BANCA D'ITALIA
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Questioni di Economia e Finanza

(Occasional Papers)

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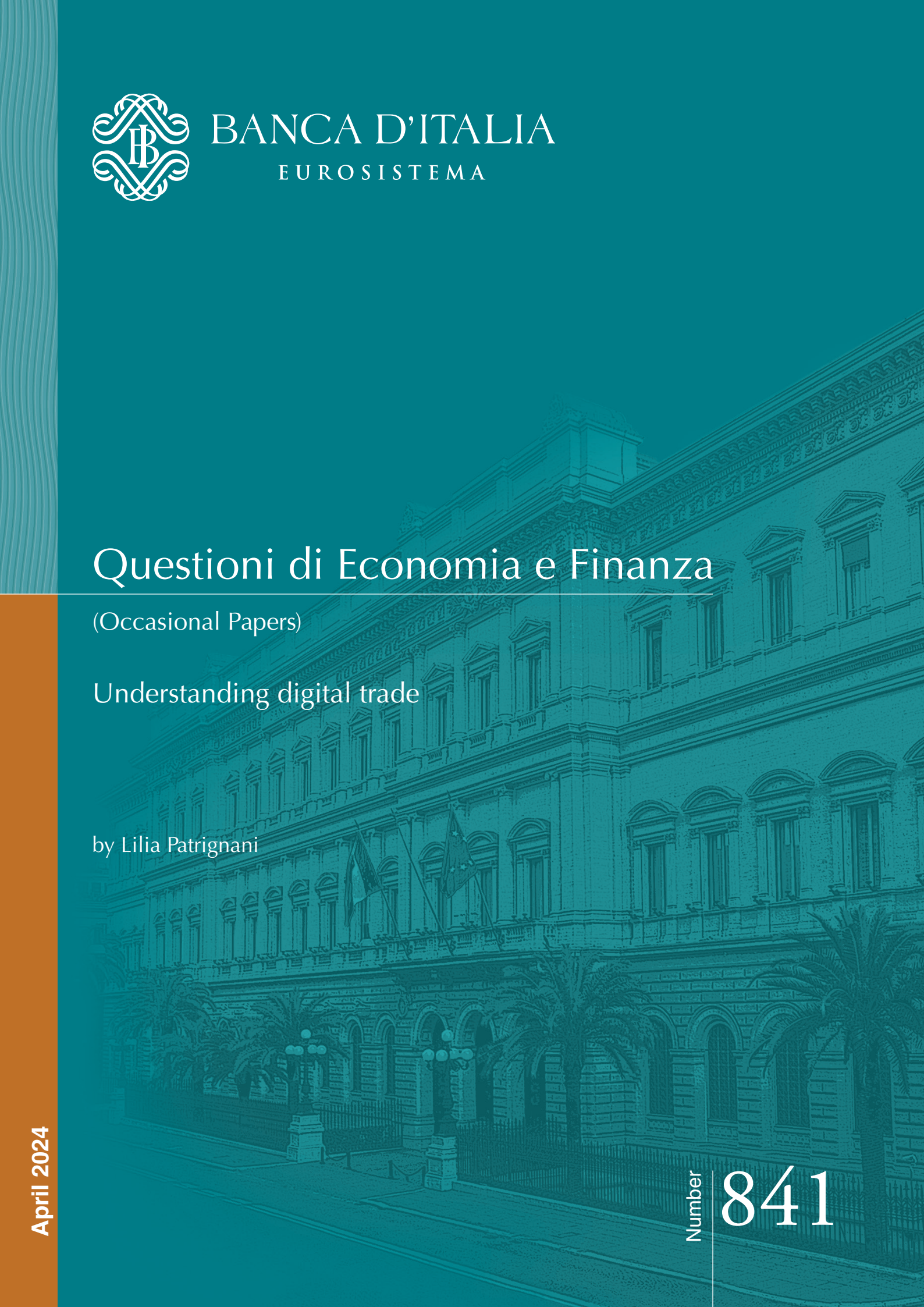
by Lilia Patrignani



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UNDERSTANDING DIGITAL TRADE

by Lilia Patrignani*

Abstract

The widespread adoption of digital technologies has significantly reshaped international trade, ushering in a new era of digitally-driven transactions. This study provides an overview of the literature on digital trade, exploring its definitions and measurement methods, its key influencing factors, and the challenges posed by fragmented digital regulations across jurisdictions. The paper highlights the growing importance of digital trade, which reached 25 per cent of global trade in 2020 according to OECD estimates. When focusing on cutting-edge digital services, like cloud computing and online advertising, the majority of exports originate from the US, while the EU's global presence remains limited. The growth of digital trade has been fuelled by the digitalization process, from the advent of the internet to the advancement of AI, alongside trade liberalization. However, recent years have seen a rise in barriers to digital trade, in the wake of growing international tensions and a fragmented regulatory landscape, potentially harming international trade.

JEL Classification: F13, F15, O33.

Keywords: digital trade, e-commerce, digital connectivity, trade agreements, data flows, digital fragmentation.

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* Bank of Italy, Directorate General Economics, Statistics and Research.

1. Introduction[2]

The Information and Communication Technology (ICT) revolution has left an indelible mark on the global economy reshaping many aspects of it, including international trade. From the mid-1980s, ICT advances and progress in computing power have radically lowered trade costs and facilitated communication and coordination for complex activities. Companies in advanced economies started to break down complex industrial processes into production stages, and outsource some of them to low-wage nations, favouring the rise of Global Value Chains (GVCs) (Baldwin, 2006). More recently, the widespread adoption of digital technologies has increased the scale, scope, and speed of trade, leading to a new era of digitally-facilitated transactions (OECD, 2023). Nowadays, consumers enjoy unprecedented access to a wide variety of digital services, from streaming services to telemedicine and online banking. Massive online platforms such as Alibaba, Amazon, and eBay link businesses and customers anywhere in the world. Businesses use cloud computing services and data-driven solutions to develop new and advanced products, incorporating artificial intelligence (AI) capabilities in the process.

In the context of this digital revolution, the term 'digital trade' has emerged in academic and policy discussions to refer to a digitally-driven form of trade, different from traditional modes of trade in physical goods. As digitalization comes of age, little is still known about the nature and the evolution of digital trade, which remains elusive even in its definition. In a joint work, the WTO, OECD and IMF broadly define digital trade as covering *digitally-ordered* trade, which encompass international e-commerce transactions, and *digitally-delivered* trade, which include services that can be provided remotely via computer networks (IMF et al., 2019 and 2023). In contrast, other definitions exclude physical goods ordered online, or include also the digital technology embedded in advanced products. The absence of a universally accepted definition and – therefore – of agreed official statistics poses challenges to digital trade measurement, and leads researchers to use various proxy measures to get a sense of its level and dynamics. All these proxies suggest that digital trade is gaining importance. According to one representative measure, it reached 25% of global trade in 2020 (OECD, 2023). Focusing on the composition of trade in *digitally-delivered* services, the WTO estimates that business, professional, and technical services comprised approximately 40% of digitally-delivered services exports in 2022, followed by computer services (20%) and financial services (16%).

The widespread adoption of digital technologies, known as the 'digitalization process', is the primary driver of digital trade, boosting both *digitally-ordered* and *digitally-delivered* trade. Digital technologies have expanded the array of services that can be delivered remotely and favoured firms' participation in GVCs, while e-commerce platforms have notably facilitated international online transactions. Looking ahead, the current generation of AI-led innovations has the potential to significantly influence international trade, by enhancing productivity, optimizing supply chain efficiency, and reducing trade costs such as those associated to language barriers.

[2] I am grateful to Oscar Borgogno, Alessandro Borin, Andrea Carboni, Riccardo Cristadoro, Michele Mancini, Michele Savini Zangrandi and Giovanni Furio Veronese for thoughts and comments.

As digital trade has gained prominence, both domestic and international regulation on digital trade-related aspects has advanced accordingly. In recent decades, there has been a significant increase in the number of trade agreements that promote the free flow of data or limit the imposition of data localization requirements. These agreements represent a key measure for policymakers to boost *digitally-delivered* trade. Additionally, agreements that ban tariffs on electronic transactions, such as the WTO Moratorium on customs duties, are crucial tools to enhance *digitally-ordered* trade. However, there has been a recent shift in digital trade policies, with regulatory restrictions on digital trade increasing in recent years. This trend is in line with a more general policy orientation towards trade, particularly in strategically significant areas. Policymakers are facing new challenges related to privacy protection and national security, which have become more relevant as international tensions escalate. Major economies such as Europe, the United States, and China have adopted different approaches to governing cross-border data flows. This regulatory heterogeneity has increased complexity and raised concerns about possible fragmentation, which could potentially harm international trade.

This work provides an overview of the literature on digital trade. Section 2 explores its definitions and measurement methods. Section 3 investigates the driving forces behind digital trade, focusing on technological advancements, like internet connectivity and AI, and policy-related factors like trade agreements. Section 4 looks at the challenges posed by the growing restrictiveness and fragmentation in domestic digital regulations. Lastly, section 5 concludes.

2. Definitions and measurement approaches

2.1. Definitions of digital trade

While there is no universally accepted definition of digital trade, the first edition of the "*Handbook on Measuring Digital Trade*" by the IMF, OECD and WTO (IMF et al., 2019) provides a characterisation based on the nature of the transaction, which is likely to become the primary reference for official statistics.[3] According to the Handbook, digital trade encompasses "all international trade that is *digitally-ordered* and/or *digitally-delivered*". *Digitally-ordered* trade refers to international e-commerce transactions, as defined by OECD (2011).[4] Instead, *digitally-delivered* trade includes "all international trade transactions that are delivered remotely over computer networks" and builds on the concept of ICT-enabled services developed by UNCTAD (2015). Notably, the Handbook's definition of digital trade is very broad. It covers international trade in (i) goods and services that are ordered digitally and physically delivered (such as the online purchase of a physical book or the online booking of a hotel stay); (ii) services that are ordered and delivered digitally (such as an e-book or software acquired online); and (iii) services not ordered digitally but delivered digitally (such as e-

[3] The second edition of the Handbook, which has been co-authored also by UNCTAD and published in August 2023, confirms this definition (IMF et al., 2023).

[4] OECD (2011) defines international e-commerce transactions as "the international sale or purchase of a good or service, conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders". Notably, the definition excludes orders made by telephone calls or manually typed emails.

learning services ordered via email, or a digital report ordered via a phone call) (Table 1). Non-monetary digital transactions are not included in the definition (Figure 1).[5]

Table 1: IMF, OECD and WTO definitions and examples

Digital trade	International trade that is *digitally-ordered* and/or *digitally-delivered*.	
Digitally-ordered trade	International trade of a good or service conducted over computer networks by methods specifically designed for receiving or placing orders. It covers cross-border e-commerce transactions in both goods and services, regardless of whether the traded product has digital characteristics or not.	Examples: - Buying a book from a foreign company's website. - Reserving a hotel through a non-resident digital intermediation platform (DIP). - Buying specialized accounting software online from a non-resident company.
Digitally-delivered trade	International trade transactions that are delivered remotely over computer networks. It comprises only services.	Examples: - Buying digitally downloadable software from a non-resident company. - Buying an app from a non-resident supplier. - Purchasing online education services from a foreign firm.

