

The DOS Advisory Panel (DAP) comprising local and international experts in the fields of statistics, data science and technology, was established in 2021 to guide DOS's strategic direction amidst the changing data and technology landscape.

DOS takes on leadership roles in both regional and international fora to be at the forefront of data developments e.g., Co-lead for the End Term Review of the ASEAN Community Statistical System Strategic Plan 2021-2025; Member and Rapporteur of the Bureau of the UN Economic and Social Commission for Asia and the Pacific Committee on Statistics; and Member of the High-level Group for Partnership, Coordination and Capacity-Building for Statistics for the 2030 Agenda for Sustainable Development 2023-2025.

Capability Development - Scaling Up Capabilities Across the Data Value Chain

As the CapCen, DOS aims to deepen data capabilities within DOS and across the Public Service. To this end, DOS is engaged in the following:

- i. Develop and implement a comprehensive Statistics and Data Management Competency Framework; elaborating on the essential areas of

skills and knowledge expected of data users and officers involved in statistical work to guide their development; and

- ii. Establish the DOS Academy as a platform for promoting statistical best practices and facilitating learning and development of statistical skills and data competencies.

Conclusion

The evolving data ecosystem presents DOS with opportunities for new strategies and capabilities, through expanding the role of DOS in data stewardship and governance for the public sector. This enables the government to better harness data to adopt data-driven approaches to improve policies to provide targeted and effective services and support to the public. Curated statistics are available via a broad range of touchpoints for personal use and business decision-making.

By engaging with our stakeholders, DOS ensures that we keep up-to-date with the latest needs and technological developments. DOS will continually work towards bolstering relevant data stewardship and governance frameworks and practices with partners in the government, private sector and international statistical community.

REFERENCES

- Organisation for Economic Co-operation and Development (OECD). (2002). Measuring the Non-Observed Economy: A Handbook. Available at: <https://www.oecd.org/sdd/na/1963116.pdf>
- Official Secrets Act 1935 (2020 Rev Ed). Available at: <https://sso.agc.gov.sg/act/osa1935>
- Public Sector Data Security Review Committee. (2019). Public Sector Data Security Review Committee Report. Available at: <https://www.smartnation.gov.sg/files/publications/psdsrc-main-report-Nov2019.pdf>
- Public Sector (Governance) Act 2018 (2020 Rev Ed). Available at: <https://sso.agc.gov.sg/Act/PSGA2018>
- Statistics Act 1973 (2020 Rev Ed). Available at: <https://sso.agc.gov.sg/act/sa1973>
- The Conference of European Statisticians (CES). (2023). Data Stewardship and the Role of National Statistical Offices in the New Data Ecosystem. Available at: https://unece.org/sites/default/files/2023-04/CES_02_Data_stewardship_for_consultation.pdf
- The Conference of European Statisticians (CES). (2022). Report of the Task Force on Data Stewardship. Available at: https://unece.org/sites/default/files/2022-06/Data_Stewardship_ver_1_020622%20-%20for%20consultation.pdf
- The United Nations Statistics Division (UNSD). (2014). Fundamental Principles of Official Statistics. Available at: <https://unstats.un.org/unsd/dnss/gp/FP-New-E.pdf>
- World Bank. (2021). World Development Report 2021: Data for Better Lives. Available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/35218/9781464816000.pdf>

Singapore’s Growth Cycle Chronology, Coincident and Leading Indicators

by Leow Geng Hui
Economic Accounts Division
Singapore Department of Statistics

Introduction

First developed after the economic recession in 1985, Singapore's composite leading and coincident indices are reviewed periodically¹ to ensure that they remain adequate and relevant in identifying and anticipating Singapore’s growth cycles.

The Singapore Department of Statistics has completed a comprehensive review of the composite leading and coincident indices, following the economic recovery from the COVID-19 pandemic.

Identification of Business Cycles

In the business cycle literature, there are three types of cycles, namely: the classical cycle, growth cycle and growth rate cycle (Table 1)². Singapore’s economic activity is characterised by growth cycles, rather than classical cycles or growth rate cycles as it has generally been on an upward trend with relatively stable growths.

TABLE 1
TYPES OF BUSINESS CYCLES

Classical Cycle	Growth Cycle	Growth Rate Cycle
Characterised by		
absolute expansions and contractions in the levels of aggregate economic activity	deviations from the long-term trend growth rate of the economy	fluctuations in the growth rate of aggregate economic activity

Singapore’s Composite Coincident Index and Growth Cycle Chronology

Singapore’s growth cycle chronology is determined from the growth cycles identified using the composite coincident index (CCI). The CCI is an aggregate of five macroeconomic indicators that move in tandem with business cycles, thus tracking the prevailing state of aggregate economic activity (Table 2).

With a more complete coverage of the different economic processes, the CCI is generally regarded as a better representation of Singapore’s overall economic activity as compared to any single macroeconomic indicator such as real gross domestic product (GDP).

The latest review in 2023 concluded that the existing set of composite coincident indicators remains a reliable representation of Singapore’s overall economic activity.

TABLE 2
SINGAPORE COMPOSITE COINCIDENT INDICATORS

Composite Coincident Indicators
Gross Domestic Product in Chained Dollars
Index of Industrial Production
Non-Oil Domestic Exports at Constant Prices
Total Employment
Retail Sales Index Excluding Motor Vehicles in Chained Volume Terms

1 Comprehensive reviews were conducted in 1991, 2004, 2011 and 2023.

2 Details on the different types of business cycles can be found in the feature article ‘Singapore’s Growth Cycle Chronology and Performance of Composite Leading Indicators’ published in the ‘Economic Survey of Singapore 2011’: https://www.singstat.gov.sg/-/media/files/publications/economy/leading_indicators.

Table 3 presents Singapore's growth cycle chronology from 1974 to 2022. Since its recovery from the Global Financial Crisis (GFC) in 2009, the Singapore economy has experienced three growth cycles (Chart 1).

Following the short-lived seven-month recovery from the GFC, Singapore entered its longest period of

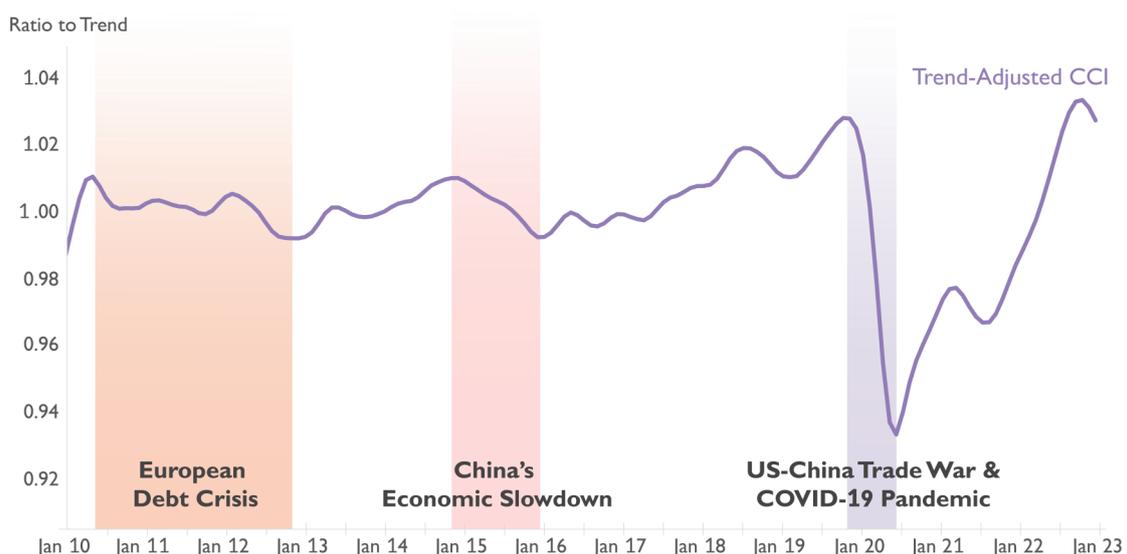
economic slowdown of 29 months since 1974. The slowdown was attributed to spill-over effects from the European debt crisis to the Asia-Pacific region, which eventually bottomed out in late 2012, after the announcement from European Central Bank on its unlimited support and bailout for affected eurozone member states.

TABLE 3 SINGAPORE'S GROWTH CYCLE CHRONOLOGY, 1974 - 2022

Dates of Peak and Trough			Average Duration in Months			
Peak (P)	Trough (T)	Peak (P)	Low-growth (P to T)	High-growth (T to P)	Full Cycle (P to P)	Full Cycle (T to T)
May 1974	Dec 1974	Feb 1976	7	14	21	38
Feb 1976	Feb 1978	May 1981	24	39	63	58
May 1981	Dec 1982	Aug 1984	19	20	39	36
Aug 1984	Dec 1985	Jun 1988	16	30	46	46
Jun 1988	Oct 1989	Aug 1990	16	10	26	36
Aug 1990	Oct 1992	Sep 1994	26	23	49	30
Sep 1994	Apr 1995	Jul 1997	7	27	34	43
Jul 1997	Nov 1998	Aug 2000	16	21	37	35
Aug 2000	Oct 2001	Apr 2002	14	6	20	20
Apr 2002	Jun 2003	May 2004	14	11	25	21
May 2004	Mar 2005	Mar 2008	10	36	46	55
Mar 2008	Oct 2009	May 2010	19	7	26	36
May 2010	Oct 2012	Nov 2014	29	25	54	38
Nov 2014	Dec 2015 ^P	Oct 2019 ^P	13	46	59	54
Oct 2019 ^P	Jun 2020 ^P	-	8	-	-	-

^P: Recent peaks/troughs are preliminary as the trend estimates may be revised when more data become available.

CHART 1 SINGAPORE'S GROWTH CYCLES, 2010 - 2022



Subsequently, China’s economic slowdown in 2014 spilled over to export-dependent Asian economies such as Singapore, Malaysia and Indonesia. Consequently, Singapore’s CCI peaked in Nov 2014 before bottoming out in early 2016, amidst an improvement in the global macroeconomic environment. Notably, Singapore registered an impressive economic expansion lasting 46 months, from Dec 2015 to Oct 2019.

The most recent cycle was registered in Oct 2019, when Singapore experienced its most severe economic recession due to a confluence of factors (including the US-China trade war and the COVID-19 pandemic) which affected demand and global supply chains. Fortunately, the acute fall in overall economic activity lasted only 8 months. By Jun 2020, Singapore’s economy embarked on its recovery phase.

Growth Cycle Recessions versus Technical Recessions

Growth cycle recessions are defined as the periods of economic downturns registered during every peak-trough phase identified by the growth cycle.

This is distinct from technical recessions which are defined as two consecutive periods of quarter-on-quarter (q-o-q) declines of the seasonally adjusted (SA) real GDP.

For example, while Singapore experienced three growth cycle recessions since 2010, the Singapore economy only slipped into a technical recession in the second quarter of 2020, following two consecutive quarters of decline in the SA real GDP (Chart 2).

