How big is China's digital economy?

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Abstract

This paper reviews international measures of digital economy with those developed by Chinese official and private sources. Given their lack of comparability, we use China' input and output and census data to come up with an internationally comparable estimate of China's size of the Information and Communication Technology (ICT) sector (the core of digital economy), both in terms of value added and employment. Based on the latest available statistics, our measurement would indicate that China's digital economy is not bigger than OECD average, especially in terms of ICT employment. This finding, which might look striking based on the current perception of China's digital economy, masks large differences across regions (with Beijing, Guangdong and Shanghai at the forefront of OECD countries).

Key words: Digital Economy, ICT, Size

1. Introduction

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In an international arm race for innovation, the digital economy has probably been China's best showcase. The rise of several influential digital tycoons – Baidu, Alibaba, Tencent and Xiaomi (BATX) etc. – has shown the world that China is a global leader in digital innovation (OECD, 2017a). Beyond its domestic market, international statistics clearly point to China's leading role in exporting the digital goods and services. Given this background, the questions are how big is China's digital economy relative to the rest of its economy and, also, how does China compare with the rest of the world.

The importance of the question, at the international level, is reflected by the prominence of the digital economy in G-20 meetings and other international forum as well as by ongoing work by OECD and IMF, among others (G20, 2017). At the national level, the Chinese government, through its statistical agency, National Bureau of Statistics (NBS), has embarked on a bold project of measurement of China's new economy and, within that broad measure, that of the digital economy. While there is no official measurement so far, NBS has reported a Digital Economy Index as a subsection of a broader self-defined New Economy index (China NBS, 2017a). Such narrow index points to a very rapid growth, in line with other similar indices compiled by the private sector, in particular the Caixin digital economy index (Caixin, 2017).

In this paper, we first review current practice in the measurement of the digital economy at the international level and move to China's own efforts. We then show that, so far, no comparison can really be made between internal measures for the size of the digital economy and China's own indices relative to the other activities. To fill that gap, we develop our own estimate of China's digital economy, understood as the size of the Information and Communication Technology (ICT) sector. To that end, we match the standards of International Standard Industrial Classification of All Economic Activities (ISIC) with Chinese ones using China's input-output sectoral. In addition, we also measure how much of the employment takes place in the ICT sector.

Our results show that, compared with the OECD countries, China has been below OECD average in terms of value added and employment share of the digital economy. While relevant, for their comparability with other countries, these results should be taken with caution as the available Chinese data is somewhat dated (IO table only for 2012 and Population Census only for 2010) and the digital economy has developed very fast in the last few years. This, however, is also the case for comparable measurements for other countries so the question remains as to whether China's digital economy has developed much faster than those of other countries in the past few years. As a way to corroborate the OECD's findings on the rapid development of China's digital economy, we use the official value added growth rate information for ICT manufacturing firms to estimate the ICT value added for subsequent years. Notwithstanding our conclusion of a narrowing gap between China's size of the digital economy and OECD average, we confirm that China's size remains below the OECD average.

Also, considering only the national level of China's digital development may mask its key importance for the country. First, China is a developing country with dual characteristics, that is, a large proportion of rural employment, which cannot be absorbed in the digital sector. Second, labor productivity in the digital sector relative to the country average is higher in China than the other OECD countries, meaning that digital sector is leading Chinese economy more than the others. Third, there are several regions in

China such as Beijing, Shanghai and Guangdong that have shown very strong digital growth. The relatively low level of digital development is actually dragged down by some low-development provinces such as Tibet, Yunnan and Guizhou.

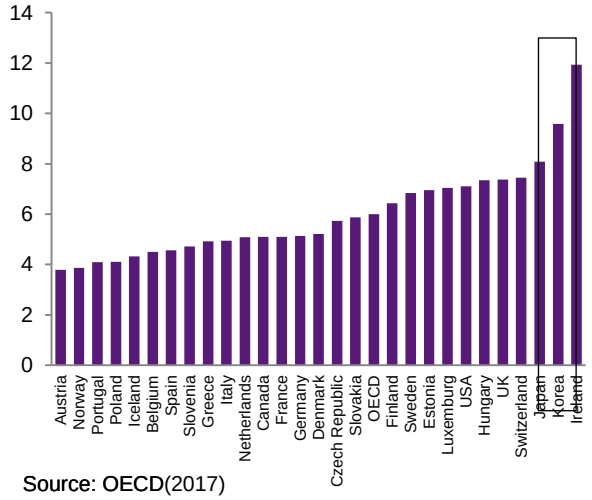
All in all, digital economy plays a key role in Chinese economy. Although digital development is not higher relative to the OECD countries, the latest data so far seems to suggest its great potential for Chinese economy. To better showcase the true development, better measurement with international consistency is an urgent task facing Chinese statistic officials.

