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# Of Bytes and Trade: Quantifying the Impact of Digitalisation on Trade

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This paper provides an overview of the evolving nature of digital trade and digital trade policies. It shows that digital trade has been growing faster than "non-digital" trade. By 2018, 24% of global trade (USD 5.1 trillion) could be considered digital trade. In parallel, countries have embraced digital trade provisions in trade agreements and new digital economy agreements have emerged. The empirical analysis shows that growing digital connectivity delivers a double dividend, increasing both domestic and international trade. It also shows that digital trade chapters have the potential to double the effect of trade agreements, while reductions in domestic barriers affecting digital trade have a strong export-enhancing effect, particularly in digitally-deliverable services. Overall, the results suggest that digital connectivity and digital trade policies play a significant and growing role in reducing trade costs and increasing trade across countries at all levels of development. The paper calls for wider participation and ambition in discussions at the WTO.

**Keywords**: Digital trade, E-commerce, Trade costs, Trade agreements, Data flows, Digital connectivity

**JEL**: F68, F13, F15, F14, O33, C54

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## Key messages

Although it is widely acknowledged that digital trade is important, little is known about its nature and evolution or the extent to which digital connectivity and digital trade policies affect trade. This paper aims to strengthen the evidence-base in these areas with a view to enabling more informed digital trade policy discussions. The paper has two main parts. The first provides an overview of the evolving nature of digital trade and digital trade policies, showing that:

- *Digital trade is growing.* Globally, digital trade, estimated using proxy variables, increased from USD 1.1 trillion to USD 5.1 trillion from 1995 to 2018. In 2018, digital trade represented 24% of global trade, up from 19% in 1995.
- *The geography of digital trade is changing.* In 1995, OECD countries represented 82% of global estimated digital trade exports; by 2018, that share had fallen to 73%. The People's Republic of China (hereafter "China") saw the biggest rise, its share of global digital trade growing from 2% in 1995 to about 6.7% in 2018. India followed closely quadrupling its share from nearly 1% to nearly 4%.
- *Digital trade provisions in regional trade agreements (RTAs) have been growing and new Digital Economy Agreements (DEAs), which touch upon new areas of co-operation, are emerging*. Since 2000 nearly one in two agreements signed had a digital trade chapter. However, these are predominantly among high-income economies. Middle-income countries have fewer and shallower digital trade provisions, and low-income countries are not currently involved in any RTA with e-commerce provisions.
- *The domestic regulatory landscape that underpins digital trade is becoming increasingly restrictive.* The OECD Digital Services Trade Restrictiveness Index (DSTRI) shows wide heterogeneities across regions. Restrictiveness is highest in the African continent, but it is falling. OECD countries have the lowest levels of restrictiveness, but restrictions are on the rise.

The second part of the paper provides an econometric analysis of the role of digital connectivity and digital trade policies in shaping trade and trade costs, showing that:

- *Digitalisation has become more important for trade.* The trade cost reducing impact of digital connectivity is three times higher now than it was in 1995.
- *Digital connectivity and digital trade policies appear to be more important determinants of trade costs for emerging economies* than they are for high-income countries.
- *Growing digital connectivity delivers a double dividend.* A 1% increase in bilateral digital connectivity increases domestic trade by 2.1% and international trade by 1.5%. This double dividend arises in countries at all levels of development, including lower-income countries and across all sectors of the economy. *There is both a domestic and an international case for growing digital connectivity.*
- *RTAs with digital trade chapters have the potential of doubling the effect of trade agreements,* however this depends on the depth of the provisions signed.
- *There is a strong case for reducing barriers affecting digital trade.* A 0.1-point reduction in the domestic DSTRI score is associated with a 145% increase in overall exports. The impact is highest for digitally-deliverable services but is also high in food and agriculture and manufacturing sectors. *The case is even stronger for emerging economies where the benefits of reform deliver greater export gains.*

Overall, the results suggest that digital connectivity and digital trade policies play a significant and growing role in reducing trade costs and increasing trade across countries at all levels of development. They underscore the significant benefits for countries at all levels of development to engage in digital trade policy discussions, whether domestically, in RTAs or at the WTO.

# 1. Introduction

Digitalisation is thought to have played a key role in reducing the costs of engaging in international trade, giving rise to new opportunities for firms and consumers to benefit from trade (WTO (2018[1]) and López González and Ferencz (2018[2])). However, little is still known about the nature and evolution of digital trade. While some studies have explored the trade-enabling effects of digital connectivity, the empirical literature has mostly overlooked a more in depth and holistic analysis of the quantitative impact of digitalisation and digital trade policies on trade and trade costs.

This is, in part, due to data limitations – coverage of trade data or of measures of digital trade policies has not overlapped in a way that enables robust analysis. However, recent updates in existing trade databases[1] and the emergence of new data sources mapping the digital trade policy environment[2] provide opportunities to undertake new analysis.

This paper has two main parts. The first uses available statistics to map the nature and evolution of digital trade and related policies. The second uses a structural gravity model to identify the quantitative impact of digital connectivity and digital trade policies on trade costs and trade flows. The aim of the paper is to provide a robust evidence-base that can feed into ongoing digital trade discussions, whether under the WTO Joint Initiative on e-commerce, in relation to digital trade provisions in regional trade agreements (RTAs), or in the context of emerging digital economy agreements (DEAs). The work is also important in the light of the COVID-19 recovery which has led to a 'new normal' that is more digital than before (Pew Research Center, 2021[3]).

The paper is structured as follows. The next section offers an overview of the evolving digital trade environment, providing preliminary estimates of the value and structure of digital trade and mapping the underlying policy environment in which digital trade is unfolding. Section 3 provides an econometric assessment of the impact of digital connectivity and digital trade policies on trade and trade costs. Section 4 concludes, providing some preliminary policy implications.

[1] For example, the 2021 update to the OECD Trade in Value Added database expanding coverage to 2018 or the USITC ITPD-E database (Borchert et al., 2022[27]).

[2] For example, the OECD Digital Services Trade Restrictiveness Index (DSTRI), the OECD Digital Trade Inventory (DTI) and the TAPED database (Burri and Polanco, 2020[9]) capturing digital provisions in trade agreements.

## 2. What do we know about the evolving digital trade environment?

Although it is clear that digitalisation matters for trade (and trade for digitalisation) [see López González and Jouanjean (2017[4]) and WTO (2018[1])], identifying how digital trade has evolved is not straightforward. Measurement issues, arising from a lack of information about how much trade is actually digitally-ordered or delivered (see OECD, WTO, IMF (2020[5]), imply that accurate estimates of the value of digital trade remain elusive. At the same time, the digital trade policy landscape is evolving rapidly. New policies – affecting both goods and services – are emerging domestically and internationally, including in the context of trade agreements.

### 2.1. Measuring digital trade is difficult, but estimates suggest it is growing and changing

Digital trade is defined in the *Handbook for Measuring Digital trade* as "all trade that is digitally-ordered and/or digitally delivered" (OECD, WTO, IMF, 2020[5]).[3] This ongoing measurement exercise suggests that, other than a possible underestimation of *de minimis* trade, there is little evidence that available trade statistics, for either goods or services, significantly undervalue the amount of digital trade that is taking place (OECD, WTO, IMF, 2020[5]).[4] The measurement challenge is largely about making digital trade more visible in trade statistics.[5] That is, identifying what trade has actually been digitally-ordered or digitally delivered.[6]

In the absence of comprehensive and comparable (official) digital trade statistics, the value of digitally-ordered or delivered trade can be approximated using a range of product-based breakdowns as proxy measures. Based on the assumption that all trade that is digitally-deliverable is indeed delivered digitally, *digitally delivered trade* can be proxied using trade in ICT services (e.g. computer and telecommunications services) and trade in other digitally-deliverable services (e.g. financial services, business services).[7]

*Digitally-ordered trade*, which covers transactions in goods and services, is more challenging to identify. In this paper, digital inputs into non-digital sectors are used as a crude proxy for digitally-ordered trade. This captures the value of inputs from ICT goods and services and digitally-deliverable services embodied in the exports of other sectors (i.e. all sectors except ICT goods, ICT services and digitally-deliverable services).[8] Here the assumption is that the use of digital inputs, whether ICT goods such as computers,

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[3] The second revision of the *Handbook* is expected mid-2023.

[4] *De minimis* trade refers to trade that is below a certain value threshold meaning it is subject to expedited procedures with fewer documentation requirements, duty free access and/or VAT free. This implies that it is often not recorded in international trade statistics (see OECD, WTO, IMF (2020[5]).

[5] Existing efforts, including the Canadian Digital Supply Use Tables which offer a comprehensive view of economic transactions related to the digital economy, also provide useful avenues to increase the visibility of digital trade transactions. See https://www150.statcan.gc.ca/n1/daily-quotidien/210420/dq210420a-eng.htm.

[6] The *Handbook for Measuring Digital trade* defines digitally-ordered trade 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". It defines digitally delivered trade as "International transactions that are delivered remotely in an electronic format, using computer networks specifically designed for the purpose". For examples of these, see OECD, WTO, IMF (2020[5]).

[7] See OECD, WTO, IMF (2020[5]) for details about these categorisations across different nomenclatures. Note that, as per this *Handbook*, only services are digitally deliverable.

[8] This measure can be calculated using Input-Output tables and identifies the domestic value added of digital inputs (ICT goods, ICT services and digitally-deliverable services) embodied in non-digital exports (all sectors except ICT goods, ICT services and digitally-deliverable services). It is worth noting that this is an imperfect proxy for digital orders, which we know are difficult to capture. It is based on the assumption that the use of digital inputs correlates with digital

ICT services such as telecommunication services, or digital platforms (classified in the sectors in which these operate – e.g. transport services for rider-sharing applications), is proportionate to the digital ordering process.[9]

These proxy measures suggest that digital trade has been growing (Figure 1).[10] Indeed, since 1995 these estimates suggest that global digital trade has grown from USD 1.1 trillion to USD 5.1 trillion in 2018. This implies that, in 2018, estimated digital trade represented almost 24% of global trade, up from 19% in 1995.[11] Moreover, digital trade is estimated to have been growing faster than 'non-digital' trade (by a factor of about 1.3) with the gap widening from 2011 onwards.[12]

The structure of digital trade, according to these estimates, has been changing. In 1995, digitally-delivered trade represented around 50% of estimated digital trade, by 2018, this share had grown to 57% – Figure 2. This is driven by in increases in *ICT services* which grew to represent 13.5% of estimated digital trade in 2018 (up from 7.3%).[13] Overall, while changes are relatively minor, they point to digital trade becoming more digitally-delivered (and therefore services oriented).

The geography of digital trade also appears to be shifting (Figure 3). In 1995, OECD countries represented 82% of global estimated digital trade exports, by 2018 that share had fallen to 73%. The United States, although still representing the largest share of estimated global digital trade exports in 2018 (15.5%) saw a decline by 1.5 percentage points since 1995. Germany, France and Italy saw their share of estimated digital trade fall by more than 2 percentage points since 1995. By contrast, The People's Republic of China (hereafter "China") saw its share rise from 2% in 1995 to 6.7% in 2018. China is the non-OECD country with the highest share of estimated digital trade, closely followed by India which quadrupled its share of global digital trade from nearly 1% to nearly 4% (similar to the rise witnessed by Ireland). Singapore also witnessed important growth in estimated digital trade nearly doubling its share from 1.6% to 3% (see Annex Table A A.1. for estimates of digital trade across all economies covered in the 2021 TiVA database).

ordering (an assumption which is hard to test). One advantage of this measure is that it captures digitally deliverable services embodied in goods, or what might be termed *digital Mode 5 services*.

[9] One important caveat of this analysis is that it does not cover Mode 3 services trade, which is likely to be important in the context of digital trade.

[10] It is difficult to tell how these estimates perform relative to more precise measures of digital trade. The extent to which they underestimate or overestimate digital trade will depend on the extent to which: i) existing trade statistics underestimate trade in parcels; ii) digitally-deliverable services are good proxies for actual digital deliveries; iii) the digital content of non-digital sectors also includes digital trade inputs that might fall outside the categories of ICT goods, ICT services and digitally-deliverable services; and iv) whether ICT goods should be considered in measures of digital trade.

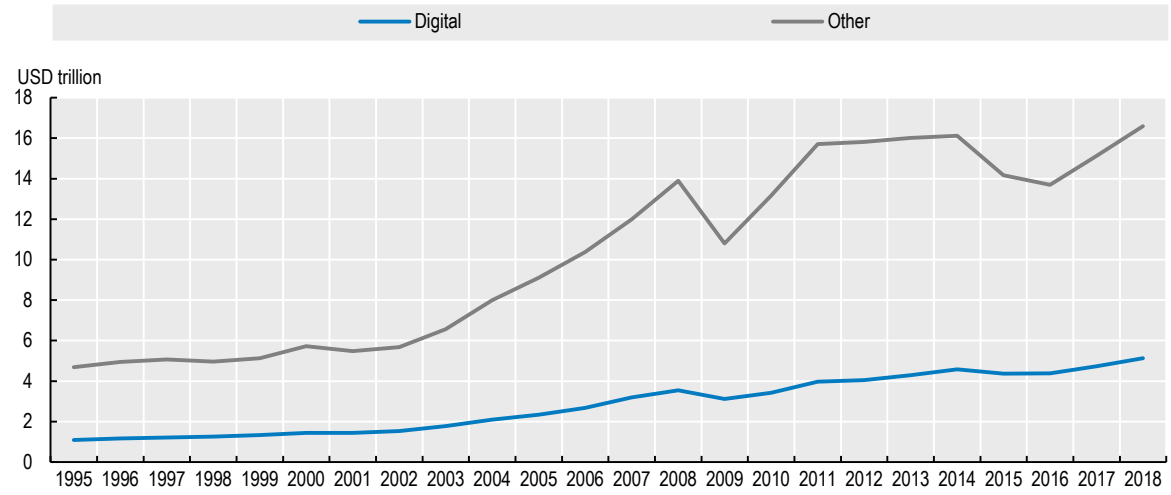
[11] If ICT goods are included, the value of digital trade rises to USD 6.5 trillion in 2018, representing almost 30% of global trade.

[12] The changes reported are in value terms and do not take into consideration changes in prices. For a discussion of these issues, see Jaax, Miroudot and van Lieshout (2023[49]).

