CLOUD COMPUTING, CROSS-BORDER DATA FLOWS AND NEW CHALLENGES FOR MEASUREMENT IN ECONOMICS

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When economists talk about 'measurement' they tend to refer to metrics that can capture changes in quantity, quality and distribution of goods and services. In this paper we argue that the digital transformation of the economy, particularly the rise of cloud computing as a general-purpose technology, can pose serious challenges to traditional concepts and practices of economic measurement. In the first part we show how quality-adjusted prices of cloud services have been falling rapidly over the past decade, which is currently not captured by the deflators used in official statistics. We then discuss how this enabled the spread of data-driven business models, while also lowering entry barriers to advanced production techniques such as artificial intelligence or robotic-process-automation. It is likely that these process innovations are not fully measured at present. A final challenge to measurement arises from the fragmentation of value chains across borders and increasing use of intangible intermediate inputs such as intellectual property and data. While digital technologies make it very easy for these types of inputs to be transferred within or between companies, existing economic statistics often fail to capture them at all.

Keywords: cloud computing, economic measurement, data flows, productivity, national accounts.

JEL codes: E01; L86; D24.

1. Introduction

When economists talk about 'measurement' they tend to refer to metrics that can capture changes in quantity, quality and distribution of goods and services. In this paper we will argue that the digitalisation of the economy, manifested in trends such as the rise of cloud computing and data-driven business models, can pose serious challenges to traditional concepts and practices of economic measurement. We present some data to underpin our arguments and discuss what can be done to improve economic measurement, reflecting digitalisation.

Cloud computing has been described by some commentators as a new 'general purpose technology' that will change the way we live and conduct business (Etro, 2009), just as telecommunication technologies and the internet did before. Broadly speaking, cloud computing refers to the use of computing services accessed remotely via the internet. As a consequence, there is a physical separation between the user of these services and the hardware used to provide them. From the perspective of businesses, there is a shift from investing in on-premise IT equipment to purchasing cloud-based services. Cloud providers on the other hand construct large and efficient datacentres, which in principle can serve customers beyond national boundaries. This allows them to decrease unit costs and lower prices over time, as well as provide flexible and technologically sophisticated services. Moreover, using cloud-based software can be a cost-effective and easy way for companies to get access to advanced tools such as artificial intelligence (AI), internet-of-things (IoT) and digital twins,[1] or robotic process automation (RPA).[2] In principle this enables them to (re-)focus on their core business, without the need to hold specific expertise and capabilities related to IT.

We argue that the rise of cloud computing poses more fundamental challenges to the way we measure economic activity (Coyle and Nguyen, 2018). First, it is related to the rise of intangible assets as the basis of value creation (Haskel and Westlake, 2017; Coyle, 1997), including data and intellectual property. Second, the global transferability of these assets means they can also be held in multiple locations simultaneously. From the perspective of business accounting as well as national

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accounts this creates ambiguity in terms of attributing economic output to a specific geography or national entity.

Industry estimates indicate that the use of cloud services is increasing rapidly. Global sales of cloud computing services are expected to exceed $200 billion in 2019 (Gartner, 2019). The main players in the cloud infrastructure and platform market are Amazon, Microsoft, and Google, while in the cloud-based software market there is additional competition from established players such as SAP, Oracle and Adobe, but also Salesforce, Workday, Box, Slack, Zoom, Shopify and Mulesoft.

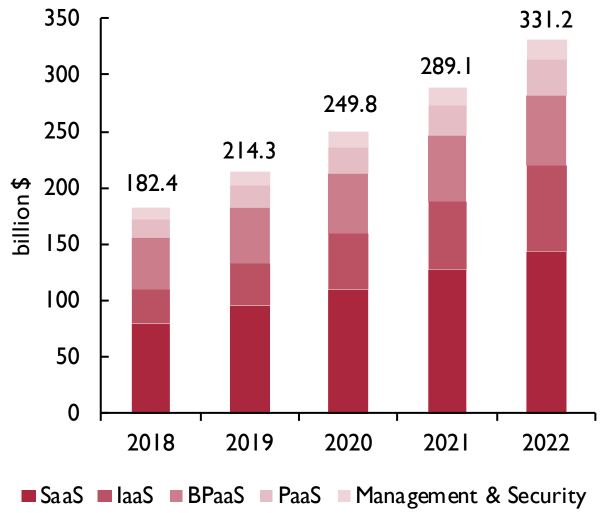
In the first part of this paper we discuss the issue of measuring rapidly falling prices of cloud services and increasing product diversification and changes in quality over time. We show how web-scraped data can be used to create a simple price index, and discuss what additional data are needed to fully track cloud computing in the national accounts. We then turn to the broader issue of intangible inputs and data as well as cloud-based advanced production technologies, as key inputs in a firm's production function. We then show that digital multinational enterprises, which rely on cross-border data flows to generate revenues, are more likely to hold their assets at home when compared to non-digital multinationals.