CHART 2 SINGAPORE’S GROWTH CYCLES WITH SEASONALLY ADJUSTED QUARTER-ON-QUARTER REAL GDP, 2010 - 2022

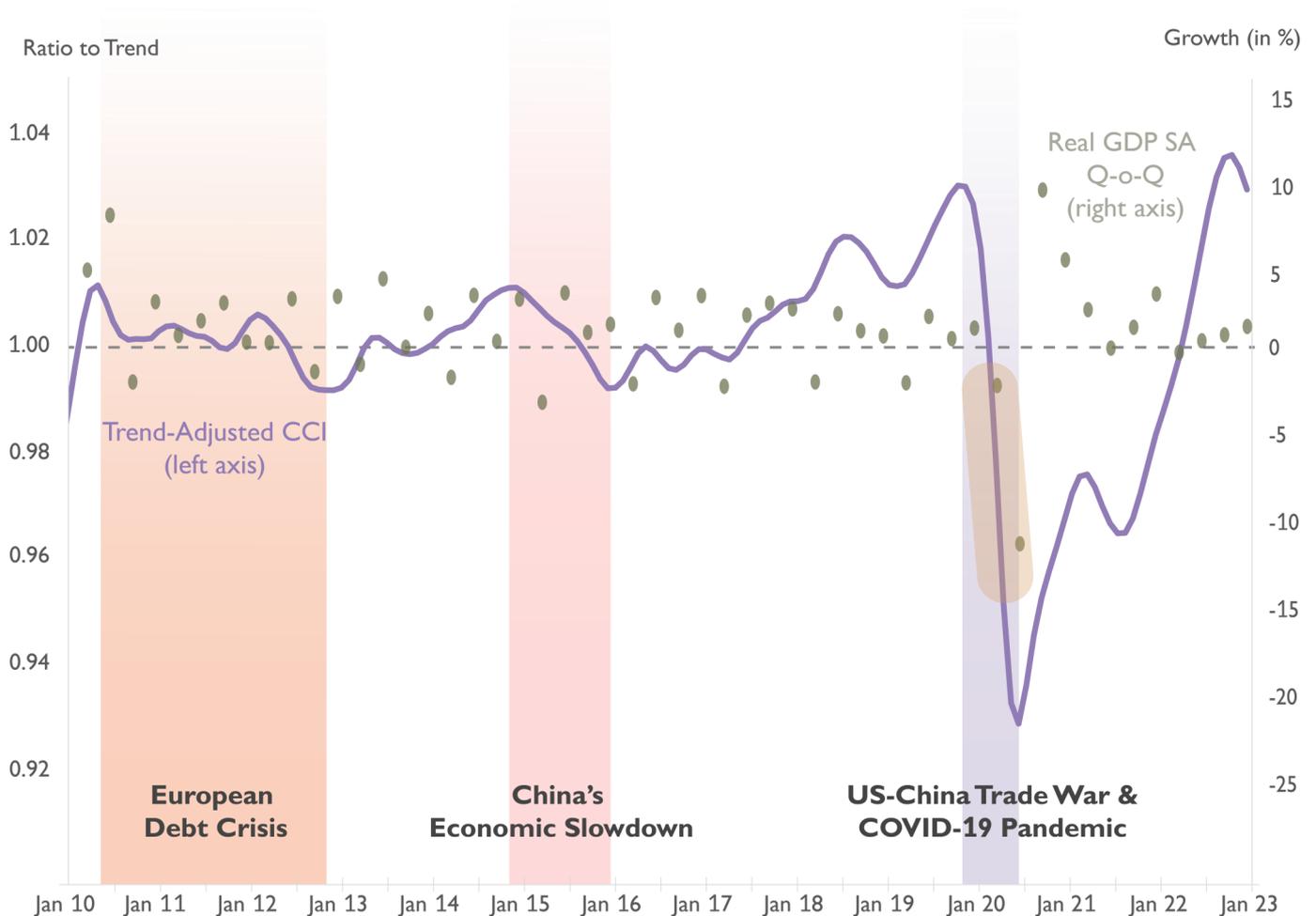


TABLE 4
SINGAPORE COMPOSITE LEADING INDICATORS

Composite Leading Indicators
Total New Companies Formed
Money Supply (M2)
Stock Exchange of Singapore Indices
Business Expectations for Stock of Finished Goods (Manufacturing)
Business Expectations for Wholesale Trade
US Purchasing Managers' Index (Manufacturing)
Total Non-Oil Seaborne Cargo Handled
Domestic Liquidity Indicator
Total Non-Oil Retained Imports at Constant Prices

TABLE 5
LEADS AND LAGS OF THE CLI OVER THE CCI,
2010 - 2022

Growth Cycle	CCI Turning Points	CLI Turning Points	Lead[+]/Lag[-] (Months)
Peak	May 2010	Feb 2010	+ 3
Trough	Oct 2012	Sep 2011	+ 13
Peak	Nov 2014	Apr 2014	+ 7
Trough	Dec 2015	Dec 2015	0
Peak*	Oct 2019	-	-
Trough	Jun 2020	Apr 2020	+ 2
Average (2010-2022)			+ 5

* The CLI was unable to anticipate the growth cycle peak in Oct 2019.

Singapore's Composite Leading Index

The composite leading index (CLI) is a predictive tool to gauge if, and approximately when, an economic expansion or recession will take place. It serves as a useful forewarning tool for economists and policymakers on the overall health of the economy.

CLIs have been compiled by many countries, e.g., Netherlands, Japan, Korea and Malaysia, and international organisations such as The Conference Board and the Organisation for Economic Co-operation and Development (OECD), with a view to anticipate upturns and downturns in the economy.

Singapore's CLI comprises nine economic indicators that exhibit leading relationships with the growth cycles of the economy (Table 4). These leading indicators have been selected based on a set of key criteria including economic significance, cyclical properties, timeliness, periodicity and statistical quality of the data series.

The latest review in 2023 suggests that the existing set of composite leading indicators remains relevant in identifying and anticipating Singapore's growth cycles. In the previous comprehensive review conducted in 2011, Singapore's CLI had an average lead of

4.8 months over the CCI for the period of 2003 to 2010. Based on the latest review, Singapore's CLI maintained its lead over CCI, with an average lead of 5.0 months for the period of 2010 to 2022 (Table 5).

For example, the CLI peaked 3 months before the economic slowdown in May 2010 and bottomed out 13 months before the subsequent recovery.

Conclusion

The latest comprehensive review in 2023 indicates that the existing CCI remains an adequate and reliable representation of Singapore's prevailing aggregate economic activity.

Findings from the review also suggest the continuing relevance of the existing CLI in identifying and anticipating Singapore's growth cycles. The results further show that the leading properties of the CLI has improved marginally for the period of 2010 to 2022, compared with 2003 to 2010.

More information and latest data on CLI are available from the information paper '[Singapore's Growth Cycle Chronology, Coincident and Leading Indicators](#)' and on the [SingStat Table Builder](#).

Experimental Estimates on Singapore’s Balance of Payments Services Trade by Modes of Supply

by Leon Tay and Soh Sing Pei
International Accounts Division
Singapore Department of Statistics

Introduction

Under the World Trade Organisation’s (WTO) General Agreement on Trade in Services¹ (GATS), trade in services is defined to cover four different modes of supply based on the locations of the supplier and consumer when a service is supplied. Conventional trade in services statistics present trade flows between countries by type of services.

Information on trade in services by modes of supply offers an extended dimension on how services are supplied to overseas customers, which are useful in policymaking and trade negotiations. For example, in Singapore, trade in services by modes of supply estimates were used to analyse the impact of the

COVID-19 pandemic² on international travel due to global lockdowns and travel restrictions, to support policy work on facilitating business travel during the pandemic and the eventual reopening of Singapore’s travel borders.

The Singapore Department of Statistics (DOS) has compiled experimental estimates on Singapore’s services trade via cross-border supply (mode 1), consumption abroad (mode 2) and presence of natural persons (mode 4). This article provides an overview of the compilation methodology and key findings for the different modes of supply under the Services Account of Singapore’s Balance of Payments (BOP)³, for the period of 2016 to 2021.

WHAT ARE THE FOUR MODES OF SUPPLY?

Modes of Supply under the GATS	Examples	
	Exports	Imports
Mode 1: Cross-border supply  <p>A service is delivered across borders, with both the supplier and consumer being in their respective territories.</p>	A law firm in Singapore delivers legal advice to an overseas client through email.	A law firm located overseas provides legal advice to a client located in Singapore through video call.
Mode 2: Consumption abroad  <p>Consumer travels abroad to consume services outside his or her home territory.</p>	Foreign tourists travelling to Singapore to attend a local concert.	Singaporeans travelling abroad and visiting museums overseas.
Mode 3: Commercial presence  <p>Service supplier establishes an affiliate, branch or representative office in another economy through which services are provided.</p>	A Singapore-based firm sets up an overseas branch abroad to provide consultancy services to residents of the country in which the branch is located in.	An overseas financial firm establishes a branch in Singapore to provide financial advisory services directly to its clients in Singapore.
Mode 4: Presence of natural persons  <p>Individual is temporarily present in an economy other than his or her own to provide a service.</p>	A Singapore-based auditing firm sends its auditor abroad for a month to conduct an audit for a client firm which is located abroad.	A consultant from another country is temporarily stationed in Singapore for a week to provide advisory services to Singapore-based clients.

1 First multilaterally agreed framework on trade in services which came into force in 1995.
 2 The World Health Organisation declared the COVID-19 outbreak a pandemic on 11 March 2020.
 3 The supply of services through mode 3 is delivered by an affiliate company (of a non-resident supplier) to residents in the same economy. These transactions are not within the scope of the Balance of Payments as the affiliate company is treated as a resident in that economy.

Data Sources and Methodology

The primary data source for Singapore's BOP services trade is the International Trade in Services Survey, which covers services transactions between residents and non-residents. Based on the recommendations and guidelines from the Manual on Statistics of International Trade in Services (MSITS) 2010, each services category is attributed to either one dominant mode (or most significant mode when there is no single dominant mode) or multiple modes (Table 1).

For services categories with several modes, a multi-pronged approach was adopted by leveraging administrative and survey data, firm-level analysis and research, as well as international recommendations including the Eurostat-WTO model⁴ to determine the allocation for each mode of supply.

The following sections present the key findings from the experimental estimates, with an analysis of the overall modes of supply trend from 2016 to 2021 and

a study of the services category contribution by each mode of supply in recent years.

Overall Modes of Supply Trend from 2016 to 2021

From 2016 to 2021, cross-border supply (mode 1) was the predominant mode of supply for both services exports and imports. Services exports and imports via mode 1 continued to increase between 2016 to 2021, registering strong year-on-year growth rates of 25 per cent and 16 per cent respectively in 2021 (Charts 1A and 1B).

In contrast, the consumption abroad (mode 2) and presence of natural persons (mode 4) supply of services recorded declines since the start of the COVID-19 pandemic and remained below the pre-pandemic 2019 level, although the exports and imports by mode 4 recovered slightly in 2021 relative to 2020 with gradual resumption in business travel.

TABLE 1 TRADE IN SERVICES WITH MODES OF SUPPLY ALLOCATION

Balance of Payments Services Category Classification ⁵	Modes of Supply Allocation
Manufacturing Services on Physical Inputs Owned by Others	2
Maintenance & Repair	2 & 4
Transport	1 & 2
Travel	2
Insurance	1
Government Goods & Services	1, 2 & 4
Construction	4
Financial	1
Telecommunications, Computer & Information	1 & 4
Charges for the Use of Intellectual Property	1 & 4
Personal, Cultural & Recreational	1 & 4
Other Business Services	1, 2 & 4

CHART 1A TOTAL SERVICES EXPORTS BY MODES 1, 2 AND 4 (\$\$BIL)



CHART 1B TOTAL SERVICES IMPORTS BY MODES 1, 2 AND 4 (\$\$BIL)



4 The Eurostat-WTO model builds on the simplified approach and the allocation of EBOPS (Extended Balance of Payments Services Classification) item is assigned to the modes based on MSITS 2010 suggestions and experts' assessment on how specific services items are most likely to be supplied to consumers. More information is available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Services_trade_statistics_by_modes_of_supply#Applied_methodology.

5 A detailed description of each services category is available at https://www.singstat.gov.sg/-/media/files/find_data/trade-and-investment/notesintrade

The contribution of mode 1 to the total services exports and imports increased from 74 per cent in 2019 to 86 per cent in 2021 and 64 per cent in 2019 to 78 per cent in 2021 respectively, as businesses were more likely to rely on the remote provision of services (Charts 2A and 2B). At the same time, the contributions of mode 2 and mode 4 fell since 2020 due to disruptions to supply chains and the halting of international travel, following global lockdowns and travel restrictions due to COVID-19.

The extent of the adverse impact arising from global travel restrictions and lockdowns during the COVID-19 pandemic on each services category was dependent on how they were mainly delivered. Services categories

that were primarily delivered through mode 1 recorded positive compound annual growth rates (CAGRs) between 2019 and 2021.

For example, services in the Telecommunications, Computer & Information, Transport, Advertising & Market Research, Business Management and Financial categories registered positive CAGRs during this period (Charts 3A and 3B). Conversely, services categories that were predominantly delivered via mode 2, such as Travel and Maintenance & Repair services were negatively impacted. The exports and imports of these services remained below their pre-pandemic 2019 levels as both suppliers and consumers were required to be physically present in the same location.