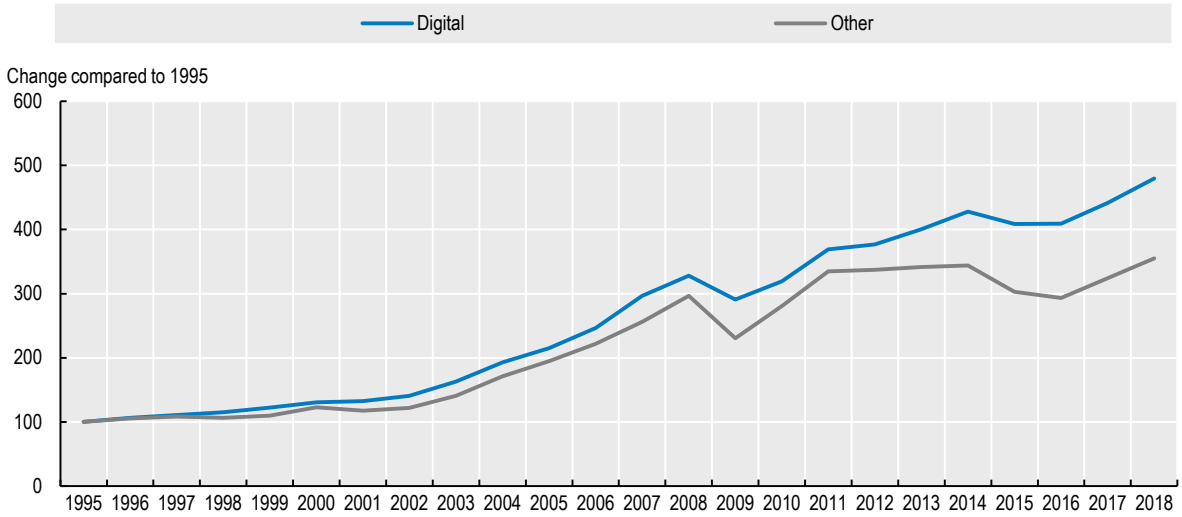
[13] See Annex Figure A A.1. for a breakdown of the different components of digitally deliverable and digitally-ordered trade.

## Figure 1. Estimates suggest that digital trade is growing faster than 'non-digital' trade

A. Value in USD trillion

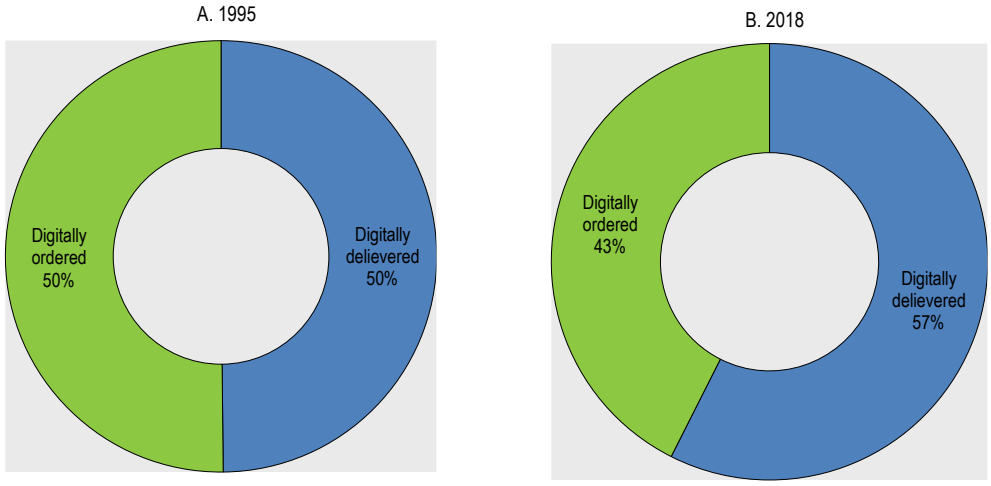



B. Growth (1995=100)



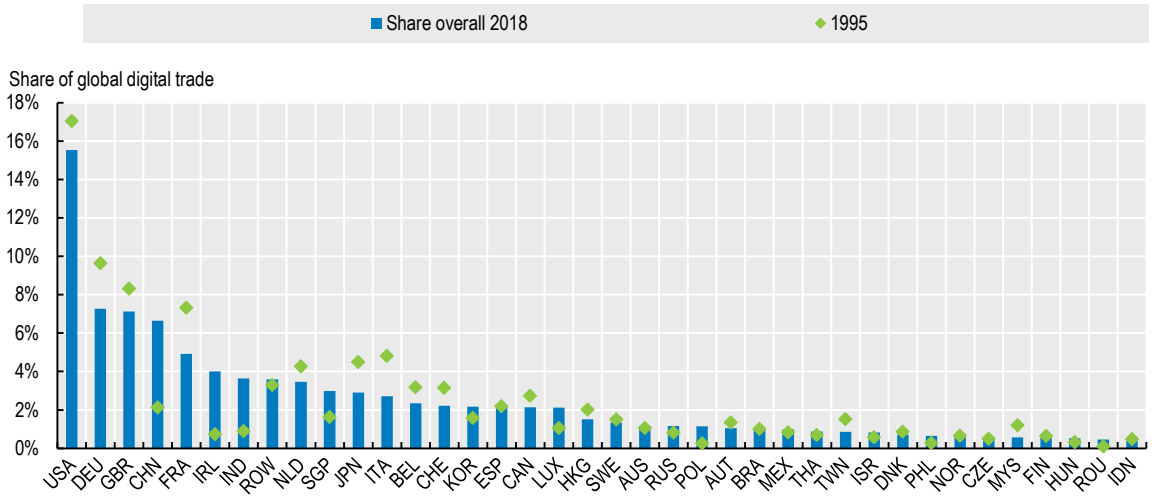

Note: Digital trade: Exports of ICT services (ISIC 61, 62, 63), other digitally-deliverable services (ISIC 58 to 60, 64 to 66 and 69 to 82) and digital inputs (ICT goods and services and other digitally-deliverable services) in non-digital sectors (all those not counted as digital). 'Other' captures non-digital trade and is calculated as the difference between total trade and digital trade. Trade data in the figure cover exports of the 66 economies in the 2021 TiVA revision (38 OECD countries and 28 economies outside the OECD area, mainly high and upper-middle income economies).
Source: Own calculations using OECD TiVA 2021 revision.

## Figure 2. Digitally delivered trade is increasingly important




Note: Digitally delivered trade is identified as ICT services (ISIC 61, 62, 63) and other digitally-deliverable services (ISIC 58 to 60, 64 to 66 and 69 to 82). Digitally-ordered trade is identified as digital inputs (ICT goods and services and other digitally-deliverable services) in non-digital sectors (all those not counted as digital). Trade data in the figure covers exports of the 66 economies in the 2021 TiVA revision (38 OECD countries and 28 economies outside the OECD area, mainly high and upper-middle income economies). It also includes a 'rest of the world' group.
Source: Own calculations using OECD TiVA 2021 revision.

## Figure 3. The geography of digital trade is shifting



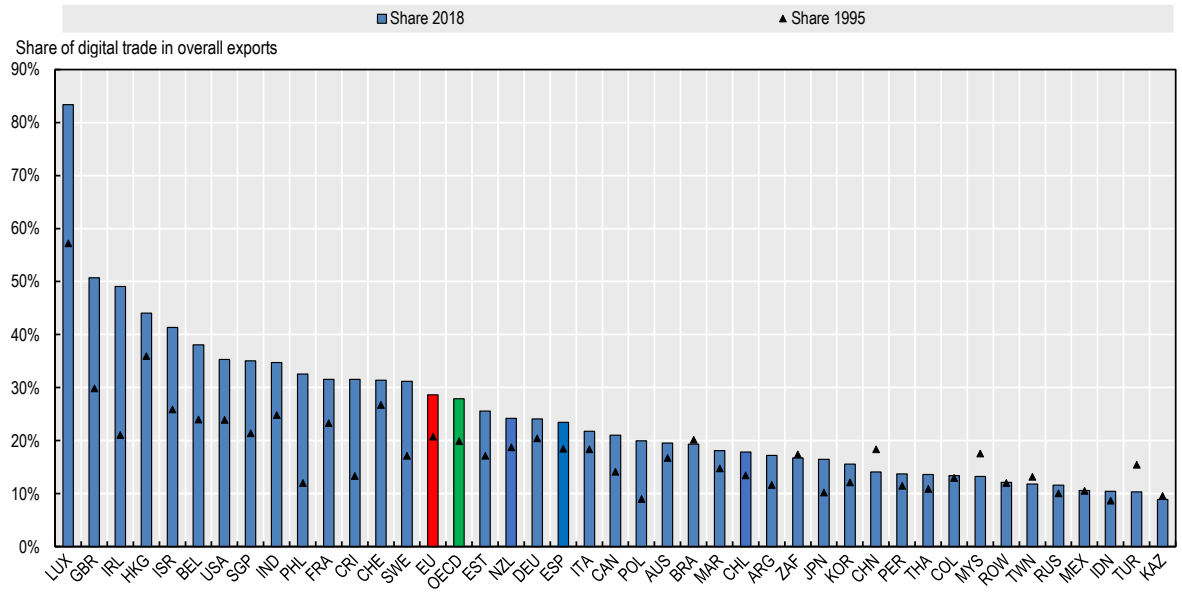

Note: Digital trade identified as exports of ICT services (ISIC 61, 62, 63), other digitally-deliverable services (ISIC 58 to 60, 64 to 66 and 69 to 82) and digital inputs (ICT goods and services and other digitally-deliverable services) in non-digital sectors (all those not counted as digital). Trade data in the figure covers exports of the 66 economies in the 2021 TiVA revision (38 OECD countries and 28 economies outside the OECD area, mainly high and upper-middle income economies). See Annex Table A A.1. for all economy-level estimates.
Source: Own calculations using OECD TiVA 2021 revision.

The relative importance of estimated digital trade over total trade, although highly heterogeneous, is also growing (Figure 4a). For countries such as Luxembourg, estimated digital trade represents over 80% of exports (up from 57% in 1995). The United Kingdom, 51%, and Ireland, 49%, complete the top 3. In the top 10 are also India, where estimated digital trade represents 35% of total exports and the United States with 35% in 2018. At the other end of the spectrum, estimated digital trade only represents 4% of total exports in Saudi Arabia. Overall, the share of estimated digital trade in total exports varies widely, but it is

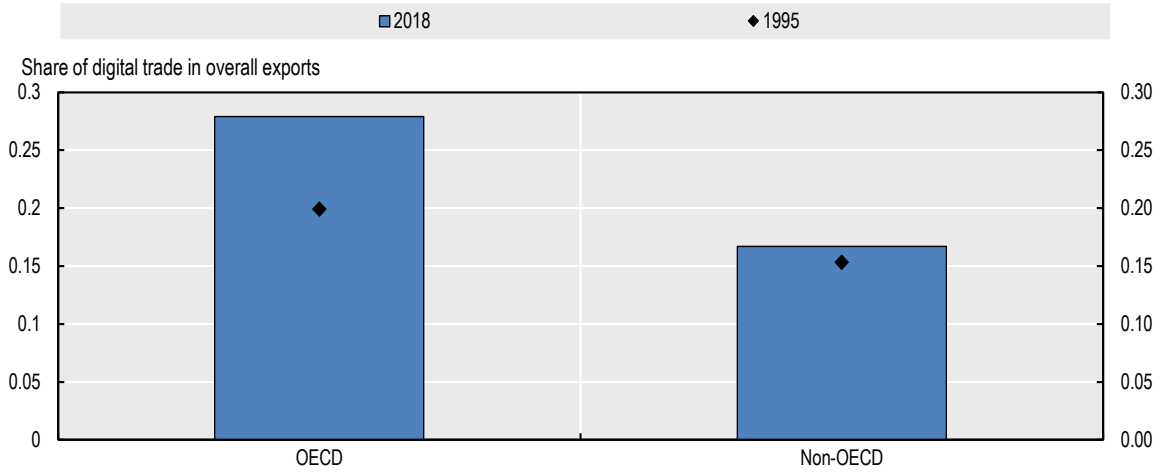
growing across most countries.[14] And while OECD countries tend to have a higher share of estimated digital trade, non-OECD countries have also seen their share of estimated digital trade rise since 1995 (Figure 4b).

## Figure 4. A growing share of country exports is becoming digital

A. Selected economies




B. Selected economies




Note: Digital trade identified as ICT services (ISIC 61, 62, 63), other digitally-deliverable services (ISIC 58 to 60, 64 to 66 and 69 to 82) and digital inputs (ICT goods and services and other digitally-deliverable services) in non-digital sectors (all those not counted as digital). See Annex Table A A.1 for economy-level estimates.
Source: Own calculations using OECD TiVA 2021 revision.

[14] Reductions in digital trade are seen in the Czech Republic, Malaysia and China in Figure 4. For the latter, in particular, the likely explanation is that manufacturing trade, including exports of ICT goods, grew at a faster pace than digitally-ordered or delivered trade during the period under investigation. Note that China increased its global share of digital trade during this period.

## 2.2. The rules that underpin digital trade are also evolving

As digital trade continues to grow, so do policy discussions on issues related to digital trade, whether in the context of the WTO, through the Joint Initiative on e-commerce, in regional trade agreements (RTAs), in new digital economy agreements (DEAs), or domestically through new regulatory reforms.[15]

### *WTO discussions on digital trade are progressing*

Multilateral discussions on digital trade began in 1998 with the introduction of the work programme on e-commerce (WTO, 1998[6]). That same year, WTO Members agreed on a Moratorium on applying customs duties on electronic transmissions, which has been regularly extended (most recently at the 12th Ministerial Conference held in Geneva in June 2022).[16] However, progress on digital trade related issues has been slow. It was not until January 2019 that a group of WTO Members agreed to "initiate exploratory work together toward future WTO negotiations on trade-related aspects of electronic commerce" (WTO, 2019[7]).

As of early February 2023, this Joint Initiative (JI) on e-commerce comprises 88 Members, covering a range of issues, including facilitating electronic transactions through discussions on e-signatures and e-payments, as well as issues such as data flows, privacy, consumer protection, cybersecurity and market access – Table 1. In a statement dated 20 January 2023, the co-chairs of the JI discussions (Australia, Japan and Singapore), noted convergence on ten articles – "paperless trading, electronic contracts, electronic authentication and electronic signature, unsolicited commercial electronic messages; online consumer protection; open government data; open internet access, transparency; cybersecurity, and electronic transaction frameworks".[17] They also noted that they will continue to strive towards greater convergence on provisions that enable and promote the flow of data, such as cross-border data flows, data localisation, and source code, and hope to reach agreement on a permanent ban on customs duties on electronic transmissions. Progress launching a new small group discussion on privacy and ICT products and the use of cryptography is also noted.[18]

### Table 1. WTO Joint Initiative on e-commerce – key areas of discussion

| |
|---|
| **1. Enabling Digital Trade/E-commerce** |
| *Facilitating electronic transactions (electronic transactions frameworks; electronic authentication and electronic signatures; electronic contracts; electronic invoicing)* |
| *Digital trade facilitation and logistics (paperless trading)* |
| **2. Openness and Digital Trade/E-commerce** |
| *Customs duties on electronic transmission* |
| *Access to internet and data (open government data; access to and use of the internet for electronic commerce/digital trade)* |
| **3. Trust and Digital Trade/E-commerce** |
| *Consumer protection (online consumer protection; unsolicited commercial electronic messages)* |
| *Privacy (personal information protection/ personal data protection)* |
| *Business trust (source code; ICT products that use cryptography)* |
| *Cybersecurity* |

[15] Important progress has also been achieved in other setting such as through the recently agreed G7 Digital Trade Principles covering i) Open digital markets; ii) Data free flow with trust; iii) Safeguard for workers, consumers, and businesses; iv) Digital trading systems; and v) Fair and inclusive global governance.

