Socio-economic effects of digital trade and artificial intelligence on EU industries including their value chains and EU imports and exports with major trade partners
BRIEFING

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ABSTRACT

Artificial intelligence and new digital technologies are transforming digital trade. They facilitate the development of new business models of trade and reduce the geographical barriers of economic transactions. Such transformations are quite useful for the small and medium enterprises. Artificial intelligence is being adopted by both digital and non-digital sectors, but its adoption varies a great deal across countries, including within the EU. Data and information flow play a crucial role in digital trade by allowing personalization.

Digital trade is not new, but it is taking new forms that are ushering a new phase of globalisation. So far digital trade mainly affected trade in goods, including through global value chains, though some service activities have already become more tradeable thanks to digital technologies. The new phase of globalisation driven by artificial intelligence and new digital technologies is likely to do for services what the previous phase did for manufacturing: to vastly increase trade between advanced and emerging economies. This prospect raises important issues for domestic policies and trade policy.
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1 Introduction

Digital trade can broadly be defined as the production, distribution, marketing, sale or delivery of goods and services by electronic means, the sale and/or shipment by traditional means of digital goods (products and services), the transmission or storage of information as a service in its own right, as well as the cross-border transfer of information whether for remuneration or not.

Digital trade has grown rapidly in recent years, both in volume and scope, as a result of technological developments. One such development is artificial intelligence (AI), which has the potential to transform digital trade by greatly reducing geographical barriers. AI refers to the capacity of software programs and machines to develop an intelligent behaviour. It is considered as a general-purpose technology. It is based on artificial neural network structures and the application of machine learning techniques that help machines to improve their performance over time and with the amount and variety of datasets they use.

In this briefing, we assess the socio-economic effects of the introduction of AI technologies in digital trade, including through global value chains (GVCs), the implication of new technologies for the entire range trade in goods and services, and with the entire range of trading partners.

Our briefing is organised as follows. In section 2 we provide evidence of the adoption and diffusion of AI. In section 3 we discuss the central role of data and flow of data in online transactions. Section 4 presents new digital models for trade that have emerged in recent years. We pay attention on how we can define digital trade and we then discuss its socioeconomic implications in relation to GVCs. We also discuss some associated policy issues related to emerging trends in globalisation and the influence of the COVID-19 pandemic shock.

2 Adoption and diffusion of artificial intelligence

AI and other digital innovations have been made possible by the exponential rise in computing power, bandwidth and digital information. Their large-scale diffusion has reshaped the way we carry out transactions and trade through online means. Such technologies were first used in the technology service sector, but applications in non-service sectors (e.g. manufacturing) followed. In services, the drop in capital costs have significantly reduced barriers to entry for start-ups. At the same time, network effects and the value of collected data often leads to competition for the market instead of competition within the market. In Europe, the United Kingdom has the strongest AI ecosystem. In 2017, EU27 had approximately a total of 490 AI firms which were uneven distributed across member states (see Figure 1). Scandinavian states have the most AI firms per capita (with Finland being the first with more than eight AI firms per 1 million inhabitants), followed Baltic States (with Estonia being the first among Baltic states with approximately three AI firms per 1 million inhabitants) and then followed by central European countries (where France has the most firms per capita). Balkan states and South-East member states, on the other hand, have a very small number of AI firms per capita. Distribution is also uneven within countries. For example, in France, out of the 109 AI firms, the 73 are located in Paris metropolitan area.

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1 Bloom et al (2020) illustrated the validity of Moore’s law for microprocessor transistors. Such technological advancements led to a fall in the US consumer price index for personal computers by nearly 95% from 1997 to 2015, while the corresponding index for all items purchased by consumers has risen by nearly 50 percent.

2 Looking at data from International Telecommunication Union, we see that internet bandwidth in 2015 is 330 times greater than internet bandwidth in 2000.

3 The ability to collect and store data and turn it into valuable information rapidly increased over the last two decades. According to OECD (2014), the digitisation of nearly all media and the increasing migration of economic and social activities to the internet generate petabytes of data every second.
Figure 1: Distribution of AI firms in Europe, 2017

Source: Asgard (2017).

But, more traditional sectors have also started to increasingly adopt AI and digital technologies – in car manufacturing, for example. Figure 2 reports the number of industrial robots across ‘traditional’ sectors (typically used in warehouses for packing and delivery).