2. Measuring cloud computing services

2.1 The cloud: a large and growing market

Businesses use cloud computing services for a variety of reasons. One key reason is to save on costs of purchasing, installing and maintaining hardware and software. While cloud providers still need to build, maintain and secure their datacentres, they can do so more efficiently due to economies of scale and specialisation. It allows them to offer lower unit costs, e.g. per computing hour or per terabyte stored. Another key advantage is that cloud services can be purchased 'on demand' meaning that they can be scaled flexibly according to current business needs (such as a sudden drop or surge in demand). Similar to the 'peak load problem' in electricity or transport markets (Steiner, 1957), this also means that the aggregate amount of IT equipment can be optimised, making economies more efficient overall. Other advantages include the fact that users can access services from anywhere with an internet connection, as well as higher reliability, security and performance due to regular updates of hardware, software and security measures.[3]

Figure 1. Global cloud market forecast

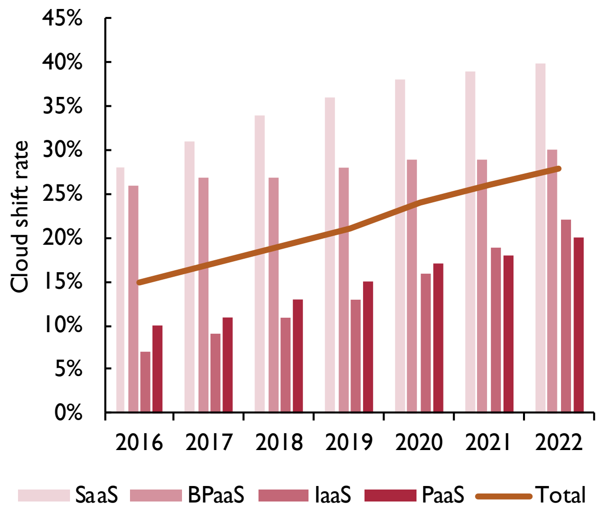


Source: Gartner Research, Press Release 2 April 2019: https://www.gartner.com/en/newsroom/press-releases/2019-04-02-gartner-forecasts-worldwide-public-cloud-revenue-to-g.

According to industry estimates, the global market for cloud computing services reached US$182 billion in 2018 (figure 1), meaning it is comparable in size to the global consultancy market.[4] More importantly, the cloud market is predicted to grow to $330 billion in annual revenues by 2022. These figures are large, which makes it somewhat surprising that there is a lack of research and public data on who is purchasing what types of cloud services, and their volume, prices and locations. Cloud services are usually divided into services related to IT infrastructure (i.e. Infrastructure-as-a-Service, or IaaS), platform provision (i.e. platform-as-a-service, or PaaS), access of software (i.e. software-as-a-service, or SaaS) and outsourcing of business processes (i.e. business-process-as-a-service, or BPaaS). In terms of revenues, the largest segments are SaaS and IaaS which make up around two-thirds of total cloud expenditure.