[16] See Andrenelli and López González (2019[45]) for a discussion of the economic implications of the e-commerce moratorium.

[17] https://www.wto.org/english/news_e/news23_e/igo_20jan23_e.pdf.

[18] https://www.wto.org/english/news_e/news22_e/ecom_28oct22_e.htm.

| |
|---|
| **4. Cross-cutting Issues** |
| *Flow of information (cross-border transfer of information by electronic means/ cross-border data flows; location of computing facilities; financial information/ location of financial computing facilities for covered financial suppliers)* |
| *Transparency, domestic regulation and cooperation (transparency; cooperation; cooperation mechanism)* |
| *Capacity building (options for capacity building and technical assistance)* |
| *Implementation periods for developing and least developed country members* |
| *Special and Different Treatment Provisions for Developing Country Members and Least Developed Country Members (options for capacity building and technical assistance)* |
| **5. Telecommunications** |
| *Disciplines relating to Telecommunications Services (scope; definitions; competitive safeguard; interconnection; universal service; licencing and authorization; telecommunications; regulatory authority; allocation and use of scarce resources; essential facilities; resolution of disputes transparency)* |
| **Annex** |
| *Logistics services, Enhanced trade facilitation for cross border e-commerce, Use of technology for the release and clearance of goods, [Electronic payments services/Electronic payments], Single windows data exchange and system interoperability/Unique Consignment Reference Numbers, Non-Discriminatory treatment of digital products, Access to online platforms/ Competition, Domestic regulation, Electronic commerce- related network products , Services market access , Temporary Entry and Stay of Electronic Commerce-Related Business Persons, Goods market access* |

Source: Adapted from Ismail (2023[8]), which draws on the December 2022 JI on e-commerce updated consolidated negotiating text (INF/ECOM/62/Rev.3).

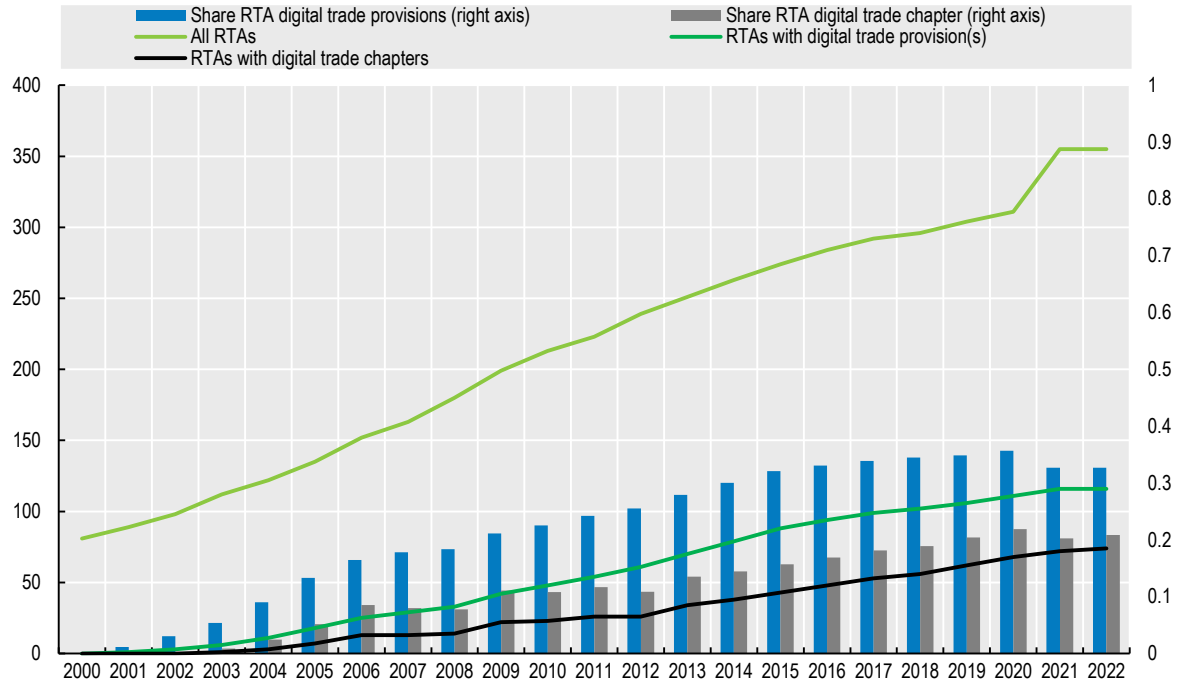
### *Digital trade provisions in trade agreements are growing*

Progress on governance of digital trade-related issues has largely taken place outside WTO discussions in the context of bilateral and regional trade agreements. Indeed, the number of RTAs with digital trade provisions has been growing – Figure 5. According to the TAPED (Trade Agreements Provisions on Electronic-commerce and Data) database (Burri and Polanco, 2020[9]),[19] by June 2022, there were 116 agreements with digital trade, or e-commerce, provisions, representing 33% of all existing agreements. 74 of these agreements had a digital trade, or e-commerce, chapter, representing 21% of all existing agreements. Overall, since 2001, 44% of agreements signed contain a digital trade, or e-commerce, provision of some sort.[20]

[19] Using the July 2022 update of the TAPED database.

[20] Digital trade provisions refer to the presence of a provision that can be considered as important for digital trade as identified in Burri and Polanco (2020[9]). Digital trade chapters refer to there being a separate chapter in the trade agreement.

## Figure 5. A growing number of RTAs have digital trade provisions




Note: Analysis only considers agreements currently in force. RTA with digital trade provisions refers to there being at least one e-commerce/digital trade provision, whether in a separate chapter or not (e.g. IP provisions which might be important for the digital economy but are not in an individual e-commerce chapter).
Source: Own calculations. RTAs are identified from the WTO RTA database. Digital provisions from the TAPED database.

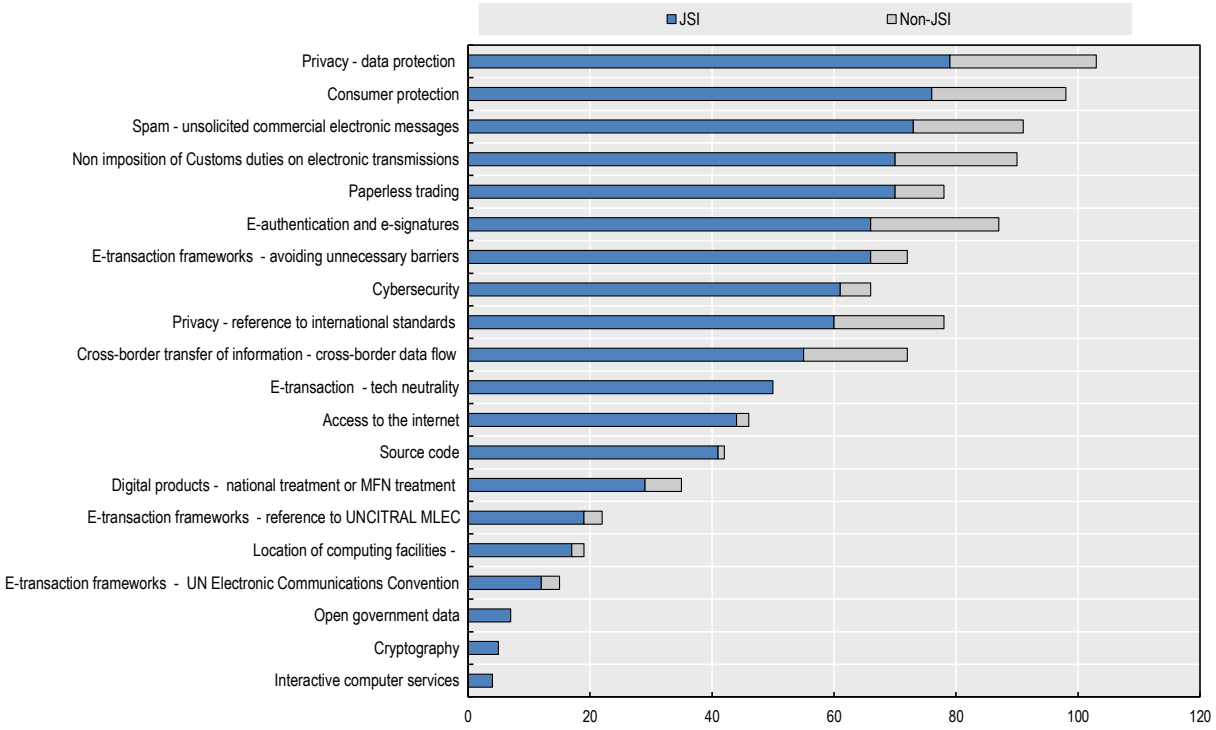
Digital trade provisions in trade agreements capture a wide array of issues important for digital trade in goods and services. They can be part of a wider e-commerce (or digital trade) chapter or appear in other chapters (e.g. IP provisions or telecoms or financial services chapters) – see Burri and Polanco (2020[9]). They cover a range of cross-cutting issues from digital trade facilitation (electronic authentication frameworks, paperless trading) to privacy and data protection; consumer protection; source code; customs duties on electronic transmissions and cybersecurity (to name but a few). As the recent OECD Digital Trade Inventory shows, the rate of uptake of digital trade provisions differs across issues, both for countries taking part in the JI discussions and for those that do not – Figure 6.

Most agreements with e-commerce chapters tend to involve higher-income economies. These also tend to contain more extensive provisions on digital trade as identified using the size of the chapter.[21] The average size of an e-commerce chapter in an agreement to which a high-income economy is a party to is almost double that of an agreement to which a lower-middle income economy is a party to (Figure 7). Low-income countries are not party to any RTA with an e-commerce chapter.

[21] This is a crude measure of the depth of the agreement. More wordy chapters might also hide a higher number of exceptions.

## Figure 6. Coverage of digital trade issues in trade agreements

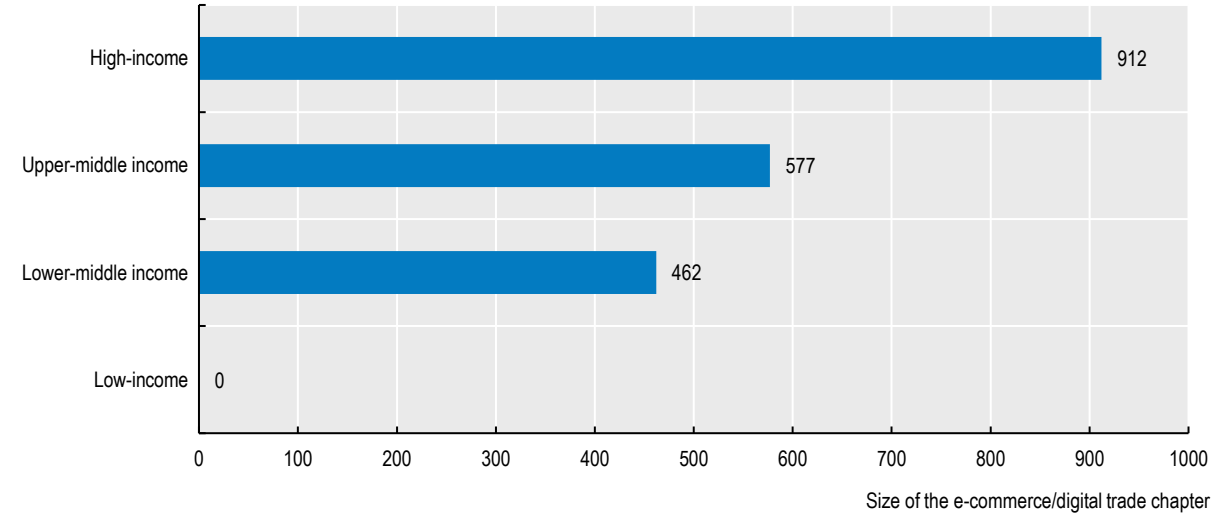
Number of jurisdictions and coverage of issues in RTAs




Note: Figure identifies number of countries with different digital trade provisions in their RTAs according to whether they are participating in the Joint Statement Initiative (JSI) on e-commerce or not.
Source: Nemoto and López-González (2021[10]).

## Figure 7. Size of e-commerce chapters in trade agreements

Number of words relating to e-commerce provisions, average by economy income group



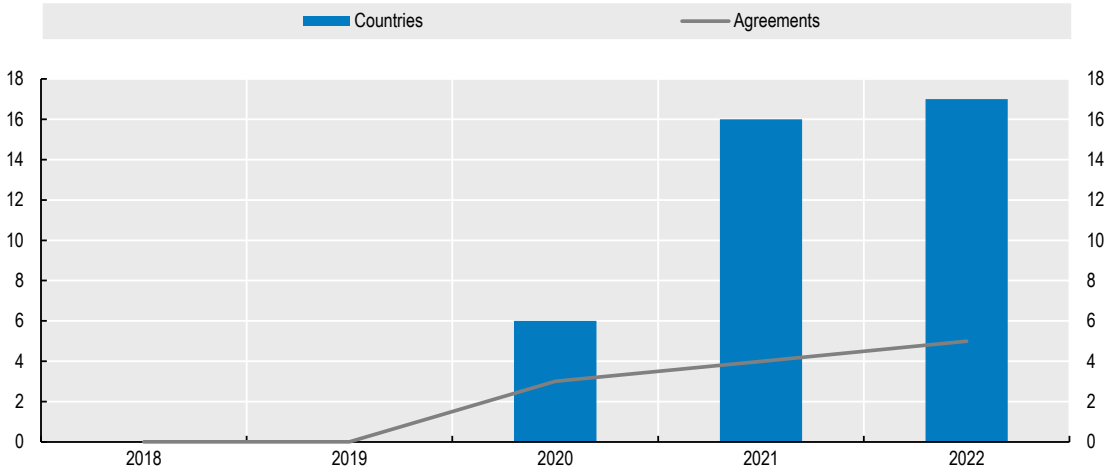

Note: Complete articles that refer to e-commerce in a specific e-commerce/digital trade chapter or annex are counted. The number of words of complete articles that refer to e-commerce in a specific ecommerce/digital trade chapter or annex are counted. Economy income groups based on World Bank income classification, January 2023, see Table A D.2.
Source: Own calculations based on the TAPED database.