Figure 2: Number of industrial robots in thousands in 2015


An industrial robot is defined as ‘an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications’ (see Petropoulos et al., 2019, based on International Federation of Robotics).
An indicator of the diffusion of AI is the trend in the number of patent applications. Figure 3 shows the number of patents related to AI technologies granted by major patent offices around the world for different periods.

![Figure 3: Number of AI patents granted by country](source: Petropoulos et al. 2019)

However, according to the European Patent Convention, software ‘as such’ is not patentable, except when specific conditions are met. Hence, we have to rely on an additional measure to capture the full picture on AI adoption. Bughin et al. (2019) collected a set of indicators by country to gauge how they stand on the key AI enablers and aggregated them into an AI Readiness Index per country. They found that the most advanced Northern European countries (Finland and Sweden) and the Anglo-Saxon countries (Ireland) lead in Europe, ahead of China and just behind the United States. But, Southern and Eastern Europe is lagging behind (Poland, Romania, Greece and Cyprus).

3 Importance of data in digital applications and its economic implications

Digital technologies have fundamentally changed the behaviour of consumers. For example, the use of internet-enabled devices, including smartphones, tablets and laptops, is widespread. These devices provide consumers with direct access and real-time information about online markets. Firms have developed digital marketing techniques that increased the transparency over information about products that are available to consumers.

The development of data analytics and machine learning has proved revolutionary in monetising data in digital services. The first fundamental change that this revolution brought about in commerce was the personalisation of services, which in turn increased the efficiency of transactions and consumer welfare and led to online commerce expansion. A survey by Deloitte (2015) finds that more than 50% of consumers expressed interest in purchasing customized products or services. At the same time, one in four consumers are willing to pay more to receive a personalized product or service, while 22% of consumers are happy to share some data in return for a more personalized customer product or service.

The free flow of data can increase the benefits from trade, provided that the online ecosystem remains trustworthy and online consumers do not face risks that their data will be used for reasons beyond their knowledge and control. Trust is a fundamental factor for the growth and success of online trade.
In the European Union, the flow of personal data in commercial contexts is governed by the General Data Protection Regulation (GDPR). The GDPR provides the framework within which the free flow of data can be achieved, but at the same time permits the use of only absolutely necessary data in transactions (data minimisation). The GDPR incorporates two data portability rights, one for Business-to-Consumer and one for Business-to-Business with the intermediation of the data subject, or an intermediary that acts on her behalf. As for non-personal data, the Free Flow of Data Regulation dictates direct data portability in business-to-business (B2B) relationships in open standard formats, where data is structured in commonly used and machine-readable formats. The Digital Content Directive provides a respective data portability in business-to-consumer (B2C) relationships.

Transfers of personal data from the EU to other jurisdictions can also bring important benefits in cross-border digital trade relationships. In such a case, legal restrictions may come into play (see Briefing 2) which make data transfers costly. Small and medium enterprises are more affected by such restraints as they may not have the adequate capacity to absorb these costs.

While data has immense value in digital trade, it may also have implications for market concentration, through data-driven economies of scope and the presence of strong network effects. That could lead to over-high entry barriers for small and medium enterprises which do not have access to adequate volumes and variety of data to improve the efficiency of their products and services. The 2019 Report of the UK Digital Competition Expert Panel concluded that concentration is particularly prominent in the following digital markets: i) online search, which is dominated by Google, with some competition from Microsoft Bing; ii) social media, dominated by Facebook and the services its owns, with some competition from Twitter and Snapchat; iii) digital advertising, dominated by Google and Facebook; iv) mobile app downloads, which is a duopoly between Apple and Google; v) commerce through online marketplaces, where Amazon is a dominant platform, with some competition from eBay.

4 The socio-economic effects of digital trade and AI on EU industries

4.1 Digital business models in the economy

The emergence of digital technologies has given rise to platform ecosystems via which goods and services are traded. Platforms have lower costs than previous market forms and achieve scale that can create significant value for the interacting sides of their markets. They are a new way of addressing the fundamental problem of economic organisation: how to coordinate supply and demand in the absence of complete information (Parker et al., 2020). To do that, they: i) adopt open digital infrastructures that allow multiple stakeholders to use it for their service and content needs; ii) establish governance rules and invest in governance enforcement mechanisms that seek to balance platform control with the necessary incentives for platform participants to engage with the platform and generate value for one another. The expansion of platform ecosystems at a global scale has created many possibilities for online trade between parties in different parts of the world, an important factor for the scaling up of small and medium enterprises.