The *Handbook* also provides guidance on reporting and measuring digital trade. To quantify *digitally-ordered* trade, the report suggests several approaches. These include integrating existing business and household surveys,[6] or relying on *digitally-ordered* shipments in customs declarations, online expenditures from VAT returns data, or online transactions from card payment data. Regarding *digitally-delivered* services, the first suggested step is to consider the value of trade in sectors that can deliver services digitally. The Handbook's list of "*digitally-deliverable* services" expands upon UNCTAD (2015) list of "potentially ICT-enabled services" and includes several additional items.[7] Starting from this list, they propose to estimate the value of

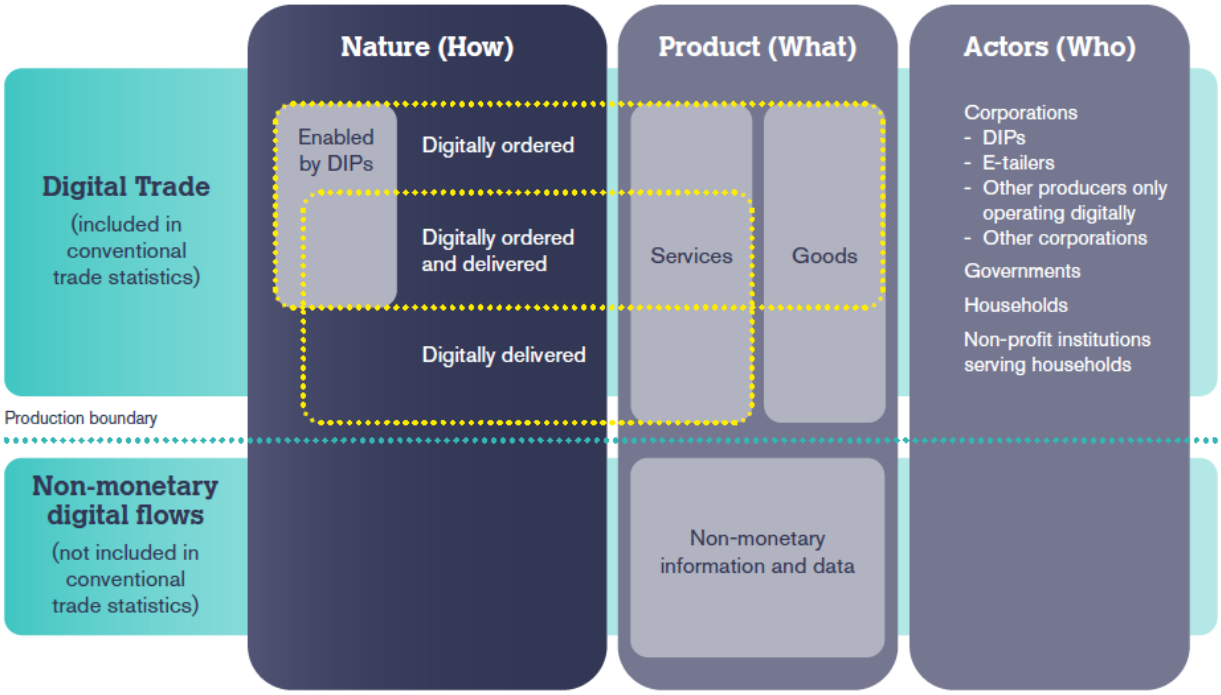
[5] The first edition of the Handbook distinguishes between digital trade and a broader notion, referred to as 'broad digital trade', which includes services delivered at zero cost, like those offered by social networking sites or search engines in exchange for personal data. Instead, the second edition does not mention the broader definition and excludes non-monetary flows from the scope of digital trade.

[6] Since 2016, the Bank of Italy has included questions on online travel bookings in its survey on Italy's international tourism. The survey reveals that between 2016 and 2021 the share of online accommodation bookings increased from 43% to 49% for residents and from 66% to 73% for non-residents. Additional information on the Bank of Italy's survey on international tourism can be found here.

[7] The Handbook's list of digitally-deliverable services include the following items: Insurance and financial services (EBOPS 6-7), Charges for intellectual properties (8), ICT (9), R&D activities (10.1) Professional and technical services (10.2 and 10.3.1), Trade-related and other business services (10.3.4-10.3.5), Audio-visual services (11.1), Health services (11.2.1), Education services (11.2.2), Heritage and recreational services (11.2.3), and Digitally deliverable services consumed abroad (recorded within Travel – item 4).

services that are actually *digitally-delivered* by considering the proportion of trade flows in the listed services that take place through cross-border mode of supply. [8]

Figure 1: IMF, OECD and WTO conceptual framework for digital trade



Source: IMF et al. (2023).

The European Commission provides a definition for digital trade that is similar to the one in the Handbook, characterizing it as the "commerce enabled by electronic means – by telecommunications and/or ICT services", covering both goods and services (European Parliamentary Research Service, 2024). Conversely, the US International Trade Commission adopts a narrower definition for digital trade, which explicitly excludes the value of sales of physical goods ordered online (Congressional Research Service, 2021). In turn, the UK Board of Trade has a broad perspective on digital trade, including in the aggregate 'modern services' like music streaming and financial data services, goods ordered online, and digital technology embedded in advanced goods such as aircraft engines, high-tech ships and self-driving cars (Board of Trade, 2021).

Finally, in policy discussions, the term 'digital trade' is often used to refer to trade in the digital era more broadly. It extends beyond digitally ordered or delivered goods and services, and can include trade flows across all sectors that are rising due to growing digital connectivity, or to cross-border data flows that support trade transactions (OECD 2023).

[8] The General Agreement on Trade in Services (GATS) distinguishes between four modes of supplying services: cross-border trade (Mode 1), consumption abroad (Mode 2), commercial presence (Mode 3), and presence of natural persons (Mode 4). Cross-border supply is defined to cover services flows from the territory of one member into the territory of another member. The Handbook suggests that the portion of digitally deliverable services supplied via Mode 1 can be estimated based on expert judgement or business surveys.

2.2. Measuring digital trade

The absence of a generally accepted definition for digital trade poses challenges to its measurement. Additionally, internationally harmonized statistics are lacking, even for *digitally-delivered* services. This has led researchers to employ different proxy measures, including trade in digitally-deliverable and orderable services, data-intensity indicators, and cross-border data flows. While each method has its limitations, they collectively represent an initial effort to estimate the levels and dynamics of digital trade in the global economy. There are four main approaches developed by the literature, which focus on (i) *digitally-delivered* and *digitally-ordered* trade, (ii) digital intensity indicators, (iii) digital corporate revenues, and (iv) cross-border data flow. In this subsection, we will briefly look at them in sequence, while Table 2 at the end of the section provides a 'snapshot' mapping of each approach with the most relevant research.

2.2.1. Digitally-delivered and digitally-ordered trade

In recent works, López González et al. (2023) and OECD (2023) adopt the Handbook's definition of digital trade and estimate its value based on bilateral trade data from the OECD TiVA database.[9] Specifically, the authors approximate *digitally-delivered* trade by considering the value of trade in (i) ICT services, (ii) publishing and broadcasting, (iii) financial and insurance activities, (iv) professional, scientific and technical activities, and (v) administrative and support service activities, under the assumption that all services within these sectors are delivered digitally. This approach aligns with the Handbook's perspective on *digitally-delivered* trade, which encompasses services that are inherently digital (such as cloud computing and streaming media), as well as sectors where in-person interactions and physical document delivery are shifting towards digital channels.[10] In turn, *digitally-ordered* trade is proxied by leveraging data from Inter-Country Input-Output tables, which allow to retrieve the domestic value added originated in the five digital sectors listed above and embedded - directly or indirectly - in international trade flows.[11] The core assumption here is that the use of digital services closely correlates with the digital ordering process. This assumption is hard to test, and the authors explicitly acknowledge the limitations of their proxy in fully capturing digital orders.

These proxy measures suggest that digital trade is growing over time, reaching USD 5 trillion in 2020 (25% of the global trade). Notably, the growth rate of digital trade is higher than that of 'non-digital trade' (Figure 2). Moreover, according to these estimates, digital trade composition has also been changing, with the share of *digitally-delivered* trade increasing from 49% to 60% of digital trade between 1995 and 2020 (Figure 3).

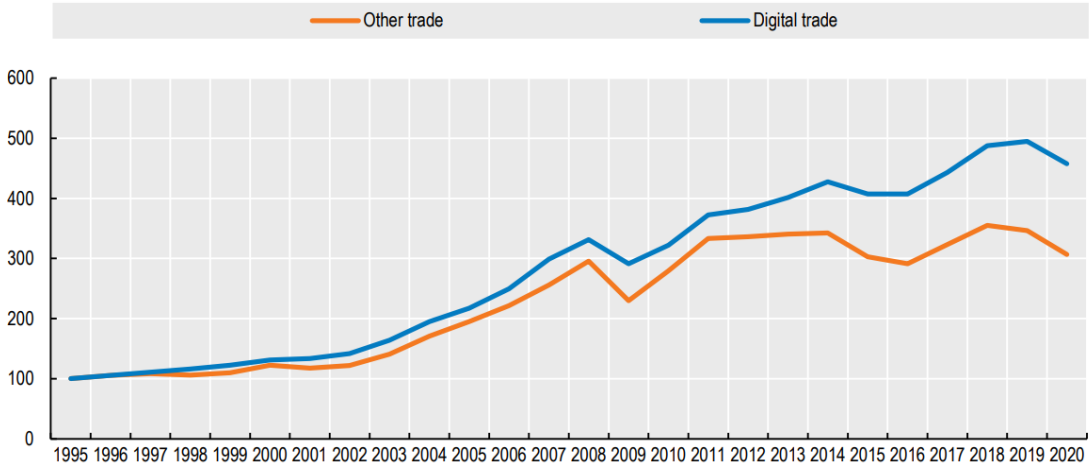
[9] The Trade in Value Added (TiVA) database provides comprehensive and internationally comparable data on the value-added content of the production of goods and services traded worldwide for 76 economies over the period 1995-2020. TiVA indicators are derived from OECD Inter-Country Input-Output (ICIO) tables. These are constructed using statistics compiled from national, regional and international sources according to the 2008 System of National Accounts (2008 SNA), and use an industry list based on the International Standard Industrial Classification Revision 4 (ISIC Rev.4).

[10] OECD, WTO, UNCTAD, IMF (2023), "Handbook on Measuring Digital Trade", Second Edition, OECD Publishing, p.69.

[11] The domestic value added content of gross export ($EXGR\ DVA$ indicator) is computed based on OECD Inter-Country Input-Output (ICIO) tables, which include information on gross output, value added and gross exports. The formula used for the calculation is: $EXGR\ DVA_{c,i,p} = V_c B_{c,c} EXGR_{c,i,p}$, where V_c is the value added to output ratio for country *c*, and $B_{c,c}$ corresponds to the Leontief inverse, that is the total domestic gross output required for one unit increase in country *c*'s demand. $EXGR_{c,i,p}$ represents gross exports from industry *i* in country *c* destined to country *p*.

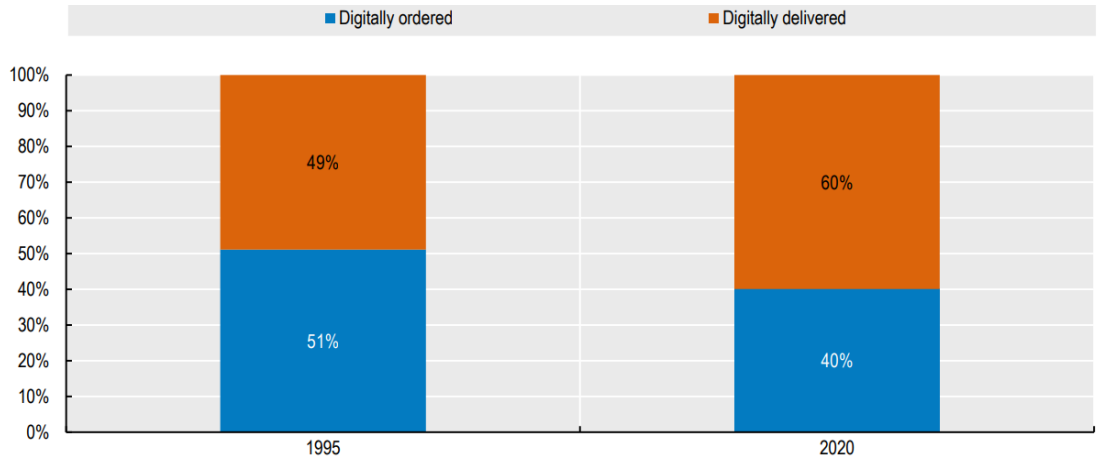
This shift is driven by the rise in ICT services trade, which accounts for 14% of digital trade in 2020 (from 7% in 1995).

Figure 2: Digital trade growth rates (1995=100)



Source: OECD (2023).

