

The Digital Economy in Singapore

The digital economy broadly encompasses the production and consumption of digital products and services, digital platforms and business activities that are enabled by digital technologies. This may include activities as ubiquitous as sending emails to more sophisticated ones such as big data analytics. In recent years, the digital economy has garnered the attention of policymakers globally, which is not surprising given that the adoption of digital technologies offers significant potential to empower individuals, transform industries and enhance the competitiveness of economies. In view of its rising prominence, it is important for policymakers to gain a better understanding of the development and contribution of the digital economy.

In this article, we examine the recent trends in, and contribution of, the digital economy in Singapore. We do so by (i) presenting the broad trends in digital adoption among households and enterprises; (ii) estimating the economic contribution of the industries that produce or enable digital goods and services; and (iii) deriving the value that cross-border data flows bring to our economy.

Singapore has made significant progress in its digital infrastructure, which has enabled the increased adoption of digital capabilities among households and enterprises

Singapore has significantly enhanced its digital infrastructure in recent years, most notably through the introduction of optical fibre and 4G networks, which has in turn dramatically increased the speed at which information is transmitted. For instance, following the roll-out of the optical fibre network, Singapore's average internet connection speed increased from 5.4 Megabits per second (Mbps) in 2012 to 20 Mbps in 2016,¹ comparable to that in Japan and Finland. Likewise, Singapore's 4G connection speed is one of the fastest in the world,² in part due to continued network investments.

On the back of advancements in our digital infrastructure, the total number of optical fibre broadband and 4G subscriptions in Singapore has more than doubled over the past five years.³ Partly facilitated by faster internet speeds, Singapore households have also gradually shifted more of their activities onto the digital space. In particular, between 2010 and 2015, there was a broad-based increase in the share of households that engaged in internet activities such as online shopping and online financial transactions (Exhibit 1A), based on findings from an annual survey conducted by the Infocomm Media Development Authority (IMDA).

On the enterprise front, firms in Singapore are also increasing their investments in digital assets to enhance their digital capabilities. Specifically, gross capital expenditure on digital fixed assets⁴ by firms rose at a Compounded Annual Growth Rate (CAGR) of 7.1 per cent between 2013 and 2015, thereby resulting in a significant accumulation of digital fixed assets among firms over this period. In tandem with their investments in digital assets, firms are also increasingly adopting digital tools in their day-to-day business activities. For instance, according to IMDA, a higher share of enterprises is using e-payment systems and mobile services to do business (Exhibit 1B).

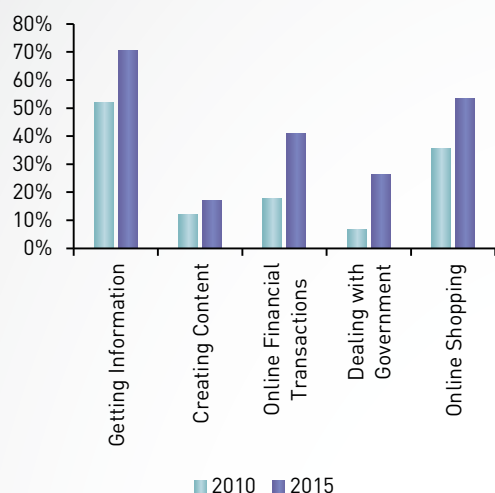
¹ Based on data from Akamai.

² Based on OpenSignal's latest 4G Speed metric, Singapore's 4G speed stood at 47 Mbps, one of the fastest in the world.

³ According to the Infocomm Media Development Authority, the total number of optical fibre broadband subscriptions increased from around 0.3 million in 2012 to over 1.1 million in 2016. Similarly, the total number of pre- and post-paid 4G subscriptions more than doubled from 2.1 million in 2013 to close to 4.9 million in 2016.

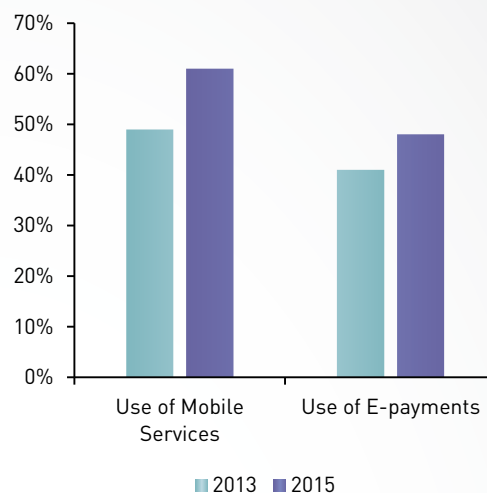
⁴ Digital fixed assets refer to computers & peripheral equipment and telecommunications equipment. Other fixed assets include land, building & structure, furniture & fittings, transport, and other machinery & equipment.

Exhibit 1A: Type of Infocomm Usage among Individuals Aged 15 and Above, 2010 and 2015



Source: Infocomm Media Development Authority

Exhibit 1B: Type of Digital Tools Used among Enterprises, 2013 and 2015



In addition to the trends highlighted above, anecdotal accounts suggest that the diffusion of other types of digital tools and capabilities such as cloud services, smart factories, etc. has also increased in recent years. With the Government's push towards greater digitalisation of the economy (e.g., through the Smart Nation initiative), the pace of digital adoption among households and enterprises is likely to be sustained or even quicken going forward.

The infocomm media sector plays a major role as a key digital enabler of individuals and enterprises...

The infocomm media (ICM) sector, comprising twelve segments that produce or enable digital goods and services (i.e., hardware⁵, telecommunications, IT services, software⁶, games, online services⁷, printing, post & courier, publishing, broadcasting, film & video and music), plays an important role in facilitating digital adoption among households and enterprises in Singapore. For instance, firms in the telecommunications industry provide services that enable access to the internet, while those in the IT services segment offer enterprises with computer programming services.