2. What international measures of the digital economy tell us about China?

International efforts to measure and compare the size and growth of digital economy are only started recently. In the G20 Digital Economy Ministerial Declaration, IMF and OECD is tasked to working on a program to analyze the impact of digitalization on measures of GDP (2017). An earlier attempt was also made by OECD in a series of publication on the digital economy outlook (OECD, 2012, 2015, 2017).

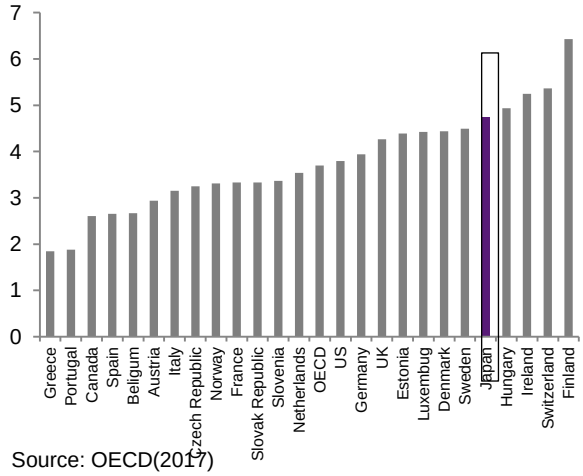
Despite these analyses, the size of digital economy has been so far only officially reported in some developed countries, such as Japan and Korea. In both cases, the reported share of value added in information and communication technology (ICT), a core activity of digital economy, as percentage of total value added is among the highest in OECD countries. Unfortunately, no comparably related information exists for China.

Chart 1 Value-added of digital economy, % of total (2011 for OECD and 2012 for China)



Source: OECD(2017)

Chart 2 Employment in the ICT sector, % of total (2011 for OECD and 2010 for China)

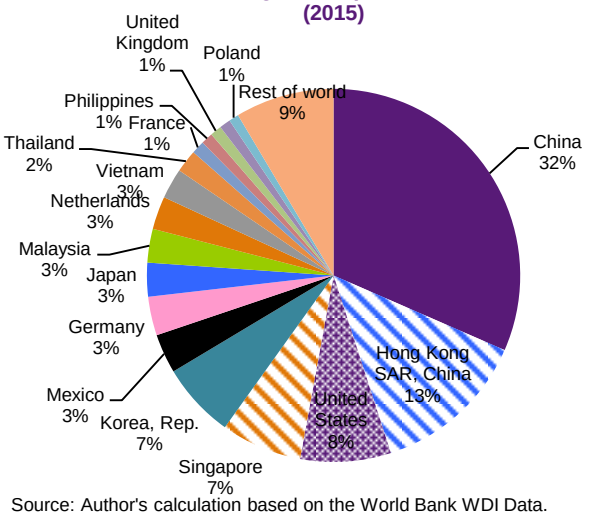


Source: OECD(2017)

The only internationally comparable data available for China in the OECD Digital Economy Outlook relates to ICT exports (OECD, 2015). It shows that China is a leading power in the gross exports of ICT goods. Our calculation using the latest trade data from World Bank WDI database confirmed this by

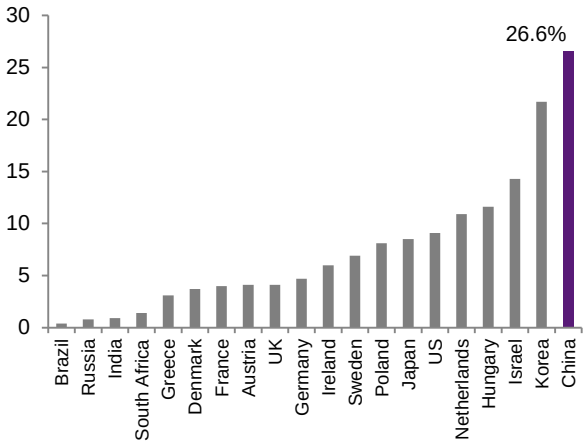
showing that the value of ICT goods exported by China reached 550 billion USD in 2015, equivalent to 26% of total exports.

Chart 3 ICT goods exports % of world total ICT goods exports (2015)



Source: Author's calculation based on the World Bank WDI Data.