Figure 3: Digital trade composition



Source: OECD (2023).

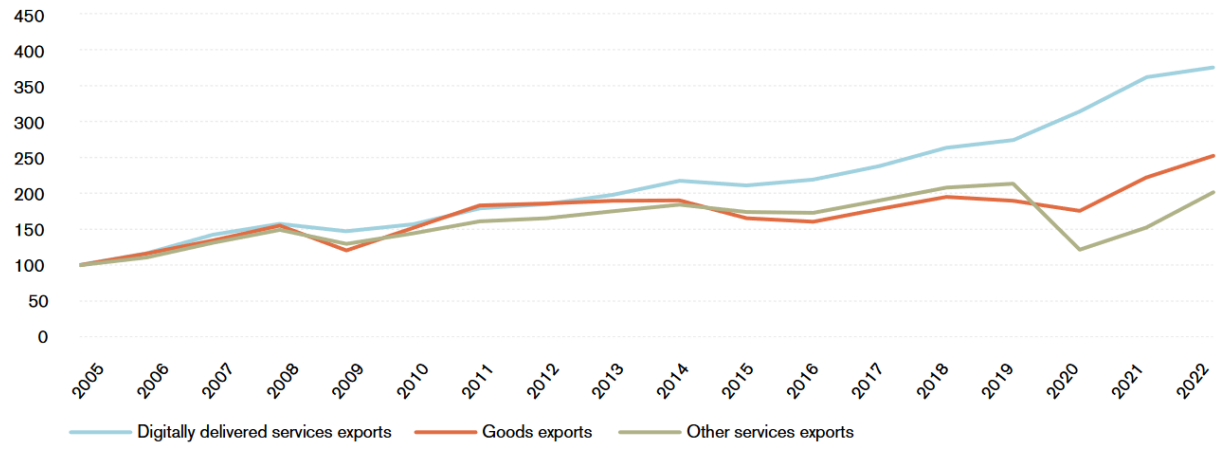
Alternatively, Ferracane et al. (2023) focus solely on *digitally-delivered* services, acknowledging the difficulties in measuring the value of *digitally-ordered* goods and services. They consider 4 different proxies for *digitally-delivered* trade, starting from the value of trade in (i) ICT goods[12] and core digital services (IT and information, publishing and telecoms), and progressively expand on this by adding (ii) business and professional services, (iii) financial services, and (iv) restaurants, accommodation, health and education services. Altogether, the four definitions range from a narrow to a very broad set of digital sectors. Instead, Suh and Roh (2023) take a narrower approach and measure digital trade as the share of cross-border trade in

[12] ICT goods refer to ISIC sector 26, which comprises computer, electronics, and optical equipment.

ICT services.[13] However, while these studies contribute to defining proxies for *digitally-delivered* trade, they do not provide information on the level or evolution of these aggregates over time.

Lastly, the World Trade Organization (WTO, 2023) estimates the value of *digitally-delivered* services by using cross-border supply exports in ICT services, financial and insurance services, telecommunication, and selected categories in business services and in personal, cultural and recreational services. Based on WTO proxy measure, *digitally-delivered* services exports reached USD 3.82 trillion in 2022, accounting for 54% of total services exports, and for 12% of total goods and services exports. The nominal value of exports in these services more than tripled since 2005. Over the 2005-2022 period, *digitally-delivered* services have grown by 8.1% per year on average, outpacing the growth in exports of both goods (5.6%) and other services (4.2%) (Figure 4). Regarding the composition of *digitally-delivered* services, in 2022 business, professional, and technical services account for around 40% of exports, followed by computer services (20%) and financial services (16%).

Figure 4: Global exports of digitally delivered services (2005=100)



Source: WTO (2023).

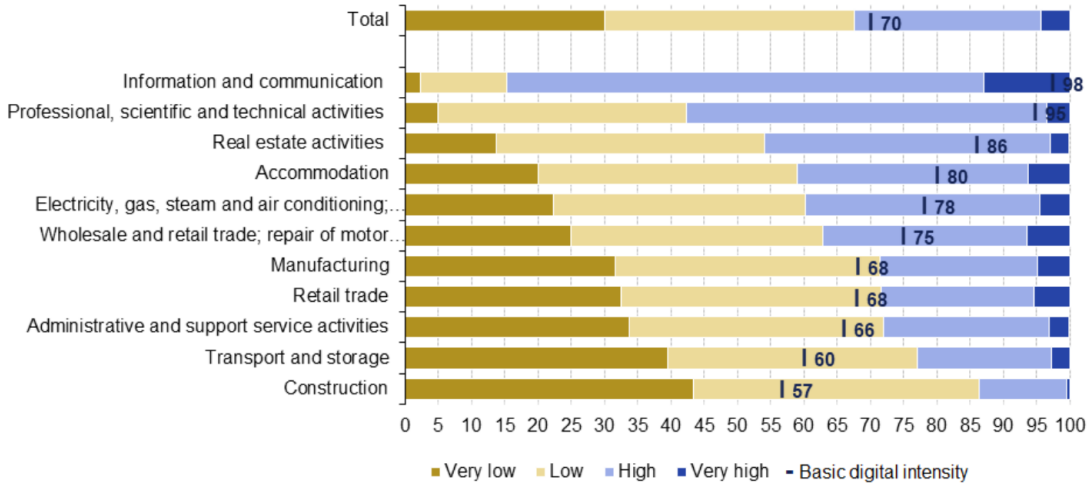
2.2.2. Digital intensity indicators

Other studies measure digital trade using digital intensity indicators. As digital technologies become increasingly important in the production process, one approach to assess digital trade dynamics is to look at trade in sectors that use digital inputs extensively. There have been many attempts to construct indexes for digital intensity, especially in the studies conducted by international institutions. The Digital Intensity Index (DII) developed by the European Commission considers the share of firms in each sector using 12 selected digital technologies (such as using AI, employing ICT specialists, having online sales). In 2022, the EC estimates that 70% of business reach a basic level of digital intensity (i.e., employ at least 4 of the 12

[13] The measure is based on OECD-WTO Balanced Trade in Services (BaTIS) dataset for bilateral service trade flows, and on the WTO Trade in Services by Mode Of Supply (TiSMOS) database for information on the share of cross-border mode of supply (Mode 1).

technologies considered) (Figure 5).[14] Not surprisingly, the most digitally intensive businesses are those operating in ICT activities, followed by professional, scientific and technical services.

Figure 5: Digital intensity of enterprises by economic activity, EU 2022



Source: EC calculations based on Eurostat data.

In turn, the OECD (Calvino et al., 2018) proposes a ranking of service sectors based on five indicators related to ICT investment, use of intermediate ICT goods and services, automation, number of ICT specialists, and online sales. Sectors ranking in the top quartile for these indicators are considered highly digitally intensive. Following this taxonomy, Lippoldt (2023) and Chikova and Peterson (2021) measure digital trade using trade in highly digitally-intensive sectors, namely: telecoms and ICT, finance, insurance, and other business services.[15] Lippoldt (2023) observes that all the five economies considered in the study experienced a rise in the share of high digital intensive services over total services exports. This trend was particularly evident during the Covid-19 pandemic, as exports in other sectors such as travel and transport experienced a strong decline. Notably, in 2021 digital intensive sectors account for more than half of services exports in four of the five case study economies (Figure 6).

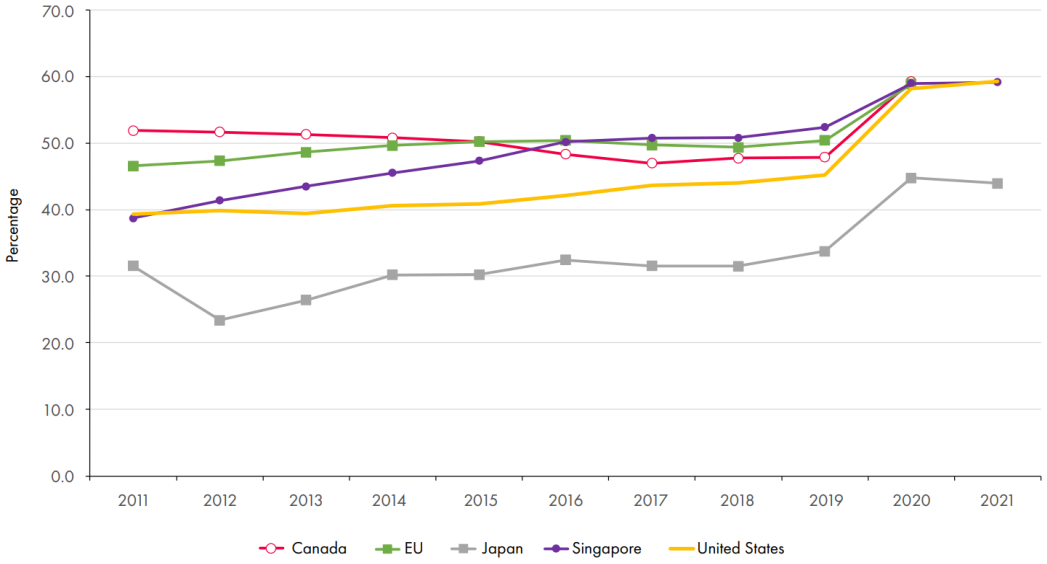
Chikova and Peterson (2021) show that over the past decades the bulk of trade between the US and the EU has shifted to digital services. While US-Europe trade in goods and non-digital services rose by roughly 50%, trade in digital services more than doubled between 2006 and 2019 (Figure 7). The authors estimate that digital services trade is responsible for 78% of the US' services exports to the EU in 2020. They note that more than half EU businesses use US-based social media platforms (such as Twitter, LinkedIn, Facebook) for customer engagement and trend research. US digital streaming companies like Netflix and YouTube serve more than 140 million European subscribers. European companies are increasingly embracing US cloud services (such as Amazon Web Services and Alphabet) and communication apps (such as Zoom, Cisco WebEx, Microsoft

[14] See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Towards_Digital_Decade_targets_for_Europe&stable=1#Digital_transformation_of_businesses.

[15] Lippoldt (2023) selects the EBOPS one-digit service sectors that correspond to the ISIC sectors identified as highly digital-intensive by the OECD. The EBOPS classification is fairly aggregate, and the author acknowledges that, for instance, the "other business services" sector likely includes services with low digital intensity (like services incidental to agriculture, forestry and fishing).

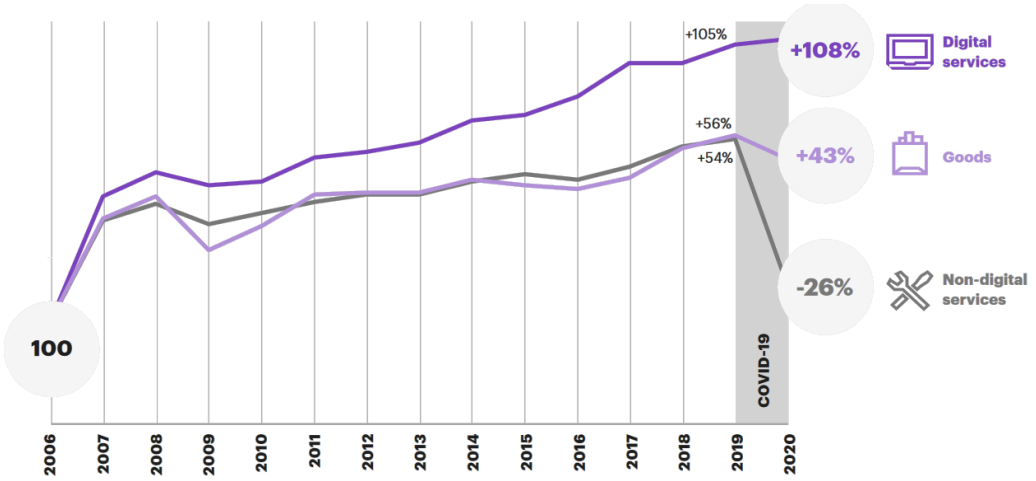
Teams). As digital adoption grows, the already significant reliance on transatlantic data in trade is expected to further intensify.