CHART 2A SHARE OF SERVICES EXPORTS BY MODES 1, 2 AND 4 (%)

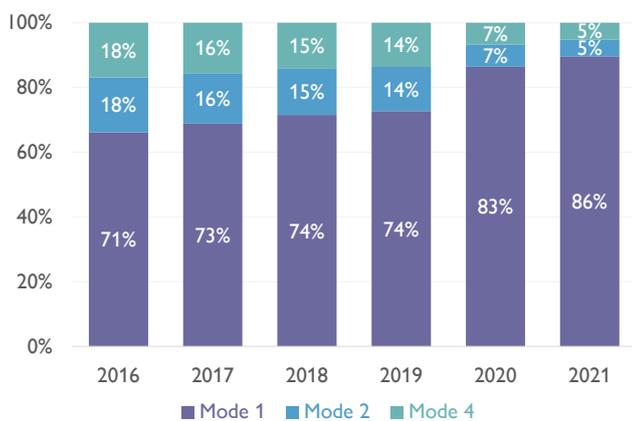


CHART 2B SHARE OF SERVICES IMPORTS BY MODES 1, 2 AND 4 (%)

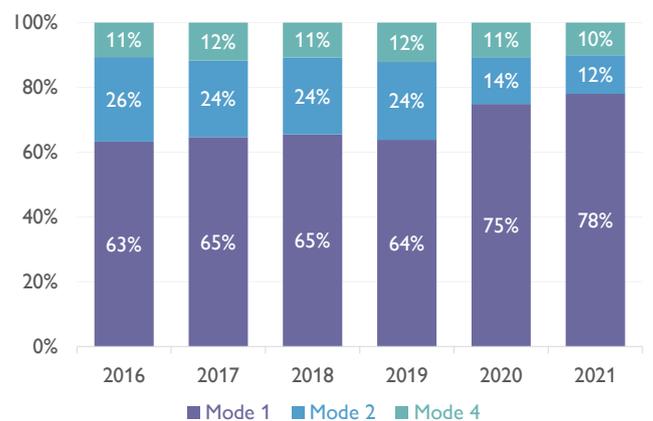


CHART 3A CAGR OF SERVICES EXPORTS FOR SELECTED SERVICES CATEGORIES, 2019 - 2021

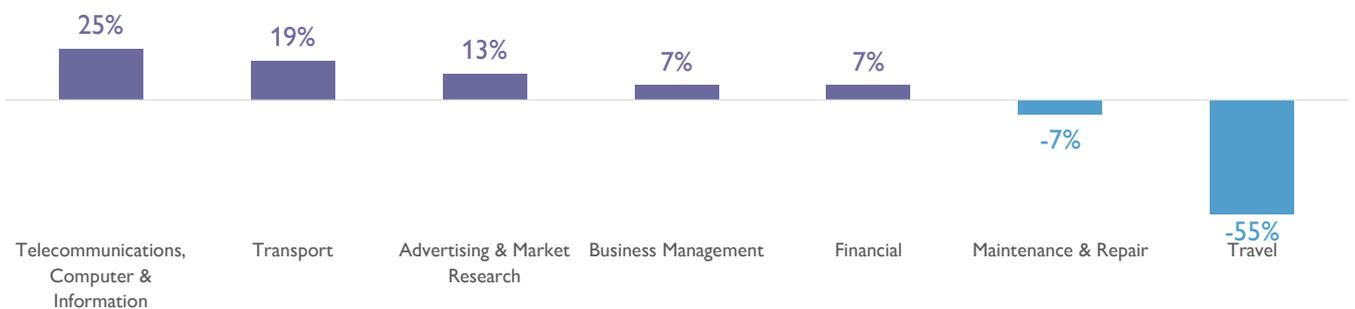
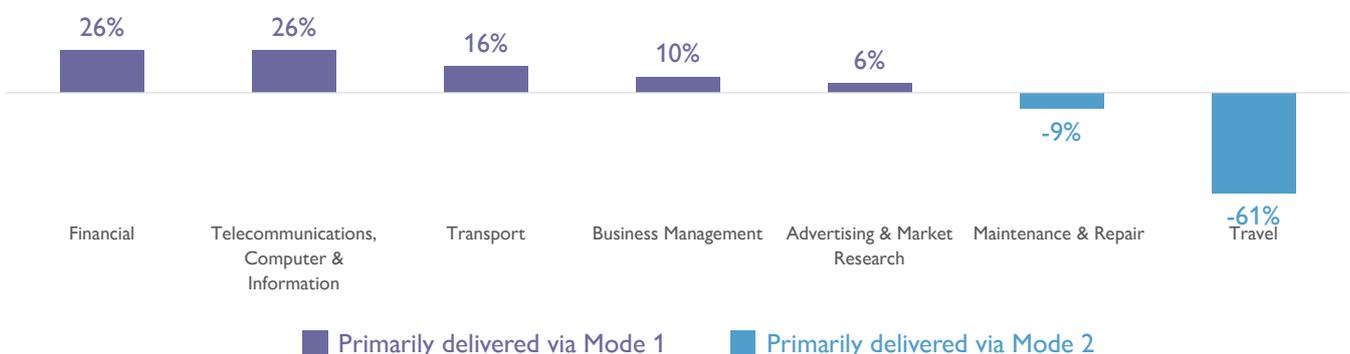


CHART 3B CAGR OF SERVICES IMPORTS FOR SELECTED SERVICES CATEGORIES, 2019 - 2021



Key Services Categories by Mode of Supply

Mode 1 - Cross Border Supply

Transport services was the largest contributor of services exports via mode 1, accounting for 39 per cent of mode 1 exports in 2021 (Chart 4A). Exports of Transport services include freight and postal & courier services, which are delivered from a supplier in Singapore to consumers located overseas. Financial services and Advertising & Market Research services were the other key contributors to mode 1 exports, contributing 17 per cent and 12 per cent respectively. The nature of these services allows them to be provided digitally.

CHART 4A MODE 1 SERVICES EXPORTS BY SERVICES CATEGORY, 2021

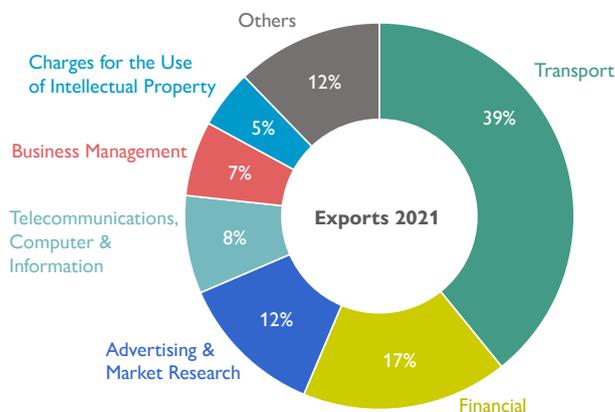
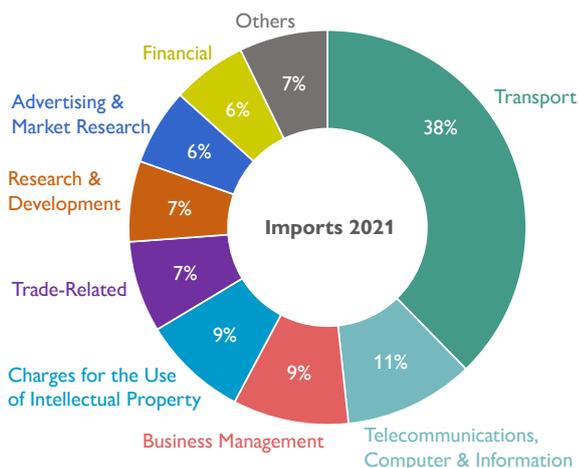


CHART 4B MODE 1 SERVICES IMPORTS BY SERVICES CATEGORY, 2021



Note: For Charts 4A and 4B, services categories with less than 5 per cent of contribution to mode 1 exports and imports are subsumed under 'Others'.

Similarly for imports, Transport services was the top services category supplied via mode 1 in 2021, followed by the Telecommunications, Computer & Information services and Business Management services (Chart 4B). These services categories jointly accounted for 58 per cent of mode 1 imports. Imports of Telecommunications, Computer & Information services under mode 1 include cloud computing and internet backbone services which are delivered via remote means, while business management services include the virtual provision of business consultancy and advisory services.

Mode 2 - Consumption Abroad

Mode 2 requires consumers to travel abroad to acquire services outside their home territory. Prior to the COVID-19 pandemic, Travel services was the largest contributor for mode 2 supply of services in 2019 (Charts 5A and 5B). The supply of Travel services via mode 2 includes the purchase of accommodation, meals abroad, souvenirs, visits to museums and theme parks, medical treatment and education received outside of the home territory.

With global lockdowns and travel restrictions put in place during the pandemic, travel services declined considerably and services categories such as Maintenance & Repair services and Transport services became key contributors to mode 2 services exports and imports respectively in 2021 (Charts 5A and 5B). Examples of Maintenance & Repair services exports via mode 2 include repair works performed in Singapore on ships and aircraft operated by overseas firms that are temporarily stationed in Singapore, while the imports of Transport services via mode 2 constitutes port-related services provided to Singapore-based carriers in overseas ports such as cargo handling, warehousing and logistic services. Similarly, the imports of Manufacturing services, which include the service payments on products sent abroad for processing or assembly, recorded an increase in its contribution of mode 2 services imports in 2021.

Mode 4 - Presence of Natural Persons

Mode 4 occurs when an individual is temporarily present in an economy other than his or her own to provide a service. In 2021, more than half of the services exported via mode 4 were attributed to Advertising & Market Research and Business Management services (Chart 6A). Examples of services

CHART 5A MODE 2 SERVICES EXPORTS BY SERVICES CATEGORY, 2021

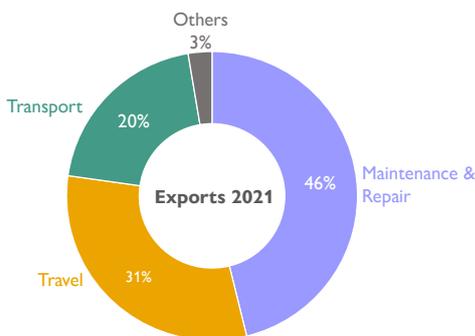
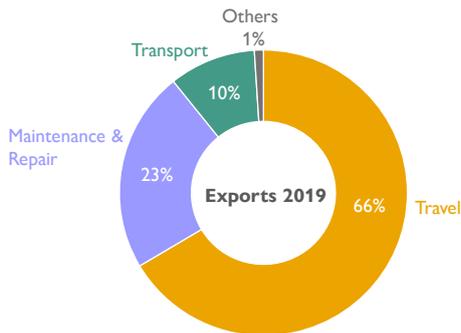
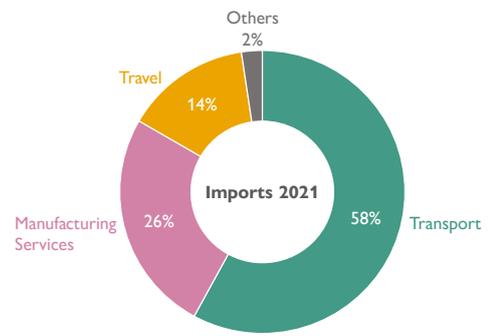
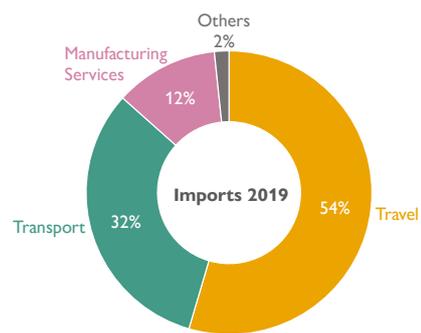


CHART 5B MODE 2 SERVICES IMPORTS BY SERVICES CATEGORY, 2021



Note: For Charts 5A and 5B, services categories with less than 5 per cent of contribution to mode 2 exports and imports are subsumed under 'Others'.

CHART 6A MODE 4 SERVICES EXPORTS BY SERVICES CATEGORY, 2021

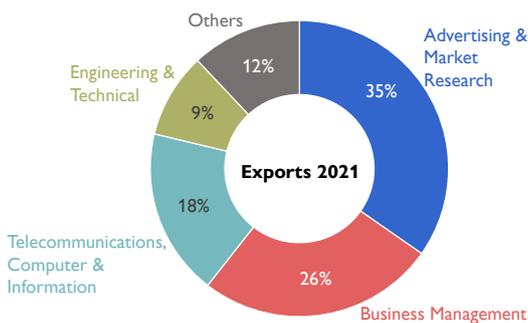
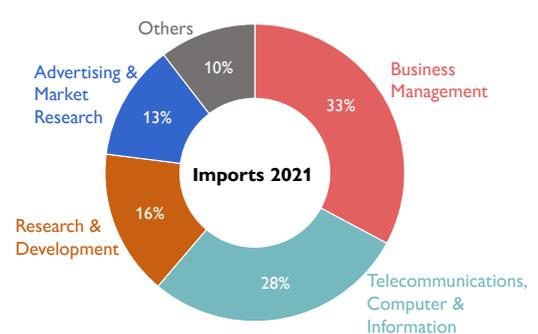


CHART 6B MODE 4 SERVICES IMPORTS BY SERVICES CATEGORY, 2021



Note: For Charts 6A and 6B, services categories with less than 5 per cent of contribution to mode 4 exports and imports are subsumed under 'Others'.

delivered include business consultants and visual directors temporarily going abroad to provide business advice and production of advertisements respectively. Imports were largely contributed by the Business Management and Telecommunications, Computer & Information services (Chart 6B). Under mode 4, Telecommunications, Computer & Information services include companies sending IT professionals abroad to provide IT systems and software support for their overseas clients.