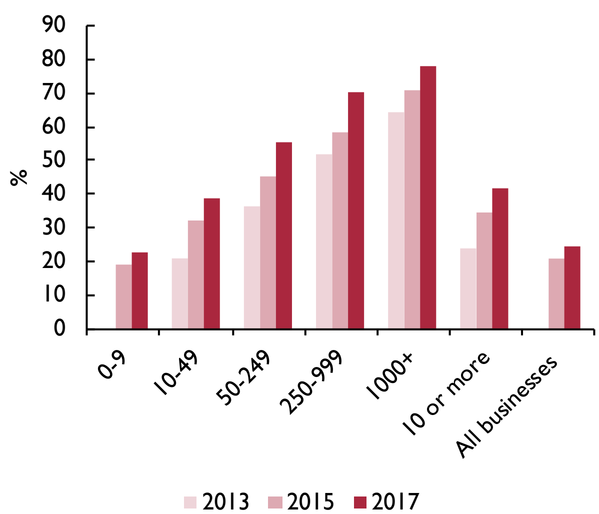
In figure 2 we show that the use of cloud services is gaining a larger share of total global expenditure on IT services. The graph shows how the 'cloud shift' has increased from around 15 per cent of total IT expenditure in 2016 to almost 20 per cent in 2018. It is projected to increase further to almost 30 per cent by 2022. This also demonstrates that considerable strategic and technological changes in business organisation are underway. We also see that some IT functions are more likely to get shifted to the cloud than others, for example software (SaaS) and business processes (BPaaS). In a way this is intuitive as these services are 'intangible', while

Figure 2. Global cloud shift of IT expenditure, 2016–22



Source: Gartner Research (2018), https://www.gartner.com/en/newsroom/press-releases/2018-09-18-gartner-says-28-percent-of-spending-in-key-IT-segments-will-shift-to-the-cloud-by-2022.

Figure 3. Share of businesses that bought any cloud computing service by business size, 2013–17



Source: E-commerce Survey, Office for National Statistics.

tangible on-premise hardware related to infrastructure (Iaas) and platforms (Paas) tends to have a longer legacy.

Looking at the distribution of cloud adoption in the UK by firm size confirms that larger firms are more likely to purchase cloud services (figure 3). In 2017, almost 80 per cent of firms with more than 1,000 employees bought some type of cloud service. The comparable figure is 42 per cent for firms with more than ten employees, which is significantly higher than the 24 per cent in 2013. However, some services are more widely used than others. For example, while a third of companies with more than ten employees purchased cloud-based storage solutions or office software, this figure decreases to 1 in 5 for database services, 1 in 7 for CRM software and 1 in 9 for computing capacity (ONS, 2018).

The ONS (2018) reports that differences also exist at the industry sector level, with 80 per cent of businesses in the ICT sector purchasing cloud services, 45 per cent in Wholesale trade and 39 per cent in Manufacturing (both double their proportion compared to 2013). At the lower end, only 19 per cent of businesses in the Accommodation & Food Services bought cloud services, which is only marginally higher than in 2013.[5]

2.2 Falling prices and increasing sophistication of cloud services

As businesses are shifting capabilities to the cloud it becomes necessary to track developments in prices and quality of what used to be physical goods and are now essentially services. To complicate matters further, these services are sold remotely and on-demand by a few large players that have a strategic interest in not publishing their sales volumes by country and product category. While in the past one could simply 'count' the number of PCs, servers and switches that were sold, and broadly track improvements in quality related to physical characteristics, this is much more difficult with services sold online and across borders. However, information on prices, volumes and quality are necessary to deflate them properly in the national accounts and failure to do so can lead to issues of 'vanished capital' (Coyle and Nguyen, 2018).

Following Byrne, Corrado and Sichel (2017), we use information on prices for key storage and computing products from Amazon Web Services (AWS) and compute a simple price index that accounts for changes in quality. We focus on AWS as it is the undisputed market leader in IT-infrastructure related products (see figure 4), which include computing (i.e. 'virtual machines') and storage. Focussing on the market leader is appropriate since it has been reported that competitors match prices to gain market share.[6]

For the computing products category we opt to track the Elastic Compute (EC2) product, while for cloud-based storage we opt for the standard S3 product. Both were introduced on the European market in 2008 via the