...and has grown significantly on the back of an increase in demand for digital goods and services

The rise in demand for digital goods and services among individuals and enterprises has propelled the growth of the ICM sector in recent years. Between 2011 and 2015, the nominal value-added (VA) of the ICM sector grew at a CAGR of 7.2 per cent, faster than the 4.2 per cent recorded for the overall economy (Exhibit 2A). Similarly, employment in the ICM sector rose between 2011 and 2015, although the pace of increase, at 2.5 per cent per annum (p.a.), was slower than that seen in the overall economy (3.2 per cent p.a.). Taken together, the productivity of the ICM sector in terms of VA per worker (VAPW) increased at a faster pace of 4.6 per cent p.a. over this period, as compared to the 0.6 per cent p.a. increase seen for the overall economy (Exhibit 2B).

⁵ The hardware segment consists of the wholesale and retail sales of computers and related accessories, telecommunication apparatus as well as office machinery and equipment.

⁶ The software segment consists of the development, publishing and wholesale sales of software (excluding games).

⁷ The online services segment consists of activities such as the development of e-commerce applications, web portals, etc.

Exhibit 2A: Nominal VA Growth, 2011 – 2015

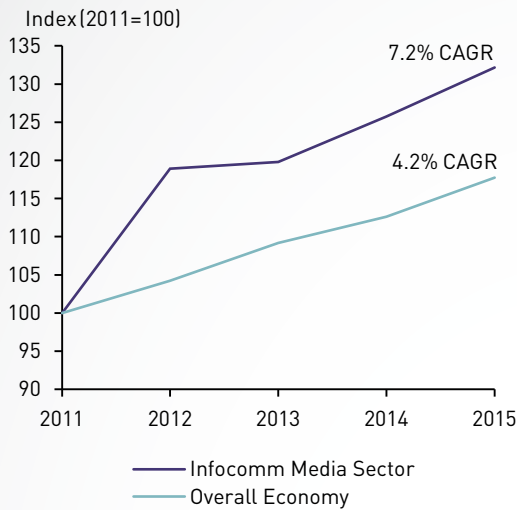
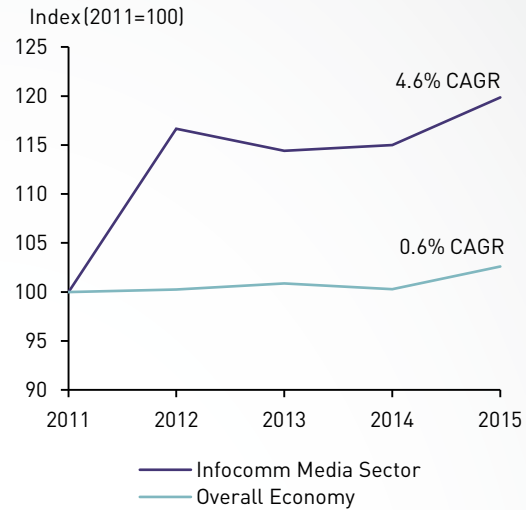


Exhibit 2B: Nominal VAPW Growth, 2011 – 2015



Source: Department of Statistics, Economic Development Board, Ministry of Manpower and MTI Staff Estimates

As a result of its robust growth, the contribution of the ICM sector to the economy increased from 7.4 per cent of nominal GDP in 2011 to 8.3 per cent in 2015. Specifically, the sector’s nominal VA reached \$32 billion in 2015, with the hardware (40 per cent), telecommunications (16 per cent) and IT services (15 per cent) segments accounting for most of the sector’s nominal VA (Exhibit 3A). In terms of employment, although employment in the ICM sector rose between 2011 and 2015, the ICM sector’s share of total employment in the economy edged down slightly to 5.3 per cent in 2015, from 5.5 per cent in 2011. As at 2015, the ICM sector employed around 200,000 workers, with the IT services (28 per cent), hardware (17 per cent) and software & games (17 per cent) segments contributing the most to the sector’s employment (Exhibit 3B).

Exhibit 3A: Share of the ICM Sector’s Nominal VA by Segment, 2015

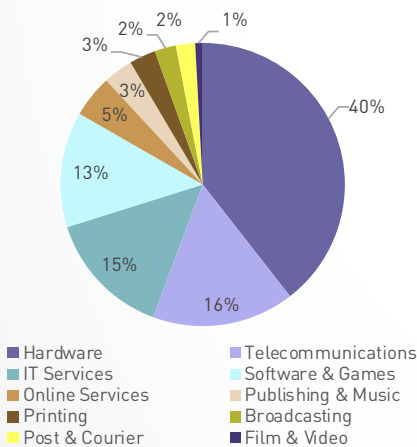
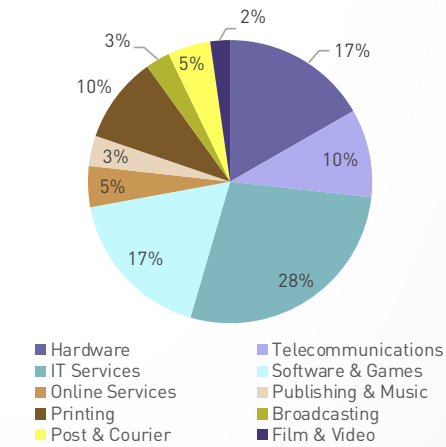