Conclusion

Statistics on trade in services by modes of supply provide a better understanding of how services

are supplied across international borders. These experimental estimates have been used to support policy work during the COVID-19 pandemic.

The findings indicated that Singapore’s services exports and imports have been primarily supplied via mode 1 in recent years and that its growth had accelerated since the start of the pandemic. Services trade via mode 1 is expected to continue growing in importance with the rapid digitalisation of services, while modes 2 and 4 will remain relevant due to the inherent nature of the specific types of services (e.g., travel, maintenance & repair) which require suppliers and consumers to be physically present in the same location.

Leveraging Technology for Compilation of the Consumer Price Index

by Sarah Ng, Lee Jia Wen and Ruth Lee
Prices Division
Singapore Department of Statistics

Introduction

Compiled by the Singapore Department of Statistics (DOS), the Consumer Price Index (CPI) measures the average price changes of a fixed basket of consumption goods and services commonly purchased by resident households over time.

Price data used in the compilation of the CPI are gathered through various modes. This article presents DOS's continual efforts to adopt the latest technology and open-source tools in the areas of price data collection, processing and compilation, which include using web-scrapers, leveraging electronic prices, integrating handheld devices in field operations and compiling reports via Python scripts.

Web-Scraping of Online Prices

Since 2015, DOS has been utilising web-scraping to automate data collection. This not only minimises respondents' survey burden, but also reduces data collection efforts. At the onset, when open-source tools were not prevalent and in-house expertise on web-scraping technology was limited, IT programmers

were engaged to develop customised web crawlers to automate the extraction of online prices. However, given the frequent changes in website layouts, the cost of re-developing these customised web crawlers was high. Eventually, these web crawlers were discontinued.

Greater Use of Open-Source Tools

DOS subsequently turned to open-source tools and explored the use of commercial point-and-click web-scrapers, like Import.IO and ParseHub. With the emergence of Python programming language, DOS ventured into the development of in-house web-scraping scripts using Python via the *Requests*, *BeautifulSoup* and *Selenium* libraries.

Detailed price information from websites retailing food, home electronics & appliances, furniture, personal effects, apparels, and medicine & health products were subsequently extracted via these software and Python scripts. Examples of data fields that were extracted directly from selected websites, using Python scripts for food and apparel items are shown in Figure 1.

FIGURE 1 EXAMPLES OF DATA FIELDS EXTRACTED FROM WEBSITES VIA WEB-SCRAPING WITH PYTHON

FOOD

	A	B	C	D	E	F	G	H	I
1	Link	Description	Packaging	Final Price	Usual Price	Discount	Availability	Extract Date	Brand
2	https://w	Golden Phoenix Thai Hom Mali Rice	5kg	13.80		0	ADD TO CART	20230712	Golden Phoenix
3	https://w	Golden Pineapple AAA Thai Premium Fragrant Rice	10kg	22.52	28.17	-20%	ADD TO CART	20230712	Golden Pineapple
4	https://w	Pagoda Pure Corn Flour	400g	1.16		0	ADD TO CART	20230712	Pagoda
5	https://w	Myojo Chicken Abalone Flavoured Instant Noodles	5×79g	2.65		Buy 2 Save 9%	ADD TO CART	20230712	Myojo
6	https://w	CHIPSMORE Original Cookies Biscuits 153G	163.2g	1.95		0	ADD TO CART	20230712	CHIPSMORE
7	https://w	Kellogg's Frosties Breakfast Cereal	300g	5.40	6.00	-10%	ADD TO CART	20230712	Kellogg's
8	https://w	Best Foods Real Mayonnaise	430ml	5.03	5.30	-5%	ADD TO CART	20230712	Best Foods
9	https://w	Woolworths Deliciously Crunchy Peanut Butter	500g	4.00		0	ADD TO WISHLIST	20230712	Woolworths

APPAREL

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Link	Product code	Name	Color	Usual Price	Final Price	Discount	Availability	Features	Dimensions	Description	No of colors	No of sizes in stock	Total no of sizes	Extract Date
2	https://Product Code: 3611	Organic Loose Fi	white		\$24.99	2 FOR \$30		Add To Bag	100% organic cot	Size: Chest Circu	Made with susi	7	7		20230707
3	https://Product Code: 3301	Super Skinny Jear	new black		\$69.99			Add To Bag	Skinny through tl	Size: Waist Circu	Super skinny, s8	3	5		20230707
4	https://Product Code: 2053	Regular Fit Grapi	floral boot		\$24.99	BUY ONE, GET ONE 50%	C	Add To Bag	Standard body lei	Size: Bust Circumf	The regular fit	1	4	5	20230707
5	https://Product Code: 4591	Frill Ribbed Ankl	dusty pink		\$9.99	\$2.00	(-80%)	Add To Bag	Ribbed Construc	Size: LengthOS	- 2Frill ribbed ankl	9	0	0	20230707

When more advanced Python libraries became available, the extraction of price information from dynamic websites was facilitated using the *Pyautogui* and *Pytesseract* libraries.

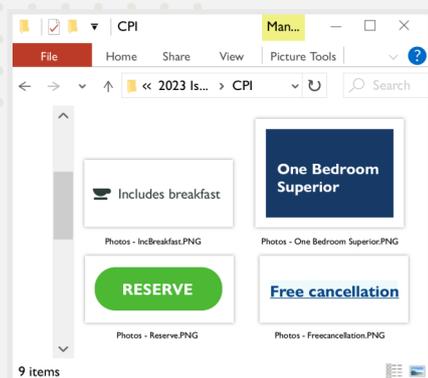
In the web-scraping of hotel room rates, the *Pyautogui* library automates the repetitive tasks of searching for the specific room type, breakfast inclusion and cancellation policy (refundable / non-refundable),

as well as clicking on the corresponding ‘reserve’ button. It can also take screenshots, such as the final price on the payment page. The *Pytesseract* library was incorporated into the script to convert the final price embedded in the screenshot into text, before loading into the CPI computerised system for data compilation.

Figure 2 details the programme flow of the Python web-scraper for the extraction of hotel room rates.

FIGURE 2 PROGRAMME FLOW TO EXTRACT HOTEL ROOM RATES

Before running the programme, the following images are stored in a folder, i.e., “One Bedroom Superior”, “Free cancellation”, “Includes Breakfast”, and “Reserve”.



At the start of the programme, the Python script reads in an input file where each row contains the following columns:

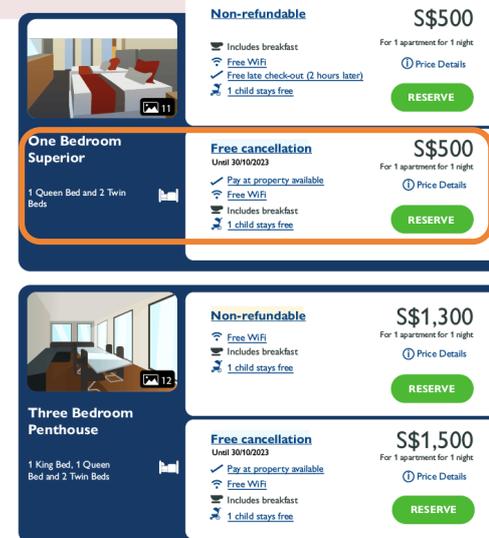
- Web link to the hotel
- Room type, breakfast type and cancellation policy

No.	City	Hotel	Weblin	Room Type	Breakfast Type	Cancellation Policy
1	Country 1	Hotel A	https://www	One Bedroom Superior	Includes Breakfast	Free Cancellation
2	Country 1	Hotel A	https://www	Three Bedroom Penthouse	Includes Breakfast	Free Cancellation
3	Country 1	Hotel A	https://www	Three Bedroom Penthouse	Includes Breakfast	Non-Refundable
4	Country 2	Hotel B	https://www	One Bedroom Superior	Includes Breakfast	Free Cancellation
5	Country 2	Hotel B	https://www	Three Bedroom Penthouse	Includes Breakfast	Free Cancellation
6	Country 2	Hotel B	https://www	Three Bedroom Penthouse	Includes Breakfast	Non-Refundable
7	Country 3	Hotel C	https://www	One Bedroom Superior	Includes Breakfast	Free Cancellation
8	Country 3	Hotel C	https://www	Three Bedroom Penthouse	Includes Breakfast	Free Cancellation
9	Country 3	Hotel C	https://www	Three Bedroom Penthouse	Includes Breakfast	Non-Refundable

Based on the input file, *Pyautogui* keys the web link into the internet browser and begin the search according to the following programme flow:

- Continue scrolling until the “One Bedroom Superior” image is found.
- Search for image of “Free cancellation” in area within 100 to 450 pixels from the top. If not found, scroll down once and repeat (ii).
- Search for image of “Includes Breakfast” within 0 to 200 pixels below the coordinates of “Free cancellation”. If not found, scroll down once and repeat (ii) & (iii).
- If all images have been found, locate image of “Reserve” button of about 1000 pixels to the right and 0 to 180 pixels down of the “Includes Breakfast” image and click on the “Reserve” button (orange box).
- If unable to find any of the images in (iv), to stop after 20 loops and move on to the next row of the input file.

Sample web layout:



Pyautogui takes a screenshot of the final payment page for successful iterations.

Pytesseract library converts the final price in the screenshot into text and exports the output to an excel file.

No.	City	Hotel	Weblin	Room Type	Breakfast Type	Cancellation Policy	Price
1	Country 1	Hotel A	https://www	One Bedroom Superior	Includes Breakfast	Free Cancellation	500
2	Country 1	Hotel A	https://www	Three Bedroom Penthouse	Includes Breakfast	Free Cancellation	1500
3	Country 1	Hotel A	https://www	Three Bedroom Penthouse	Includes Breakfast	Non-Refundable	1300
4	Country 2	Hotel B	https://www	One Bedroom Superior	Includes Breakfast	Free Cancellation	450
5	Country 2	Hotel B	https://www	Three Bedroom Penthouse	Includes Breakfast	Free Cancellation	1500
6	Country 2	Hotel B	https://www	Three Bedroom Penthouse	Includes Breakfast	Non-Refundable	1250
7	Country 3	Hotel C	https://www	One Bedroom Superior	Includes Breakfast	Free Cancellation	550
8	Country 3	Hotel C	https://www	Three Bedroom Penthouse	Includes Breakfast	Free Cancellation	1550
9	Country 3	Hotel C	https://www	Three Bedroom Penthouse	Includes Breakfast	Non-Refundable	1250

Greater Use of Web-Scraping

Web-scraping is an efficient method to collect online prices. It reduces survey burden while allowing for automated extraction of more data points at a higher frequency. During the COVID-19 pandemic when physical price collection was impeded, the use of web-scraping mitigated some of the price collection challenges.

With more community contributions to open-source libraries, the use of web-scraping techniques can be further enhanced over time and leveraged to extract more online price data for compilation purposes.

Aligned with international best practices, DOS adopts the following principles to ensure that web-scraping is carried out consistently, ethically, and transparently:

- i) Minimise burden on the website owners (e.g., by adding idle time between requests; web-scraping at a time of day when the web server is not expected to be under heavy load);
- ii) Identify DOS to the website owners as an explicit “declaration of intent” to carry out web-scraping; and,
- iii) Web-scrape data for statistical purposes only.

Leveraging Electronics Returns from Major Supermarket Chains

DOS has been collaborating with major supermarket chains to obtain their electronic price data directly for CPI compilation since 2015. These prices are compiled using actual sales transactions of consumer goods obtained via their electronic points of sales (POS). This way, discounts given by the supermarkets are taken into account. Previously, the price data was collected via in-person visits which was significantly more laborious.

The list of items monitored from supermarkets ranged from perishable items to groceries and healthcare products. To facilitate the identification of the required items for CPI compilation, DOS specifies the barcodes for each monitored item in the data file to the supermarkets.

Apart from time savings gained in place of in-person visits, the use of electronic prices also improved the quality of data used for CPI compilation as they are derived from actual purchase transactions which are more reflective of the monthly average prices paid by consumers.

Use of Handheld Devices for Price Collection

Another area which DOS focused on was the improvement in data capturing for field operations through the adoption of handheld devices.

Since 2019, field interviewers have been recording the information collected via web-based survey forms in the handheld devices. Replacing hardcopy survey forms with digital capture and identification via Singpass not only enhance the security of the field data collected, but also improve operational efficiency, through automated data validation and minimal data entry.