### *New digital economy agreements and other initiatives are emerging*

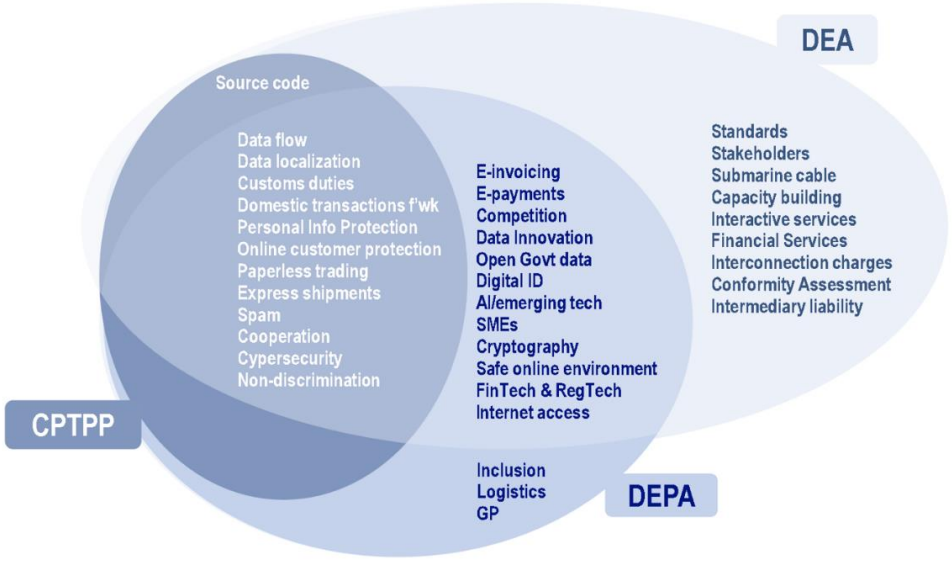
In parallel, countries have also increasingly started negotiating broader digital economy agreements (Figure 8a). These include, among others, the Digital Economy Partnership Agreement (DEPA) between New Zealand, Singapore and Chile and the Digital Economy Agreement between Australia and Singapore. Since 2020 up until end of 2022, five digital economy agreements have entered into force,[22] all of which are underpinned by an existing RTA (e.g. all existing DEPA members are also party to the Comprehensive and Progressive Agreement for Transpacific Partnership (CPTPP)). This is partly why these digital economy agreements incorporate many of the issues discussed in the RTAs, but they also extend discussions across a number of areas including cooperation on artificial intelligence, digital identity, open government data, etc. (Figure 8b).

## Figure 8. Digital economy agreements discussing broader digital economy issues are emerging

A. Number of countries and agreements




B. Example of content of these digital economy agreements




Sources:
Panel A: Based on TAPED database, agreements entered into force by 2022 considered.
Panel B: Honey (2021[11]), https://www.tradeexperettes.org/blog/articles/untangling-the-digital-noodle-bowl-the-case-for-depa.

[22] An additional three DEAs have been signed by end 2022 but not entered into force. These include, the MERCOSUR E-commerce agreement, the Korea-Singapore Digital Partnership Agreement, and the UK-Ukraine Digital Trade Agreement.

For instance, both DEPA and Australia-Singapore DEA cover issues related to Artificial Intelligence (AI) or SMEs which are not often included in digital trade chapters in RTAs. However, these tend to be best endeavour clauses seeking to promote shared values and continued dialogue and cooperation.[23] The agreements are often characterised as 'living agreements': "designed to deepen mutual understanding of the digital economy and to be responsive to emerging technologies, business models and regulatory challenges" (Honey, 2021[11]). In a world where rapid technological change is having a profound impact on our economies and societies, flexible and more coordinated approaches to the governance of the digital economy can have an important role to play in shaping digital trade.

As such, interest in these agreements is rising. In addition to recent DEAs, China (November 2021), Canada (May 2022) and Costa Rica (2023) submitted a formal request to launch negotiations for their accession to the DEPA,[24] and an agreement has been reached for Korea to begin negotiations to formally join. Moreover, the United Kingdom and Ukraine agreed a Digital Trade Agreement (DTA) in November 2022. In January 2023, the Korea-Singapore Digital Partnership Agreement (KSDPA) entered into force.

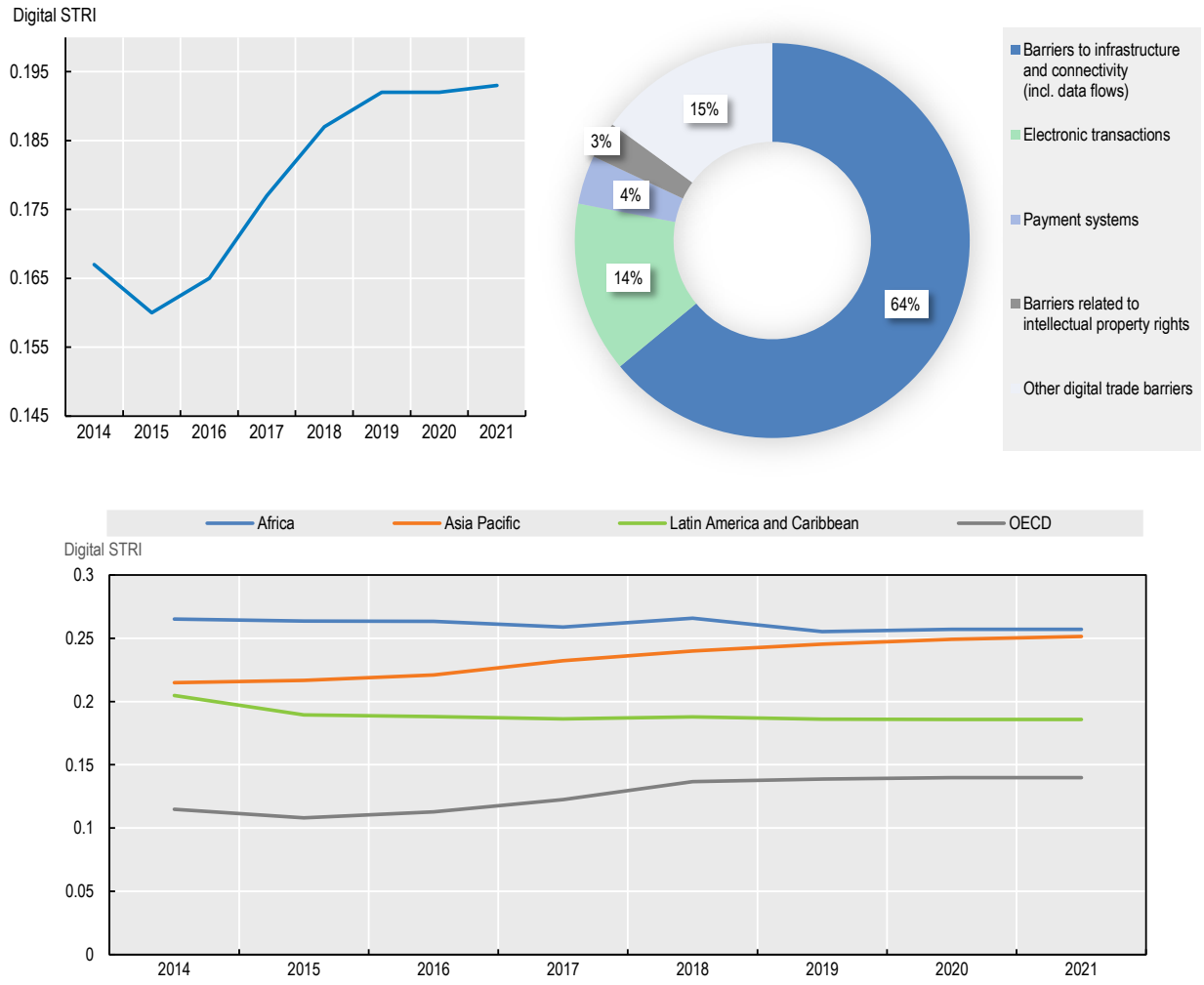
### *However, domestic restrictions on digital trade are rising*

Despite progress in discussing digital trade related provisions internationally, evidence from the OECD Digital Services Trade Restrictiveness Index (DSTRI) suggests that domestic regulation affecting digital trade has become increasingly tight, especially as concerns infrastructure and connectivity (Figure 9). The 2022 DSTRI database, which includes 74 economies and has a wider coverage in Africa, Latin America, and Asia, also shows that there is wide heterogeneity across regions (Figure 9c). The average level of restrictiveness is lower in OECD countries and the Americas than in the African and Asian economies covered. However, the DSTRI also shows that there has been strong progress in Africa in lowering barriers to digital trade and in narrowing the gap with more developed economies.

[23] For example, the AI chapter of the DEPA stipulates that: "Parties shall endeavour to promote the adoption of ethical and governance frameworks that support the trusted, safe and responsible use of AI technologies [..] In adopting AI Governance Frameworks, the Parties shall endeavour to take into consideration internationally recognised principles or guidelines, including explainability, transparency, fairness and human-centred values."

[24] On 18 August 2022, the DEPA Parties established a Working Group for China to begin DEPA accession negotiations. A similar group was also established on 24 August 2022 for Canada.

## Figure 9. Digital trade barriers are intensifying and concentrate in infrastructure and connectivity issues




Note: Panel a shows the simple average DSTRI for the 74 economies currently covered. The DSTRI ranges between zero and one, one being the most restrictive.
Source: OECD Digital Services Trade Restrictiveness Index, 2022.

## 3. What is the impact of digitalisation and digital trade policies on trade and trade costs?

Two observations emerge from the analysis above. The first is that digital trade is growing and changing, in structure and in geography. The second, that the policy landscape that underpins digital trade is becoming increasingly complex. However, little is known about the drivers of change and the role of digital trade policies in this process. A better understanding of these issues can help policy makers better address both the challenges and opportunities of the digital transformation for trade.

The impact of digital connectivity and digital trade policies on trade is multifaceted (see López González and Jouanjean (2017[4]) and WTO (2018[1]). Digital connectivity and digital trade policies have a direct impact on the ability to order and to deliver trade digitally. But they will also impact trade beyond that which is currently defined as digital trade. Indeed, digitalisation or digital trade policies can reduce overall trade costs at the border or can help to identify new trading opportunities (suppliers or customers) even when

trade transactions are not digitally-ordered or delivered. This is why the focus of this section is on the broader impact of digital connectivity and digital trade policies on trade in general.[25]

## 3.1. What does the empirical literature suggest?

To date, analysis of the impacts of digitalisation on trade flows and trade costs has mainly explored the trade-enabling role of digital connectivity. This empirical literature has largely used proxy measures for digital connectivity in a gravity model setting (Box 1). Freund and Weinhold (2004[12]) estimated that a 10 percentage point increase in the growth of web hosts in a country could lead to a 0.2 percentage point increase in export growth. Similarly, Lin (2015[13]) showed that a 10% increase in the number of Internet users raised international trade by 0.2%-0.4%. Choi (2010[14]) focused on the effect of Internet use on services trade, highlighting that a doubling of Internet usage in a country increased trade in services between 2% and 4%.

In a similar vein, López-González and Ferencz (2018[2]) showed that a 10% increase in 'bilateral digital connectivity' raised goods trade by nearly 2% and services trade by about 3%.[26] López-González and Sorescu (2021[15]) found that the impact of digitalisation on parcels trade was nearly twice that of total goods trade, showing that a 10% increase in bilateral digital connectivity raised trade in parcels by around 4%. More recent work by Herman and Oliver (2022[16]) finds that a one standard deviation increase in 'joint internet connectivity' can increase trade by over 38%.[27] Benz, Jaax and Yotov (2022[17]) also highlight the importance of digitalisation for growing services tradability in the past two decades.[28]

### Box 1. Using the structural gravity model for trade analysis

The gravity model has become the workhorse for international trade analysis. Since its first use in Tinbergen (1962[18]), the gravity model has received numerous theoretical underpinnings, most notably by Anderson (1979[19]), Eaton and Kortum (2002[20]), Anderson and Van Wincoop (2003[21]) and Arkolakis, Costinot and Rodriguez-Clare (2012[22]) (see also Head and Mayer (2014[23]), Yotov et al. (2016[24]), Yotov (2022[25]) for a summary of the literature). These theoretically derived underpinnings are collectively referred to as the *structural gravity model*.

At its most basic, the gravity model stipulates that trade between two countries is proportionate to their economic mass, measured as their share in world GDP, and a set of trade costs, some of which are bilateral, such as distance, or specific trade policies others multilateral, such as how remote you are from others (multilateral resistance).[1]

A number of important lessons have emerged from the empirical application of structural gravity models. The early literature, motivated by theoretical underpinnings, underscored the importance of exporter-year and importer-year fixed effects to control for multilateral resistances (Anderson and Van

[25] Different product-based categorisations including agriculture, manufacturing, ICT goods, ICT services, digitally-deliverable services and other services, are also used to identifying whether these impacts differ across different broad sectors.

[26] Bilateral digital connectivity is defined as the minimum of the shares of the population with access to the internet across two countries.

[27] Joint internet connectivity is defined as the product, between two countries, of the shares of individuals connected to the internet.

[28] Using data on eBay transactions and a gravity model for online and offline trade, Lendle et al. (2016[48]) found that distance plays a reduced role on trade conducted over the platform relative to offline trade. The authors suggest that reductions in search costs have a trade cost reducing effect on such trade. Kim, Dekker and Heij (2017[47]) also rely on private company data, providing further evidence of the diminishing role of distance, and hence trade costs, on online trade. Indeed, growing evidence supports the idea that there is a diminishing impact of distance on international trade (Kim, Dekker and Heij, 2017[47])), including for services trade (Benz, Jaax and Yotov, 2022[17])).

Wincoop, 2003[21]), and where possible country-pair fixed effects (to control for time invariant and unobservable trade costs between country pairs). Later, emphasis was placed on the use of Poisson Pseudo-Maximum-Likelihood (PPML) estimators to account for heteroscedasticity[2] and zero trade flows (Santos Silva and Tenreyro, 2006[26]).

More recently, focus has shifted towards the use of theory-consistent 'domestic trade flows' in the estimation process [see Yotov et al. (2016[24])].[3] This enables the identification of a 'border effect' capturing the extent to which countries trade more domestically than they do internationally. An important advantage of using domestic trade flows is that, by interacting explanatory variables with a border dummy, it enables the identification of impacts that might otherwise be collinear with the use of certain fixed effects. For example, it enables the analysis of the impact of country-specific policies that do not vary across trade partners as might be WTO membership but also unilateral domestic regulations.