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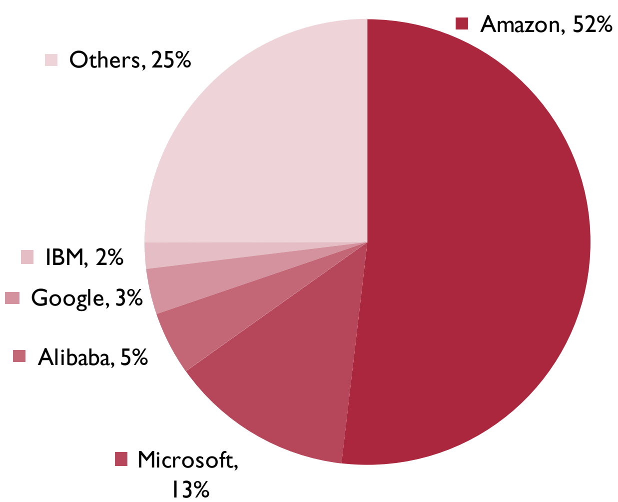
Figure 4. Global public IaaS market share by cloud provider, 2017

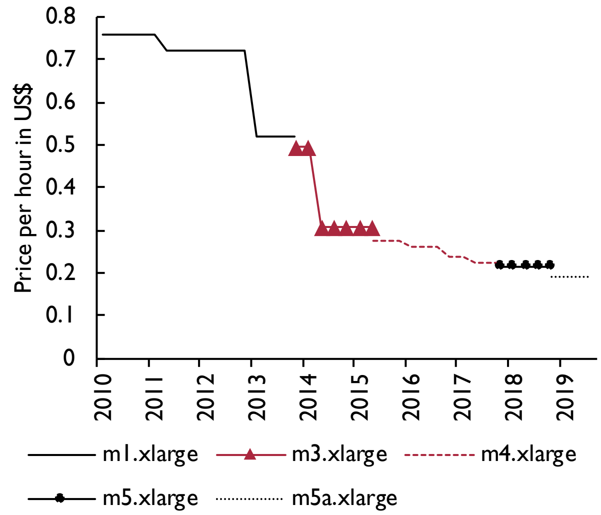


Source: Gartner Research, 2017, https://www.gartner.com/en/newsroom/press-releases/2018-08-01-gartner-says-worldwide-iaas-public-cloud-services-market-grew-30-percent-in-2017.

Dublin datacentre and are reported to be among the most widely used AWS products, according to market analysts *2nd Watch*.[7] We use Dublin prices as Amazon introduced both products to the European market via its datacentre there in 2008. Their first datacentre in the UK opened in December 2016 in London, and prior to that UK clients were mainly served via Dublin (though in theory they could also purchase services that are physically hosted in the US). Since all prices are quoted in US$ we expect exchange rate fluctuations to play no role. We compute a full quarterly price series from 2010 to 2018 by accessing historical price lists via the internet archive (archive.org).[8] In figure 5 we show the development of nominal prices for a general-purpose computing instance. We can see that nominal prices decreased by more than 70 per cent from \$0.76 in 2010Q1 to \$0.214 in 2018Q3. In figure 5 we show the development of nominal prices for extra-large (xlarge) computing instances. We can see that nominal prices decreased by more than 74 per cent from 0.765 in 2010Q1 to 0.1925 in 2019Q3.

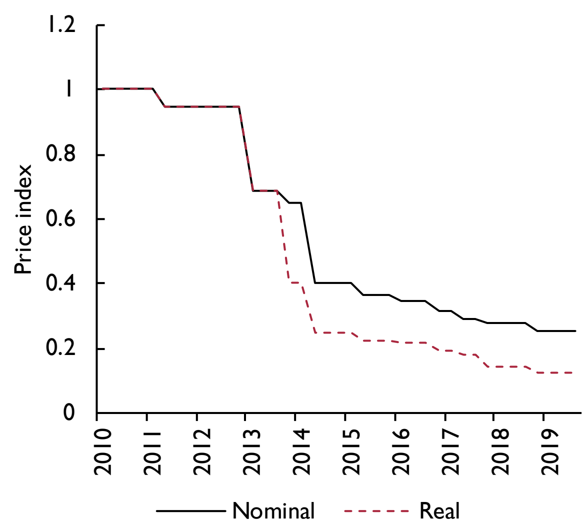
We approximate the 'quality' of a computing product by using a performance measure provided by AWS, which measures the number of 'EC2 computing units' for each computing instance type. Changes in computing performance are driven by the technology in the processors, which are upgraded continuously though the number of 'virtual cores' remains constant

Figure 5. Nominal price of AWS General Purpose EC2 xlarge Linux instance, 2010Q1–2019Q3



Source: Authors' calculations based on AWS prices.
Note: m1 to m5a indicate sequential upgrades in processors.