At the same time, the development of blockchain technologies has provided a non-intermediated alternative for secure online transactions. Blockchain is a decentralised and distributed digital record of transactions (distributed ledger). It is made of a continuously growing list of records, which are combined in ‘blocks’, which are then ‘chained’ to each other using cryptographic techniques. Once added to a blockchain, information is time-stamped and cannot be modified, so that attempted changes can easily be detected. Transactions are recorded, shared and verified on a peer-to-peer basis. In this way, trust in online transactions increases and intermediaries are less needed for the ecosystem to work properly.
4.2 Digital trade

Digital trade is not new, but it is taking new forms that are adding a new dimension to the process of globalisation, as Baldwin (2016) and López González and Jouanjean (2017) have cogently explained.

There is broad consensus that digital trade encompasses digitally-enabled international transactions in goods and services that can be either digitally or physically delivered (Lopez-Gonzalez and Jouanjean, 2017). Figure 5, borrowed from Lopez-Gonzalez and Jouanjean (2017), has become the standard illustration of what digital trade entails.

**Figure 5:** Typology of digital trade

Digitally-enabled but physically-delivered trade can involve both B2C transactions in final goods and services, and B2B transactions in intermediate goods and services, including within GVCs. Equally, digitally enabled and delivered trade can involve both goods (through 3D printing) and services, though more often the latter than the former, and final B2B or intermediate B2B transactions.

Goods and services that are physically delivered across borders do not differ according to whether the transaction that enables the trade is digital or not. One can buy the same product in a store or on an online platform. Similarly, one can book the same flight through a travel agent or an online platform. Digitisation in this case can facilitate the transaction. This is even more the case for GVC trade, which would not have been possible without the digital connectivity that has enabled firms to fragment their processes of production across the world and to exploit locational comparative advantages. This has generated a huge increase in trade in intermediate products, which has been the main driver of the growth in international trade in recent decades. Digitisation has therefore increased the physical delivery of final and (mainly) intermediate goods and services, but it has not changed the nature of trade.

The situation is different for digitally-enabled and delivered trade in goods and (mainly) services. Here, digitisation has created entirely new opportunities for international trade, mainly in services that could not be traded previously. Machine-learning AI systems are even starting to enable, as Baldwin (2019) discussed, tele-migration, the kind of trade that happens when workers sitting in one nation telecommute into offices in another, and possibly even communicate with one another in different languages thanks to automatic machine translation.

4.3 Socio-economic effects of digital trade

Unfortunately, there is no reliable estimate of the importance of digital trade from international institutions such as the Organisation for Economic Co-operation and Development or the World Trade Organisation, which have produced reports on digital trade (OECD, 2019; WTO, 2018), or public agencies
in the EU, the US or other major trading nations. It is impossible therefore for the moment to have a sense of the share of global trade in goods and services that is digitally enabled and how fast it is growing.

Nonetheless, it should be clear that, so far, the digital transformation has mainly impacted on physically delivered trade, although digitally delivered trade has also been impacted to some extent. Since it is easier to physically deliver goods than services, it follows, that the digital transformation has had a greater impact on trade in manufactured goods (both final products and intermediate goods in global value chains) than on trade in services (mainly in global value chains), though some services have been impacted as well.

We share the view of Baldwin and Forslid (2019) that the next stage of the digital transformation, which is already underway and will vastly increase the digital delivery of trade, will affect trade in manufactured goods far less than it will affect trade in services. In fact, robotics and AI may actually reduce trade in manufactured goods, while vastly increasing trade in services.

In manufacturing activities, the main impact of the next stage of the digital transformation will be to reduce employment even further compared to what has already happened in the previous stages of the digital transformation. Some, like Baldwin and Forslid (2019), even predict that manufacturing will become jobless. This would obviously have huge socio-economic implications, but they would be generated through changes in production processes rather than via trade changes.

The impact of a new technology on trade, especially between advanced and developing or emerging economies with vastly different labour costs, depends essentially on two factors. The first is the extent to which the new technology reduces transportation and other transaction costs, thereby increasing the ability of firms to source products from the cheapest location in terms of labour costs. The second factor is the labour-intensity of the production process.