Notes

1. Multilateral trade resistance refers to the barriers to trade that each country faces with all its trading partners.
2. If the error terms in the usual log linear specification of the gravity equation are heteroscedastic, this violates the assumption that they are statistically independent of the regressors (i.e., dependent variables used) and suggests that the estimation method leads to inconsistent estimates of the elasticities of interest
3. Domestic trade flows are important for a number of reasons [see Borchert et al. (2022[27]), Yotov (2021[28]), Yotov (2022[25])]. They provide solutions to the "missing globalisation puzzle", which refers to the surprising finding that the volume of trade has become increasingly sensitive to distance (Disdier and Head, 2008[29]). They also enable estimating the importance of international trade relative to domestic trade.

Other papers have used the gravity model to derive estimates of trade costs and identify the relative contribution of different elements of these (Box 2).[29] While there are many different methods for estimating trade costs (see Chen and Novy (2011[30]), Arvis et al. (2013[31]), WTO (2018[1]) and WTO (2021[32])), including those that attempt to isolate the cost of regulatory barriers rather than total trade costs (Benz and Jaax, 2020[33]), the estimates based on these different approaches converge in their interpretation. They show that, while trade costs are falling, they remain relatively high, particularly for developing countries.

For instance, depending on whether a country is high or low-income, Arvis et al. (2013[31]) estimate average trade costs to be between 82% and 227% (of the value of trade) in manufacturing sectors, and between 143% and 310% in agriculture. More recently, and using a different method, Benz and Jaax (2020[33]) estimate that regulatory barriers to services trade costs between 57% and 255%, depending on the sector of activity. The WTO Trade Costs Index estimates reveal that overall, trade costs for 34 individual goods and services sectors in 2018 range from 120% (for chemicals and chemical products) to 620% (for real estate activities). Trade costs are therefore also highly heterogeneous across goods and services, sectors, and countries.

Where the impact of digital connectivity on trade cost is concerned, Chen and Novy (2011[30]), Arvis et al. (2013[31]), WTO (2018[1]) and WTO (2021[32]) provide decompositions of trade costs into their constituent elements, including preliminary assessments of selected digital connectivity indicators. WTO (2021[32]) shows that ICT connectedness, proxied by broadband and mobile coverage, plays a relatively small part in explaining variation in bilateral trade costs. Distance is found to be the most important determinant of variation in bilateral trade costs across most sectors (explaining 24-30% of variation). In turn, ICT connectedness explains 3% of trade cost variation in agriculture, 4% in manufacturing and 6% in services.

[29] This analysis comes from a long line of work on trade costs. Eaton and Kortum (2002[20]), Anderson and Van Wincoop (2003[21]), and Anderson and Van Wincoop (2004[40]) adapted the gravity framework to analyse variable trade costs. Melitz (2003[41]), Das, Roberts and Tybout (2007[37]) , Helpman, Melitz and Rubinstein (2008[46]), Chaney (2008[42]) and Egger et al. (2021[35]) focused on decompositions of trade costs into fixed and variable components in the context of the heterogeneous firm literature. Arkolakis, Costinot and Rodriguez-Clare (2012[22]), (Anderson and Yotov (2010[44]), Dekle, Eaton and Kortum (2007[43]), Deakle, Eaton and Kortum (2008[38]) and Chaney (2016[39]) developed new theoretical methods underlining the importance of trade and transaction costs, quantifying the effect of trade policy shocks.

Overall, the emerging literature suggests that digital connectivity is likely to play a quantitatively important impact on international trade, including services, which can be more readily delivered via digital networks (Benz, Jaax and Yotov, 2022[17]), and goods that can be ordered online and delivered as parcels (López González and Sorescu, 2021[15]). However, there is little to no empirical evidence on how and to what extent digital trade policies affect trade costs and trade flows.

### Box 2. Trade costs

Trade costs are the costs involved in getting products from where they are produced in one country to where they are consumed in another. They include information, transportation and regulatory costs and can vary significantly across and within countries and goods and services traded.

Trade costs are an integral part of structural gravity models but, unlike the mass variables, they are not directly observed and are therefore more difficult to capture. They include a range of geographical and policy elements which can be estimated or inferred from the structural gravity model.

Egger and Nigai (2015[34]) estimate trade costs by decomposing bilateral trade flows into exporter-sector-time and importer-sector-time fixed effects. They use the residual from this regression, multiplied by a sector-specific trade elasticity, as a measure of trade costs (Annex B). Egger et al. (2021[35]) provide a comprehensive review of different trade cost calculations. They also estimate trade costs using a similar method, albeit relative to domestic trade flows, capturing all trade frictions that make international trade more costly than domestic trade. The WTO Trade Cost Index uses this approach to derive trade costs estimates for 43 economies and 31 sectors between 2000 and 2018 (http://tradecosts.wto.org/).

## 3.2. Digitalisation and digital trade policies have played an important and multifaceted role in trade cost reductions

Digital connectivity has indeed played a key role in reducing both domestic and international trade costs. A 1% increase in digital connectivity is associated with a 0.3% reduction in domestic trade costs and a 0.1% reduction in international trade costs (Table A E.2).[30] Enhancing digital connectivity therefore delivers a double dividend in the form of lower domestic and international trade costs.

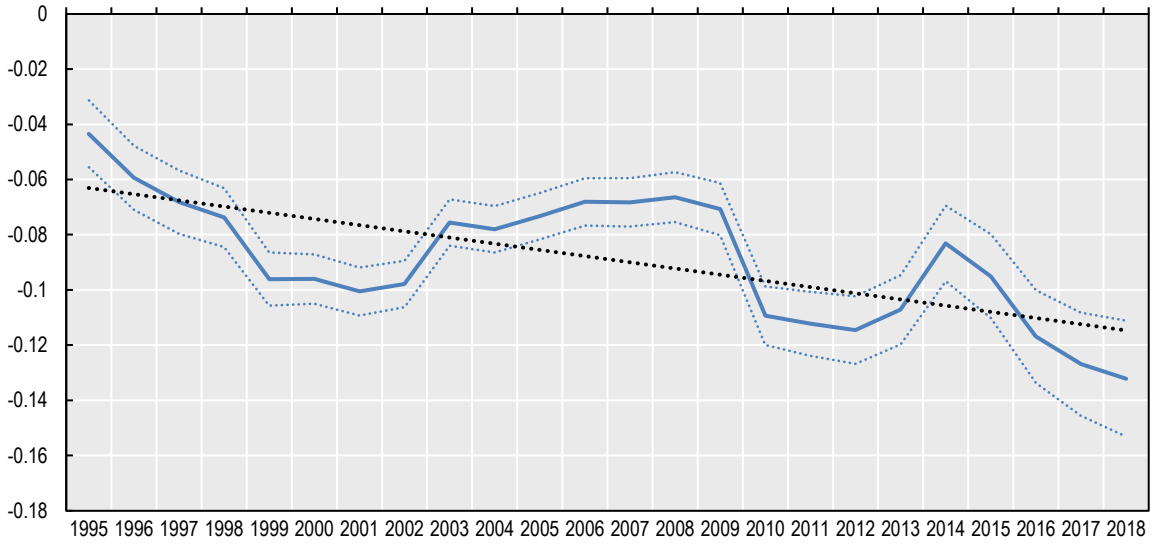
Where international trade costs are concerned, the trade-cost reducing role of digital connectivity is seen to have become more important over time (Figure 10). By 2018, the impact of digital connectivity on international trade costs is three times higher than it was in 1995.

The regulatory environment for digital trade is also important (Figure 11). A 0.1-point increase in the average DSTRI between countries leads to a 15.4% increase in international trade costs. The effect of digital trade barriers on trade costs is bigger for emerging countries (9.6%) than for high-income countries (5.2%). This underscores the importance of removing digital trade restrictions for emerging economies so that they can take advantage of emerging opportunities of digitalisation for trade.

[30] Trade costs calculated following Egger and Nigai (2015[34]), digital connectivity is the minimum, between two countries, of that share of the population connected to the Internet. Domestic and international effects identified by interacting domestic and border dummies, see Annex C.

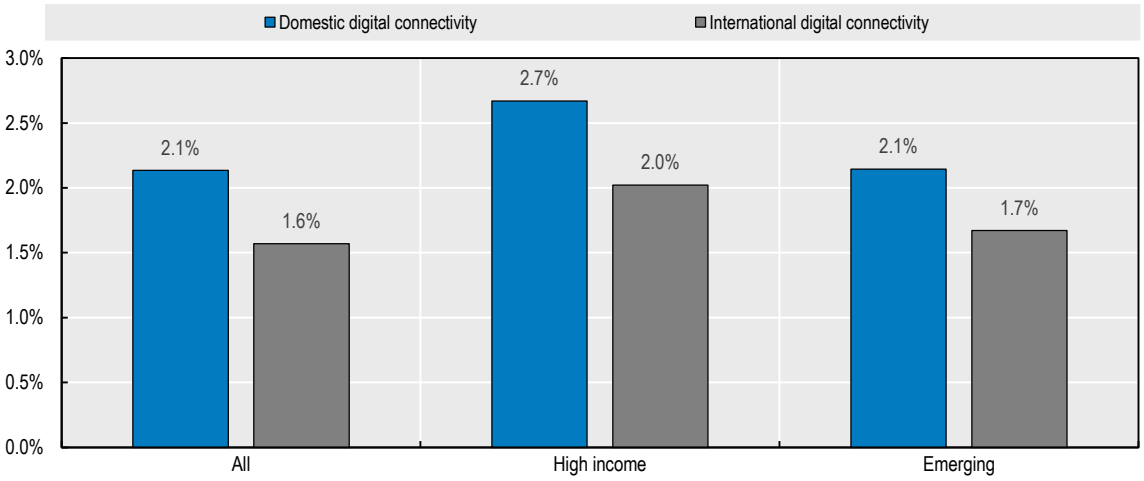
## Figure 10. Digital connectivity reduces international trade costs, including through its impact on the "border effect"

Impact of digital connectivity on international trade costs by year (1995-2018)




Note: The graph plots the impact of increasing minimum digital connectivity on international trade costs. Blue dotted lines show the 95% confidence intervals. See Annex Table A E.1. for the regression results.
Source: Own calculations using TiVA 2021 database.

## Figure 11. Impact of digital trade restrictiveness on international trade costs




Note: This chart shows the impact of a 0.1-point increase in the average Digital STRI between two economies on international trade costs of high income and emerging countries. See Annex Table A E.3. for regression results.
Source: Own calculations using TiVA 2021 database.

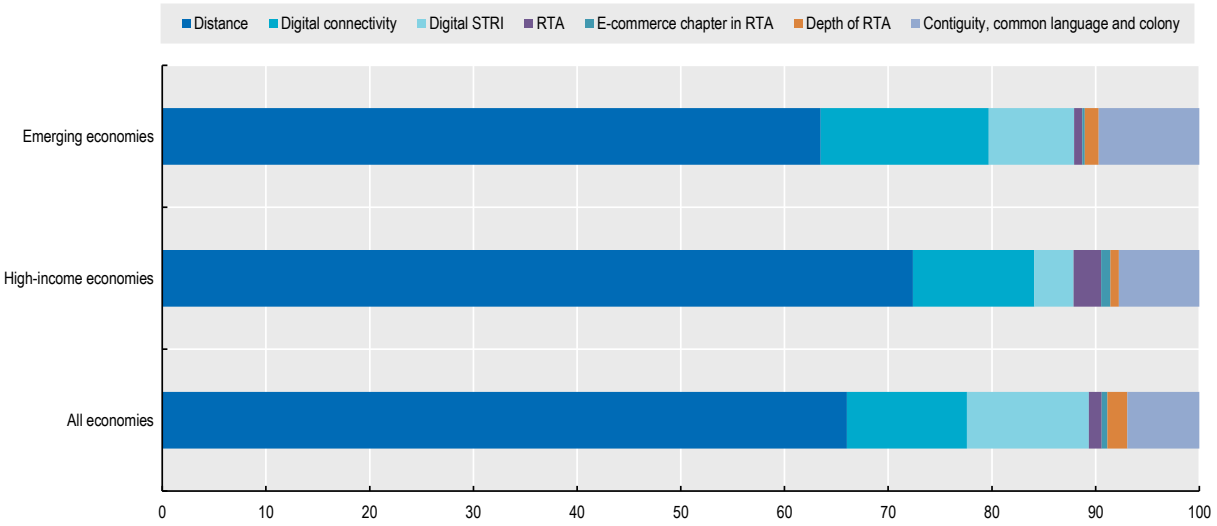
While important, digitalisation and digital trade policies are not the main determinants of trade costs, structural factors, including distance are most important (Figure 12).[31] That said, digital connectivity account for 11% of the explained variance of overall trade costs with digital trade policies (the DSTRI) another 11% (when looking at overall variance, including that not captured by the model, these explain 5%

[31] On average, the variables explain around 45% of the variation in trade costs.

each). There are also differences across countries at different levels of development. Digital connectivity and digital policies appear to be more important determinants of trade costs for emerging economies than they are for high-income countries.

### Figure 12. Decomposition of trade costs by determinant

Contribution (%) to explained trade costs variation, by level of development




Note: Data captures the contribution of each determinant to the explained variance of trade costs. The contribution to the variance is calculated as the product of the determinant's coefficient (based on the regression coefficients in Annex Table A E.3) and the covariance between the determinant and trade costs divided by the variance of trade costs.
Source: Own calculations using TiVA 2021 database.

## 3.3. Digitalisation and digital trade policies can increase trade across all sectors and for countries at all levels of development

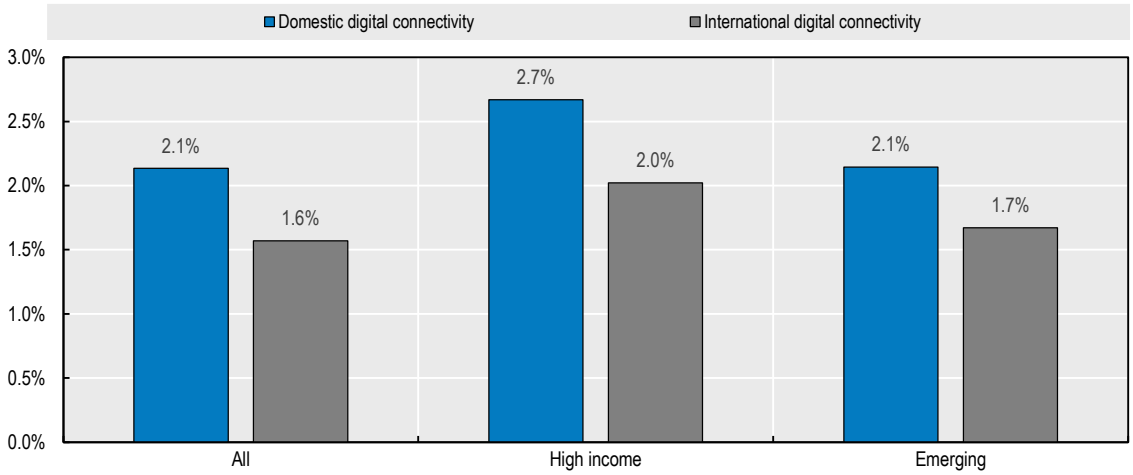
The trade-cost reducing impact of digital connectivity translates into a quantitatively significant trade flow increasing effect.[32] Indeed, the double dividend of increasing digital connectivity persists. On average, a 1% increase in domestic digital connectivity is associated with a 2.1% increase in domestic trade and a 1.5% increase in international trade (Figure 13).[33] The impact of digital connectivity on trade is found to be a little larger for high-income countries than it is for emerging economies. This can be explained, in part, by the fact that emerging economies tend to face higher border costs than high-income countries. Indeed, the 'border effect' which captures the extent to which countries trade less internationally than they do domestically, incorporating a range of structural and policy elements, is 13% higher for emerging economies than it is for high-income economies. Digital connectivity matters also for lower-income economies, which would benefit from a larger impact on international trade from improved digital connectivity than upper-middle income economies (Box 3).