Some features of the web-based forms in handheld devices (Figure 3) include:

- i) Field interviewers can view information on the outlets to be surveyed for the day and those upcoming, including item descriptions, addresses of establishments, stall numbers, prices from previous period, etc. This helps them plan the routes to conduct field collection more efficiently.
- ii) Prices collected in the previous survey period can be copied over to the current survey period with a click of a button for each establishment, doing away with the need to perform data entry for each item.
- iii) Real-time computation of month-on-month percentage change in price is integrated in the web-based form. It serves as a validation check so that clarifications could be made with respondents promptly.
- iv) Common reasons for price changes such as increase in rental cost are embedded as dropdown options for field interviewers to select from in the web-based form, eliminating the need for them to type in the same reason for applicable items.

FIGURE 3 WEB-BASED SURVEY FORM INTERFACE

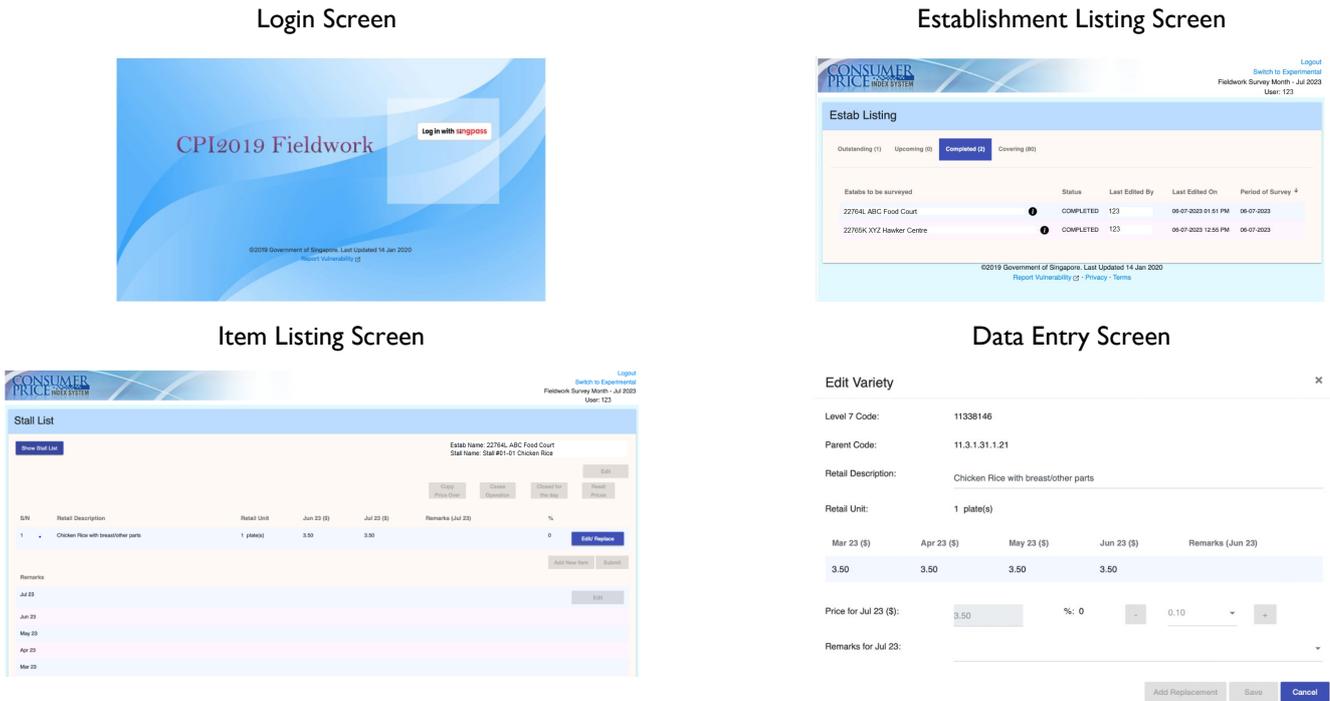


FIGURE 4 PROGRAMME FLOW FOR THE GENERATION OF MULTI-DIMENSIONAL DATA CUBES

- The Python programme reads in the annual and monthly average retail prices tab sheets 'T1' and 'T2' in the excel file for "Tables on CPI and percentage changes up to class level and average retail prices of selected consumer items" using the Pandas library.

Variables	2010 Jan	2010 Feb	2010 Mar	2010 Apr	2010 May	2010 Jun	2010 Jul	2010 Aug	2010 Sep	2010 Oct	2010 Nov	2010 Dec	2011 Jan	2011 Feb	2011 Mar	2011
Premium Thai Rice (Per 5 Kilogram)	11.99	11.84	12.33	12.55	12.58	12.67	12.57	12.35	12.30	12.67	12.71	12.63	12.60	12.41	12.68	12
Ordinary White Bread (Per 400 Gram)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.39	1.40	1.40	1.40	1.44	1.44	1
Vitamin Enriched Bread (Per 400 Gram)	1.64	1.64	1.58	1.58	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.62	1.56	1
Wholemeal Bread (Per 400 Gram)	na	na														
Instant Noodles (Per 5 Packets)	2.12	2.13	2.15	2.18	2.18	2.15	2.17	2.13	2.17	2.20	2.19	2.18	2.18	2.20	2.22	2
Lean Pork, Chilled (Per Kilogram)	12.63	12.89	12.98	12.70	12.69	12.53	12.65	12.74	12.63	12.65	12.58	12.58	12.96	13.27	12.65	12
Streaky Pork, Chilled (Per Kilogram)	13.25	13.80	13.61	13.61	13.63	13.60	13.59	13.62	13.66	13.67	13.72	13.90	14.14	13.77	13	13
Pork Rib Bones, Chilled (Per Kilogram)	15.43	15.93	15.84	15.84	15.95	15.87	15.89	15.73	15.92	15.91	15.86	15.91	16.09	16.52	16.07	16
Beef, Chilled (Per Kilogram)	na	na														
Mutton, Chilled (Per Kilogram)	14.09	14.09	14.09	14.09	14.59	15.33	15.41	15.31	15.88	15.98	16.26	16.26	16.26	16.99	17.79	17
Whole Chicken, Chilled (Per Kilogram)	5.40	5.47	5.42	5.37	5.40	5.49	5.58	5.63	5.64	5.67	5.71	5.65	5.73	5.83	5.79	5
Chicken Wing, Chilled (Per Kilogram)	na	na														
Duck, Chilled (Per Kilogram)	6.56	6.59	6.53	6.49	6.50	6.55	6.62	6.70	6.64	6.63	6.64	6.65	6.79	6.93	6.80	6
Lean Pork, Frozen (Per 500 Gram)	na	na														
Pork Rib Bones, Frozen (Per 500 Gram)	na	na														
Beef Cube, Frozen (Per 500 Gram)	na	na														
Whole Chicken, Frozen (Each)	na	na														
Chicken Wing, Frozen (Per 2 Kilogram)	na	na														
Cod Fish (Per Kilogram)	37.58	38.50	38.12	39.07	39.28	38.64	39.81	40.74	40.93	41.31	41.30	42.25	43.67	43.75	45.42	46
Gold Banded Scad (Kuning) (Per Kilogram)	5.58	5.66	5.59	5.72	5.68	5.74	5.74	5.76	5.78	5.81	5.82	5.68	5.85	5.67	5.85	5
Floury Grouper (Per Kilogram)	13.02	14.44	13.10	13.15	12.83	12.46	12.81	13.01	13.25	13.00	13.06	12.89	13.89	14.37	13.93	14
White Pomfret (Per Kilogram)	20.86	24.92	19.94	20.85	20.70	21.17	22.13	22.57	22.51	21.93	22.22	22.45	26.91	26.81	23.37	22
Salmon (Per Kilogram)	23.42	24.31	24.19	24.91	25.37	25.29	25.66	25.52	25.58	25.53	25.61	25.81	26.27	26.75	25.91	26

- The programme extracts the required rows and stores them as a data frame.
- The `melt()` function is then used to transform the data frame from the existing wide form to the tidy format, i.e., the data is unpivoted into rows. It also renames the column label 'Variables' to 'Consumer Item', the column label for average price to 'M1', and the column label for the months to 'Month'.

Sample output in Python:

Month	Consumer Item	M1
2010 Jan	Premium Thai Ri	11.99
2010 Jan	Ordinary White	1.4
2010 Jan	Vitamin Enriche	1.64
2010 Jan	Wholemeal Brea	na
...		
2023 Jun	Premium Thai Ri	13.67
...		

```
.melt(id_vars=['Consumer Item'], var_name='Month', value_name='M1')
```

FIGURE 4 PROGRAMME FLOW FOR THE GENERATION OF MULTI-DIMENSIONAL DATA CUBES
(cont'd)

- The *NumPy* library's *.nan* function converts "na" text value to a special floating-point value "NaN" and sets the 'Flag_M1' values for each data point as 0. A *for* loop is also used to amend 'Flag_M1' values as "3" if a data point is not available.
- A *lambda* function is added to convert the date format from 'YYYY Mmm' to 'Mmm-YY'.

```
.apply(lambda x: datetime.strptime(x, '%Y %b').strftime('%b-%y'))
```
- The data frame is further sorted by a descending order for 'Month'.
- The programme repeats the above steps for the annual prices found in the 'T1' tab sheet, and exports the transformed data frames to excel.
- The *Openpyxl* library applies some formatting features to the exported file such as setting cell alignment to center, adding thin borders, setting number formats to 2 decimal places and auto-fitting column width.

Sample output in Python:

Month	Consumer Item	M1	Flag_M1
Jun-23	Premium Thai Ri	13.67	0
...			
Jan-10	Premium Thai Ri	11.99	0
Jan-10	Ordinary White	1.4	0
Jan-10	Vitamin Enriche	1.64	0
Jan-10	Wholemeal Brea	NaN	3

Sample output in Excel:

Month	Consumer Item	M1	Flag_M1
Jun-23	Premium Thai Rice (Per 5 Kilogram)	13.67	0
...			
Jan-10	Premium Thai Rice (Per 5 Kilogram)	11.99	0
Jan-10	Ordinary White Bread (Per 400 Gram)	1.40	0
Jan-10	Vitamin Enriched Bread (Per 400 Gram)	1.64	0
Jan-10	Wholemeal Bread (Per 400 Gram)		3

* Multi-dimensional data cubes for the CPI are available on the [SingStat Website](#).

Compilation of Reports via Python

Besides data collection, Python libraries (*Pandas*, *NumPy* and *Openpyxl*) are used to automate the monthly generation of multi-dimensional data cubes for the CPI* (Figure 4). These libraries facilitate the extraction and merging of data from different file types and format them into the required structure.

Previously, the generation of multi-dimensional data cubes involved manual extraction of existing datasets in different frequencies and their consolidation into a single file in the required format. These tasks were repetitive and time consuming.

With the use of Python, the multi-dimensional data cubes are now generated in a timely, consistent and structured manner each month. Human error is

reduced and the savings in man-hours led to greater productivity and efficiency.

Conclusion

The COVID-19 pandemic has accelerated the adoption of technology worldwide. DOS keeps pace with evolving technologies by benchmarking against best practices in the private sector and its international counterparts, and tapping on new software and open-source tools to ensure that data collection, processing and compilation methods remain relevant and efficient.

For an animated introduction to how price data are gathered for the compilation of the CPI, check out the video on "[How are Prices Collected for the Compilation of Consumer Price Index](#)".

Rebasing and Release of More Granular Services Producer Price Indices

by Chan Zi Qi and Llewellyn Ho,
 Producer Price Indices Section, Prices Division
 Singapore Department of Statistics

Introduction

The Singapore Department of Statistics (DOS) compiles a suite of Services Producer Price Indices (SPPIs) to measure the changes in the average prices of services produced by establishments, for selected industries of the Singapore economy. SPPIs facilitate the analysis of macro-economic conditions and in monitoring price movements of the services sector. In the national accounts, SPPIs are used to deflate the value added and output of each service industry.

This article highlights some of the initiatives DOS has undertaken to improve data sharing with the general public, as well as key insights from the rebasing of the Accounting Services, Freight Forwarding and Sea Freight Transport price indices to base year 2022.

Public Release of More Granular SPPIs

Quarterly SPPi reports consisting of selected prices indices at the overall level were published since 2020.

Figure 1 shows an extract of the Sea Freight Transport Price Index (SFTPI) in the inaugural SPPi report.

To enable greater data sharing, DOS recently revamped the report to include more granular sub-indices of the SPPIs. This is useful for businesses to better track movements of prices in the services industries to evaluate their competitiveness. The full list of SPPIs and their sub-indices are indicated in Table 1.

Alongside the inclusion of more granular sub-indices of the SPPIs, the revamped SPPi report incorporates the use of bold colours and visuals to better engage data users and make it more reader-friendly. Figure 2 shows an extract of the SFTPI in the revamped report.

In addition to the revamped SPPi report, a new interactive dashboard was released to visualise the SPPIs clearly and concisely for quick identification of key trends, patterns and insights. Figures 3 shows a screenshot of the dashboard.