Exhibit 3B: Share of the ICM Sector’s Employment by Segment, 2015

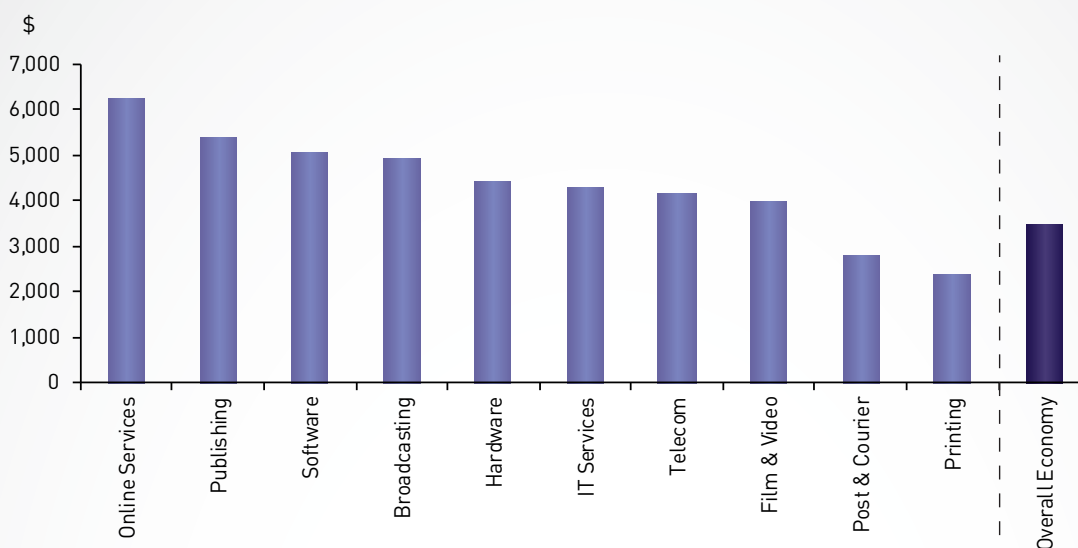


Source: Department of Statistics, Economic Development Board and Ministry of Manpower

The ICM sector is also a source of good jobs for resident workers, with median wages that are higher than the median wage in the overall economy

The ICM sector is also a source of good jobs for resident workers. With the exception of the post & courier and printing segments, the median wages of resident workers in the other segments of the ICM sector were higher than the median wages of resident workers in the overall economy in 2015 (Exhibit 4).

Exhibit 4: Median Nominal Gross Monthly Income from Work of Full-Time Resident Employees, 2015



Source: Ministry of Manpower

Notes: The median nominal gross monthly income from work excludes employer CPF contribution. Data for the games and music segments were excluded due to data suppression.

In summary, the ICM sector plays an important role in the Singapore economy as it is a key enabler of digital adoption by individuals and enterprises. Bolstered by the strong demand for digital goods and services, the ICM sector has outperformed the overall economy in recent years in terms of nominal VA and productivity growth. The ICM sector is also a source of good jobs for Singaporeans, paying median wages that are higher than the median wages in the overall economy.

Another major aspect of the digital economy relates to cross-border data flows

Cross-border data flows constitute an important part of the digital economy, as they partly reflect the amount of services that are traded between countries via digital means. In particular, some services firms rely on Information & Communications Technology (ICT) to access international markets and export their services to overseas customers, and in doing so, generate data flows between countries. Examples would include market research or legal services firms that provide services to overseas clients mainly through digital means (e.g., over email, cloud-based platforms or the firm's own platform on the World Wide Web).

Such information flows between countries – which are stored as bytes of data⁸ – are facilitated by a network of physical cables located under the seabed, with the transmitted information accessible through a platform such as the World Wide Web. In general, submarine cable networks can be categorised as public networks⁹ or private networks¹⁰, with the latter increasingly being deployed by large digital content providers like Google, Facebook and Amazon. Given that the amount of cross-border data flows is likely to be correlated with the pervasiveness of the digital economy, the former can be used as a broad indicator to track how countries are performing in relation to the digitalisation of their economies.

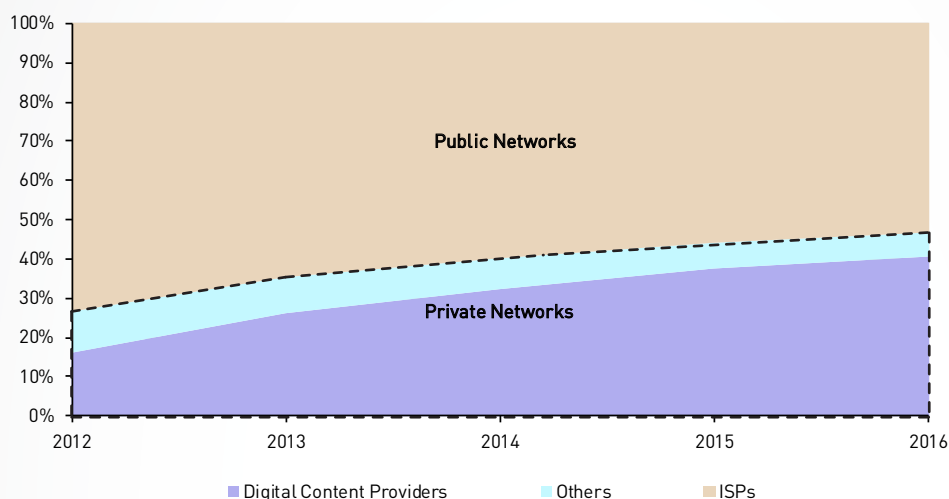
⁸ For instance, ten bytes of data could contain information on one word, while hundred bytes could contain information on a sentence.