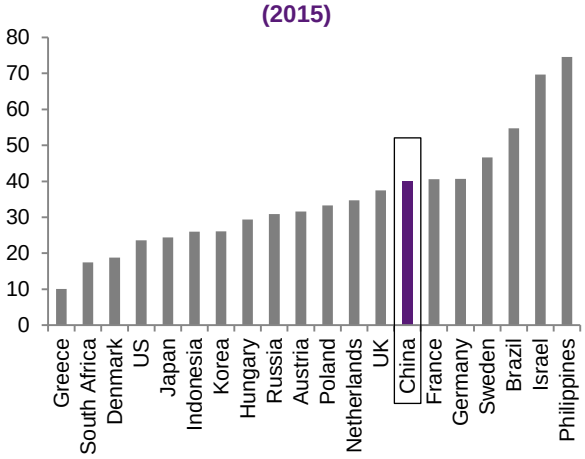
Chart 4 ICT goods exports % of the country's total goods exported (2015)



Source: Author's calculation based on the World Bank WDI Data.

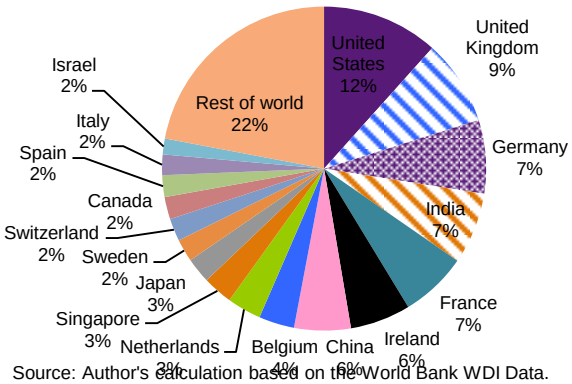
ICT also plays an important role for China's exports of services, accounting for 40% of China total exports of services. This share is higher than that of Japan or the US (Chart 5) although lower than the Philippines, Israel, Brazil, Sweden, Germany and France. This translates in China's share of ITC service exports remaining quite small (6% of total as shown in Chart 6).

Chart 5 ICT services exports % of total services exports by country (2015)



Source: Author's calculation based on the World Bank WDI Data.

Chart 6: exports of ITC services as % of world total ICT service exports (2015)

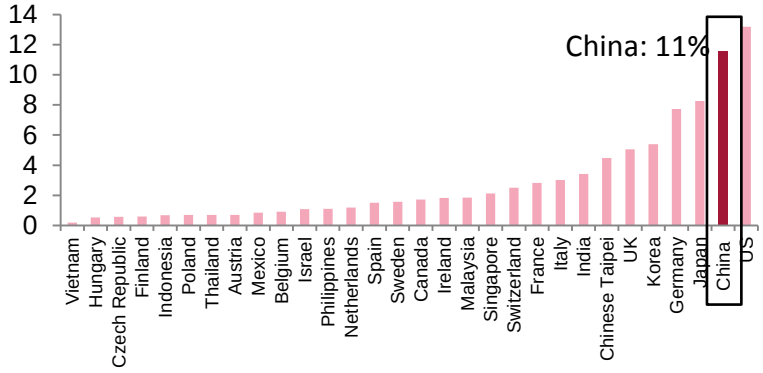


Source: Author's calculation based on the World Bank WDI Data.

While comparable data on ITC exports looks quite promising, it is not enough to offer a full picture of the size of China's digital economy. This is particularly the case when focusing on the value added of the digital economy as ICT manufacturing products are assembled in – and exported from - China but

with a good part of its value added produced elsewhere. It turns out that China's value added in the foreign demand for ITC exports are only half of total ITC exports (Chart 7), which brings China down in terms of global share of ITC exports, right below the US (with 11% global market share).

Chart 7 ICT exports value-added, % of world total (2012)



Source: OECD(2015), page 93, figure 2.12

The marked difference between ITC gross export and ITC exports in value added point to the importance of using value added data to estimate the size of the digital economy in China. We now move to the attempts made by Chinese official and use our available source to measure the size of China's digital economy in China.

3. Official and private attempts to measure of China's digital economy

During its G20 presidency in 2016, China supported global efforts to agree on a definition of the digital economy within the *G20 Digital Economy Development and Cooperation Initiative*. Based on that global initiative, the digital economy refers to "a broad range of activities that include using digitalized information and knowledge as the key factor of production, modern information networks as an important activity space, and the effective use of ICT as an important driver of productivity growth and economic structure optimization".