Figure 6: Share of high digital intensive sector exports over total services exports



Source: Lippoldt (2023).

Figure 7: EU–US bilateral trade evolution (2006 = 100)



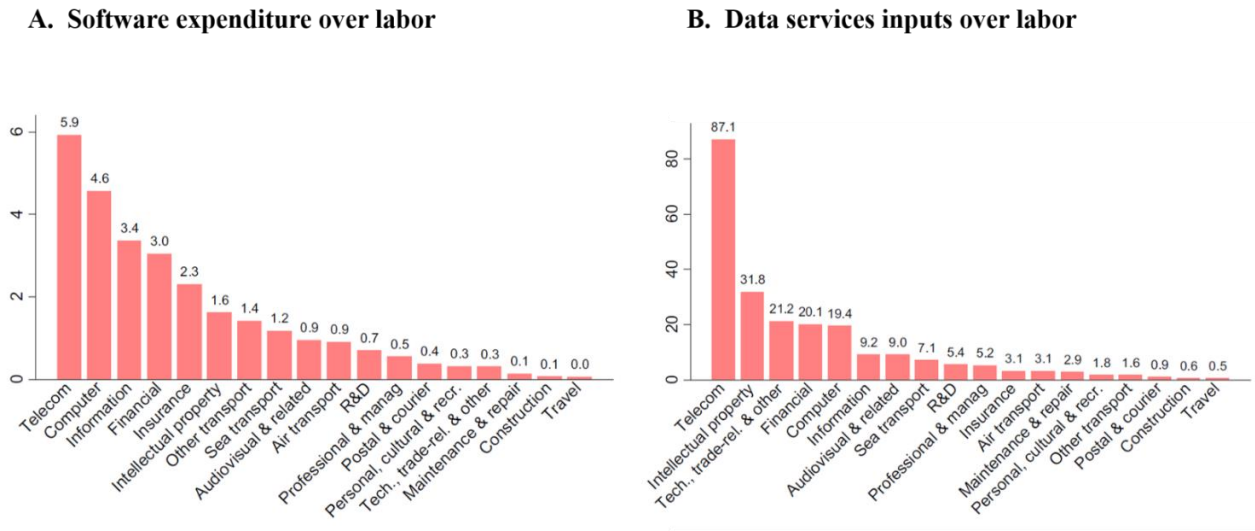
Source: Chikova and Peterson (2021).

Alternatively, Ferracane et al. (2023) propose measuring digital trade by using the 'data intensity' indicator developed by van der Marel and Ferracane (2021). The authors estimate data intensity for each service sector using either (i) the ratio of software usage to labour costs (from the US Census ICT survey), or (ii) the ratio of sector's input use of data services to labour cost (from BEA 2007 input–output Use Table).[16] Using US data,

[16] To compute this second proxy the authors first identify 8 sectors that provide data to the other downstream services sectors. They include, inter alia, telecommunication, data processing and hosting services, internet service providers and web search portals, software publishers, and other computer-related services. Then, they compute the ratio between the BEA's input data services usage based on the purchaser's prices and labour for each downstream services sector at the 6-digit level. Labour is sourced from the US Bureau of Labor Statistics.

the sectors with the highest software-to-labour ratios are telecommunications, computer services, information services, finance, and insurance (Figure 8).

Figure 8: Data intensity indicators



Source: van der Marel and Ferracane (2021).

Lastly, Chiappini and Gaglio (2023) measure digital intensity for each country and sector as the share of intermediate consumption in digital inputs over total intermediate input consumption, exploiting Inter-Country Input-Output tables from the World Input-Output Database (WIOD). Digital inputs include digital goods (manufacture of computer, electronic, and optical products) and digital services (software publishing, telecommunications, computer programming, consultancy and related activities, and information service activities).[17]

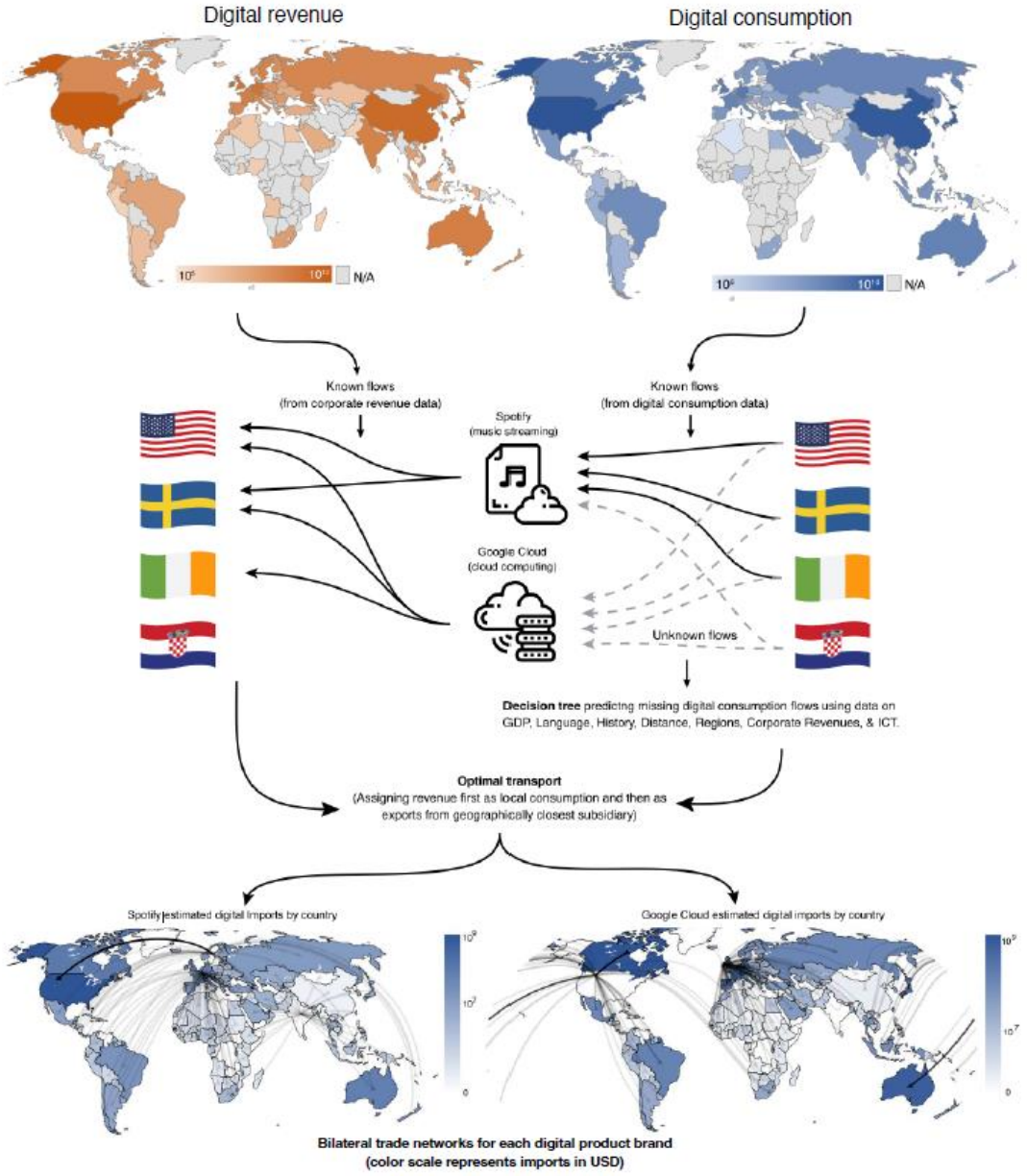
2.2.3. Digital corporate revenues

Stojkoski et al. (2023) employ a different approach to measure digital trade, based on micro-level data. The authors adopt a narrow definition of digital trade, characterizing it as the international commerce of goods and services that exist solely or primarily in digital form, such as movies and video games. Notably, the definition excludes international trade in physical goods ordered online, as well as trade in traditional services, like tutoring and legal counselling, even when delivered digitally.

Their approach involves estimating the value of bilateral digital trade by combining data on digital corporate revenues with data on country digital consumption (Figure 9).

[17] They provide evidence that digital intensity positively affects sectoral exports, the effect being larger for manufacturing than for services sector. They explore two possible transmission mechanisms, finding that digital intensity facilitates trade between countries by reducing the negative impact of geographical distance and language barriers, and by improving the quality of exported products.

Figure 9: Stojkoski et al. (2023) methodology for estimating trade in digital products



Source: Stojkoski et al. (2023).

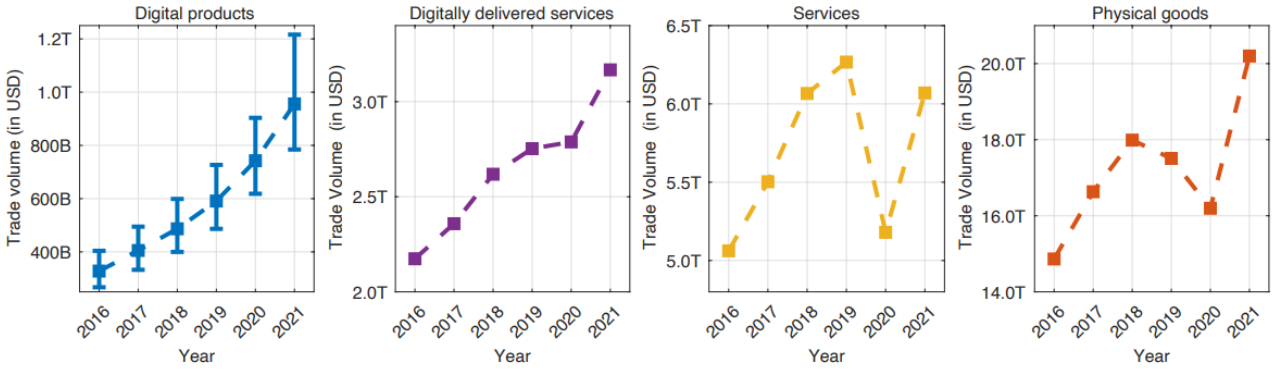
The authors first identify the countries of origin of digital production. They source revenue data from Orbis for the largest firms that are primarily engaged in online business activities. They then leverage Statista's Digital & Technology Market classifications to identify the digital product sectors in which each firm operates, and allocate the firms' revenues across these sectors. The 2,502 firms in the dataset operate in 29 digital sectors, including cloud computing, web hosting, digital advertising, music streaming, online education, online marketplace, payment services. These data are complemented by revenue and consumption data sourced from AppMagic, a mobile market intelligence company. The company provides information on consumption patterns for 13,629 unique firms and app developers offering mobile games and applications downloaded from the Apple Store and Google Play. Country consumption patterns in online games and applications are used to

identify the destination countries of digital products.[18] Finally, revenue and consumption data are merged together by connecting each digital product to its country of origin and to the countries where consumption took place.[19]

The authors' estimates show that digital products trade has been increasing rapidly, at an annual rate of 24% in the period from 2016 to 2021, while services and physical goods trade grew at a rate of 4% and 6%, respectively (Figure 10). For 2021, the authors estimate trade in digital products to be USD 0.96 trillion, approximately 3.6% of world trade. These figures are three times lower than those reported for trade in *digitally-delivered* services (see subsection 2.2.1), as the authors do not include the digital delivery of traditional services, and digital trade involving small firms. Notably, 65% of digital products trade is accounted for by 3 sectors: digital advertising (30%), online marketplaces (18%), and cloud computing (17%).

Looking at the geography of digital trade, the paper shows that the majority of digital exports originate from the US, while the presence of European companies in global markets is limited (Figure 11). Revenues from digital products generated by European companies, when allocated according to the nationality of the parent company, are negligible compared to the EU's GDP.