⁹ Public networks refer to network cable capacity that is typically jointly owned by a consortium of internet service providers (ISPs). Each ISP in the consortium is allotted a specific bandwidth capacity and contributes to the maintenance and upkeep of the network. The ISPs in turn sell access to the bandwidth that they own to their clients. As the bandwidth capacity on these networks is available to a wide range of users at a given time, there may be instances of latency (i.e., longer time taken for data to be transmitted) and a reduction of quality during periods of high traffic.

¹⁰ Private networks refer to network cable capacity that is deployed by institutions who require bandwidth capacity for their dedicated use. Examples of such institutions include large digital content providers such as Google, Facebook and Amazon. These digital content providers require cross-border bandwidth to synchronise the data in their data centres that are located around the world and to distribute their content to end-users. Institutions may choose to own their own private network capacity for a variety of reasons, including cost considerations, to reduce latency, to improve quality and also for privacy reasons.

In our region, for example, we find that cross-border data flows (measured by used international bandwidth) passing through Asia¹¹ rose sharply at a CAGR of 51 per cent between 2012 and 2016. This came on the back of an increase in the number of broadband subscriptions in the region, in line with increasing digital adoption by households and enterprises.¹² At the same time, the share of cross-border data flows accounted for by private networks has also increased steadily over the years, from 16 per cent in 2012 to 40 per cent in 2016, driven by large digital content providers (Exhibit 5).¹³ This suggests that regional demand for the services (e.g., international video calling, cloud computing services, etc.) supplied by these content providers has surged in recent years.

Exhibit 5: Share of Cross-Border Flows in Asia, 2012 – 2016



Source: Telegeography Research

Notes: Others refer to private network capacity that is owned by institutions other than large digital content providers. Examples of such institutions include research and educational institutions.

Similar to the trends in Asia, cross-border data flows passing through Singapore have also increased rapidly...

The volume of cross-border data (from public and private networks) passing through Singapore has increased significantly in recent years. Specifically, Singapore's cross-border data flows grew by 65 per cent p.a. from 2012 to 2016 to reach 24,000 gigabits per second in 2016. This pace of growth was generally on par with or higher than that seen in other digitally-ready economies (Exhibit 6A).¹⁴ On a per capita basis, Singapore's cross-border data flows has also outstripped that of other digitally-ready economies (Exhibit 6B).

¹¹ Cross-border data flows passing through Asia refer to imports, exports as well as transshipment data traffic.

¹² According to Telegeography, the number of broadband subscriptions in Asia grew at a CAGR of 27 per cent from 2012 to 2016, with China contributing to a substantial portion of this growth.

¹³ Traditionally, large digital content providers leased bandwidth capacity from ISPs to transmit their data across borders. However, as the amount of data they handle has risen sharply over time, fuelled by robust demand for their services (e.g., international video calling, cloud computing services etc.), it has become more economically viable for the content providers to directly own the network cable capacity. Doing so also allows them to improve the quality of the services (i.e., reduced latency) that they provide.

¹⁴ This article defines digitally-ready economies as the top-ranked countries in the World Economic Forum's Networked Readiness Index. Apart from Singapore, these include the United States, Sweden, Finland, Norway and Japan.

Exhibit 6A: Cross-border Data Flows of Selected Economies, 2012 – 2016

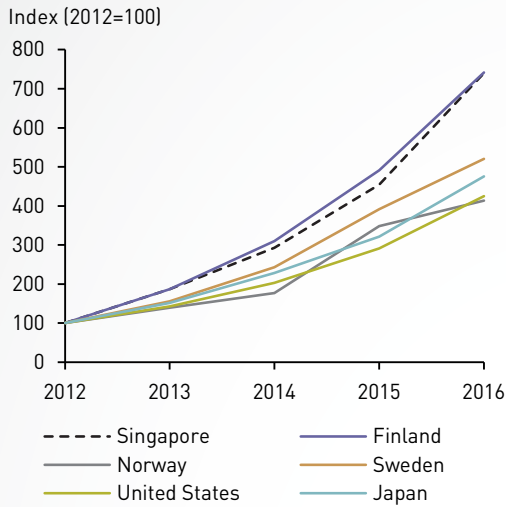
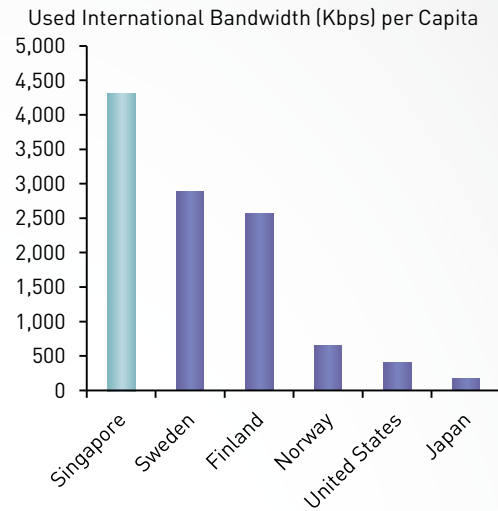