FIGURE 1 INAUGURAL QUARTERLY SPPi REPORT: EXTRACT OF THE SFTPI

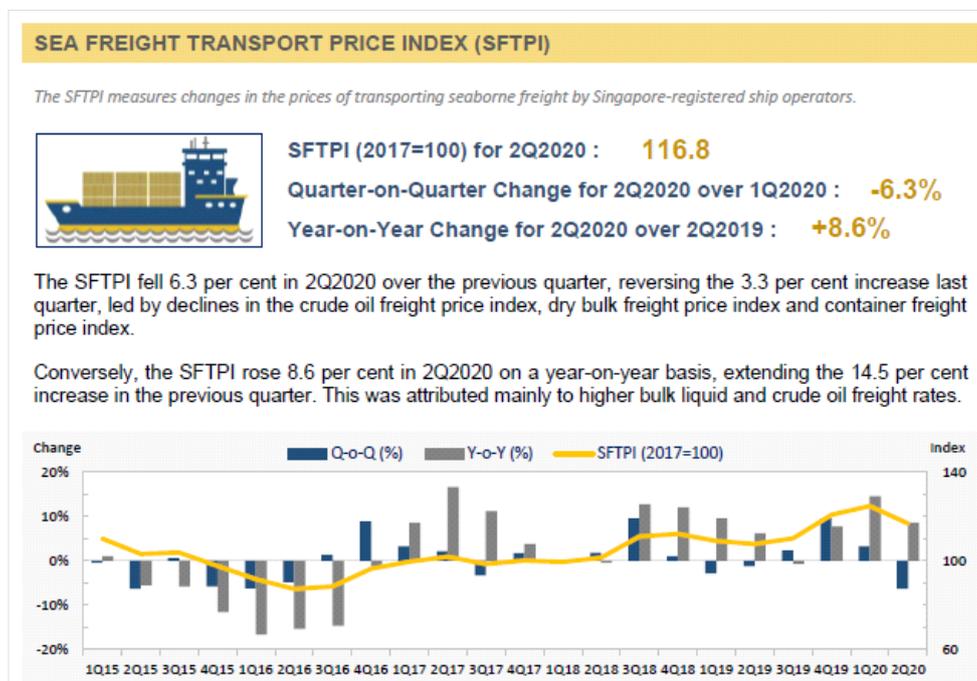


TABLE 1 LIST OF SPPIs AND THEIR SUB-INDICES

	<p>Accounting Services Price Index (ASPI)</p> <ul style="list-style-type: none"> Accounting & Auditing Book-keeping
	<p>Cargo Handling Price Index (CHPI)</p> <ul style="list-style-type: none"> Container Depot Services Crane Services Stevedoring Services
	<p>Computer Consultancy & Information Services Price Index (CISPI)</p> <ul style="list-style-type: none"> Computer Programming & Consultancy Information Services & Online Marketplaces
	<p>Freight Forwarding Price Index (FFPI)</p> <ul style="list-style-type: none"> Sea Freight Air Freight Land Freight
	<p>Sea Freight Transport Price Index (SFTPI)</p> <ul style="list-style-type: none"> Containerised Freight Transport Dry Bulk Freight Transport Liquid Bulk & Gas Freight Transport
	<p>Telecommunication Services Price Index (TSPI)</p> <ul style="list-style-type: none"> Wired & Wireless Services Internet Access Providers & Others
	<p>Warehousing & Storage Price Index (WSPI)</p> <ul style="list-style-type: none"> General & Refrigerated Warehousing Dangerous Goods Storage

FIGURE 2 REVAMPED QUARTERLY SPPI REPORT: EXTRACT OF THE SFTPI

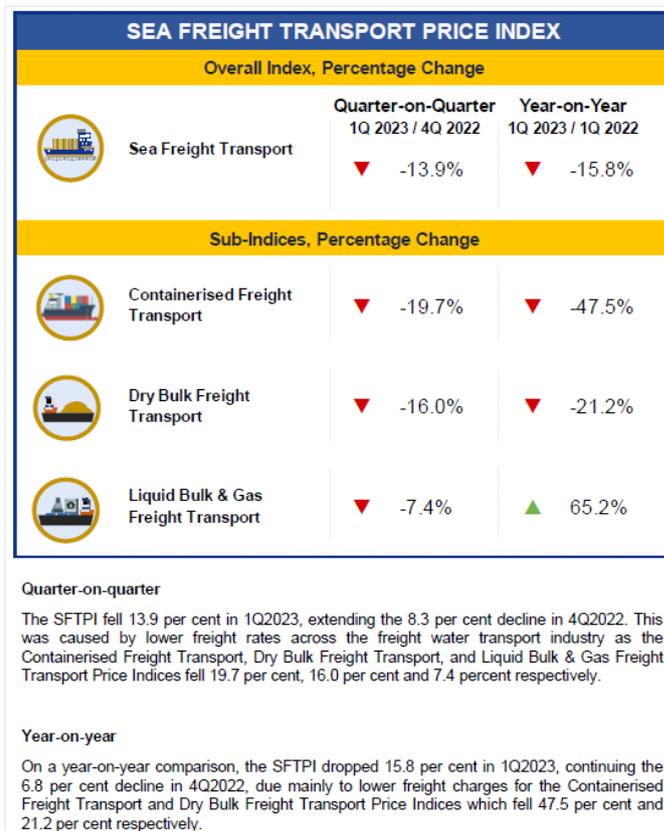
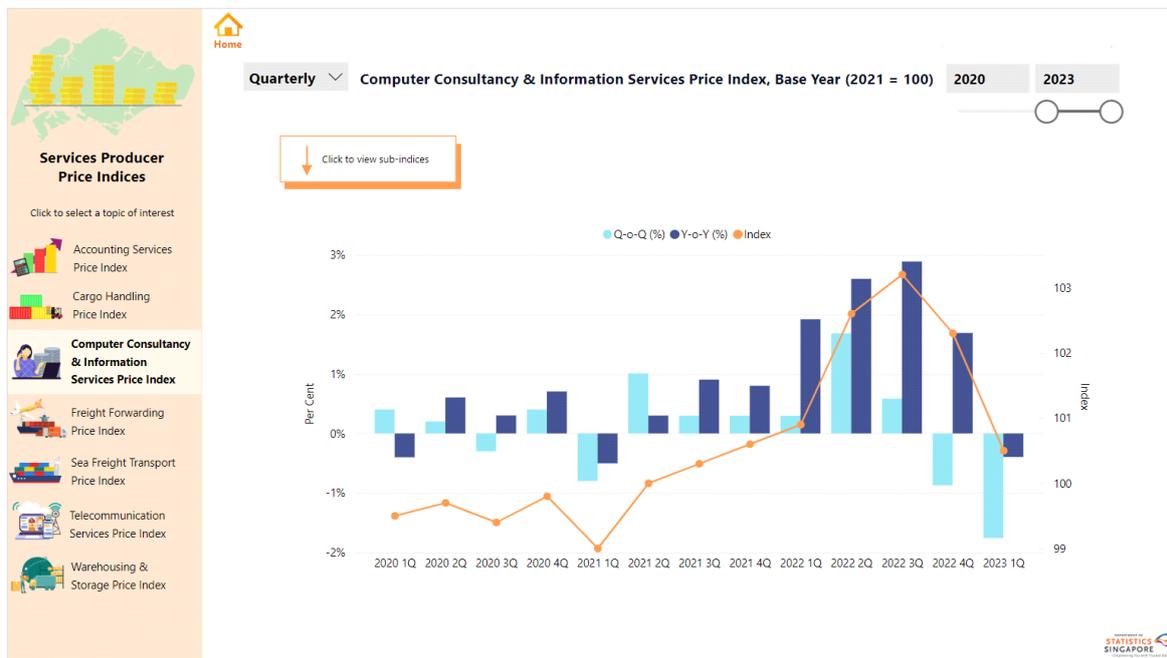


FIGURE 3 SPPI INTERACTIVE DASHBOARD



Rebasing Exercise for SPPIs

Rebasing exercises are conducted every four to five years to ensure that the weighting structure and the coverage of services products of the SPPIs are representative of the market share and the latest activities of the services industries.

In 2022, four of the SPPIs were rebased to base year 2021¹. In 2023, the Accounting Services Price Index (ASPI), Freight Forwarding Price Index (FFPI) and Sea Freight Transport Price Index (SFTPI) were rebased to base year 2022, introducing changes to weighting patterns as well as improvements to the methodology for the compilation of these indices.

The weights of the SPPIs and their sub-indices were mainly derived from Operating Revenue (OR) data collected from DOS's surveys, supplemented by administrative data where available.

Accounting Services Price Index (ASPI)

Business advisory and tax services saw notable increases in weights, as compared to accounting and auditing services. The demand for business advisory

and tax services may have been driven by changes in tax rules such as the Base Erosion and Profit Shifting (BEPS) 2.0 framework² and the demand for more family offices³.

Figure 4 shows the index structure, weights, and changes in weights in percentage-point of the ASPI from base year 2017 to 2022.

Freight Forwarding Price Index (FFPI)

The rank order of the freight forwarding transport mode remained the same across the two base years with Sea Freight Forwarding being the largest weight contributor, followed by Air Freight Forwarding and Land Freight Forwarding. In the 2022-based FFPI, the weight share for Air Freight Forwarding increased 6.1 percentage points, rising from 35.3 percent to 41.4 percent. In contrast, the Sea Freight Forwarding and Land Freight Forwarding weights share declined 5.5 percentage points and 0.6 percentage points respectively.

Figure 5 depicts the index structure, weights, and changes in weights in percentage-point of the FFPI from base year 2017 to 2022.

FIGURE 4 CHANGES IN INDEX STRUCTURE AND WEIGHTING PATTERNS OF THE ASPI

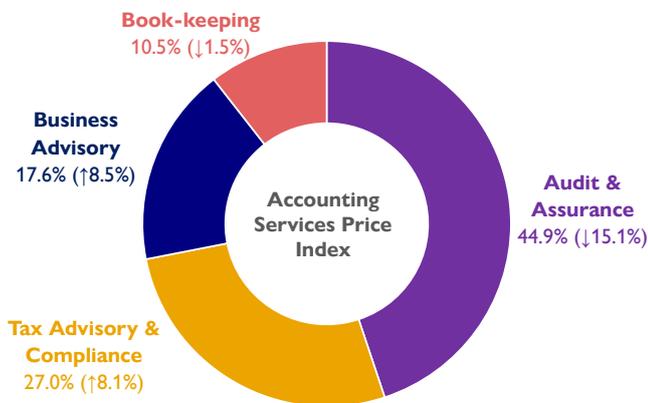


FIGURE 5 CHANGES IN INDEX STRUCTURE AND WEIGHTING PATTERNS OF THE FFPI



1 Read about this 2022 rebasing exercise from the SSN Issue 2, 2022: <https://www.singstat.gov.sg/-/media/files/publications/reference/newsletter/ssn222.ashx>

2 "Singapore businesses, don't underestimate impact of new tax rules": <https://home.kpmg/sq/en/home/media/press-contributions/2022/12/impact-of-new-global-minimum-tax-rules-on-sg-businesses.html>

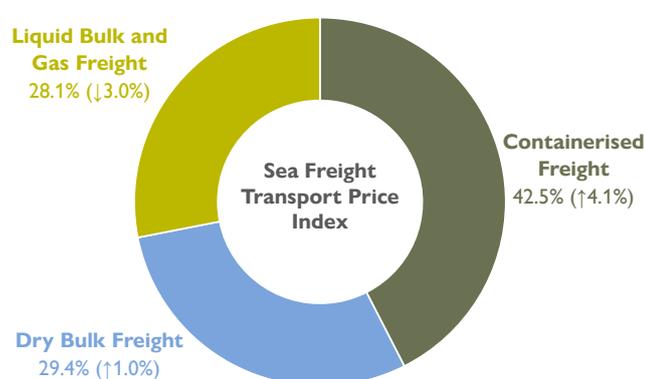
3 "More ultra-wealthy families setting up offices in Singapore, and they're not just coming from Asia ": www.channelnewsasia.com/singapore/family-offices-ultra-rich-set-singapore-financial-sector-3182131

Sea Freight Transport Price Index (SFTPI)

In the 2022-based SFTPI, the Containerised Freight Transport Price Index continued to be the largest contributor to the weights at 42.5 per cent, increasing 4.1 per cent from the 2017-based SFTPI, mainly due to a surge in demand for container shipping across key trade routes. This was followed by the Dry Bulk Freight Transport Price Index (29.4 per cent) and Liquid Bulk and Gas Freight Transport Price Index (28.1 per cent).