Figure 10: Volume of trade in digital and physical products

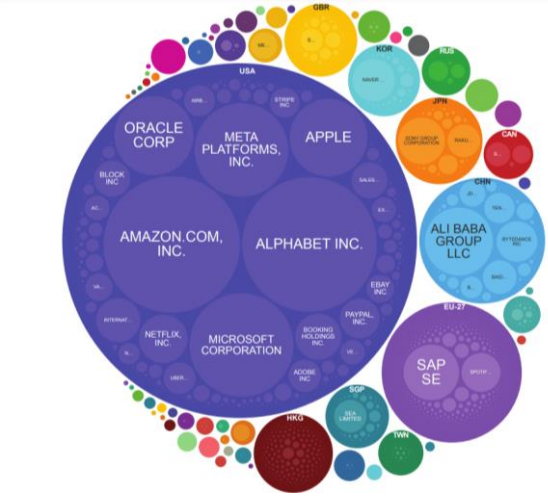


Source: Stojkoski et al. (2023).

[18] AppMagic data covers 13,629 firms and app developers operating in 60 different countries, for the years 2016-2021. The authors employ machine learning techniques to extend consumption data coverage to additional 129 countries and to the 29 digital sectors identified based on Orbis data. Specifically, they use a gradient-boosted regression tree (GBRT) model, which builds decision trees sequentially and combine their predictions so to optimize the gradient of the loss function with respect to the model's predictions. The model's features are motivated by gravity models of trade, and include brand-level variables, such as the total revenues of the brand, as well as features descibing the relationship between the country that develops and the one that consumes the products, such as shared language, borders, common colonizers, geographic distance, GDP, and ICT capacities.

[19] Corporate revenues are matched to the estimated consumption patterns using an optimal transport procedure that assigns consumption to the revenues of the geographically closest subsidiary (without exceeding the revenue of the subsidiary). For instance, considering Google Cloud consumption and revenues in each country, the process begins with estimating where Google Cloud revenues resulting from consumption in one country, such as Sweden, are originated. Google Cloud consumption is first assigned to the cloud revenues of Google Sweden. Then, if consumption is larger than the revenues of Google Cloud in Sweden, the excess volume is assigned to the geographically closest subsidiary that has revenues not yet assigned to another country. In this way the authors provide conservative estimates for international trade of digital products, as they prioritize allocating revenues to domestic consumption.

Figure 11: Digital product exports, by headquarters location

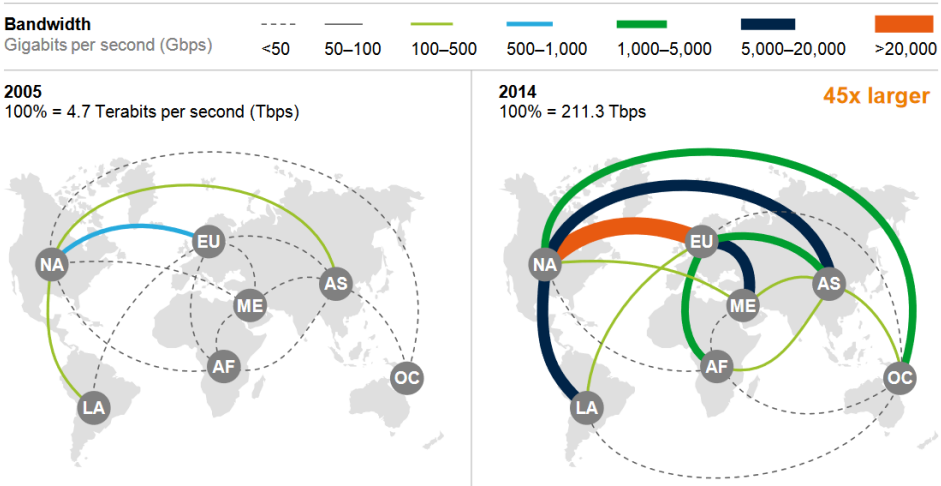


Source: Stojkoski et al. (2023).

2.2.4. Cross-border data flow

Lastly, another method for studying digital trade trends is to look at cross-border data flows. To estimate data flows, McKinsey & Company uses cross-border internet traffic (Lund and Manyika, 2016) and cross-border internet bandwidth (Manyika et al., 2016) from TeleGeography. Both these proxy measures point to a large increase in digital trade flows. Between 2002 and 2012, cross-border internet traffic grew by 60% a year, while the amount of cross-border bandwidth that is used has grown 45 times larger between 2005 and 2014 (Figure 12). While these indicators are able to capture also non-monetary flows, they do not contain information about the economically relevant content of these flows, making it difficult to translate this information into economic value. Moreover, these proxies may not accurately reflect the actual level of cross-border data flows. On the one end, they can overestimate international flows, as internet hubs may route data across many borders to connect two endpoints. On the other hand, they can underestimate data flows when the server hosting the content is located within the same country as the user, despite the content originating from abroad.

Figure 12: Used cross-border interregional bandwidth



Source: Manyika et al. (2016).

Table 2 summarizes the different approaches employed in the literature for measuring digital trade along with the corresponding estimation results.

Table 2: Approaches on measuring digital trade

Measurement proxy	Reference literature	Estimation results
Digitally-delivered and digitally-ordered trade	• Ferracane et al. (2023) • López González et al. (2023) • OECD (2023) • Suh and Roh (2023) • WTO (2023)	• Digital trade i. $5tr in 2020 (25% of global trade). ii. 6.3% annual growth rate (1995-2020).* • Digitally-ordered trade i. $2tr in 2020 (10% of global trade).* ii. 5.3% annual growth rate (1995-2020).* • Digitally-delivered trade i. $3.82tr in 2022 (54% of services trade). ii. 8.1% annual growth rate (2005-2022). * Own calculations based on OECD (2023) data.
Digital intensity indicators	• Calvino et al. (2019) • Chikova and Peterson (2021) • Lippoldt (2023) • van der Marel and Ferracane (2021)	• In 2021, trade in digital intensive sectors accounted for more than 50% of services exports for EU, US, Singapore and Canada. • In 2020, digital services trade represented 78% of US' services exports to the EU.
Digital corporate revenues	• Stojkoski et al. (2023)	• Digital trade reached $0.96tr in 2021 (3.6% of global trade). • Digital trade grew by 24% per year (2016-2021).
Cross-border data flow	• Lund and Manyika (2016) • Manyika et al. (2016)	• Cross-border internet traffic grew by 60% a year (2002-2012). • Cross-border bandwidth usage increased by 45 times (2005-2014).

3. Key drivers of digital trade: digitalization and trade liberalization

As discussed in section 2, there is no single recognised definition for digital trade, but there is a growing consensus among international organisations that it encompasses cross-border digital ordering and delivery (IMF et al., 2019 and 2023). The proxy measures used in the literature suggest that digital trade has been growing in the last decades (López González et al. 2023; WTO, 2023). The widespread adoption of digital technologies, known to as the 'digitalization process', is the primary driver of digital trade, impacting both *digitally-ordered* and *digitally-delivered* trade. Moreover, digital trade liberalization, by lowering barriers on digital services trade and prohibiting the imposition of customs duties on e-commerce, play a complementary

role in facilitating digital trade. In what follows we take in turn these two drivers of digital trade: digitalization (subsection 3.1) and trade liberalization (subsection 3.2). At the end of each subsection a table summarizes the different topics discussed, the relevant literature and the main results found therein.

3.1. The digitalization process: from the Internet to the AI

Several empirical studies have emphasized the trade-enabling role of digitalisation. Digital technologies have expanded the array of services that can be delivered remotely, while online platforms like Amazon and eBay have notably facilitated *digitally-ordered* trade. Moreover, digitalization has favoured firms' participation in Global Value Chains (GVCs). In line with these findings, empirical evidence suggests that the impacts of the internet revolution extend beyond digitally ordered and delivered services, influencing also trade in more traditional sectors. Looking ahead, advances in AI technology are likely to significantly enhance digital trade. This subsection provides an overview of the research on the impacts of digitalization on global trade, while Table 3 at the end of the subsection lists the main reference literature.

Digitalization expands the set of digitally-deliverable services

For what concerns *digitally-delivered* services trade, the internet revolution is making many services that were previously non-tradeable easily accessible across borders, by allowing a spatial separation of office workers and offices (Baldwin, 2022). Looking at the phenomenon of business process offshoring, Blinder and Krueger (2013) estimate that, as of 2008, approximately 25% of all jobs in the US could potentially be outsourced to workers abroad, with high 'offshorability' observed in sectors like finance, insurance, and information services, as well as technical and professional services. Recent trends indicate that the array of tradable services is expanding. Law firms are shifting from physical offices to online platforms that allow private clients to connect remotely. Similarly, the education sector is leveraging digital technology by creating virtual classrooms that allow the delivery of online courses to students worldwide. Virtual reality glasses provide a full view of faraway locations, letting specialists inspect production facilities in other countries without being physically present (WTO, 2018). Beyond facilitating trade in traditional services, digital technologies have given rise to new services that are inherently digital in nature. This involves downloading software, using cloud computing for data storage, and enjoying real-time content through audio and video streaming. Online gaming has also become popular, allowing users to have virtual experiences and make virtual purchases within online spaces. Furthermore, as the internet has exponentially improved in speed and accessibility in recent years, there has been a significant shift from physical to purely digital forms for various contents that were previously traded in tangible formats, such as CDs and DVDs.

Online platforms boost digitally-ordered trade

Regarding *digitally-ordered* trade, the rise of online platforms, like Amazon, eBay or Alibaba, have significantly reduced search costs and facilitated matching between potential buyers and sellers (Goldfarb and Tucker, 2019), by providing information on the characteristics of the products and on the counterparts. Moreover, by providing mechanisms such as feedbacks and guarantees, digital platforms also make it easier to ascertain reputation and enforce contracts (WTO, 2018). In the tourism sector, platforms such as Expedia,

Booking.com and Airbnb have simplified travel search and booking processes, leading to the rise of the peer-to-peer accommodation market (Brauckmann, 2017).

Lendle et al. (2016) estimate that the effect of distance on cross-border trade flows is approximately 65% smaller for eBay transactions compared to total international trade in the same set of countries and products. Carballo et al. (2022) study the effects of the introduction of the ConnectAmericas platform on Peruvian exports, using detailed data on firms' participation in the platform and their export activities as reported to the national customs. Their estimates suggest that joining the platform resulted in increased firms' total exports, particularly for those firms that are small or had no digital presence, and to less familiar destinations.

Digitalization enhances global value chain participation

Digital technologies can favour Global Value Chain (GVC) participation by reducing barriers faced by firms when joining GVCs, such as verification and monitoring costs in firm-to-firm relationships. Moreover, the widespread availability of high-speed internet has the potential to greatly facilitate GVC participation by smaller firms and by firms in countries with bad infrastructure, which can specialize in the provision of digital services rather than physical goods (Antràs, 2020).

Fort (2017), analyzing data on US firms' choices between domestic and foreign suppliers of manufacturing services, shows that the adoption of communication technologies enhances participation also in manufacturing segments of GVCs. The effect increases with the industry's ability to codify product specifications in an electronic format, and it is 6pp higher for 'semiconductor machinery' industry compared to 'other apparel'.[20]

Internet adoption increases digital and non-digital trade

In line with digitalization expanding the array of tradable services, research indicates that higher levels of internet penetration and usage correlate with increased trade in services, both in terms of exports and imports (Choi, 2010; Freund and Weinhold, 2002). Similarly, López González and Ferencz (2018) show that increased internet usage has a positive impact on bilateral trade in *digitally-deliverable* sectors, like telecoms and computer services, while negatively affecting construction.