However, when it comes to the actual measurement of digital economy, the consensus among exports is much less clear and this is also the case in China. The mainstream voice aired by the Chinese National Bureau of Statistics (NBS) claims that the sectoral based analysis –adopted in many OECD countries - may ignore the fact that only some products of a sector are linked to digital economy while others not. This is why NBS has started to move to product-level data within some relevant sectors. In other words, China's NBS believes a better strategy is to also measure the digital economy at the product level (China NBS, 2017b). While relevant, there is no doubt that measuring the digital economy at the product level is very ambitious, as product information is not widely available for all sectors. It is reported that some internal trials on product-level measurement of the digital economy have also been made but no further details are revealed so far (China NBS, 2017c).

In the meantime, China's NBS has been focusing on measuring the so-called New Economy, partly as a response to the government's long-lasting strategy to develop strategically important sectors and

increase the relative size of the "new" economy. Although the New Economy is a much broader concept than the digital economy, with even traditional Chinese medicine and environmental protection sectors included, the digital economy is treated as a sub-index of NBS's measurement of the New Economy. sectors is nonetheless included as a subsidiary. According to the first "New Economy" Report published by China's NBS on August 2017, Chinese NBS introduced its statistical method for value added of the New Economy (China NBS, 2017d). There are three basic methods – direct measurement method, value added ratio extrapolation method, proportion method – that are adopted in the measurement with application to different economic activities according to their availability of data (Table 1). Because NBS has not published specific methodology of measuring digital economy, we believe the same methodology for New Economy could be also applies to digital economy from the official perspective.

Table 1 "Three NEWs" (New Industry, New types of business and New business models) value added computation methods

Method		Formula		Scope of application
Direct accounting method	Directly compute by production approach or expenditure approach	Production approach: Value added = Final output – Intermediate input	Expenditure approach: Value added = Payroll expenses + Net production tax + PPE depreciation + Retained earnings	Applicable to industries with more detailed financial information, for example, industrial strategic emerging industry, high-tech manufacturing, and financial service industry.
Value added ratio estimation method	Estimate from total output and value added ratio	Value added = Total output × Value added ratio (value added ratio is computed from economic census or related statistical surveys.)		Applicable to industries with less detailed financial information but statistical reports that reveal output of "Three New" production activities, like other new service industry, high-tech service industry, technology business incubator, e-commerce, city business complex, national economic and technological development zones, etc..
Proportional computing method	Estimate by the proportion of respective industry output of total output	Value added = Respective industry value added × ("Three NEWs" output ÷ Respective industry total output) (the share of "Three NEWs" output in respective industry total output is computed from economic census or related statistical surveys.)		Applicable to industries with no detailed financial information but economic census or related statistical surveys that show the proportional output, like strategic emerging service industry.

Source: China NBS(2017d).

Despite the heated discussion in methodology, no official data has ever been released regarding either for the New Economy Index or digital economy. On the August's report, the NBS only released an index characterizing the growth rate of the New Economy including a related sub-index measuring digital economy. The methodology for the official digital economy index is much simpler compared with the previous official methodology discussion, which used an alternative Big Data method to construct the measure from the users' perspective. The digital economy index only includes five specific measures: internet broadband access users, mobile internet users, mobile internet access traffic, e-commerce transaction, the share of online retail sales over total retail sales. The official results show that the annual growth rate for digital economy was nearly 40 percent in 2015.

Table 2: Compare China's digital economy coverage with OECD

OECD Measurement	**China: Caixin Digital Economy Measurement**	**China: NBS Digital Economy Index Measurement**
Manufacturing activity: 1. ISIC (Rev. 3.1) 3000 – Office, accounting and computing machinery	CIC 6510 - Software development CIC 6520 - Information technology	1. Internet Broadband access users 2. Mobile internet users

2. ISIC (Rev. 3.1) 3130 – Insulated wire and cable 3. ISIC (Rev. 3.1) 3210 – Electronic valves and tubes and other electronic components 4. ISIC (Rev. 3.1) 3220 – Television and radio transmitters and apparatus for line telephony and line telegraphy 5. ISIC (Rev. 3.1) 3230 – Television and radio receivers, sound or video recording or reproducing apparatus, and associated goods 6. ISIC (Rev. 3.1) 3312 – Instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process equipment 7. ISIC (Rev. 3.1) 3313 – Industrial process equipment Service activity: 1. ISIC (Rev. 3.1) 5151 – Wholesale of computers, computer peripheral equipment and software 2. ISIC (Rev. 3.1) 5152 - Wholesale of electronic and telecommunications parts and equipment 3. ISIC (Rev. 3.1) 6420 - Telecommunications 4. ISIC (Rev. 3.1) 7123 - Renting of office machinery and equipment (including computers) 5. Computer and related activities.	service activities (1) information integration, (2) information consulting (3) data store and processing (4) Digital game/movie and software service (5) client interactive service	3. Mobile internet access tranffc 4. e-commerce transaction 5. The share online retail sales over total retail sales

Source: OECD(2015), Caixin (2017), China NBS (2017a).