[32] See Annex C for details on the gravity trade estimations and Annex E for key results.

[33] This double dividend also appears in the work of Herman and Oliver (2022[16]) although they find that international trade increases by more than domestic trade. Differences in results are likely due to the use of different indicators of digital connectivity (they use the product of the share of people connected to the internet) but also, importantly, to the fact that they capture changes (they use bilateral fixed effects in their specification). Introducing digital connectivity here as the minimum between the connectivity of the two trading partners allows for a more straightforward interpretation of the elasticity. Estimates in this paper are closer to changes in levels with domestic trade already being larger than international trade, hence the larger effect.

## Figure 13. The double dividend of digital connectivity

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




Note: Results from a gravity model for the period 1995-2018 using PPML and reporter-sector-year and partner sector-year fixed effects. See Annex Table A E.4. for regression results.
Source: Own calculations. using TiVA 2021 database.

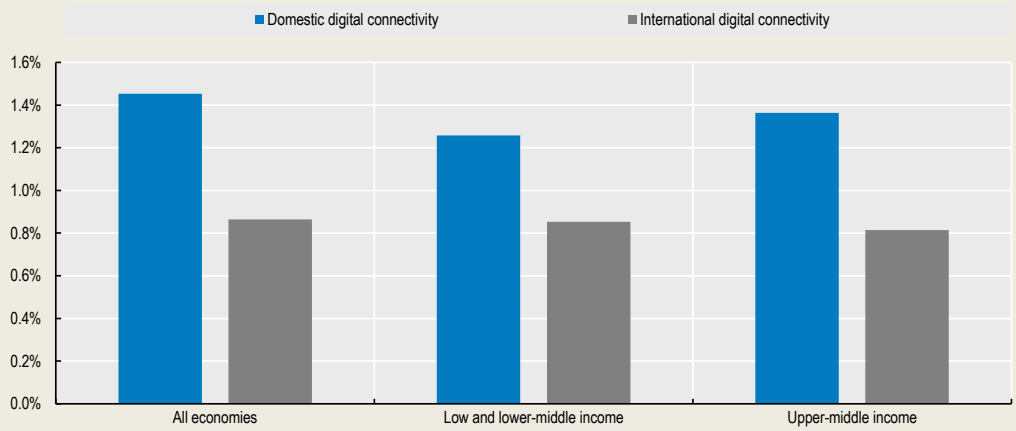
## Box 3. Impacts of digital connectivity and digital trade policy environment on trade in developing economies

Drawing on the USITC ITPD-E gravity database allows to extend the country coverage to low-income and lower-middle economies, while incorporating both domestic and international trade flows in the gravity model (see Annex D for more details on the ITPD-E database).

Digital connectivity has a positive impact on both domestic and international trade in low-income and lower-middle income economies. A 1% increase in domestic digital connectivity is associated with a 1.3% increase in domestic trade and a 0.9% increase in international trade in low and lower-middle income economies (Figure 14). Moreover, the effect of digital connectivity on international trade is slightly higher than that for upper-middle income economies, for which a 1% increase in domestic digital connectivity is associated with a 0.8% increase in international trade.

### Figure 14. There is a double dividend of digital connectivity also for lower-income economies

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

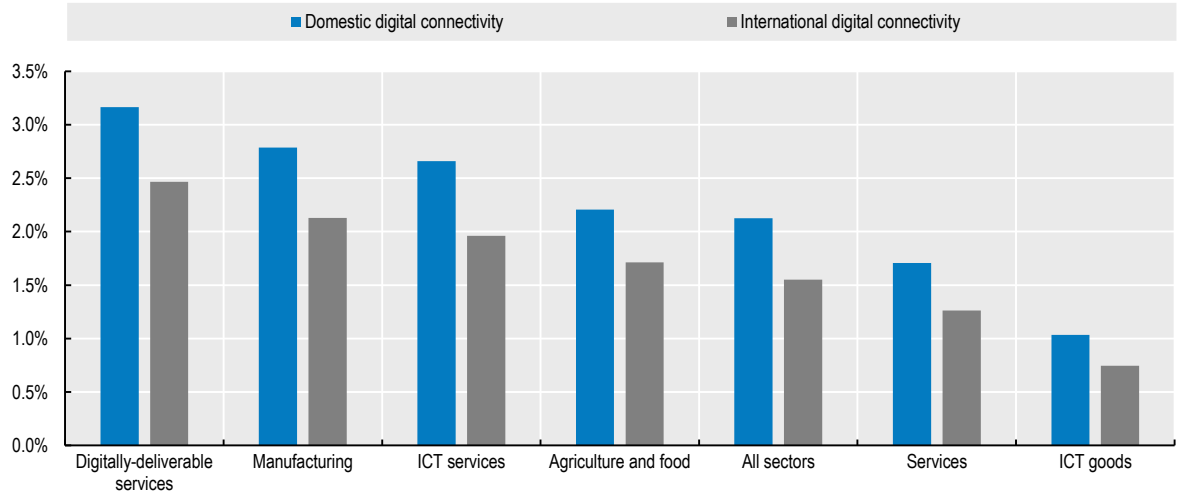



Note: Results from a gravity model for the period 1995-2019 using PPML and reporter-sector-year and partner-sector-year fixed effects. See Annex Table A E.5. for regression results
Source: Own calculations using USITC ITPD-E gravity database.

Digital connectivity matters across all sectors of the economy, but it is most important for digitally-deliverable sectors. Importantly, digitalisation is also key for agriculture and food sectors (Figure 15).

## Figure 15. Digital connectivity matters across all sectors of the economy

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




Note: Results from a gravity model for the period 1995-2018 using PPML and reporter-sector-year and partner-sector-year fixed effects. See Annex Table A E. 6. for regression results.
Source: Own calculations using TiVA 2021 database.

The impact of e-commerce chapters in RTAs on trade is found to be positive for both high-income and emerging economies. Signing an RTA with an e-commerce provision is found to increase exports of high-income countries by 10.3%, nearly twice as much as a shallow agreement (i.e. an agreement without an e-commerce chapter), and exports of emerging economies by 16.9% (Table 2). However, the relationship between e-commerce chapters and trade depends strongly on the depth of the e-commerce provisions signed (Table A E.4).[34] More work is needed to tease out the impact of e-commerce chapters in RTAs on countries at different levels of development.

## Table 2. Impact of digitalisation and e-commerce chapters in RTAs on trade

| | All | High income | Emerging |
|---|---|---|---|
| Log of minimum bilateral digital connectivity | 0.172*** | 0.0701*** | 0.285*** |
| | (16.55) | (4.09) | (13.63) |
| EU | 0.346*** | 0.343*** | 0.701*** |
| | -15.63 | -16.13 | -10.71 |
| No e-commerce RTA | 0.0635*** | 0.0404** | 0.197*** |
| | -4.28 | -2.35 | -10.02 |
| RTA with an e-commerce provision | 0.0969*** | 0.0983*** | 0.156*** |
| | -3.83 | -4.51 | -3.09 |
| Constant | 10.85*** | 11.24*** | 10.59*** |
| | -287.47 | -168.67 | -164.8 |
| N | 4 650 388 | 3 007 349 | 1 597 170 |

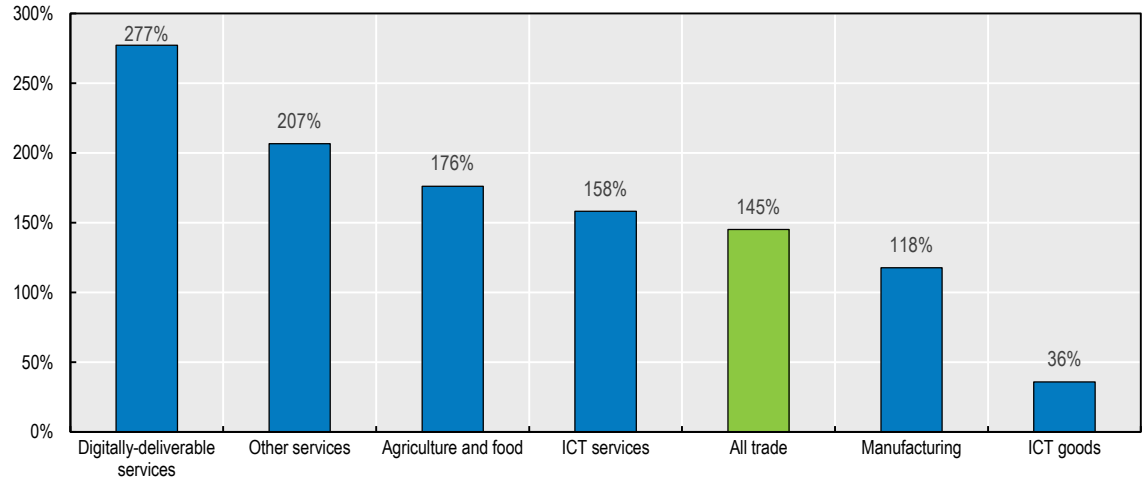
Note: Results from a gravity model for the period 1995-2018 using PPML and reporter-partner, reporter-sector-year and partner-sector-year fixed effects.
Source: Own calculations.

[34] Annex C provides details on the specification and the depth of RTAs variable used.

There is a strong case for domestic regulatory reform to enhance export competitiveness. A 0.1-point reduction in the domestic DSTRI score, which captures an important domestic regulatory reform, is associated with an increase in total exports of 145% (Figure 16).[35] The effect is highest for digitally-deliverable services of 277% and 'other services' exports of 206%. Importantly, the case for reform is not limited to services. An equivalent reduction in the domestic DSTRI score is associated with a 176% increase in exports in agriculture and food sectors and a 117% increase in exports in manufacturing sectors.[36] As was the case with trade cost, regulatory reform yields greater benefits for emerging economies than for high-income economies (Table A E.9). This analysis can be used to model changes in the digital trade environment such as identifying the *ad valorem* equivalent (AVE) of moving towards full restrictions on data flows (Box 4).

## Figure 16. Impact of digital trade restrictiveness on trade by broad sector

Impact of decreasing domestic DSTRI by 0.1 points




Note: Values show the impact of reducing digital trade restrictiveness captured by a 0.1-point reduction of the DSTRI. The values are calculated as the exponent of the DSTRI coefficient. The *ad valorem* equivalent can be calculated using the following equation as per Benz and Jaax (2020[32]): exp(-(-0.1*DSTRI coefficient)/(elasticity-1))-1. Using the elasticities from Egger et al. (2021[34]) the AVE for all trade is around 19.3% and for digitally-deliverable trade 32.1%. See Annex Table A E.8.
Source: Own calculations using TiVA 2021 database.

[35] A 0.1-point change in the DSTRI can entail an important regulatory reform. For comparison, a 0.08 decrease captures a move from a more to a less restrictive approach to data transfers.

[36] The magnitudes are comparable to Benz and Jaax (2020[33]) who obtained trade costs reductions from reducing regulatory barriers in services (measured as a 0.1-point reduction in the STRI) up to 109% for financial services.

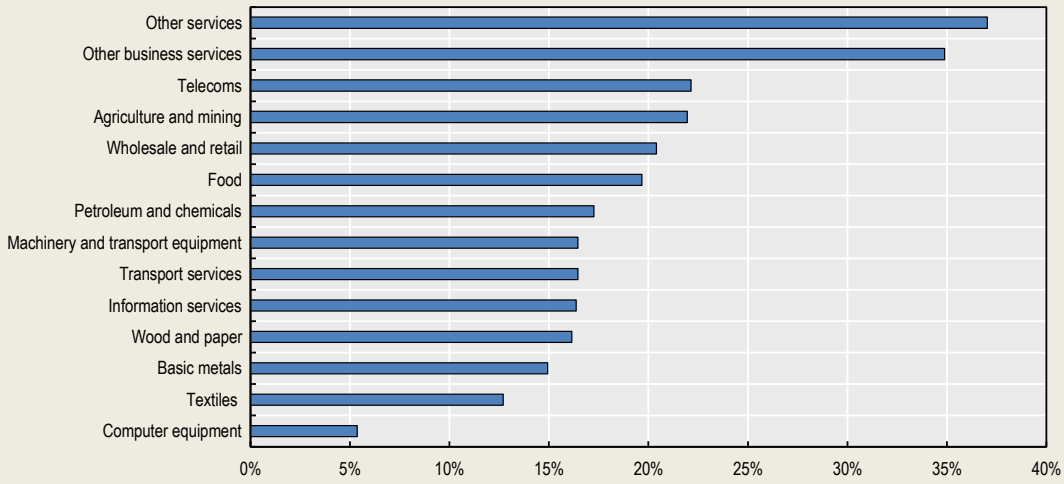
## Box 4. Simulating the potential implications of data flow prohibitions

One important feature of the DSTRI is that it can also be used to simulate changes in regulations. This can be used to identify preliminary estimates of *ad valorem* equivalents of changes in data flow regulation. This can be done through a two-step procedure. In the first step, the elasticity of trade with respect to changes in the domestic regulatory environment, as captured by the DSTRI, is calculated (similar to what is done in the context of Figure 15). In the second step, the DSTRI simulator is used to identify the change in the DSTRI score arising from a prohibition to the flow of data. This information, and measures of the elasticity of substitution of trade, is combined using the following equation (following Benz and Jaax (2020[33])):

$$AVE_i = \exp\left(-\frac{\Delta DSTRI_i * \beta_{DSTRI\_k}}{(\sigma_k - 1)}\right) - 1$$

Where the *ad valorem* equivalent (AVE) of changes to the DSTRI in sector *k* is the exponent of minus the change in the DSTRI score ($\Delta DSTRI_i$), here assumed to be of 0.1 points, multiplied by the coefficient obtained from regressing the DSTRI score on sector k (Figure 16 provides results by broad sector). This expression is divided by the elasticity of substitution ($\sigma_k$) minus one (obtained from Egger et al. (2021[35]). It shows the *ad valorem* equivalent of the trade cost increase that arises from a 0.1-point increase in the domestic DSTRI score across different sectors.