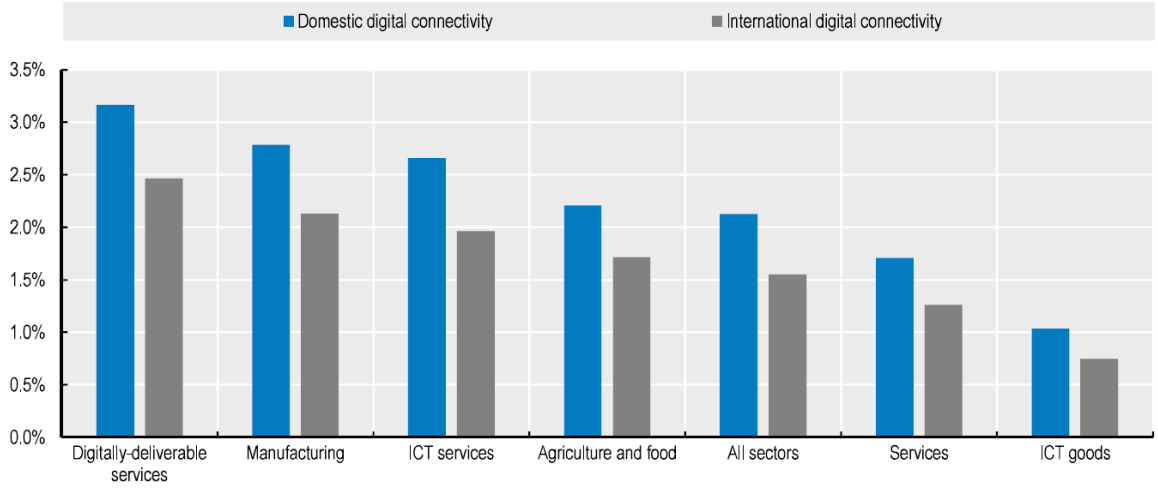
Moreover, the rise of e-commerce platforms and improvements in supply chain efficiencies have contributed to increased trade also in more traditional sectors. Visser (2019) and Kitenge and Lahiri (2022) find that digital technologies enhance trade opportunities by reducing cultural and language barriers. Using data from 1995 to 1999, Freund and Weinhold (2004) show that the growth in internet adoption, measured by the number of web hosts, increased exports even during the early stages of the technology. Lin (2015) confirms these findings, showing a positive effect of internet usage on bilateral trade for nearly 200 countries over the 1990-2006 period. More recently, Herman and Oliver (2023) observe a positive relationship between internet use, bandwidth capacity, and trade in both goods and services. Similarly, López González et al. (2023) find that

[20] On the other hand, advancements in machine learning and robotics have significantly contributed to the increasing prevalence of automation in various industries. Automating tasks may represent an alternative to offshoring for firms in advanced economies aiming at reducing labour costs, thus reducing GVC participation of less developed countries. However, automation also tends to decrease firms' costs and increase productivity and optimal scale, thereby increasing their demand for intermediate inputs, many of which continue to be sourced from less developed economies (Antràs, 2020).

growing digital connectivity translates into a significant increase in international trade flows. While the impact is particularly high for *digitally-deliverable* services, its significance extends also to sectors such as manufacturing and agriculture (Figure 13).

Figure 13: Impact of digital connectivity on trade flows, by sector

Impact of a 1% improvement in bilateral digital connectivity on domestic and international trade.



Source: López González et al. (2023).

AI adoption and the future of digital trade

Lastly, Artificial Intelligence (AI) technology has the potential to significantly enhance digital trade. The current generation of AI represents a revolution in predictive capabilities, driven by recent progress in deep learning. Generative AI systems such as ChatGPT, Bard, and DALL-E, which use simple natural language prompts, have recently made AI accessible to everyone. While research on the impact of AI on digital trade is relatively limited, Goldfarb and Trefler (2018) describe the features for an appropriate model of international trade in the context of AI. The authors emphasize the need to account for economies of scale and scope, given the substantial computing power and data needed for training models, and the possibility to integrate AI technologies across various applications. Additionally, as a knowledge-intensive industry, knowledge externalities are also important. They suggest that the effectiveness of AI-focused trade policies crucially depends on the presence of scale and the absence of rapid international knowledge diffusion.[21]

Ferencz, López González and García (2022) provide qualitative discussions of how AI impacts international trade, focusing on three main channels. *Firstly*, AI can boost productivity. In the financial sector, for instance, AI is employed to improve banks' credit decisions, personalize financial services, and detect fraud. Brynjolfsson et al. (2023) study the impact of introducing a generative AI-based conversational assistant in customer support agencies. They find that access to the tool increases productivity, as measured by issues resolved per hour, particularly for newer and less-skilled workers. Moreover, they show that AI assistance

[21] The authors also note that privacy policies targeting consumer protection may disadvantage domestic AI firms compared to foreign ones, and they emphasize the need for regulatory harmonization to prevent a race to the bottom. The authors suggest alternative policies, such as data localization rules, limited access to government data, and industry regulations to support domestic firms.

improves customer sentiment and reduces requests for managerial intervention. *Secondly*, AI can enable greater supply chain efficiency. AI systems can increase efficiency in logistics by helping with the management of inventories and warehouses, the coordination of shipments across countries, the predictions of future demand trends and the accuracy of just-in-time delivery. Business can also use AI to improve physical inspection and maintenance of assets along supply chains (Meltzer, 2018). *Finally*, AI can reduce trade costs such as language barriers through automated translation systems. Brynjolfsson et al. (2019) find that the introduction of an upgraded machine translation system has significantly increased US exports to Spanish-speaking Latin American countries on eBay, by reducing matching frictions between consumers and sellers who speak different languages.

Sun and Trefler (2023) study the impact of AI on international trade in mobile app services. Based on 2015-2020 usage data for more than 35,000 mobile apps and on app developer's AI patents data, the authors quantify the AI deployed in each of these apps using a large language model (LLM) that that identifies which apps use which AI algorithms.[22] They find that AI deployment raises an app's number of foreign users by more than 10-fold.

Table 3 summarizes the main literature on the effects of the digital revolution on global trade.

Table 3: Literature on the impacts of digitalization on international trade

Topic	Reference Literature	Main findings
Digitalization and digitally-delivered trade	• Baldwin (2022) • Blinder and Krueger (2013) • WTO (2018)	• Digital technology allows for spatial unbundling of labour and labourers and increase jobs 'offshorability'. • Digital technology creates new digital services.
Digitalization and digitally-ordered trade	• Carballo et al. (2022) • Goldfarb and Tucker (2019) • Lendle et al. (2016) • WTO (2018)	• Online platforms lower search costs, improve buyer-seller matching, and facilitate reputation assessment. • Online platforms reduce the role of distance and boost exports.
Digitalization and GVCs	• Antràs (2020) • Fort (2017)	• Digital technologies reduce barriers to joining GVCs, also for manufacturing segments of GVCs.
Internet penetration and global trade	• Choi (2010) • Freund and Weinhold (2002) • Freund and Weinhold (2004)	• Higher levels of internet penetration and usage correlate with increased trade in both goods and services.

[22] For each app *a* and AI patent *p*, the authors input the app description and patent text into Google's LLM, BERT, and ask it whether the app likely uses the algorithm described in the patent. The answer comes back in the form of a cosine similarity ρ_{ap} which is large (small) if the app and patent texts covers similar (dissimilar) subject matter and is used as a measure for the AI in patent *p* deployed by app *a*. The ρ_{ap} are then aggregated to measure AI deployment at the app level. The authors also explore AI knowledge spillovers by constructing a measure that takes into account whether the app description is cosine similar to the set of all filed AI patents.

	• Herman and Oliver (2023) • Kitenge and Lahiri (2022) • Lin (2015) • López González and Ferencz (2018) • López González et al. (2023) • Visser (2019)	
AI and international trade	• Brynjolfsson et al. (2019) • Brynjolfsson et al. (2023) • Ferencz, López González and García (2022) • Goldfarb and Trefler (2018) • Meltzer (2018) • Sun and Trefler (2023)	• AI can boost trade through increased productivity, improved supply chain efficiency, and reduced trade costs. • AI-based conversational tools increase productivity for less skilled workers. • Automated translation systems reduce matching frictions between consumers and sellers. • AI deployment in mobile apps increases the number of foreign users.

3.2. The role of trade liberalization

In addition to digital technologies, there is evidence that trade agreements can play a complementary role in boosting digital trade. Unlike barriers to trade in goods, which are primarily in the form of tariffs, services are hard to tax at the border. Barriers to services are typically complex, involving regulatory measures, licensing requirements, or differences in technology standards. Therefore, trade agreements that facilitate the free flow of data or limit the imposition of data localization requirements represent a key measure for policy makers to boost *digitally-delivered* trade. On the other hand, agreements aimed at prohibiting customs duties in e-commerce can significantly enhance *digitally-ordered* trade. This subsection provides an overview of the existing literature on the effects of digital trade facilitation provisions on global trade, with Table 4 at the end of the section summarizes the main research contributions.

As digital trade has gained prominence, both domestic and international regulation on digital trade-related aspects has advanced accordingly. Within the multilateral context, the WTO began discussions on digital trade in 1998, adopting a Work Programme on e-commerce and agreeing to a Moratorium against customs duties on electronic transmissions. However, progress on digital trade-related issues has been slow, and only in 2019 a group of WTO members, led by Singapore, Australia and Japan, started negotiating a Joint Initiative (JI) on E-Commerce. The initiative covers negotiations on various topics, such as e-payments, data flows, privacy, consumer protection, cybersecurity, and market access.[23] Moreover Japan, as the 2023 G7 president, actively promoted the concept of 'data free flow with trust' (DFFT) and has taken steps to operationalize this concept

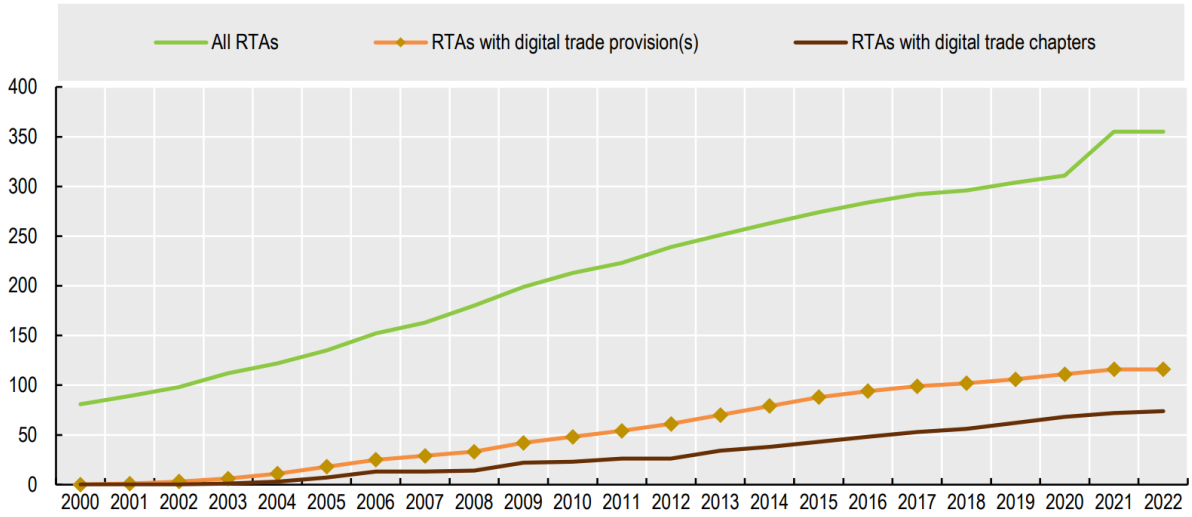
[23] As of February 2024, 90 members are currently negotiating the Joint Initiative on E-Commerce. On 23 October 2023, the US announced that it ended its support for the E-commerce JI proposals on data flows, data localization and source code, while remaining committed to the rest of the negotiating issues.

by establishing a DFFT Community at the OECD, aimed at aligning the diverse regulations on the transfer of personal data.

The slow pace of multilateral initiatives has led many economies, such as Canada, China, the EU, Japan, Singapore, and the US, to put forward regional trade agreements (RTAs) to address some relevant digital-trade related matters, like the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), or the e-commerce chapter of the Regional Comprehensive Economic Partnership (RCEP).

The Trade Agreements Provisions on E-Commerce and Data (TAPED) database developed by the University of Lucerne (Burri and Polanco, 2020; Burri et al., 2023) provides information on digital trade provisions within trade agreements. The database maps 432 preferential trade agreements signed between 2000 and 2023, coding provisions related to topics like e-commerce, data flows, data localization, and intellectual property. Data shows a steady increase in the negotiation of agreements that include provisions or chapters on digital trade-related topics (Figure 14). Of the 49 regional agreements signed from January 2020 to November 2023, 44 (90%) contain digital trade provisions, and 26 (53%) have separate chapters on the subject (Burri et al., 2023).