In recent decades, the digital transformation has allowed manufacturing firms based in advanced countries to source labour-intensive products or components from locations with relatively cheap labour. Such GVC trade between advanced and developing or emerging economies was the main driver of the huge increase in globalisation that started in about 1990. If, as Baldwin and Forslid (2019) predict, parts of manufacturing becomes jobless, then by definition the second factor disappears and decisions taken by firms on where to locate production will no longer depend on relative labour costs, but only on other costs. This could mean that some production activities will become localised closer to places of consumption than is currently the case, at least for products where transportation costs are significant. In principle, therefore, one should expect that the new wave of digital transformation will reduce trade in manufactured products (at least in activities for which there is less labour demand), especially if transportation costs remain significant.

If transportation costs also decrease substantially thanks to new digital technologies, then location of production would completely cease to be related to labour costs or transportation costs. Think, for instance, of 3D printing, through which digital technologies enable international trade to be delivered

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5 A report by the US International Trade Commission (USITC, 2017) estimated that global e-commerce amounted to USD 27.7 trillion in 2016, up 44% from 2012. The report estimated that B2B transactions amounted to USD 23.9 trillion, six times larger than B2C transactions (USD 3.8 trillion). However, these statistics do not break down e-commerce transactions by origin. As a result, domestic and cross-border transactions are not separately identifiable.

6 UNCTAD publishes annually estimates of the total value of global e-commerce transactions. However, UNCTAD’s estimates refer to both domestic and cross-border transactions and do not permit to separate one from the other. See, for instance, UNCTAD (2019).

7 Trade in primary products has been much less affected by the digital transformation than trade in manufactured products (or trade in services).
digitally. In principle, one would expect that 3D printing will reduce international trade. However, a study by Freund et al. (2019) of 36 products that are increasingly being 3D printed found a positive effect on trade, but this positive effect of 3D printing on trade decreases with product weight and could even reverse for bulky products. At this stage, however, 3D printing is still very limited, and opinions differ a lot as to how much it can and will replace manufacturing. Moreover, 3D printing requires printer equipment and supplies, which typically involve international transactions.

In services, the main impact of the next stage of the digital transformation, which is already happening (and has accelerated because of the COVID-19 pandemic), is reducing drastically transportation and other transaction costs, rendering tradable many services that have been hitherto non-tradable. It is here that the socio-economic impact of the new digital transformation, which is making more and more services digitally deliverable, will be greatest. Because services tend to be highly labour-intensive and those services that are becoming digitally tradable are typically intensive in medium- to high-skilled labour, AI together with digital technologies, will vastly increase the potential to delocalise production from advanced countries to countries with relatively cheap skilled labour.

Before the COVID-19 crisis, Baldwin and Forslid (2019) already argued that firms in advanced countries were turning more and more to remote workers to perform an increasingly wide range of tasks. Although these remote workers were mainly in the same countries as the firms, meaning these activities did not constitute international trade transactions, Baldwin and Forslid (2019) noted that wage differences between advanced and developing or emerging countries, and talent shortages in advanced countries, were driving more and more firms to turn to foreign-based online service workers, whom they refer to as ‘telemigrants’.

All this suggests obviously that competition between advanced and developing or emerging economies, based on lower labour costs in developing countries, is set to increase. So far it was to the East Asian countries (including China) that manufacturing jobs from advanced migrated. Soon it will be to South Asia (mainly India) and other countries with good education systems, that services jobs from advanced economies will migrate, and on a much bigger scale than what has already occurred.

**Box 1: Additive manufacturing and global value chains**

Additive manufacturing or 3D printing is ‘a process of making a three-dimensional solid object of virtually any shape from a digital model’ (https://www.sme.org/additive-manufacturing-glossary/). It is used for prototyping and for distributed manufacturing in a wide range of applications, in commercial, industrial and public sectors (e.g. manufacturing of components for cars, trains and planes, manufacturing of printers in schools and public libraries, bioprinting and so on).

3D printing makes customisation much easier and less costly in order to match the desired preferences. This is because in order to change the produced solid project, you only need to change the computer code that defines its characteristics.

Surveys (Sculteo, 2017; De Bucker and Flaig, 2017) have shown constant high growth rates of the adoption of this technology, its penetration of new markets and its market value. Specifically, the market for additive manufacturing is estimated to reach a value of between USD 5.6 and USD 22 billion dollars in 2020.