Figure 6. Price index (nominal and quality-adjusted) for AWS General Purpose EC2 xlarge Linux instance, 2010Q1–2019Q3



Authors' calculations based on AWS prices.

within a product class. For example, in 2017 new Intel Xeon Platinum processors were introduced that are able to provide twice as many floating point operations per second (FLOPS) than previous Xeon Broadwell or Haswell processors. Upgrades in processor technology are indicated by m1-m5 in figure 5. We have no obvious quality characteristics for storage products which seem to be sold mainly based on monthly price per GB stored.

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Figure 6 shows that correcting nominal prices for changes in quality is crucial, as quality adjusted prices are falling even faster, particularly after 2013 (the year AWS and others started upgrading the processors to Intel Xeon Sandy Bridge or Ivy Bridge). As described in more detail in Coyle and Nguyen (2018), this exercise can be repeated for ten different instance classes (from small to 24X.Large) and two operating systems (Linux and Windows). Overall, we can show that quality-adjusted price indices drop by up to 87 per cent (computed over 35 quarters), compared to 74 per cent for the equivalent unadjusted index. The largest average price drops are 5.5 per cent per quarter (computed over 13 quarters) compared to 4.4 per cent in the nominal series.

In terms of magnitude these price drops seem large, but they are comparable to price indices reported for telecommunication services (Abdirahman *et al*., 2017) and smartphones (Byrne, Sichel and Aizcorbe, 2019).

3. Cloud computing lowers entry barriers to advanced production technologies

The spread of cloud computing can raise business productivity further by providing easier access to cutting edge technologies that would not necessarily be available to many businesses. This is because by buying cloud-based services there is no need for lumpy upfront investments in equipment and capabilities (though it does require organisational change to achieve significant efficiency benefits). Some examples include tools in machine-learning and artificial intelligence, early applications in quantum computing, but also advanced digital solutions for industrial processes based on IoT or robotic process automation. In some sense this confirms the notion of cloud computing being a general-purpose technology that can enable the adoption of complementary digital technologies. Crucially, many of these types of solutions are available 'off-the-shelf', with the shelf being one click away for anyone with an internet connection.

Without doubt, artificial intelligence is transforming how businesses work, and will continue to do so. At the same time, the needs of AI applications in terms of computing power and access to large datasets make them predestined to run on the cloud. All large providers offer readily available AI services at competitive prices, including Amazon SageMaker, Microsoft Azure Cognitive Services, Google AI Hub, and IBM Watson, among others. In addition, they often provide free training and documentation on how to use these services, lowering entry barriers further. A statement on the AWS website confirms this point: "*Our mission is to make machine learning accessible to every organization by solving the toughest challenges hindering AI adoption, including complexity, cost, and data preparation*" and: "*Best of all, with AI Services on AWS no machine learning experience is required*".[9]

2nd Watch, which manages cloud computing services for hundreds of clients, reports that AWS is increasingly selling tools related to big data and machine learning, including Athena, Glue and SageMaker. According to AWS already more than 10,000 customers are using SageMaker. The company claims that it reduces the costs of labelling data and inference by 70 per cent or 75 per cent, respectively. Furthermore, it is supposed to raise algorithm performance by a factor of ten, and model optimisation by a factor of two. Overall, for businesses adopting cloud-based AI solutions this means that productivity should increase.

Another advanced and increasingly cloud-based technology is robotic process automation (RPA). It is designed to use "*the power of AI, machine learning and the cloud to deliver a Digital Workforce that's intelligent, connected, simple to use and scalable*", according to Blue Prism, one of the market leaders. Further, it can be used to "*Build operational agility with a Digital Workforce that never tires, and never needs a vacation. The more it learns, the more efficient it becomes. Automation of manual, back office work through AI-driven software […] reins in cost and improves efficiencies*".[10] The solutions by Blue Prism can run on the public cloud of all major providers.