Figure 14: Number of RTAs with digital trade provisions



Source: OECD calculations based on TAPED data.

Using TAPED data, Suh and Roh (2023) show that the inclusion of digital trade-related provisions in RTAs is associated with an increase in bilateral digital trade, with deeper agreements having a stronger effect. Other studies focus on the overall impacts on trade. For instance, Herman and Oliver (2023) select seven types of provisions from the TAPED dataset (including data flows, custom duties prohibitions for e-commerce and data protection) to construct a bilateral measure of digital provisions in trade agreements. Using a gravity model framework, they find that digital trade facilitation provisions in trade agreements significantly increases trade for high-income exporters, especially for services. Based on the same database, López González et al. (2023) find that the presence of an e-commerce chapter in trade agreements between two countries increases trade flows, both for high-income and emerging economies. However, the authors are not able to disentangle the

effect of e-commerce liberalization from a more general deepening of the provisions in the agreement.[24] In turn, Ma et al. (2023) adopt a staggered DID model to analyse the impact of data flow provisions on international trade. They find that data free flow promotes trade in services, while results for trade in goods are less robust. The effects on service exports are higher when the level of internet access increases. Lastly, Wu, Luo and Wood (2023) use the TAPED database to construct indicators for the depth and the scope of digital trade rules.[25] Using the gravity framework, they show that both indicators have a significant promotional effect on global value chain (GVC) trade in services,[26] with the impact on GVC forward exports (i.e. domestic value-added exports of intermediates re-exported to third countries) being greater than the impact on GVC backward exports (foreign value-added in services exports).

Another set of studies focus on the impacts of specific digital trade agreements. Ferracane at al. (2023) examine the effects of the adequacy decisions in the context of the EU General Data Protection Regulation (GDPR).[27] Using a structural gravity model, the authors find that countries granted EU adequacy status exhibit an increase in bilateral digital trade. Notably, the results are mainly driven by the two adequacies granted by the European Commission to the US. Using a synthetic control approach, they also show that the effects on digital trade can be very heterogeneous across countries. In turn, Lippoldt (2023) observes an increase in some "high digital intensity" exports of 5 selected economies (EU, US, Canada, Singapore and Japan) following the adoption of trade agreements (like the CPTPP or the EU-Singapore RTA in 2019).

While these findings suggest a positive relation between regional agreements and digital trade, it is important to acknowledge that estimating the impacts of trade regulations comes with several challenges. As an example, for the GDPR, it is challenging to find a suitable control group and a clear start date, due to the presence of global spillovers and variable compliance and enforcement (Johnson, 2023).

Table 4 summarizes the main literature on the effects of digital trade agreements on global trade.

Table 4: Literature on the impacts of digital trade agreements on international trade

Topic	Reference Literature	Main findings
Impacts of the inclusion of digital trade provisions in RTAs	• Burri and Polanco (2020) • Burri et al. (2023) • Herman and Oliver (2023)	• Digital trade provisions in RTAs boost bilateral trade. • Data free flow provisions promote trade in services.

[24] The authors acknowledge that there is a potential upward bias in the estimation of the trade impact of an e-commerce chapter, as RTAs including e-commerce chapters could potentially be more likely to be 'deep' agreement, meaning they are more extensive in the number of policy areas they cover beyond e-commerce.

[25] The TAPED database distinguishes between 'soft,' 'mixed' and 'hard' commitments, assigning to provisions a value of 1, 2 and 3, respectively, so that the legal enforceability score of each trade agreement can be calculated. The depth indicator is computed by dividing the sum of the legal enforceability scores of the digital provisions contained in the trade agreements by the total number of digital provisions. The scope indicators are based on the number of words and articles related to digital trade contained in the agreement.

[26] Data for bilateral value-added trade in services are sourced from Asian Development Bank's 2007–2019 Multi-Regional Input–Output (ADB MRIO) database, which features measures developed in Borin and Mancini (2019).

[27] Adequacy decisions establish that a non-EU country has a regulatory regime in place that ensures a level of data protection that is equivalent to that ensured within the EU. These decisions allow personal data to flow freely between the EU and the adequacy-granted country without additional safeguards (Borgogno and Savini Zangrandi, 2022).

	• López González et al. (2023) • Ma et al. (2023) • Suh and Roh (2023) • Wu, Luo and Wood (2023)	• Broader and more comprehensive digital trade rules positively impact GVC services trade.
Impacts of specific trade agreements	• Ferracane at al. (2023) • Johnson (2023) • Lippoldt (2023)	• EU adequacy decisions under GDPR lead to increased bilateral digital trade. • Exports in "high digital intensity" sectors increased following the adoption of trade agreements like CPTPP or EU-Singapore RTA.

4. Weighting digital trade fragmentation

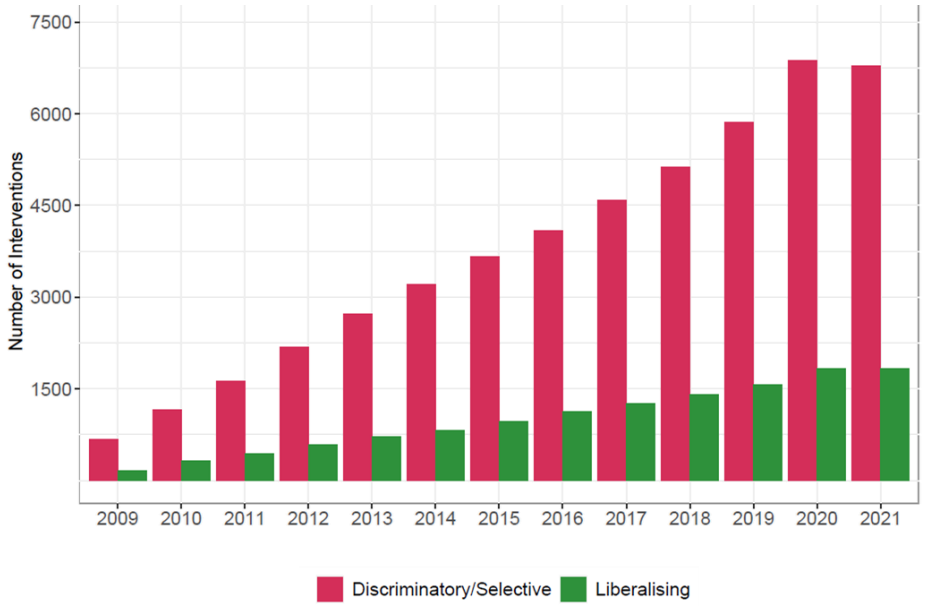
Despite progress in negotiating regional rules for digital trade, unilateral domestic policies on digital trade-related topics tightened over the last few years, and the regulatory landscape appears highly fragmented. Exchanges in data are currently subject to multiple and overlapping regulations, chiefly in the realms of privacy, antitrust and national security (Borgogno and Savini Zangrandi, 2022). Different approaches reflect different sensitivities and priorities. In the EU, the General Data Protection Regulation (GDPR) establishes the right to privacy, which results in limitations to cross-border transfer of personal data. In China, the Data Security law restricts the export of certain kinds of data deemed sensitive from a national security standpoint (Borgogno and Savini Zangrandi, forthcoming). The landscape of cross-border data restriction is also in a state of constant change. Although the US does not impose federal restrictions, for example, numerous states are adopting GDPR-like privacy safeguards, and Chinese access to US national's TikTok data sparked national security concerns currently at the attention of the Committee for Foreign Investments in the US (CFIUS).

This regulatory heterogeneity has increased complexity and raised concerns about possible fragmentation, potentially harming international trade (Altman and Bastian, 2022). Based on Global Trade Alert (GTA) data, Evenett and Fritz (2022) identify almost 13,500 global policy interventions taken since November 2008 that are relevant to a broad definition of the digital economy.[28] Of these policies, only 2,600 (19%) liberalised cross-border commerce, while the rest were discriminatory (Figure 15).[29]

[28] The authors focus on various policy interventions affecting the digital economy. These include interventions related to products in the UNCTAD's list of ICT goods, but also policies affecting the cross-border trade in metals needed to produce information technology (like lithium), or policies affecting the manufacture of semiconductors technology.

[29] The GTA classifies each entry according to whether its implementation would alter the relative treatment of the affected domestic and foreign commercial interests. This Relative Treatment Standard (RTS) is used to classify public policy intervention as either liberalising or harmful/discriminatory.

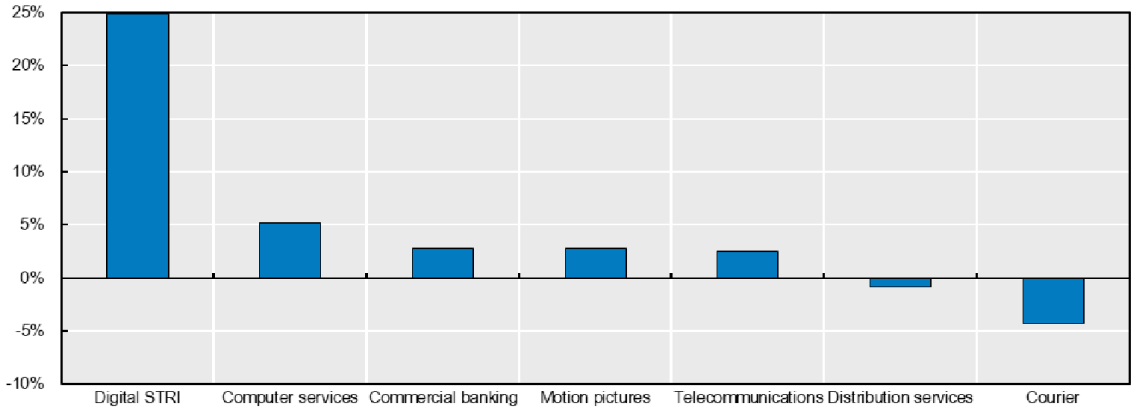
Figure 15: Digital economy interventions in force end of each year



Source: Evenett and Fritz (2022).

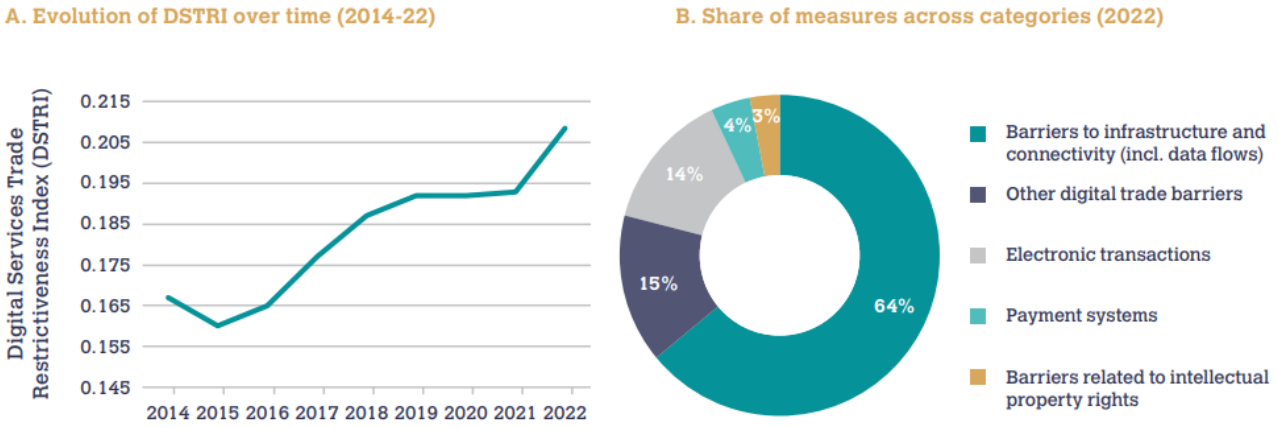
An emerging body of literature has started to focus on the effects of domestic barriers to digital trade. The OECD's Digital Services Trade Restrictiveness Simulator Index (DSTRI) serves as a valuable indicator for assessing regulatory and policy barriers to digital trade across countries. The index categorizes policy measures that impact trade in digitally-enabled services across 85 countries. These include policies affecting infrastructure and connectivity (such as the use of best practice in regulating interconnections, access to communication services, and policies influencing cross-border data flows and data localization), barriers related to electronic transactions (such as discriminatory practices in licensing or taxation), access to payment systems, and intellectual property rights. Moreover, the OECD STRI provides insights into sector specific regulatory barriers and can be used to track restrictions to key sectors that enable digital trade, such as computer services, telecommunications, courier, distribution, commercial banking and content related services. These indicators suggest that regulatory barriers are increasing. Between 2014 and 2022, the average DSTRI grew by 25% (Figure 16), with most of the barriers affecting infrastructure and connectivity (Figure 17).