### Figure 17. Trade cost increase arising from a 0.1-point increase in the domestic DSTRI




Note: The figure shows by how much export costs increase as a result of a 0.1-point increase in the Digital STRI. See Annex Table A E.8. for coefficients.
Source: Own calculations using TiVA 2021 database.

By inserting the change in the DSTRI that would arise from a country moving towards a full prohibition of data flows, as identified through the DSTRI simulator, the AVEs of data flow prohibitions for specific countries in specific sectors can be calculated. These represent how much trade cost would increase as a result of not being able to transfer data abroad. Table 3 shows these results highlighting that, using the estimation approach in this paper, for many OECD countries, the AVE of data flow prohibitions can be well above 100% across digitally-deliverable services sectors such as other business services and other services. Impacts are also found to be high in agriculture and food. For China, which is the most restrictive in terms of data flows within the sample, the impact is zero as there is little room of becoming more restrictive.

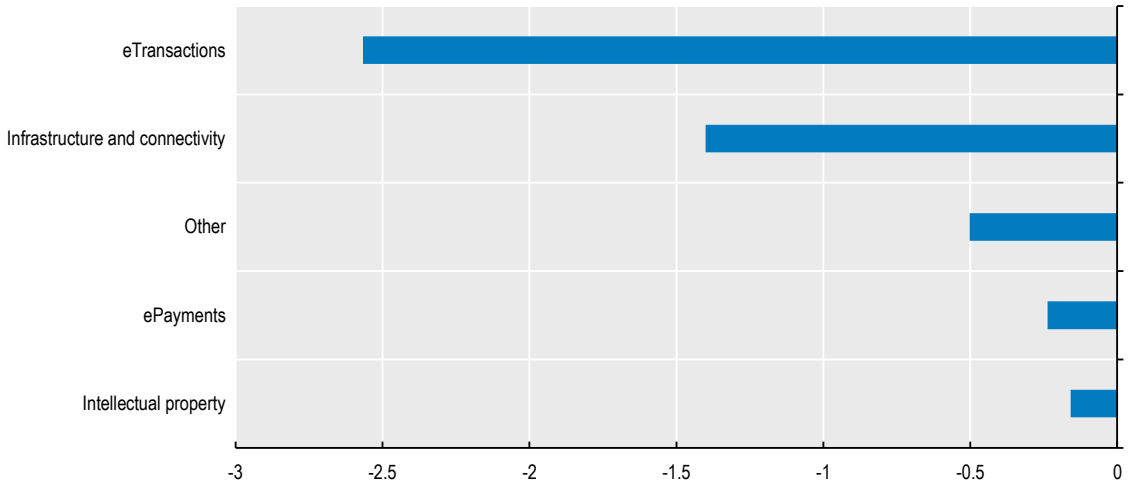
## Table 3. Simulating the potential increase in export costs arising from a scenario where countries prohibit the flow of data

| | Australia | Brazil | Canada | China | EU* | India | Indonesia | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture and mining | 68% | 43% | 81% | 0% | 55% | 27% | 22% | 68% | 68% | 81% |
| Food | 60% | 38% | 71% | 0% | 48% | 24% | 20% | 60% | 60% | 71% |
| Textiles | 36% | 24% | 43% | 0% | 30% | 15% | 13% | 37% | 36% | 43% |
| Wood and paper | 48% | 31% | 57% | 0% | 39% | 19% | 16% | 48% | 48% | 57% |
| Petroleum and chemicals | 51% | 33% | 61% | 0% | 42% | 21% | 17% | 52% | 51% | 61% |
| Basic metals | 44% | 29% | 52% | 0% | 36% | 18% | 15% | 44% | 44% | 52% |
| Computer equipment | 15% | 10% | 17% | 0% | 12% | 6% | 5% | 15% | 15% | 17% |
| Machinery and transport equipment | 49% | 32% | 58% | 0% | 40% | 20% | 17% | 49% | 49% | 58% |
| Wholesale and retail | 62% | 40% | 75% | 0% | 50% | 25% | 21% | 62% | 62% | 75% |
| Transport services | 49% | 32% | 58% | 0% | 40% | 20% | 17% | 49% | 49% | 58% |
| Telecoms | 68% | 44% | 82% | 0% | 55% | 27% | 22% | 69% | 68% | 82% |
| Information services | 48% | 32% | 58% | 0% | 40% | 20% | 17% | 49% | 48% | 58% |
| Other business services | 118% | 72% | 145% | 0% | 93% | 43% | 35% | 118% | 118% | 145% |
| Other services | 127% | 77% | 157% | 0% | 100% | 45% | 37% | 128% | 127% | 157% |

Note: Values show *ad valorem* equivalents of moving from current stance to prohibition of data flows. *Digital STRI data for Germany.
Source: Own calculations using TiVA 2021 database.

When looking at how different types of barriers, as identified by the Digital STRI, affect trade, there is very clear evidence that higher barriers across the five different categories of the DSTRI have a negative impact on trade (Table A E.7). Figure 18 summarises the results by multiplying the mean of the independent variables capturing each barrier category by the coefficient obtained in the regression.[37] The results show that, overall, regulatory measures affecting e-transactions matter most, followed by infrastructure and connectivity measures (which include restrictions on data flows and data localisation measures), and 'other measures', which include performance or commercial presence requirements.

## Figure 18. Impact of different barriers affecting digital trade (2014-18)




Note: Bars identify the mean of the independent variables capturing each barrier category multiplied by the coefficient obtained in their regressions against total trade. See Annex Table A E.10 for the regression results. The bigger the bar, the bigger the influence of the variable on overall trade.
Source: Own calculations using TiVA 2021 database.

[37] This allows us to assess the overall effect of that particular barrier on trade. Since the dependent variable is the same across all estimations, this provides a crude way of identifying what barriers matter more (although it does not identify at this stage if differences are statistically significantly different from zero).

Overall, the analysis shows that digital connectivity and digital trade policies matter for trade and trade costs. However, they also highlight that impacts differ across sectors and countries at different levels of development. There is a double dividend from increasing digital connectivity across both high-income and emerging economies which means that there is both a domestic and an international case for growing connectivity. At the same time, there is a strong case for regulatory co-operation between countries on digital trade policies, especially in emerging economies which are more affected than high-income economies.

The analysis presented herein is robust to different specifications (whether PPML or regular fixed effects models) and sources of data (such as ITPD-E).[38] Given that this is a first attempt at capturing many new facets of the impact of the digital trade environment on trade, the analysis also reveals a number of interesting areas for future analysis. This includes a more refined analysis of the impact of digital trade provisions in RTAs, whether overall or with respect to specific provisions. The variety of existing digital trade provisions in trade agreements is large, and disentangling the most binding elements can be difficult. The other elements that may require further future analysis relate to the interactions between digitalisation and other variables of interest such as distance, the 'border' effect and also the variables of digital trade policies.

## 4. What do we learn from this exercise?

The results presented herein suggest that digital trade is not only growing but also changing. They also underscore an evolving regulatory environment. Since 2000, almost one in two new trade agreements signed has an e-commerce provision. However, uptake by middle-income countries has been slower and shallower than that of high-income countries. Low-income countries have, to date, not taken part in these at all.

More recently, new Digital Economy Agreements are emerging. These cover a wider range of issues, going beyond what is covered in many digital trade chapters, including co-operation on artificial intelligence, underwater cables, digital identity and open government data. In parallel, discussions on digital trade are underway between 88 countries at the JI on e-commerce[39] with issues covered being similar to those appearing in e-commerce chapters of RTAs.

Against the backdrop of growing international discussions on digital trade, there has been an overall tightening of domestic regulatory approaches, albeit with differences across regions. The African region appears to have the most restrictive environment for digital trade, but there is evidence of ongoing liberalisation. In turn, OECD countries have the lowest level of restrictiveness, but the trend is towards tightening regulation.

To date, the magnitude of digital trade and the impact of these policies has been difficult to capture, largely due to measurement difficulties. However, using proxy variables, this paper has shown that digital trade could represent as much as 24% of all trade. In some countries, digital trade represents more than half of total exports.

Where impact of digitalisation on trade is concerned, the paper shows that digital connectivity not only plays a statistically significant role in reducing trade costs and therefore increasing trade, but that this effect is growing in time. The paper also highlights that there is a double dividend from increasing digital connectivity, raising both domestic and international trade for countries at all levels of development. It also shows that digitalisation matters across all sectors of the economy, including agriculture and food as well as manufacturing activities.

Last, but certainly not least, this paper shows that digital trade policies matter. Indeed, having a trade agreement with an e-commerce chapter is seen to double the benefits of an RTA, however the results are sensitive to the depth of these provisions. More work in this area is required to better capture the impact

[38] Tables showing the results of specifications using the ITPD-E database are available upon request.

[39] As of February 2023.

of e-commerce provisions on trade. Moreover, domestic policies, especially those that affect electronic transactions and infrastructure and connectivity, have a quantitatively important and significant trade reducing effect.

The paper makes a particular effort to identify the extent to which these issues differ across countries at different levels of development. It finds that, largely, there is a strong case for both developed and developing countries to engage in wider digitalisation and liberalisation of digital trade. While the paper does not extensively cover low-income countries due to data challenges, evidence using the ITPD-E database suggests that digital connectivity is an important contributor to trade flows in lower-income economies.

Overall, the findings from this paper support the idea that countries at all levels of development have much to gain from embracing the digital transformation for trade. This underscores the importance of a wider and more ambitious engagement in digital trade policy discussions, whether in trade agreements, emerging digital economy agreements or in discussions at the Joint Initiative on e-commerce at the WTO.

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# Annex A. Digital trade estimates

## Table A A.1. Estimated digital trade by country (1995 and 2018)

| | 1995 | | | 2018 | | | Change | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | Value of digital trade ('000 USD) | Share of digital trade exports | Share of global digital trade exports | Value of digital trade ('000 USD) | Share of digital trade exports | Share of global digital trade exports | Value of digital trade ('000 USD) | Share of digital trade exports (percentage points) | Share of global digital trade exports (percentage points) |
| ARG | 2,958.91 | 11.63% | 0.27% | 12,917.52 | 17.20% | 0.25% | 9,958.61 | 5.57% | -0.02% |
| AUS | 11,651.52 | 16.72% | 1.07% | 59,589.85 | 19.52% | 1.16% | 47,938.33 | 2.80% | 0.09% |
| AUT | 14,708.29 | 18.91% | 1.35% | 54,098.53 | 23.46% | 1.05% | 39,390.23 | 4.54% | -0.30% |
| BEL | 34,750.34 | 23.96% | 3.19% | 120,277.30 | 38.07% | 2.34% | 85,526.96 | 14.11% | -0.84% |
| BGR | 1,436.48 | 24.83% | 0.13% | 7,714.62 | 19.56% | 0.15% | 6,278.15 | -5.27% | 0.02% |
| BRA | 11,169.57 | 20.18% | 1.02% | 52,499.46 | 19.35% | 1.02% | 41,329.89 | -0.84% | 0.00% |
| BRN | 167.70 | 6.68% | 0.02% | 470.25 | 6.89% | 0.01% | 302.55 | 0.20% | -0.01% |
| CAN | 30,005.68 | 14.16% | 2.75% | 109,349.64 | 21.03% | 2.13% | 79,343.96 | 6.88% | -0.62% |
| CHE | 34,466.37 | 26.75% | 3.16% | 113,559.22 | 31.40% | 2.21% | 79,092.85 | 4.65% | -0.95% |
| CHL | 2,809.51 | 13.42% | 0.26% | 15,134.43 | 17.83% | 0.29% | 12,324.92 | 4.41% | 0.04% |
| CHN | 23,330.99 | 18.38% | 2.14% | 341,542.96 | 14.06% | 6.65% | 318,211.97 | -4.32% | 4.51% |
| COL | 1,574.59 | 12.97% | 0.14% | 7,015.66 | 13.41% | 0.14% | 5,441.07 | 0.45% | -0.01% |
| CRI | 558.98 | 13.36% | 0.05% | 6,207.28 | 31.53% | 0.12% | 5,648.31 | 18.17% | 0.07% |
| CYP | 1,452.43 | 25.11% | 0.13% | 7,410.33 | 57.73% | 0.14% | 5,957.90 | 32.62% | 0.01% |
| CZE | 5,508.65 | 22.83% | 0.51% | 30,068.27 | 17.62% | 0.59% | 24,559.62 | -5.22% | 0.08% |
| DEU | 105,259.47 | 20.45% | 9.65% | 373,094.94 | 24.10% | 7.26% | 267,835.47 | 3.64% | -2.39% |
| DNK | 9,586.56 | 15.88% | 0.88% | 36,562.64 | 23.05% | 0.71% | 26,976.08 | 7.17% | -0.17% |
| ESP | 24,008.88 | 18.49% | 2.20% | 109,558.94 | 23.43% | 2.13% | 85,550.06 | 4.95% | -0.07% |
| EST | 388.51 | 17.15% | 0.04% | 4,855.10 | 25.57% | 0.09% | 4,466.59 | 8.42% | 0.06% |
| FIN | 7,128.04 | 15.14% | 0.65% | 27,874.25 | 28.36% | 0.54% | 20,746.21 | 13.22% | -0.11% |
| FRA | 79,973.47 | 23.32% | 7.33% | 252,948.80 | 31.55% | 4.92% | 172,975.33 | 8.24% | -2.41% |
| GBR | 90,729.44 | 29.87% | 8.32% | 366,030.55 | 50.71% | 7.13% | 275,301.12 | 20.83% | -1.19% |
| GRC | 1,835.98 | 9.84% | 0.17% | 10,989.43 | 15.16% | 0.21% | 9,153.45 | 5.32% | 0.05% |
| HKG | 22,003.69 | 35.94% | 2.02% | 77,858.30 | 44.07% | 1.52% | 55,854.61 | 8.13% | -0.50% |
| HRV | 1,132.56 | 21.38% | 0.10% | 6,419.22 | 26.40% | 0.12% | 5,286.67 | 5.02% | 0.02% |
| HUN | 3,682.98 | 21.76% | 0.34% | 26,940.27 | 21.64% | 0.52% | 23,257.29 | -0.12% | 0.19% |
| IDN | 5,392.63 | 8.67% | 0.49% | 22,917.45 | 10.43% | 0.45% | 17,524.82 | 1.75% | -0.05% |
| IND | 9,951.40 | 24.81% | 0.91% | 186,999.83 | 34.74% | 3.64% | 177,048.43 | 9.94% | 2.73% |
| IRL | 8,070.94 | 21.07% | 0.74% | 205,946.40 | 49.07% | 4.01% | 197,875.46 | 28.00% | 3.27% |
| ISL | 382.39 | 15.90% | 0.04% | 2,974.94 | 26.09% | 0.06% | 2,592.56 | 10.19% | 0.02% |
| ISR | 6,346.27 | 25.88% | 0.58% | 42,246.59 | 41.33% | 0.82% | 35,900.32 | 15.45% | 0.24% |
| ITA | 52,520.10 | 18.36% | 4.82% | 139,142.60 | 21.76% | 2.71% | 86,622.50 | 3.39% | -2.11% |
| JPN | 49,039.26 | 10.21% | 4.50% | 149,005.78 | 16.46% | 2.90% | 99,966.51 | 6.25% | -1.60% |
| KAZ | 770.44 | 9.59% | 0.07% | 6,136.76 | 8.92% | 0.12% | 5,366.32 | -0.67% | 0.05% |
| KHM | 99.41 | 9.20% | 0.01% | 1,498.41 | 9.88% | 0.03% | 1,399.00 | 0.68% | 0.02% |
| KOR | 17,297.34 | 12.14% | 1.59% | 111,492.61 | 15.56% | 2.17% | 94,195.27 | 3.42% | 0.58% |
| LAO | 81.20 | 17.11% | 0.01% | 445.15 | 7.50% | 0.01% | 363.95 | -9.61% | 0.00% |
| LTU | 251.37 | 11.83% | 0.02% | 4,722.45 | 15.80% | 0.09% | 4,471.08 | 3.97% | 0.07% |
| LUX | 11,538.57 | 57.25% | 1.06% | 108,638.68 | 83.36% | 2.12% | 97,100.11 | 26.11% | 1.06% |
| LVA | 346.77 | 20.23% | 0.03% | 3,657.08 | 24.32% | 0.07% | 3,310.31 | 4.09% | 0.04% |
| MAR | 1,367.75 | 14.79% | 0.13% | 7,776.64 | 18.10% | 0.15% | 6,408.88 | 3.31% | 0.03% |
| MEX | 9,173.30 | 10.55% | 0.84% | 50,683.80 | 10.56% | 0.99% | 41,510.50 | 0.01% | 0.15% |
| MLT | 1,701.10 | 51.30% | 0.16% | 11,495.61 | 61.77% | 0.22% | 9,794.51 | 10.46% | 0.07% |
| MMR | 70.60 | 6.37% | 0.01% | 3,195.71 | 14.59% | 0.06% | 3,125.11 | 8.22% | 0.06% |