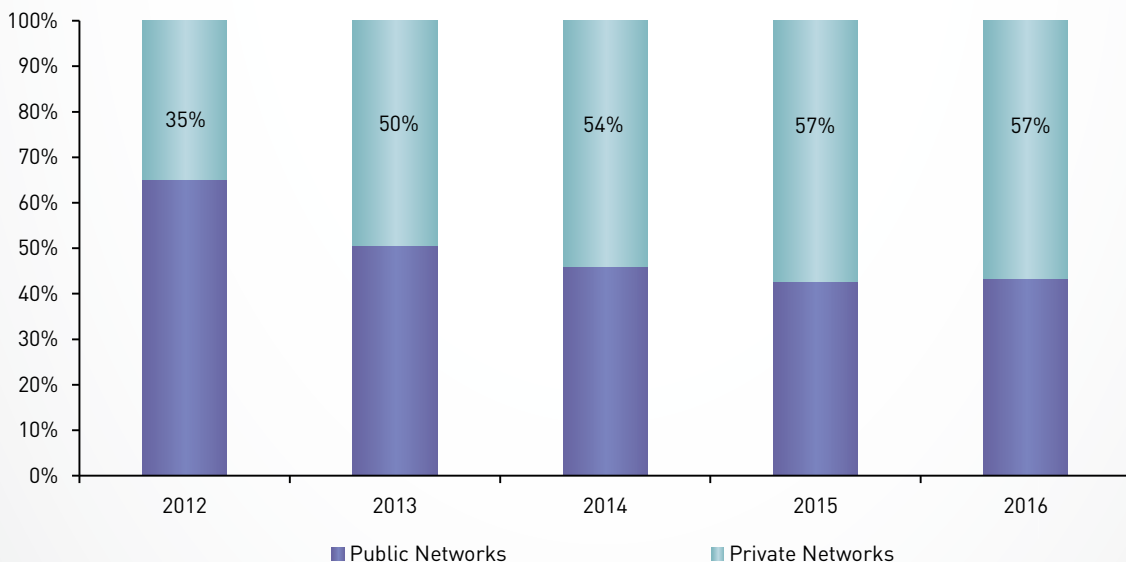
Exhibit 6B: Cross-border Data Flows Per Capita of Selected Economies, 2016



Source: Telegeography Research, United Nations Department of Economic and Social Affairs, World Population Prospects

The increase in Singapore’s cross-border data flows over this period was largely driven by data flows through private networks. Indeed, the share of Singapore’s cross-border flows through private networks rose rapidly within a span of five years to reach 57 per cent in 2016, surpassing that of public networks (Exhibit 7). In turn, the increase in data flows via private networks was driven by digital content providers. According to analysts such as those in Telegeography, Singapore is a key hub for the distribution of digital content to the region. They attribute this to Singapore’s pro-business environment, advanced ICT infrastructure and extensive network connectivity, which have helped to attract digital content providers to deploy network capacity as well as host their content and services in Singapore.

Exhibit 7: Share of Cross-border Data Flows Through Public and Private Networks in Singapore, 2012 – 2016



Source: Telegeography Research

...reflecting in part the rising prominence of services trade that can be delivered digitally

In addition to reflecting Singapore's hub status for the distribution of digital content in the region, the increase in cross-border data flows through Singapore may also be due to the rising prominence of digitally-deliverable services trade.¹⁵ The dollar value associated with the export of such digitally-delivered services is the most direct economic value that can be ascribed to cross-border data flows.¹⁶ As such, following the framework employed by the US Department of Commerce, this section quantifies the direct economic contribution of cross-border data flows by estimating the value generated by services trade that are digitally deliverable.¹⁷

For a start, we determine the categories of services trade that are likely to be primarily delivered through digital means. The United Nations Conference on Trade and Development defines seven categories of services trade that are ICT-enabled, or digitally deliverable. These categories correspond to five broad categories of our services trade statistics as shown in Exhibit 8 below.

Exhibit 8: Digitally-Deliverable Services Trade Categories in Singapore

Digitally-Deliverable Services Trade	
Financial & Insurance Services	Includes financial intermediary and auxiliary services, commissions on financial derivative transactions, as well as the payment of insurance premiums
Telecommunications, Computer & Information Services	Includes teleconferencing services, computer software consultancy services and web design & development services
Charges for the Use of Intellectual Property (IP)	Includes charges for patents, industrial processes and designs & franchises
Personal, Cultural & Recreational Services	Includes audio-visual services and services associated with the production of motion pictures
Other Business Services	Includes a diverse range of services such as advertising and market research services, architectural design services and legal services

Notes: We are unable to determine the share of trade in these categories that are actually delivered by digital means. As such, we take the trade value of the entire services trade category (e.g., personal, cultural & recreational services) to be digitally-deliverable services trade rather than just the segments that are traded digitally (e.g., production of motion pictures). Hence, similar to Nicholson and Noonan (2014), our view is that this analysis can be interpreted as an upper-bound estimate of the value accruing to digitally-deliverable services trade.

Singapore's trade in digitally-deliverable services has grown at a faster pace compared to other digitally-ready economies

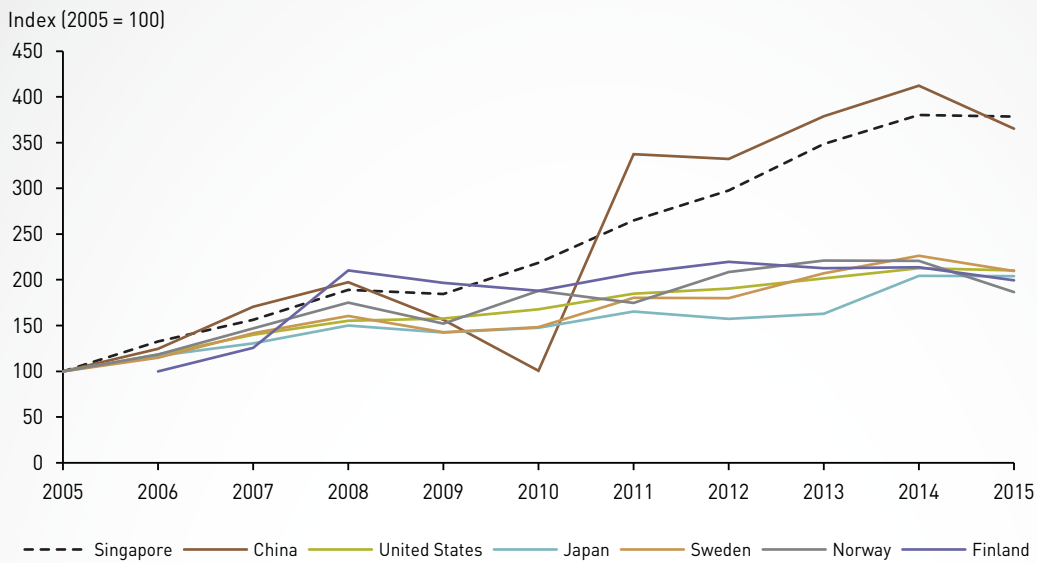
Summing up the value of trade (in nominal terms) in the above five categories, we find that Singapore's total trade (i.e., imports and exports) of digitally-deliverable services has grown at a faster pace than other digitally-ready economies. Specifically, Singapore's total trade in digitally-deliverable services (in US dollars) grew by 14 per cent p.a. from 2005 to 2015, similar to the pace of growth in China, but faster than other digitally-ready economies such as the United States (7.7 per cent p.a.) and Japan (7.4 per cent p.a.) (Exhibit 9).