The NBS is not the only institution calculating China's development in the digital economy. Another famous institutions – Caixin, has also reported its own version of the digital economy. Caixin uses section 2.3 of the official Classification of Emerging Sectors of Strategic Importance published by NBS in 2012 to define the digital economy sector (China NBS, 2012). It actually includes only two key sectors that are related to digital economy: high-end software development sector and new information technology service (Table 2). Moreover, Caixin adopted the standard production function method, with measurement on capital, labor and innovation inputs respectively, as a base to estimate the development of digital economy. Nearly all of Caixin's measurements on the inputs are collected through Big Data Analysis. For example, the wage and employment data are measured through cooperation with an anonymous online job-seeking platform. The Caixin digital economy index presents an even brighter picture than the official one. According to its index, the digital economy has experienced 176% of increase from Jan. 2016 to Apr. 2017.

Table 3: Caixin's method and data source for the estimation of digital economy index

Estimation method – Production estimation

$$\boldsymbol{lnDigital\ Economy = \alpha \cdot Labor + \beta \cdot Capital + (1 - \alpha - \beta) \cdot Technology\ Innovation}$$

Labor Input (α: 40%)	**Capital Input (β : 40%)**	**Technology Innovation ($1 - \alpha - \beta$: 30%)**
1. Digital sector average wage relative to total social average wage 2. Position available in the digital sector relative to all positions available	1. Proportion of venture capital in the digital sector 2. Proportion of auction 3. Proportion of the firms' registered capital 4. Proportion of newly registered capital in the digital sector	1. The share of researchers in the digital sector (Source?) 2. The share of new inventions and patents in the digital sector (Source?) 3. Patent conversion rate in the digital sector (Source?)

Source: Caixin(2017)

Although these results from indices are promising and seem to be consistent with the OECD's analytical judgement via exports and R&Ds data on China's digital development, it seems not comparable with the OECD standard of measuring ICT sector. Moreover, one cannot yet estimate of how large the digital economy is relative to the total scale of Chinese economy.

4. Our own measurement of China's digital economy

To fill the gap of measuring digital economy in a comparable method with respect to the OECD countries before official statistical announcement, we try to use the officially publicly available data to characterize the size of digital economy for China. Specially, we rely on two types of data – China's input-output table (2012) and China's Population Census (2010) – to do calculation for value added and employment following the OECD methodology. The cross-sectional characteristic of the two data means that we can only draw a static conclusion for China's digital economy, so this can be taken as only an addition to the previous two measures capturing the growth rate of the digital economy.

- The input-output table is the only data source that provides value added information on narrowly defined sectors, even for the service sector but the latest one was in 2012. To the best of our knowledge, all the other data sources in China either only provides value added information for industrial sector, or measures service value added with a very broad classification which makes it impossible to disentangle the digital activities.
- The Population Census, conducted every ten years, is probably the most reliable source to characterize employment activities in China at narrowly defined sectoral level. It also identifies one person's employment status.

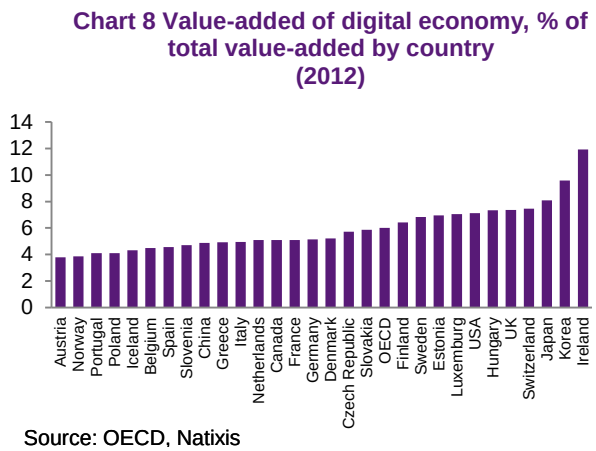
However, even with the availability of the database, the calculation regarding digital economy is not easy. Specially, Chinese industry classification does not follow the international standard – ISIC, or NACE, etc. To make our estimate as close as to the definition of the OECD, we choose to select the sectors that most matches the OECD definition and classify the following sectors as digital sectors: (1) Digital manufacturing goods: office, accounting and computing devices; telecommunication devices; measuring devices; electronic and optical products; computer; (2) Digital services: telecommunication service; software and information service. The comparison of our definition with that of the OECD is shown in table 4.