Figure 16: Change in average Digital STRI and the STRI scores for selected sectors (%), 2014-22



Source: OECD (2023).

Figure 17: Trend in the OECD DSTRI score



Source: IMF at al. (2023).

López González et al. (2023) show that an increase in a country's DSTRI significantly impacts its bilateral trade flows, especially for digitally-delivered services.[30] Suh and Roh (2023) consider a bilateral measure of DISTRI, computed as the product between the exporter's and importer's index value. They observe that an increase in digital trade restrictiveness has a negative impact on digital trade.[31]

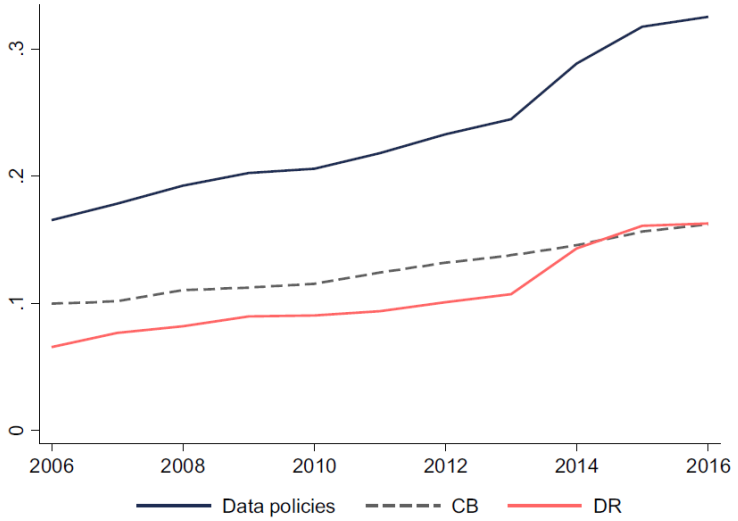
Van der Marel and Ferracane (2021) construct an indicator to assess the restrictiveness of countries' data policies. The index is based on the European Centre for International Political Economy (ECIPE) database and covers policies that restrict cross-border data flows (such as bans to transfer data and local storage requirements) and policies affecting the domestic use of data (such as data retention requirements). It is a weighted average of the restrictiveness level of different data policies, with weights reflecting policies' costs for digital trade. Evidence based on the ECIPE points to an increase in data policy restrictions over time. Between 2006 and 2016 both the Cross-border (CB) and the Domestic Regulatory (DR) policies components of the index show a clear upward trend (Figure 18).[32]

[30] We note that the DSTRI is not a bilateral measure. Therefore, the study captures the effect of the general digital policy regime of a country on bilateral trade flows, even though these policy regimes may vary based on the trading partner.

[31] This approach precludes investigating the effect of country-year-specific policies. To assess the impact of unilateral digital trade policies, the authors employ an alternative specification featuring variables for both the importer's and the exporter's DSTRI. While trade barriers of both exporter's and importer's DISTRI negatively affect digital trade, they find that unilaterally imposed digital trade regulations are more import-restrictive than export-restrictive.

[32] The first sub-index on cross-border data flows covers three types of measures, namely (i) a ban to transfer data or a local processing requirement for data; (ii) a local storage requirement, and (iii) a conditional flow regime. The second sub-index covers a series of subcategories of policies affecting the domestic use of data. These are: (i) data retention requirements, (ii) subject rights on data privacy, (iii) administrative requirements on data privacy, (iv) sanctions for non-compliance, and (v) other restrictive practices related to data policies.

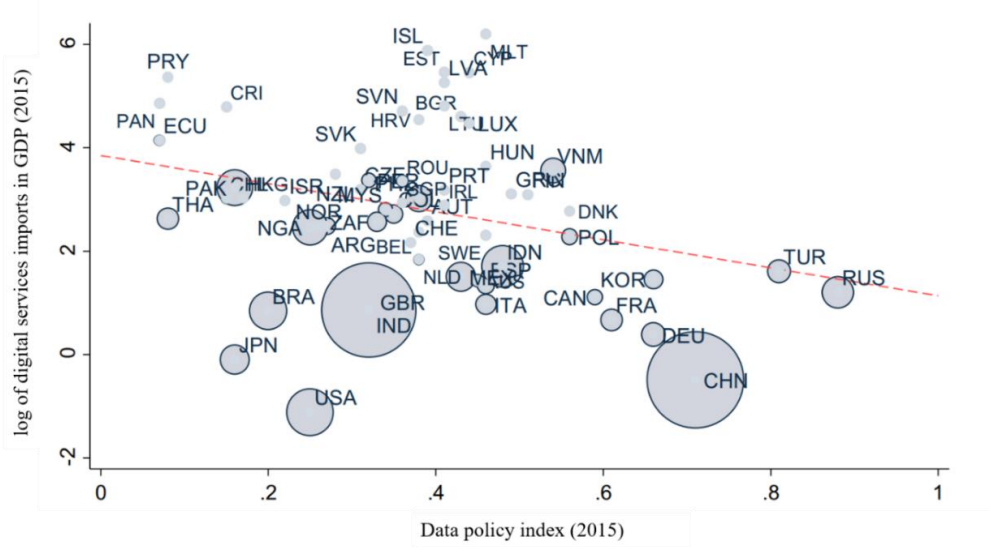
Figure 18: Average ECIPE Digital Trade Restrictiveness Index, 2006-2016



Source: van der Marel and Ferracane (2021).

The authors observe a negative correlation between the data policy index and imports in data-intense services (Figure 19).[33] More formally, using a fixed effects model, they show that restrictive cross-border data flows policies are associated to significantly lower levels of services imports.[34] The authors, however, acknowledge potential endogeneity concerns stemming from reverse causality and suggest interpreting these results as correlations rather than causal impacts.

Figure 19: Digital-intensive services imports in GDP and data policy index, 2015



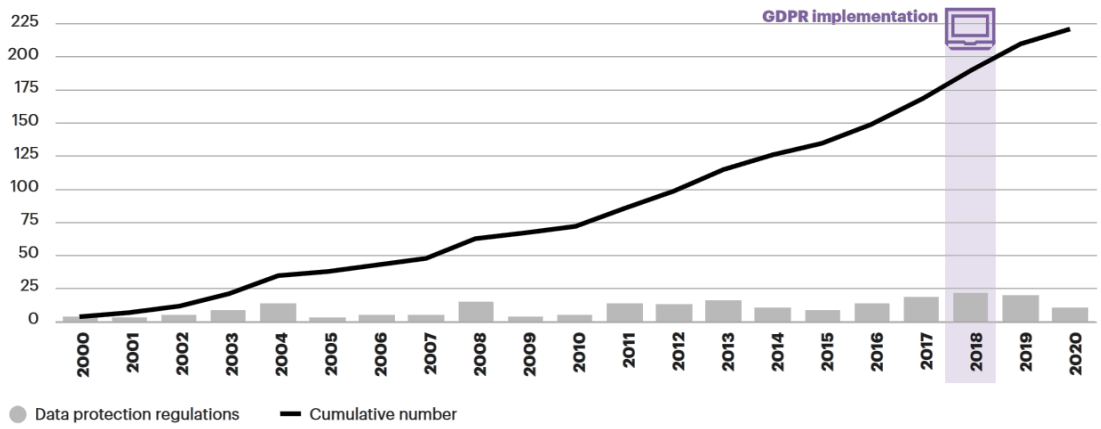
Source: van der Marel and Ferracane (2021).

[33] Data-intense services are here defined as the top 5 most data-intense sectors following based on capitalised software expenditure. For details on how the authors measure data intensity see section 2.2.2.

[34] The independent variable used in the specifications is constructed by interacting the country-specific data policy index with the data-intensities of each downstream services sector, based on the assumption that sectors more reliant on data are those that are likely to be more affected by changes in data policies.

Similarly, Chikova and Peterson (2021) look at the evolution of data protection laws based on data sourced from ECIPE, UNCTAD and Data Protection Laws (DLA) Piper. They observe that the number of data protection regulations enacted across the globe is increasing, with more than 220 still in force as of 2020 (Figure 20). The authors explore the potential consequences of invalidating the US adequacy status within the GDPR framework using a gravity model. They first estimate the impact of all adequacy decisions granted by the EU over the past 20 years, and then reverse the results to show a significant decline in trade in digital services following the adequacy invalidation. Moreover, drawing on estimates from van der Marel and Ferracane (2021), the authors simulate the extreme case of a full ban on data flows from the EU to the US. They set the ECIPE Digital Trade Restrictiveness Index to the maximum level of 1, finding a disruptive impact on digital services trade.

Figure 20: Number of data protection regulations across the globe



Source: Chikova and Peterson (2021).

Lastly, Cory and Dascoli (2021) develop an index of how restrictive a country's rules are for cross-border data transfers based on selected OECD indicators of product market regulation.[35] They find that restrictions on data flows are associated with a significant decrease in the portion of gross output traded.[36]

Table 5 summarizes the main literature on the effects the imposition of barriers to digital trade and data flow.

Table 5: Literature on the effects of barriers to digital trade

Topic	Reference Literature	Main findings
Effects of policy barriers to digital trade	• Evenett and Fritz (2022) • López González et al. (2023) • Suh and Roh (2023)	• The number of restrictive policies affecting the digital economy is increasing. • OECD's DSTRI is rising.

[35] Before 2018, the index is constructed based on two OECD indicators: "Administrative Barriers to Startups" and "Administrative and Regulatory Opacity". In 2018, the OECD changed its reporting methods and the index considers "Simplifications and Evaluations of Regulations" and "Barriers in Service and Network Sectors" indicators.

[36] Gross output measures the total amount of goods and services traded, including both final and intermediate output. Following van der Marel and Ferracane (2021), the policy restrictiveness index in the regression model is interacted with the data-intensities of each downstream services sector, computed as software expenditure per worker.

		• Increased DSTRI negatively affects bilateral trade.
Effects of data policy restrictions	• Chikova and Peterson (2021) • Cory and Dascoli (2021) • Van der Marel and Ferracane (2021)	• The number of data protection regulations is rising. • Restrictions on data flows correlate with a decrease in services imports and in the portion of gross output traded.

5. Conclusion

The absence of a universally accepted definition of digital trade has led to the adoption of various methods for measuring its relevance and evolution over time. The proxies explored in the emerging literature include indicators like trade in digitally-deliverable services and digital intensity measures. All measures show the same qualitative results: a significant and growing share of total trade is "digital". Examining the determinants of digital trade, the literature underscores the key role of the widespread adoption of the internet and advanced technologies, coupled with the complementary influence of digital trade agreements.

However, as digital trade gains importance, new regulatory challenges are emerging for trade policy, including those related to privacy and national security issues. In the last years, we observe an emerging trend of increasing fragmentation in the regulatory landscape on digitally-related topics, particularly on cross-border data flows. Notable examples of data flow regulation include the EU's GDPR and Chinese regulations to ensure national data sovereignty, effectively leading to barriers to digital trade. While reasons for regulation stem from legitimate concerns, the multiplicity of regimes is leading to an increasingly complex and fragmented regulatory landscape. The recent US withdrawal from the WTO's Joint Statement Initiative on E-Commerce, a key ongoing multilateral discussion on digital trade regulation, confirms this trend.

Economic studies suggest that restrictive digital policies may hinder not only digital trade but international trade in broad sense. Further research is needed to explore the economic impact of growing regulatory heterogeneity on data governance and international data flows, in order to shed light on how fragmented digital regulations influence global trade relationships.

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