¹⁵ Digitally-deliverable services trade would include the distribution of digital content in the region if a fee is involved, e.g., subscription to Apple music, purchase of cloud storage services, etc.

¹⁶ To note, a higher volume of cross-border data flows may not necessarily be associated with a higher value of services trade that is delivered digitally. For instance, the free streaming of a high-definition video that is hosted on a server located overseas may generate a large amount of cross-border data. On the other hand, the export of legal services through the internet may involve large sums of money but only generate a small amount of cross-border data.

¹⁷ This framework was used in a US Department of Commerce study by Nicholson and Noonan (2014) on "The Value of Digitally Deliverable Services". Similar to the study, our analysis does not capture digitally-deliverable data and services delivered at no price (e.g., data flows related to the use of social media services and other free online services). However, services related to the operation of these free services, such as advertising services, are included in this analysis if they are exported to other countries from Singapore.

Exhibit 9: Trade in Digitally-Deliverable Services of Selected Economies, 2005 – 2015

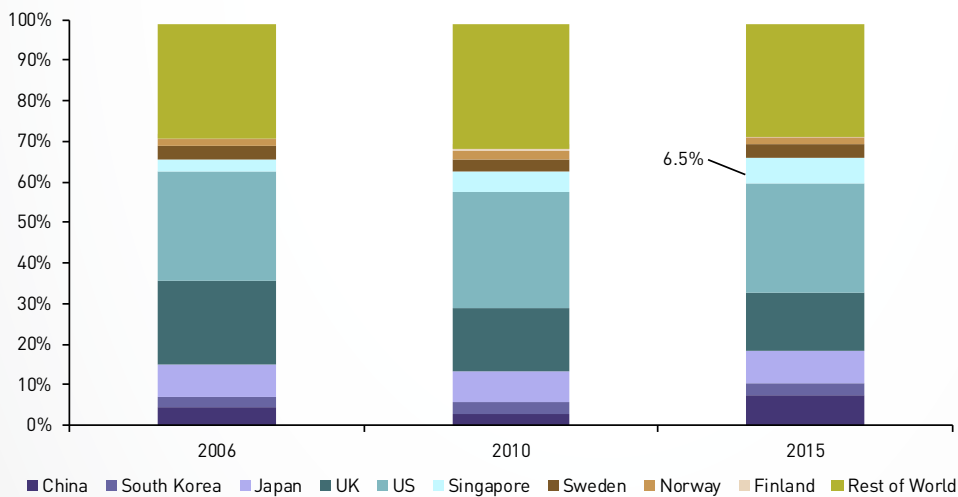


Source: World Trade Organisation Trade in Commercial Services

Notes: Data for Finland in 2005 is not available. As such, a base year index of 2006 is used instead.

Given the rapid pace of growth in our digitally-deliverable services trade, Singapore's share of the global trade in digitally-deliverable services has close to doubled, from 3.5 per cent in 2005 to 6.5 per cent in 2015 (Exhibit 10). By contrast, Singapore's share of global merchandise trade (in nominal terms) has remained stable at around 2 per cent over the same period.

Exhibit 10: Global Share of Digitally-Deliverable Services in Value Terms, 2005 – 2015



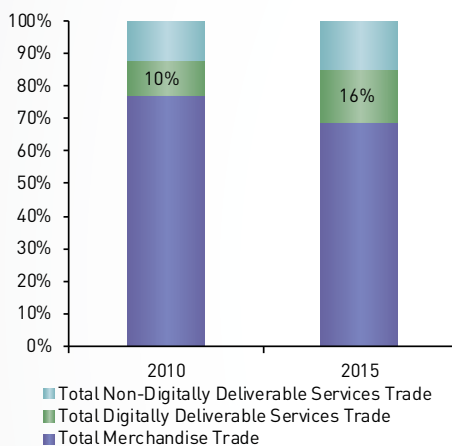
Source: World Trade Organisation Trade in Commercial Services

Notes: Data for Finland in 2005 is not available.