Figure 6 highlights the index structure, weights, and changes in weights in percentage-point of the SFTPI from base year 2017 to 2022.

FIGURE 6 CHANGES IN INDEX STRUCTURE AND WEIGHTING PATTERNS OF THE SFTPI



Key Methodological Enhancements

Improved Data Collection Processes

Data collection processes were refined to improve data quality and reduce respondent burden where possible.

Typically, a separate industry survey would be conducted before the preliminary price survey to collect the OR breakdown for weights computation. This was necessary for DOS to correctly identify services products in order to collect data from the respondents based on their revenue contribution.

For the ASPI, based on knowledge of the industry and internet research, DOS was able to send a simplified industry survey questionnaire, along with the preliminary price survey, to the respondents. This greatly reduced the amount of effort required by respondents while shortening the time required for DOS to complete the rebasing exercise.

In the case of the SFTPI, the pricing of voyage charter services was challenging due to the volatility of freight rates in the voyage charter⁴ market, especially given its importance to the industry as compared to time charter voyages⁵.

Therefore, companies providing voyage charter services were requested to provide the Time Charter Equivalent (TCE) where available. The TCE is a shipping industry measure to compare spot rates on a period-to-period basis and reflects price changes more accurately.

DOS will continue to monitor the TCE rates to ensure that it is reflective of the voyage charter market prices.

Updated Coverage of Services Products and Companies

To ensure that the coverage of services products was representative of the current activities and market share of the industry, the sample of the companies was revised for the rebased FFPI and SFTPI.

For the FFPI, more than half of the companies in the 2022-based index were newly surveyed, while the remaining companies were representative firms carried over from the 2017-based FFPI. This reduced respondent fatigue and maintained the quality of data over time.

For the SFTPI, the Lavallee-Hidiroglou⁶ method for stratified sampling was adopted to reduce the overall sample size while ensuring that the coverage of the water transport industry remained sufficient and representative.

4 Voyage Charter is a type of ship chartering whereby the charterer hires out a ship for a specific voyage to transport cargo from a loading port to a discharge port.

5 Time charter is a type of ship chartering whereby the charterer hires out a ship for a specified period of time.

6 The Lavallee-Hidiroglou method stratifies the population into two or more size strata. The firms in the large size stratum are selected with certainty, whereas the firms in the smaller size strata are sampled using simple random sampling without replacement.

FIGURE 7 PRICE TREND COMPARISON OF THE 2017-BASED AND 2022-BASED ASPI, FFPI AND SFTPI



Comparison of Price Trends

Figure 7 compares the price trends between the 2017 and 2022-based price indices. This evaluation of the three SPPIs spans from the first to the fourth quarter of 2022, in which the period overlaps both base years. While there were differences in the magnitude of change between the two series, the price trends of the rebased ASPI, FFPI and SFTPI generally moved in the same direction. Any deviation in price trends was attributed mainly to the changes in weightage and coverage of services products.

Future Plans

DOS constantly reviews and refines data collection methods, while maintaining the data quality of the SPPIs.

To minimise respondent burden and reduce the costs of data collection, the use of Internet prices and administrative data will be explored.

The use of administrative data increases the coverage of products to ensure that the indices are representative of current market activities.

Concurrently, survey respondents of these price surveys are encouraged to adopt e-survey as their preferred mode of survey submission for greater convenience and flexibility, thereby facilitating the data collection process.

Lastly, DOS is experimenting with the development of new SPPIs to meet the needs of data users. Keep a look out for them!

Third Meeting of the DOS Advisory Panel

The Singapore Department of Statistics (DOS) Advisory Panel was established in 2021 to guide DOS's strategic direction, amidst the changing data and technology landscape, and ensure that we remain relevant and responsive to the diverse needs of our data users.

DOS organised the third DOS Advisory Panel (DAP) meeting on 12 and 13 September 2023 with the theme of **'Data Stewardship and Governance in an Evolving Data Ecosystem and Measuring the Green Economy and Sustainability'**.

The DAP is chaired by the Singapore Chief Statistician, Dr Koh Eng Chuan, and comprises the following local and international members who are experts in the fields of statistics, data science and technology:

Mr Benny Chan

Managing Director,
Head of Group Channels and Digitalisation,
United Overseas Bank Limited

Mr Lee Bing Yi

Partner, Sustainability & Climate Change,
Financial Services Assurance,
PwC Singapore

Prof Ong Yew Soon

President's Chair Professor of Computer Science,
School of Computer Science and Engineering,
Nanyang Technological University
Chief Artificial Intelligence Scientist, A*STAR
Co-Director, Singtel-NTU Cognitive &
Artificial Intelligence Joint Lab
Co-Director, A*STAR SIMTECH-NTU Joint Lab
on Complex Systems

Prof Bertrand Loison

Vice-Director and Head of Data Science,
AI & Statistical Methods Division,
Swiss Federal Statistical Office, Switzerland

Mr Gary Dunnet

Deputy Chief Methodologist,
Statistics New Zealand, New Zealand

Mr Osama Rahman

Director, Data Science Campus,
Office of National Statistics, United Kingdom

The third DAP meeting discussed the role of National Statistical Offices (NSOs) in data stewardship and governance and the advantages and challenges for NSOs in undertaking this role. Members shared their experiences in the private sector, academia and NSOs, and provided insights on the areas where DOS is well-positioned to play an expanded role in data stewardship and data governance.

The DAP also exchanged views on the growing importance of green economy and sustainability. Members discussed the pivotal role of NSOs in measuring and monitoring progress through green economy and sustainability indicators to guide policy formulation and assess the effectiveness of initiatives.

DOS expresses our appreciation to all panel members for the insightful discussions, and we look forward to the fourth DAP meeting in 2024.

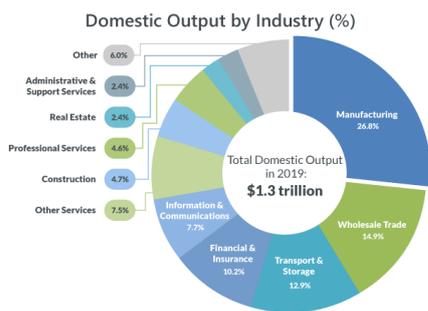


Singapore Supply, Use & Input-Output Tables 2019: An Analysis of Multipliers, Linkages and Structural Changes

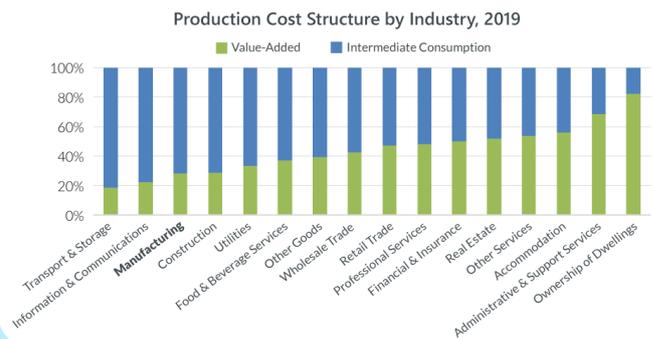
Singapore Supply-Use Tables (SUTs) 2019

In 2019, the Singapore economy produced \$1.3 trillion worth of goods and services.

Manufacturing was the largest contributing industry.



While the Manufacturing industry contributed a significant amount of output to the Singapore economy, only 27.9% of its output produced was attributed to Value-Added (VA).



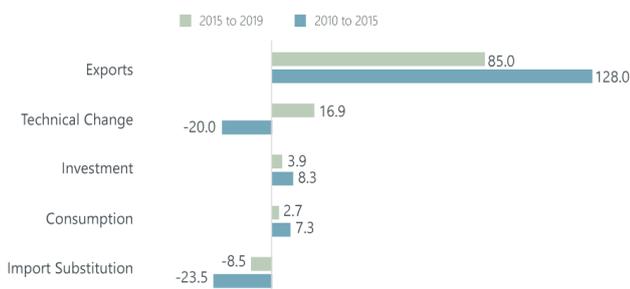
Between 2010 and 2015, the Singapore economy experienced significant output growth, driven primarily by increases in final demand. Exports contributed 63.4% of the output increase, taking into account the direct effect as well as indirect effects on all the industries.

	Technical Change	Final Demand Change	Final Demand Change, of which			Import Substitution	Total
			Consumption	Investment	Exports		
2010 vs 2015	6.4%	100.1%	22.4%	14.3%	63.4%	-6.5%	100.0%
	\$14,968.7	\$234,688.9	\$52,609.7	\$33,491.5	\$148,587.8	-\$15,196.1	\$234,461.6
2015 vs 2019	-1.3%	102.4%	15.0%	-1.6%	89.0%	-1.1%	100.0%
	-\$3,425.1	\$263,586.1	\$38,718.8	-\$4,192.3	\$229,059.6	-\$2,799.8	\$257,361.2

From 2015 to 2019, total output growth was again driven primarily by increases in final demand. Exports' contribution rose to 89% of the output increase.

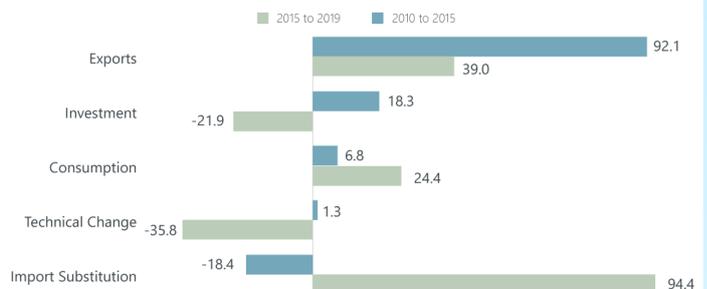
Sources of Output Change

Sources of Output Change of the Information & Communications Industry (%)



For the Information & Communications industry, exports was the largest driver of growth (85% of its output growth) from 2015 to 2019. This was lower than the 128% contribution from 2010 to 2015.

Sources of Output Change of the Manufacturing Industry (%)



For the Manufacturing industry, exports was the largest driver of growth (92.1% of its output growth) from 2015 to 2019, higher than the 39.0% contribution from 2010 to 2015.

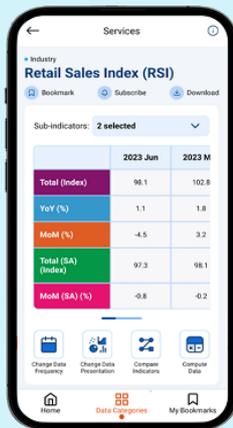
Read more in the newly released Information Paper: [Singapore Supply, Use and Input-Output Tables 2019: An Analysis of Multipliers, Linkages and Structural Changes](#)



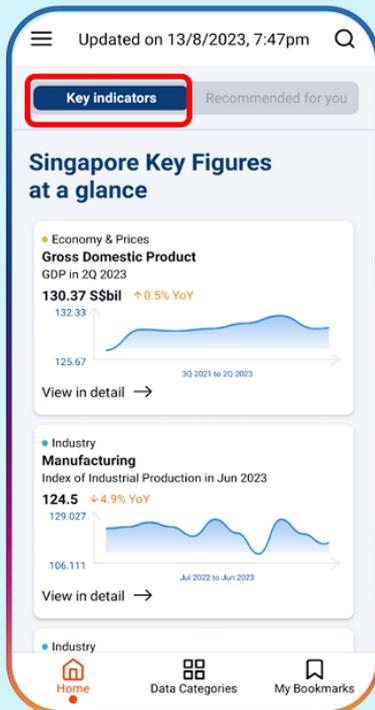
Download the Enhanced SingStat Mobile App today!



<https://go.gov.sg/smaapple> <https://go.gov.sg/smagoogole>



New and Improved Features



Get a quick preview of the important indicators

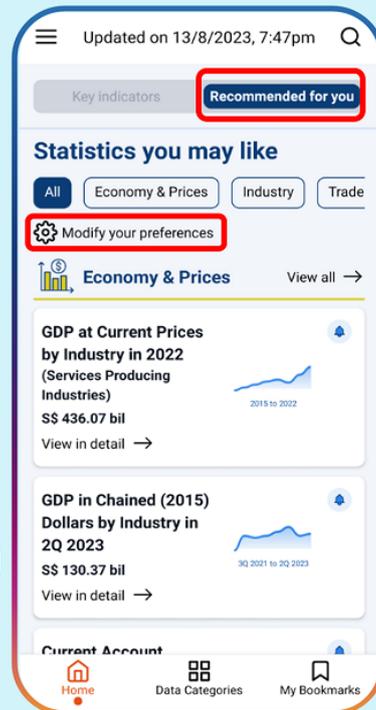
View key economic and socio-demographic indicators such as GDP, Population, Consumer Price Index, Household Income, and preview the data trends.