Our classification for China	OECD definition for ICT
1. Culture and office machinery 2. Computer	1. ISIC (Rev. 3.1) 3000 – Office, accounting and computing machinery
3. Wire, cable and related apparatus	2. ISIC (Rev. 3.1) 3130 – Insulated wire and cable
4.Telecommunication devices	3. ISIC (Rev. 3.1) 3210 – Electronic valves and tubes and other electronic components
5.TV broadcast, radio and radar devices Video devices	4. ISIC (Rev. 3.1) 3220 – Television and radio transmitters and apparatus for line telephony and line telegraphy 5. ISIC (Rev. 3.1) 3230 – Television and radio receivers, sound or video recording or reproducing apparatus, and associated goods
6.Measurement devices	6. ISIC (Rev. 3.1) 3312 – Instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process equipment
7.Electronic process equipment	7. ISIC (Rev. 3.1) 3313 – Industrial process equipment
8.Electronic and telecommunication services	8. ISIC (Rev. 3.1) 5152 - Wholesale of electronic and

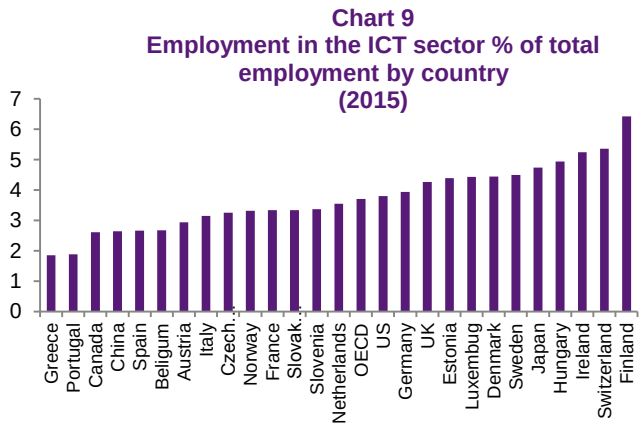
	telecommunications parts and equipment 9. ISIC (Rev. 3.1) 6420 – Telecommunications
9.Software and information technology services	10. ISIC (Rev. 3.1) 5151 – Wholesale of computers, computer peripheral equipment and software 11. ISIC (Rev. 3.1) 7123 - Renting of office machinery and equipment (including computers) 12. Computer and related activities.

Source: OECD(2015), China's 2012 Input-Output Table.

Chart 8 and 9 reports our estimates under the premise in terms of value added and employment respectively. Different from what OECD's export and R&D measures have shown, both the value added (4.8%) and employment (2.6%) share of the ICT sector is lower than the OECD average (6% and 3.7%), and fall far behind Japan. The result is more consistent with the OECD estimates of domestic value added embedded in exports for China, which shows a much lower ratio than the gross exports. In other words, China seems to produce more ICT products, but the value added and employment invested in the digital economy is less strong.