Within Singapore, digitally-deliverable services trade has also risen in prominence over the years, driven by the trade in financial & insurance services and other business services

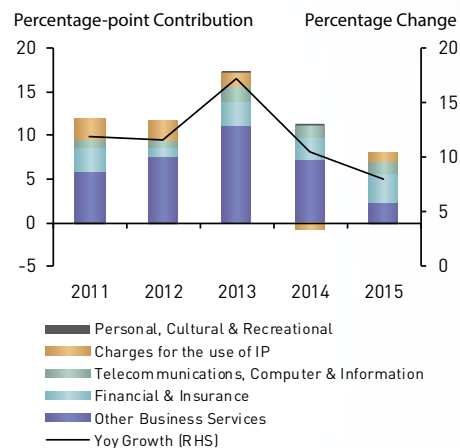
In tandem with its strong growth, the share of digitally-deliverable services trade in Singapore's total trade (i.e., comprising digitally-deliverable services trade, other categories of services trade¹⁹ and merchandise trade) has also increased, from 10 per cent in 2010 to 16 per cent in 2015 (Exhibit 11A). This increase was driven primarily by trade in the financial & insurance and other business services categories (Exhibit 11B). Collectively, these two categories of digitally-deliverable services trade grew by 13 per cent p.a. between 2010 and 2015, and by 2015, accounted for around 75 per cent of total digitally-deliverable services trade in Singapore. Underpinned by a conducive business environment and well-established ICT infrastructure, the rapid growth of digitally-deliverable services trade in Singapore is likely a reflection of our position as an attractive business location from which firms are able to operate out of to serve the region.

Exhibit 11A: Share of Total Goods and Services Trade, 2010 and 2015



Source: Department of Statistics and MTI Staff Estimates

Exhibit 11B: Decomposition of Digitally-Deliverable Services Trade Growth, 2011 – 2015



Singapore's digitally-deliverable services exports generate significant VA for our economy

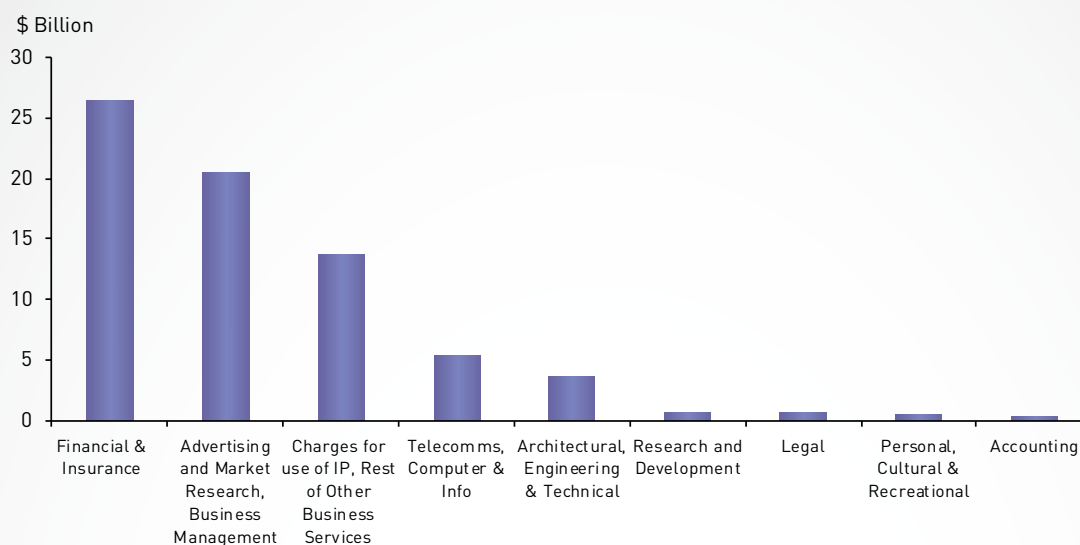
We next estimate the VA generated from digitally-deliverable services exports using the latest 2013 Input-Output Tables published by the Department of Statistics (see Annex for details on the methodology).²⁰ Our results show that the VA from digitally-deliverable services exports accounted for around 18 per cent of Singapore's nominal GDP in 2015, with financial & insurance as well as advertising and market research & business management services exports contributing the most to GDP (Exhibit 12).²¹

¹⁹ These services trade categories are those that are not primarily delivered online. Examples include tourism services, construction services, transportation services etc.

²⁰ This methodology was also used by Nicholson and Noonan (2014).

²¹ As previously noted, we are not able to determine the share of exports in these categories that are delivered by digital means. As such, this estimate can be taken as an upper-bound estimate of the direct value accruing to digitally-deliverable services exports.

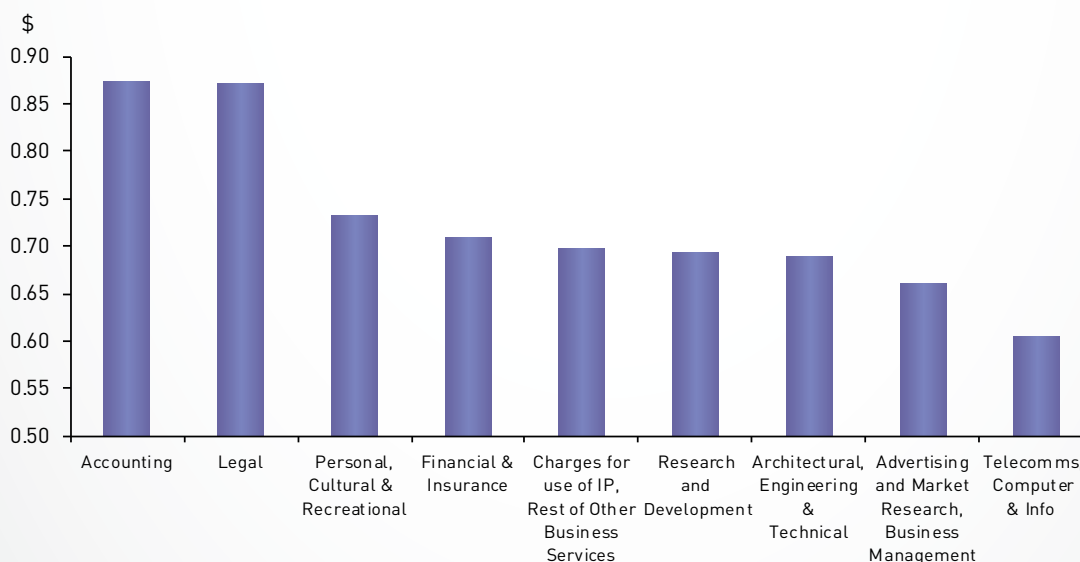
Exhibit 12: VA Contribution of Digitally-Deliverable Services Exports, 2015