As this technology is expected to be adopted widely, it is also going to affect global value chains (Rehnberg and Ponte, 2016; Laplume et al, 2016) in **two main ways**: i.e. by **shortening the development cycles of products** (which are currently produced by traditional manufacturing techniques), ii. by **discouraging offshoring** of manufacturing activities and by leading to **localisation** of production **close to the point of consumption**.
4.4 Policy issues

Our discussion suggests that the latest developments in digitisation, although affecting both trade in manufactured goods and trade in services, is having and will have even more in the future its greatest impact on trade in services. Hence, we share the view of Baldwin and Forslid (2019) that globalisation is entering a new phase, driven by digitally-delivered trade in services. We also share the view of van der Marel (2020) that ‘globalisation is not in decline, but simply changing’.

During the previous phase of globalisation, which was and is still largely driven by GVC trade in manufactures, a growing number of industrial activities were outsourced to countries with much lower labour costs than Europe (and within Europe from western to eastern or south-eastern countries), with goods then exported from these countries to various destinations, including Europe. During this phase, industrial employment in Europe and in other advanced economies declined substantially, although the value of industrial production continued to increase. This came about as companies concentrated on high value-added activities, outsourcing lower value-added ones and replacing manual labour by robots or other machines. But overall employment did not decrease. It simply shifted to services but with significant socio-economic consequences, including in terms of the organisation of work, female participation in the labour force and income distribution.

The new phase of globalisation, which is only now starting, will now also transform employment in services, at least in those activities that were hitherto non-tradable (or little tradable), which will now become not only potentially deliverable digitally but actually digitally delivered. This will provide new employment opportunities for some European workers, but for others who have been sheltered from international competition, it could mean that their jobs will be outsourced to other parts of the world where there is an abundant well-educated labour supply. Whether or not total employment opportunities will remain unchanged and only job composition will change is obviously impossible to predict. During earlier phases of technological transformation and globalisation, there was more change in the composition of jobs than in the number of jobs, though there was also a reduction in the number of hours worked per person and a welcome increase in leisure.

What role can and should policy play to accompany such transformation? We see two different areas: domestic policies and trade policy.

The main relevant domestic policies are education, training and retraining, and other social policies aimed at equipping people to master digital technologies and adapt to change. More than ever, societies with flexi-security policies, like the Nordic countries, which combine high quality education and people rather than job security, will be best prepared to manage the digital transformation. But these policies are expensive, so they require states to be able to raise sufficient resources, including by taxing digital activities.

As far as trade policy is concerned, the European Union has an interest in improving its access to markets where the level of restrictiveness on digital services trade is high. According to Ferencz (2019), the OECD digital services trade restrictiveness index (DSTRI) for 2018 was equal to 0.2 or less in all EU countries (except Latvia and Poland) but nearly 0.4 or more in countries like Brazil, China and India. If successful, the on-going WTO plurilateral negotiations on e-commerce – defined by the WTO as ‘the production, distribution, marketing, sale or delivery of goods and services by electronic means’ (and therefore similar to

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8 The OECD’s DSTRI identifies, catalogues, and quantifies barriers that affect trade in digitally enabled services across 44 countries. It covers many barriers, including those in communication infrastructure, movement of information across networks as well as in electronic transactions and payments. It aggregates the restrictions into an index that ranges between 0 and 1, with 0 being most open and 1 most restrictive.
the notion of digital services used by the OECD and in this briefing) – may produce a reduction in trade barriers. However, we share the viewpoint of Hufbauer and Lu (2019) that multilateral disciplines in digital services will need to be complemented by bilateral and/or regional agreements to deliver significant improvements in market access.

We close by reflecting on the consequences of COVID-19 for the digital transformation and digital trade. Before the crisis, the trends we discussed in this briefing were already clear. What was not clear, however, was the pace at which the transformation would take place. There is no doubt that the crisis has accelerated this pace. Teleworking has become a reality for large segments of the population and is here to stay, although not at the level that it reached at the peak of lock downs. And with teleworking becoming ubiquitous, telemigration, which was still considered not long ago as belonging to the distant future, is sure to soon follow. More generally, we should now expect that the new phase of globalisation driven by digitally-delivered trade in services will unfold more rapidly than we had anticipated. We should be prepared for it.
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