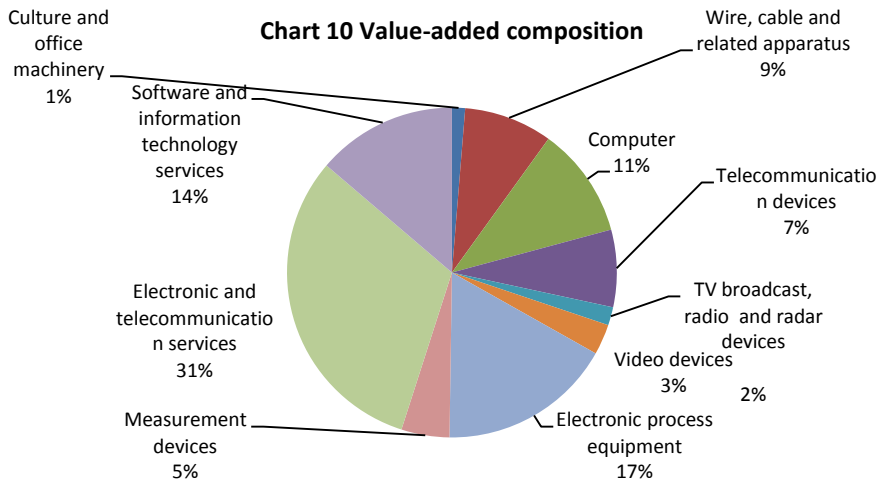
Source: OECD, Natixis



Source: OECD, Natixis

However, this does not necessarily mean a less developed digital sector in China. After all, the country is a low-income developing economy with vast heterogeneity across the country – annual GDP per capita is still 8123 dollar and rural population accounts for 43 percent of the total population, both which do not lay strong economic basis supporting the development of digital economy. If we only consider the share of digital employment in the urban sector, the share will reach 4.53 percent, significantly higher than the OECD average level.

Another feature of China's digital sector is its concentration on manufacturing activities. Manufacturing production, such as electronic, computer and telecommunication devices amount to about 55 percent of total value added in China's ICT sector. In turn, service activities only contribute to 45 percent of total value added of ITC sector. This implies that China's digital economy is still deeply rooted in manufacturing. Moving forward, China transformation towards a more service-oriented economy should also push ITC services further.



Moreover, China's labor productivity in the ICT sector is about 1.8 times higher than its average labor productivity, whereas the OECD labor productivity in the digital sector is only 1.6 times higher than the average. In other words, digital sector is contributing more to its economic growth than the OECD countries (chart 10). Moreover, the low national level also masks the unequal development of digital sectors within China. In terms of ICT employment share, leading cities such as Beijing, Shanghai and Guangdong have already shown very high ratio - 8.4%, 8.2% and 7.9%, exceeding nearly all major OECD countries, but the low national level is nonetheless dragged down by the much less developed regions such as Tibet and Guizhou whose employment share in the ICT sector is even less than 0.1% (Chart 11 and 12).

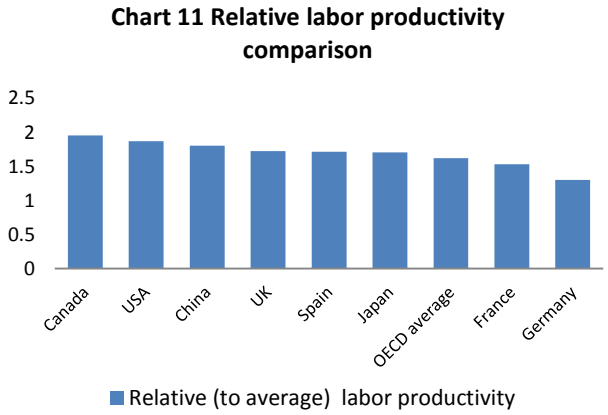


Chart 12 ICT share of employment

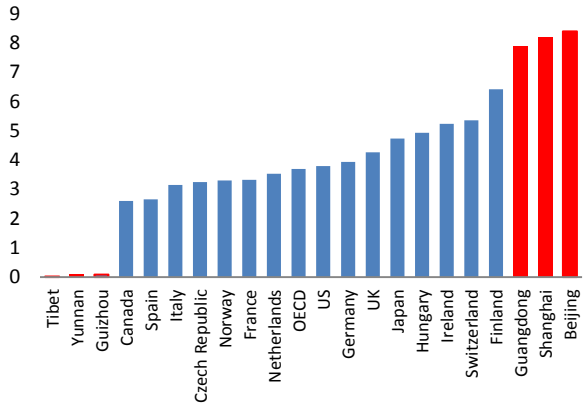
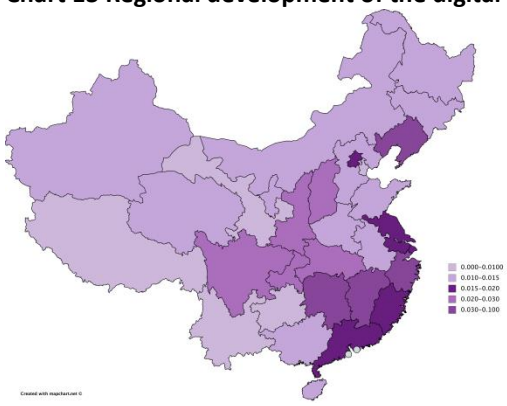