Source: Department of Statistics and MTI Staff Estimates

In addition, digitally-deliverable services exports also generate higher VA per dollar of exports as compared to other forms of exports. Specifically, the VA per dollar of digitally-deliverable services exports was \$0.69, higher than that for non-digitally deliverable services exports (\$0.49) and merchandise exports (\$0.33). The higher VA that accrues to a dollar of digitally-deliverable services exports could be due to the fact that the intermediate inputs used in the production of such services exports have higher domestic content as compared to non-digitally deliverable services exports and merchandise exports, which use more imported products as intermediate inputs.²² In terms of the different types of digitally-deliverable services trade, we find that accounting and legal services exports generate the highest VA per dollar, while telecommunications, computer & information services exports generate the lowest VA per dollar among all the digitally-deliverable services exports (Exhibit 13).

Exhibit 13: VA per Dollar of Digitally-Deliverable Services Exports, 2013



Source: Department of Statistics and MTI Staff Estimates

²² This is broadly in line with the finding of an earlier study by Chan, Y. J. and Lim, Y. (2012) on an "Update on Value-added from Singapore's Exports", which noted that the VA per dollar of overall services exports in 2010 was 1.5 times as high as the VA per dollar of merchandise exports, because merchandise exports tend to use more imported products as intermediate inputs.

Conclusion

Over the years, Singapore has made significant progress in enhancing its ICT infrastructure, which forms the backbone of the digital economy. At the same time, more of our households and enterprises are also embracing the adoption of digital tools and digital capabilities. Collectively, these trends have supported the growth of the ICM sector and cross-border data flows in Singapore.

Reflecting the progress made, Singapore has been placed near or at the top of various international digital economy-related rankings. Most recently, Singapore was placed first on the World Economic Forum's Networked Readiness Index – an index that measures how well an economy uses ICT to boost competitiveness.²³ Nonetheless, there remains room for improvement. For instance, in terms of the usage of ICT by individuals and businesses, we are ranked behind the top digitally-ready economies in one of the sub-indices of the Networked Readiness Index. Towards this end, the Government will continue to assist individuals and companies to adopt and benefit from digitalisation, such as through the SkillsFuture for Digital Workplace initiative and the SME Go Digital programme.

Contributed by:

Mr Reuben Foong, Economist
Ms Ngiaw Kwee Ann, Economist
Mr Ng Woon Chian, Economist
Economics Division
Ministry of Trade and Industry

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Chan, Y. J. and Lim, Y. (2012). Update on Value-added from Singapore's Exports. *Economic Survey of Singapore, Third Quarter 2012*.

²³ The Networked Readiness Index is a composite indicator made up of four main sub-indices, namely Environment, Readiness, Usage and Impact. Under the Environment sub-index, pillars such as the political, regulatory, business and innovation environment are examined. For the Readiness sub-index, pillars such as ICT infrastructure, affordability and skills are considered. Under the Usage sub-index, the extent to which individuals, enterprises and the government leverages on ICT is evaluated. Lastly, for the Impact sub-index, the social and economic impact of ICT usage in the country are assessed.

Annex: Methodology for Estimating VA from Digitally-Deliverable Services Exports

We used a standard Input-Output (IO) open multiplier model to calculate the VA from exports to key markets based on the latest available (2013) IO tables.

Similar to previous studies by Nicholson and Noonan (2014) and Chan, Y. J. and Lim, Y. (2012), we map each digitally-deliverable export category to the 71 sectors of the IO tables. The VA multiplier for each sector, as given by the IO tables, is then multiplied to these export categories, to obtain the VA generated from digitally-deliverable services exports. For more information on the definition and interpretation of multipliers from the IO tables, please refer to the Department of Statistics' publication on the IO tables.

Our mapping of digitally-deliverable services exports to sectors in DOS' IO tables takes guidance from Nicholson and Noonan's (2014) mapping of digitally-deliverable services categories to the US Bureau of Economic Analysis' (BEA) IO tables. The mapping of digitally-deliverable services export categories to our IO tables is shown in the table below.

Digitally-Deliverable Services	IO2013 Sectors
Financial & Insurance	<ul style="list-style-type: none"> • Banking and finance • Insurance, reinsurance & pension funds • Fund management activities • Other auxiliary financial & insurance services
Accounting	<ul style="list-style-type: none"> • Accounting, tax consultancy and auditing services
Advertising and Market Research, Business Management	<ul style="list-style-type: none"> • Management consultancy, advertising and market research
Architectural, Engineering & Technical	<ul style="list-style-type: none"> • Architectural & Engineering Services
Research & Development	<ul style="list-style-type: none"> • Research & Development
Legal	<ul style="list-style-type: none"> • Legal services
Other Business Services (excluding Accounting, advertising and market research, business management, architectural, engineering and technical, research and development and legal services) and Charges for the Use of Intellectual Property	<ul style="list-style-type: none"> • Business representative offices & HQ • Other professional scientific and technical services • Rental & leasing • Real estate • Other administrative and business support services • Publishing
Telecommunications, Computers & Information	<ul style="list-style-type: none"> • Telecommunications • Computer programming, consultancy and information services
Personal, Cultural & Recreational	<ul style="list-style-type: none"> • Media entertainment • Arts, entertainment & recreation