Our final example is quantum computing, and despite its potential to be faster than any supercomputer existing today, quantum computers are complex and expensive as they rely on qubits which are highly sensitive to any form of disruptions. This means that for the average business, access to these superior quantum processing units (QPUs) will only be possible remotely via the cloud. At the moment, several providers offer 'quantum cloud' services, led by IBM, Rigetti Computing, and D-Wave.[11]

4. Cloud computing as an enabler of data-driven business models

In 2017, *The Economist* claimed: "*The world's most valuable resource is no longer oil, but data*".[12] While businesses have always used data in some form or another, advances in cloud-based technologies are a key enabler of data becoming more central to most businesses. At the same time, the growing importance of data poses two main challenges for economic measurement. The first is

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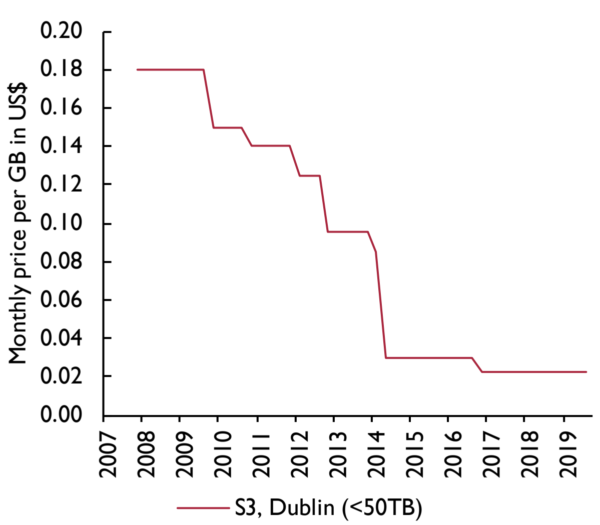
that it is difficult to establish the economic 'value' that some quantity of data has. It is even harder to 'quality-adjust' data based on its characteristics. The second challenge is related to the fact that technically it is very easy to transfer data across borders and store copies of the same data in multiple locations simultaneously. Again the 'value' of cross-border data flows is very difficult to capture conceptually and empirically. These challenges are discussed in detail in Nguyen and Paczos (2019, *forthcoming*).

A key point is that the volume of data (e.g. measured in Gigabytes or Terabytes) is meaningless when thinking about its value. For example, a lot of media content that is shared on social media is relatively low value on its own and it takes up considerable storage space. However, the analysis and insights based on aggregated user data can be highly valuable and monetised via targeted advertising or other services. Data is as valuable as the information content it carries and depends on ways in which it can be monetised in a commercial setting. The introduction of 5G technology and the internet-of-things, driving machine-to-machine communication, are only going to deepen these challenges as data becomes ubiquitous.

As mentioned above, the measurement issues around cloud computing and data are compounded (and indeed partially caused) by the fact that it is very easy to move data around, also across borders. Today, cross-border flows of data are the backbone of international commerce. It has been estimated that cross-border data

Figure 7. Monthly price in US$ for storing 1 GB using AWS S3, 2007Q4–2019Q3



Source: Authors' calculations based on AWS data.

flows contribute more to global GDP than trade in goods and that total used cross-border bandwidth per second has increased from 11 TB in 2007 to 704 TB in 2017 (McKinsey Global Institute, 2016, 2019).

One reason for this rapid increase in use is that the costs of storing data in the cloud have decreased dramatically.[13] For example, the nominal price of storing 1 GB of data in the AWS cloud for a month has decreased from $0.18 in 2007 to $0.023 in 2019 – a drop of more than 87 per cent (figure 7). Nguyen and Paczos (2019) discuss how data can enable the creation of entirely new business models (e.g. online platforms such as Airbnb or Uber), while it can also enhance existing ones (e.g. Airbus Skywise or BMW CarData). Hence, 'data' becomes an intermediate input to the production function of many firms. Companies can also have strategic reasons for storing data in different places, including to exploit differentials in costs, redundancy (protection from disasters) and regulations (e.g. local storage requirements). If we do not measure the volume and value of these flows across borders, we could be missing some potentially large flows of economic value from our trade and foreign investment statistics.