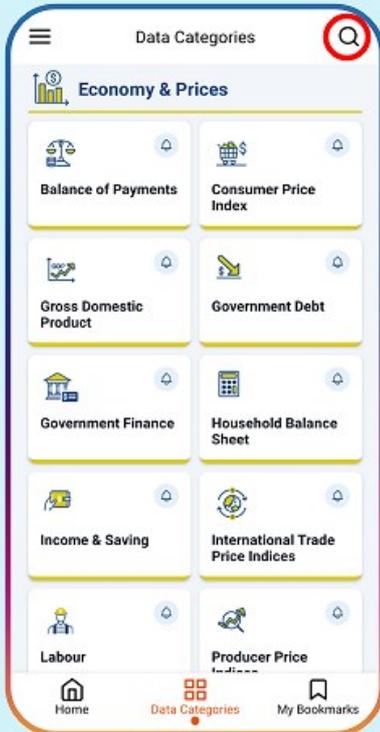


Indicate your profile for tailored data recommendations

View recommended statistics and useful information based on your profile and data interest.

Change your profile and topics of interest easily with the 'Modify your preferences' button.

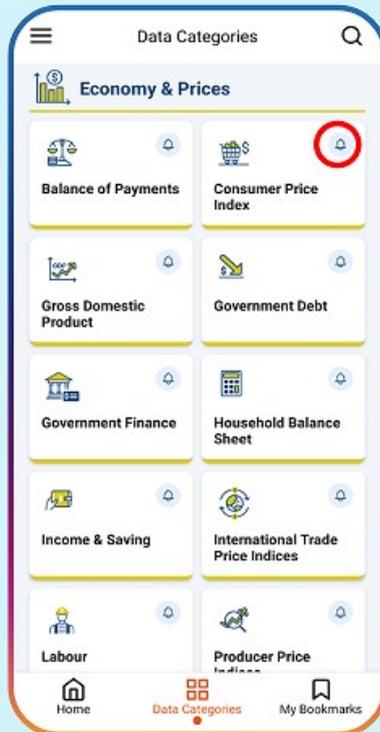
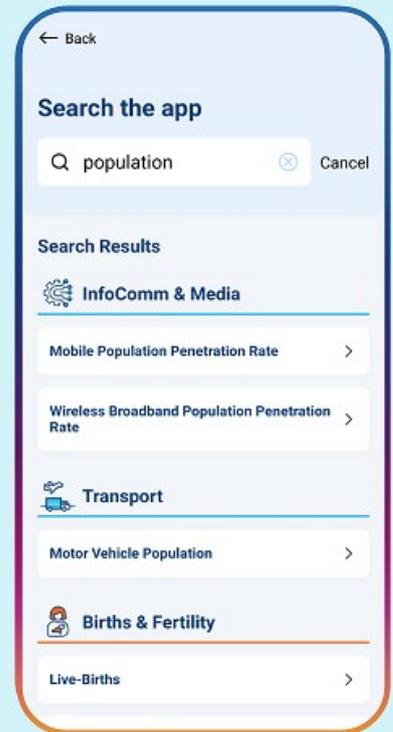




Discover data via data categories or keyword search

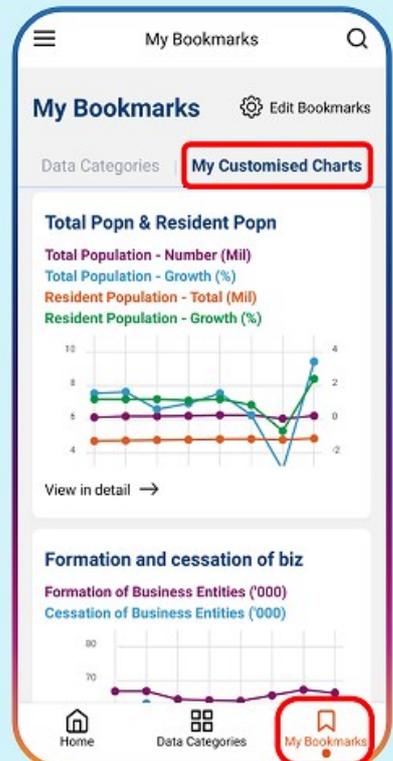
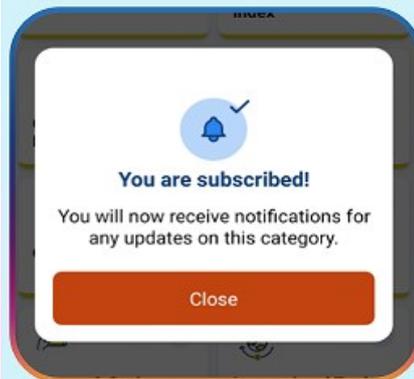
Discover data of by exploring the list of data categories.

Search for data of your interest via keyword search. Recent 5 searches will be displayed to speed up the search process.



Receive notifications on data updates

Subscribe to data categories or indicators for alerts on data updates.



Customise charts and bookmark for future reference

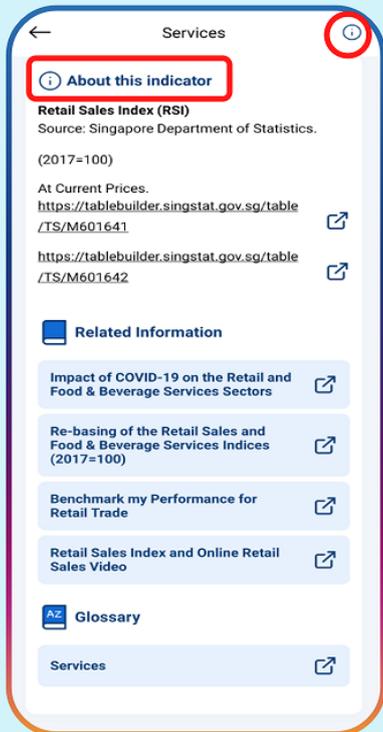
Compare indicators in chart view and bookmark them for future reference.

Access your bookmarked charts via 'My Bookmarks' icon.



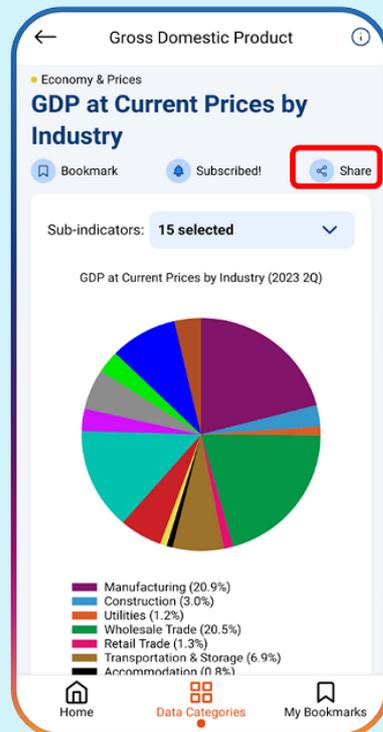
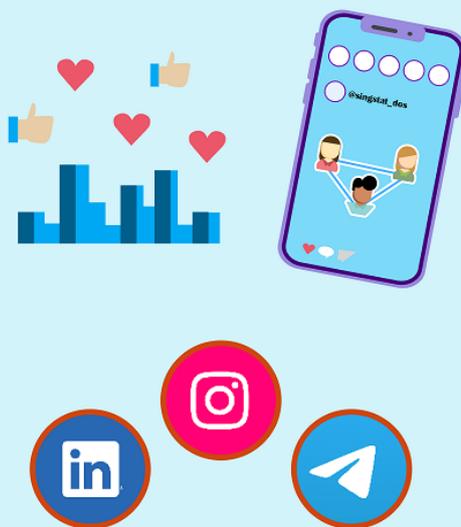
Access related information and detailed data series

Access footnotes, related information such as publications and infographics, glossary and historical data series in the SingStat Table Builder easily via the 'i' icon for each indicator.



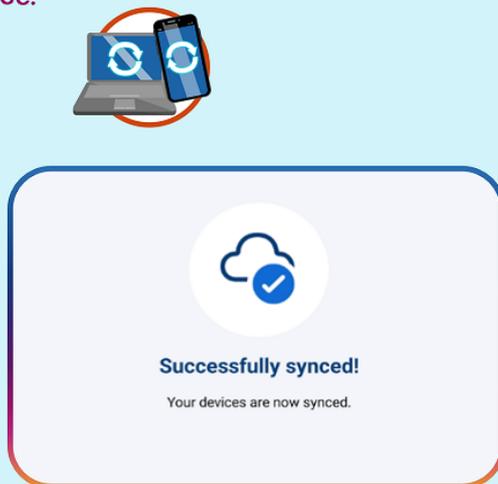
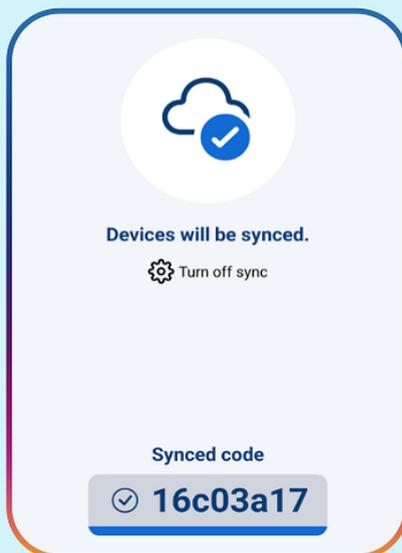
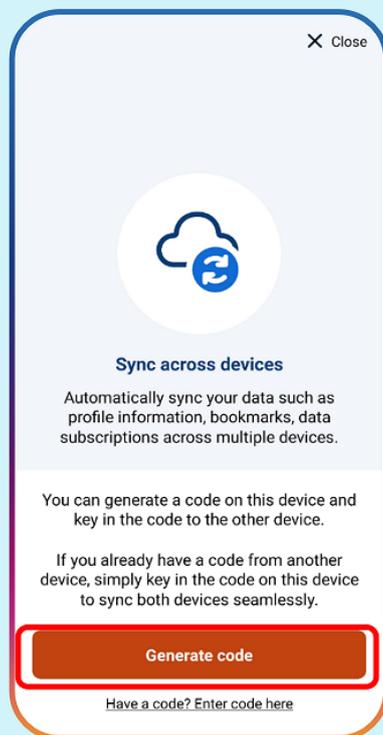
Share charts via social media

Share charts with the 'Share' icon and select the social media platform for sharing.



Enjoy seamless access across all your devices with device-synchronisation

Automatically sync your information such as profile and data interests, bookmarks and data subscriptions across multiple devices for seamless access and greater convenience.



OVERSEAS VISITORS

The Singapore Department of Statistics welcomed visits from New Zealand, the United Kingdom and the United Arab Emirates and hosted virtual sharing sessions with Timor-Leste and Uzbekistan from June to September 2023.

National Institute of Statistics Timor-Leste and Timor-Leste Ministry of Finance

Delegation led by Mr Silvino Lopes, National Director of System and Report; National Institute of Statistics of Timor-Leste.

Statistics New Zealand

Mr Neil Hurley, Executive Director, Transformation

Statistics Agency under the President of the Republic of Uzbekistan

Delegation led by the Heads/ Deputy Heads of:

- Department of Industry Statistics
- Department of Demography and Labor Statistics

- Department of International Cooperation and Data Exchange
- Department for Organization and Conducting of Censuses
- Department of Maintenance and System Service of Statistical Registers

UK Office for National Statistics and UK Geospatial Commission

- Mr Osama Rahman, Director of Data Science Campus
- UK Geospatial Commission team led by Ms Thalia Baldwin, Director of UK Geospatial Commission

Department of Government Support, Emirate of Abu Dhabi

Delegation led by His Excellency Ahmed Tamim Hisham Ibrahim Al Kuttab, Chairman of the Department of Government Support and Member of the Abu Dhabi Executive Council.

CONTENTS

1

Data Stewardship and Governance in the Singapore Department of Statistics

7

Singapore's Growth Cycle Chronology, Coincident and Leading Indicators

11

Experimental Estimates on Singapore's Balance of Payments Services Trade by Modes of Supply

16

Leveraging Technology for Compilation of the Consumer Price Index

21

Rebasing and Release of More Granular Services Producer Price Indices

26

Third Meeting of the DOS Advisory Panel

27

SU-IOT 2019: An Analysis of Multipliers, Linkages and Structural Changes



Statistics Singapore Newsletter Issue 2, 2023

The Statistics Singapore Newsletter is issued twice a year by the Singapore Department of Statistics.

It aims to inform readers on recent statistical findings as well as latest information on statistical methodologies, processes, products and services.



@SingStat



@singstat_dos



@SingStatvideo



@sg-department-of-statistics

www.singstat.gov.sg
info@singstat.gov.sg