Chart 13 Regional development of the digital sectors

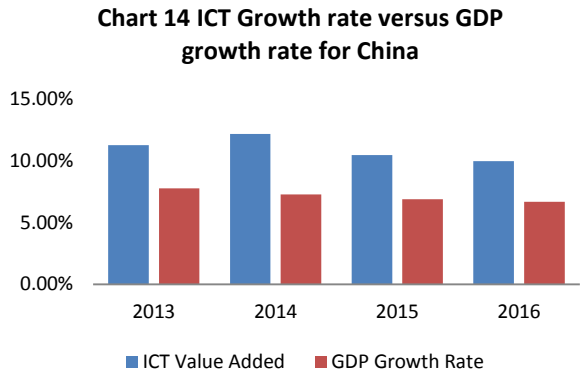


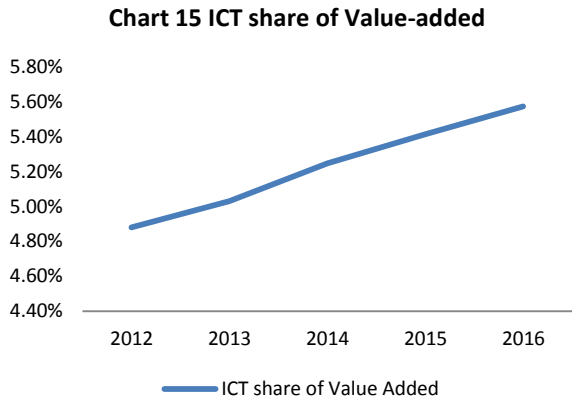
5. Recent developments in China's digital economy

One of the most obvious challenge to our finding of a relatively small size of China's digital economy is that we can only measure the value added of the ICT sector as early as 2012. While this is also true for the rest of countries in the OECD sample, making our findings for China comparable with the rest, it is also true that China's progress seems to have been very rapid based on the emergence of giant high-tech companies. In fact, the indices developed by China's NBS and Caixin point to annual growth rates since 2016 between 40 for the former and 176 percent for the latter. However, such growth rates do not answer the question of the size of China's digital economy as they are indices and are not even expressed in terms of value added. In addition, they are non-standard in the sense that compiled using big-data analysis.

Within this context, and with the already described data constraints, we address the issue of the change in the size of China's digital economy. To that end, we choose a narrower definition of value added in the ICT sector, namely the ICT manufacturing value for industrial firm, as reported by China's Ministry of Industry and Information Technology, and we calculate the growth rate. This indicator has two clear weaknesses compared to the more general estimates of ICT value added used before. First, it is only a measure of manufacturing firms; i.e., it excludes all service activities. Second, only enterprises with total sales above 20 million RMB are included in this data set.

Using that narrower dataset, we conclude that, from 2013 to 2016, China's ICT value added growth rate has hovered above 10 percent whereas the average GDP growth rate declined from 7.8 percent to 6.7 percent, echoing our previous finding that the digital sector is indeed leading Chinese economy. If we take the value added for ICT sector and other sectors in 2012 as given, and apply this growth rate for the subsequent four years, we can confirm that the ICT sector has increased its size significantly (Chart 15) reaching 5.6 percent in 2016. Despite this apparent progress, we should point out that the current level is still lower than the OECD average of value added share (6%) in 2012.





6. Conclusion

This paper reviewed existing discussion on China's measurement of digital economy, briefly introduce the current practice in the measurement, and propose our own estimates on the actual size of China's digital economy versus the other OECD countries. With a carefully matching methodology as close as to the ISIC standard, we calculate the value added and employment share of the ICT activities and compare it with the OECD countries. The results show that China is still below the average of OECD's development in the digital sectors both in terms of value added and employment share.

However, there will be strong potential in the digital sector in China. First, China still has a large pool of rural employment. Given that digitalization is much higher in the urban sector, the country's digital share will continue to rise with the process of urbanization. Second, the digital sectors' relative labor productivity is higher in China than the OECD average, implying its more important role in enhancing its role in boosting the economy. Third, the development is unevenly distributed in different regions, with the developed regions such as Beijing and Shanghai see even higher share than the OECD countries but the least developed regions quite lagging behind. If the leading digital development spill over to the other regions, a new round of high-tech development is expected to emerge in the future.

Last but not the least, we attempt to obtain a more recent proxy of China's digital economy by narrowing the definition to the manufacturing sector for which data is only available. We find that, even if the growth of China's manufacturing ICT sector is very fast, China's ICT share of value added is still very likely to be below OECD average in 2016. In other words, China is still catching up in their ICT development with the developed world.

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