5. Global value chains and the transfer of intellectual property

It is a well-known fact that the global fragmentation in the production of goods and services poses additional challenges to the agenda of measurement for economic statistics (Ahmad *et al.*, forthcoming). Some of these include digital trade, specialisation within global supply chains, and transactions of intangible assets (Dunnell, Galindo-Rueda and Laux, 2007). Particularly difficult to measure are transactions that take place between affiliated companies, as these generally do not involve the market (UNECE, 2015). Following the OECD (2017) these types of transactions should be recorded based on the arm's length principle, i.e. 'as if' they would occur under comparable circumstances between independent enterprises. However, if these transactions are increasingly digital and intangible (or tangible with a high share of embedded intangible value), it becomes harder to define 'comparable circumstances' as the true value might be inherently unobservable in the marketplace. Similarly, since intangible assets often function as complements to labour and tangible assets, they might be of little value outside the boundaries of the firm.

One phenomenon where we can observe some of these issues is 'factoryless manufacturing', which arises if companies outsource their production activities to a

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Table 1. Top 100 MNEs in 2015 divided into non-financial, ICT, and digital

MNE category	Total sales ($trn)	Total assets ($trn)	Foreign sales (share of total)	Foreign assets (share of total)	Ratio foreign sales to assets
Non-financial	8	14.5	65%	62%	1.04
ICT	2.9	4.6	63%	43%	1.21
Digital	0.8	1.5	40%	27%	1.49

Source: UNCTAD (2017).

contract manufacturer whilst keeping all necessary R&D and design activities in-house (Coyle and Nguyen, 2019). Issues for economic measurement arise since this makes it more difficult to measure the distribution of economic output across countries and across industry sectors within countries. For example, if a UK-based company is conducting all of its research, development and design in the UK, but then outsources production to a contract manufacturer in, say, Malaysia, it is not always clear what is actually recorded and where. The contract manufacturer will receive designs and specifications and possibly rights to use patents, which is an export/import of intellectual property. At the same time, the final product (such as a vacuum cleaner) that is shipped and sold back in the UK should technically be domestic consumption (the contract manufacturer never 'owned' the final product), while the same vacuum cleaner sold in France would be a goods export from the UK.

As described above, businesses are increasingly relying on data as an input to production, and specialisation within specific production stages is increasing. Further, large scale studies confirm that multinational enterprises (MNEs) are increasingly relying on intangible assets to generate value-added (Chen *et al.*, 2017). Hence it is highly likely that some of the more 'intangible' transfers are not recorded correctly or in an economically meaningful way. A final issue is that these measurement errors can lead to misallocation of economic activity across sectors, as some activity should be reclassified from services to manufacturing (Bernard and Fort, 2015).

One way to gauge the extent of this further is to look at where firms are located in terms of their assets versus their sales. According to UNCTAD (2017) the Top 100 non-financial MNEs in 2015 realised 65 per cent of their sales abroad. They also held 62 per cent of their assets abroad, leading to a foreign-sales-to-assets ratio of 1.04 (see table 1). At a similar share of foreign sales, ICT MNEs (e.g. Apple, Samsung and AT&T) only held 43 per cent of their assets abroad, leading to a ratio of 1.21. Interestingly, for the first time the report also lists the Top 100 'Digital' MNEs and shows that the ratio of foreign sales (40 per cent of total) to foreign assets (27 per cent of total) was 1.49. Hence, when compared to other MNEs, the digital entities managed to generate an even higher share of their sales abroad, while keeping the bulk of their assets at home. This ratio increases even further to 2.63 when only looking at the sub-category 'internet platforms', which includes Alphabet (Google), Facebook, eBay and Twitter. It shows an interesting pattern as firms that are relying more on intangible assets appear to be able to do so while keeping the majority of their assets at home. To understand the full implications of these patterns more research into digital MNEs is needed, although a good starting point is Li *et al.* (2019) who examine the business models of various online platforms.

6. Discussion and implications for policymakers

In this paper we have discussed the increasing use of cloud computing services and cross border flows of data and intellectual property. We highlighted some of the associated challenges that arise for economic measurement, in terms of quantity, quality and distribution. We can summarise the main points as follows:

- Cloud computing is arguably a general-purpose technology (GPT) and the global market for it is large and growing. At the same time prices have been falling rapidly, while the quality of cloud services is increasing. As firms purchase these services, they will reduce investment in on-premise hardware and software.

- A lack of information on the usage of different products across firms and countries means that we cannot measure quantity or volume, which would be needed for a full quality-adjusted price index. This is crucial, however, to deflate cloud services correctly in the national accounts;

- Cloud computing means that firms face lower barriers to advanced production techniques such as artificial

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intelligence and robotic process automation. It is likely that firms are increasingly making use of them. This can be considered as process innovation that so far is not measured since we do not have reliable and large-scale data on the use of these techniques across firms.

- New and old business models are increasingly using data as an input to production. Moving data and storing it in different places around the globe is enabled by the cloud as prices for storage have decreased steadily. This means we need to start approximating the economic value of data and data flows.

- The fragmentation and digitalisation of global value chains is driven by transfers of data and intellectual property within and between companies. Heightened specialisation such as in the case of 'factoryless manufacturing' challenges how we currently measure the distribution of economic activity across countries and sectors.

The rise of cloud computing as a GPT is associated with fundamental transformations in modern economies which challenge our interpretation of economic statistics. At the same time policymakers need robust and reliable knowledge and evidence to support their decision making. Two areas that stand out are competition policy and issues of taxation. While research on this topic is growing, we still know too little. At the same time we are hopeful that progress is being made, as shown by the recent publication of a report by the Digital Competition Expert Panel (Furman *et al*., 2019), ongoing work by the OECD and WTO on Measuring Digital Trade[14] and by the European Commission on Fair Taxation in the Digital Economy.[15]

NOTES

1 As the term suggests a 'digital twin' is the digital copy of a physical machine or system that can be updated in real-time, e.g. by using machine-generated sensor data.
2 RPA is a type of business process automation that relies on a digital co-worker (or 'software robot') using AI to automate and optimise repetitive tasks such as invoicing or bookkeeping.
3 Cloud providers are selling a subscription-based service, and hence need to guarantee 'uptime' or 'ongoing accessibility' to generate revenue. This is different from the 'traditional' sale of a server, which is typically purchased upfront and then it becomes the responsibility of the IT department to ensure its operability.
4 Gartner estimates that the global market for consulting services reached $188 billion in 2018, Gartner Research, 23 April 2019: https://www.gartner.com/en/documents/3907120/market-share-analysis-consulting-services-worldwide-2018.
5 We also observe a shift to cloud services at the level of private consumers. For example, Spotify could be considered a 'CD player in the cloud', Netflix a 'DVD player in the cloud', Dropbox a 'hard drive in the cloud' and Stadia or xCloud a 'game console in the cloud'. To some degree they are all replacing tangible goods with intangible services.
6 For example, in 2013 Microsoft announced that it will match prices of AWS which it sees as its key competitor in the IaaS market.
7 https://www.2ndwatch.com/blog/popular-aws-products-2018/.
8 From 2016 onwards, we have the full price lists that were kindly provided to us by AWS.
9 AWS website, accessed 28 June 2019: https://aws.amazon.com/ai/.
10 Blue Prism website, accessed 19 June 2019: https://www.blueprism.com/product/digital-exchange.
11 Via its product 'LEAP', D-Wave provides free access to 1 min of QPU / month and charges $2,000 per QPU hour.
12 *The Economist*, print edition, 6 May 2017: https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data.
13 Arguably one of the most important metrics for choosing between cloud providers to store data is price, though there are other factors that matter, including storage redundancy, data transfer costs, availability, and latency. If availability or retrieval time is less of a concern for a business, so-called 'cold' storage can cost as little as $0.0018 per GB/month via Microsoft Azure (Western Europe region, July 2019).
14 OECD-WTO Handbook on Measuring Digital Trade (draft), March 2019: http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=SDD/CSSP/WPTGS(2019)4&docLanguage=En
15 https://ec.europa.eu/taxation_customs/business/company-tax/fair-taxation-digital-economy_en.

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