| | 1995 | | | 2018 | | | Change | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | Value of digital trade ('000 USD) | Share of digital trade exports | Share of global digital trade exports | Value of digital trade ('000 USD) | Share of digital trade exports | Share of global digital trade exports | Value of digital trade ('000 USD) | Share of digital trade exports (percentage points) | Share of global digital trade exports (percentage points) |
| MYS | 13,108.82 | 17.55% | 1.20% | 28,931.15 | 13.24% | 0.56% | 15,822.33 | -4.31% | -0.64% |
| NLD | 46,646.96 | 24.12% | 4.28% | 178,169.39 | 34.31% | 3.47% | 131,522.43 | 10.19% | -0.81% |
| NOR | 7,295.02 | 14.29% | 0.67% | 31,986.97 | 20.27% | 0.62% | 24,691.95 | 5.99% | -0.05% |
| NZL | 3,330.29 | 18.75% | 0.31% | 13,113.71 | 24.18% | 0.26% | 9,783.42 | 5.43% | -0.05% |
| PER | 805.74 | 11.51% | 0.07% | 7,333.38 | 13.73% | 0.14% | 6,527.64 | 2.23% | 0.07% |
| PHL | 3,008.73 | 12.02% | 0.28% | 33,231.43 | 32.58% | 0.65% | 30,222.70 | 20.56% | 0.37% |
| POL | 2,819.97 | 9.02% | 0.26% | 58,554.89 | 19.96% | 1.14% | 55,734.92 | 10.95% | 0.88% |
| PRT | 5,505.80 | 17.65% | 0.50% | 19,276.99 | 19.36% | 0.38% | 13,771.20 | 1.71% | -0.13% |
| ROU | 1,207.38 | 14.30% | 0.11% | 23,419.35 | 27.21% | 0.46% | 22,211.97 | 12.91% | 0.35% |
| ROW | 36,106.09 | 12.04% | 3.31% | 184,095.99 | 12.12% | 3.58% | 147,989.90 | 0.08% | 0.27% |
| RUS | 9,023.28 | 10.06% | 0.83% | 59,425.91 | 11.61% | 1.16% | 50,402.64 | 1.54% | 0.33% |
| SAU | 2,518.23 | 4.76% | 0.23% | 13,291.39 | 4.38% | 0.26% | 10,773.16 | -0.38% | 0.03% |
| SGP | 17,957.08 | 21.40% | 1.65% | 153,654.47 | 35.04% | 2.99% | 135,697.39 | 13.64% | 1.34% |
| SVK | 1,910.63 | 19.25% | 0.18% | 15,046.14 | 17.78% | 0.29% | 13,135.51 | -1.47% | 0.12% |
| SVN | 1,615.10 | 17.34% | 0.15% | 7,632.28 | 21.28% | 0.15% | 6,017.18 | 3.94% | 0.00% |
| SWE | 16,508.47 | 17.13% | 1.51% | 69,069.83 | 31.17% | 1.34% | 52,561.37 | 14.04% | -0.17% |
| THA | 7,687.20 | 10.89% | 0.70% | 44,678.01 | 13.62% | 0.87% | 36,990.80 | 2.73% | 0.16% |
| TUN | 1,335.93 | 17.27% | 0.12% | 2,705.40 | 15.23% | 0.05% | 1,369.47 | -2.04% | -0.07% |
| TUR | 5,871.41 | 15.46% | 0.54% | 21,965.69 | 10.32% | 0.43% | 16,094.28 | -5.14% | -0.11% |
| TWN | 16,760.36 | 13.19% | 1.54% | 44,205.47 | 11.80% | 0.86% | 27,445.11 | -1.39% | -0.68% |
| USA | 185,986.41 | 23.92% | 17.05% | 797,710.96 | 35.33% | 15.53% | 611,724.55 | 11.41% | -1.52% |
| VNM | 887.17 | 13.13% | 0.08% | 21,533.92 | 8.72% | 0.42% | 20,646.75 | -4.40% | 0.34% |
| ZAF | 5,994.97 | 17.43% | 0.55% | 17,510.18 | 16.75% | 0.34% | 11,515.21 | -0.69% | -0.21% |
| Total | 1,090,571.50 | | | 5,136,507.17 | | | 4,045,935.67 | | |
| Average | | 17.86% | 1.49% | | 23.63% | 1.49% | | 5.76% | 0.00% |

Note: Digital trade identified as ICT services (ISIC 61, 62, 63), other digitally-deliverable services (ISIC 58 to 60, 64 to 66 and 69 to 82) and digital inputs (ICT goods and services and other digitally-deliverable services) in non-digital sectors (all those not counted as digital).
Source: Own calculations using OECD TiVA database 2021 version.

## Annex B. Methodology to derive trade costs

The gravity model of trade expresses trade flows as a function of the (economic) size of the trading countries and trade costs. A generic sector-specific structural gravity equation can be expressed as:

$$\left(X_{ij}\right)^k = \frac{Y_i^k E_j^k}{Y^k}\left(\frac{T_{ij}^k}{\Pi_i^k P_j^k}\right)^{-\theta^k} \quad (1)$$

where trade flows from country *i* to country *j* in sector *k*, $X_{ij}^k$, are a function of the supply of sector *k*-goods from country *i*, $Y_i^k$, and expenditure for sector *k*-goods in country *j*, $E_j^k$. $T_{ij}^k > 1$ are trade costs when sector *k*-goods are shipped from exporter-country *i* to importer-country *j*. $\theta^k$ is the sector-specific trade elasticity, and $\Pi_i^k$ and $P_j^k$ are the price indices representing outward and inward multilateral resistance terms, respectively. The size term is captured by $\frac{Y_i^k E_j^k}{Y^k}$ and shows the hypothetical level of frictionless trade between two countries, which is proportional to their overall share of global economic activity. The trade cost term, $\frac{T_{ij}^k}{\Pi_i^k P_j^k}$, is a scaling factor that takes into account trade frictions.

While economic size can be readily observed using available statistics, trade costs are more difficult to capture and include a range of geographical and policy elements. There have been a number of attempts at estimating these trade costs. In this paper, trade is assumed to be a function of the observable trade-cost measures and total trade costs, where all exporter-sector-time (ikt) and importer-sector-time characteristics (jkt) are sub-summed in ikt ($A_{it}^k$) and jkt ($B_{jt}^k$) terms respectively. Hence, a generic gravity model can be formalised as follows:

$$X_{ijt}^k = A_{it}^k B_{jt}^k T_{ijt}^k \quad (2)$$

where $X_{ijt}^k$ is the exports of country *i* to country *j* at time *t* in sector *k*, and $A_{it}^k$ and $B_{jt}^k$ are exporter-sector-time and importer-sector-time fixed effects, respectively, which capture country-specific effects, and the term $T_{ijt}^k$ [40] (which corresponds to term $\left(\frac{T_{ij}^k}{\Pi_i^k P_j^k}\right)^{-\theta_k}$) in the above gravity equation captures pair-sector-time components which can be attributed to bilateral trade frictions between exporting country *i* and importing country *j* in sector *k* at time *t*. Taking logs to obtain $x_{ijt}^k$ = log ($X_{ijt}^k$) and $\tau_{ijt}^k$ = log ($T_{ijt}^k$) [41] and sub-summing all *ikt* and *jkt* terms in $a_{it}^k$ and $b_{jt}^k$, we obtain:

$$x_{ijt}^k = a_{it}^k + b_{jt}^k + \tau_{ijt}^k \quad (3)$$

This empirical model can be estimated for each sector and year with country- fixed effects $a_{it}^k$ and $b_{jt}^k$ to obtain an estimate of $\tau_{ijt}^k$ as a residual. This residual is transformed using the sectoral trade elasticities $\theta^k$ to obtain $t_{ijt}^k$, our trade cost measure.

$$t_{ijt}^k = -\widehat{\theta^k}\,\tau_{ijt}^k \quad (4)$$

[40] The residual term is attributed to $t_{ijt}^k$.

[41] Log variables are referred to in small letters and using capital letters otherwise.

Trade elasticities ($\theta^k$) at the 2-digit ISIC Rev. 4 level are based on Egger et al. (2021[35])(Table A B.1) sector-specific dispersion parameters. The analysis relies on the (Egger et al., 2021[35]) recent estimates for two main reasons. First, the structural gravity model used for the analysis in this paper is consistent with the model used in Egger et al. (2021[35]) (i.e. a supply-side model). Second, Egger et al. (2021[35]) provide a sector mapping closest to the sector categories used in the analysis here. Trade elasticities from WTO (2021[32]) (estimated with the same approach in Egger et al. (2021[35])) are employed for robustness checks in calculating trade costs. As there are only minor differences in the magnitudes of the two sets of estimates, the regression results differ only marginally.[42]

Trade costs are calculated using the TiVA database (description of the database and the coverage of countries and sectors is provided in Annex D). They are also calculated using the ITPD-E database for the robustness checks undertaken.

[42] Regression results using estimates based on WTO (2021[32]) are not presented in this paper for brevity, but they are available upon request.

## Table A B.1. Trade elasticities at the sectoral level

| ISIC 4 code | Sector code in Egger et al. (2021[35]) | ISIC 4 sector | - θ |
|---|---|---|---|
| D01T02 | 1 | Agriculture, hunting forestry | -4.33 |
| D03 | 1 | Fishing and aquaculture | -4.33* |
| D05T06 | 2 | Mining and quarrying, energy production products | -3.9 |
| D07T08 | 2 | Mining and quarrying, non-energy production products | -3.9* |
| D09 | 2 | Mining support service activities | -3.9* |
| D10T12 | 3 | Food products, beverages and tobacco | -4.35 |
| D13T15 | 4 & 5 | Textiles, wearing apparel, leather and related products | -3.82* |
| D16 | 6 | Wood and products of wood and cork | -4.02 |
| D17T18 | 7 | Paper products and printing | -4.41 |
| D19 | 8 | Coke and refined petroleum products | -3.69 |
| D20 | 9 | Chemical and chemical products | -4.6 |
| D21 | 9 | Pharmaceuticals | -4.6* |
| D22 | 10 | Rubber and plastics products | -4.26 |
| D23 | 11 | Other non-metallic mineral products | -3.99 |
| D24 | 12 | Basic metals | -4.14 |
| D25 | 12 | Fabricated metal products | -4.14* |
| D26 | 14 | Computer, electronic and optical products | -4.56* |
| D27 | 14 | Electrical equipment | -4.56 |
| D28 | 13 | Machinery and equipment nec | -4.18 |
| D29 | 15 | Motor vehicles, trailers, and semi-trailers | -4.23 |
| D30 | 15 | Other transport equipment | -4.23* |
| D31T33 | 16 | Manufacturing nec; repair and installation of machinery and equipment | -4.19 |
| D35 | 17 | Electricity, gas, steam, and air cond. supply | -3.83 |
| D36T39 | 17 | Water supply, sewerage, waste, and remediation activities | -3.83* |
| D41T43 | 18 | Construction | -3.17 |
| D45T47 | 20 & 21 | Wholesale and retail trade; repair of motor vehicles | -3.5* |
| D49 | 23 | Land transport | -4.33 |
| D50 | 24 | Water transport | -3.92 |
| D51 | 25 | Air transport | -3.22 |
| D52 | 26 | Warehousing and support activities for trans. | -4.39 |
| D53 | 27 | Postal and courier services | -4.44* |
| D55T56 | 22 | Accommodation and food services activities | -3.63 |
| D58T60 | 27 | Publishing and broadcasting | -4.44* |
| D61 | 27 | Telecommunications | -4.44 |
| D64T66 | 28 | Financial and insurance activities | -4.13 |
| D68 | 29 | Real estate activities | -3.31 |
| D69T75 | 30 | Professional, scientific, and technical activities | -3.88* |
| D84 | 31 | Public administration and defense | -4.07 |
| D85 | 32 | Education | -3.76 |
| D86T88 | 33 | Human health and social work | -3.7 |
| D94T96 | 34 | Other service activities | -4.44 |
| D97T98 | 35 | Activities of households | -2.99 |

Note: Compared to the sectoral classification in Egger et al. (2021[35]), the sectoral classification in TiVA is more disaggregated. The corresponding aggregate sectoral trade elasticities based on Egger et al. (2021[35]) that are used as proxies for more disaggregated sectors in the TiVA database are denoted by *.
Source: Egger et al. (2021[35]).

# Annex C. Trade costs and trade flow baseline models

## Trade costs specifications

The trade costs obtained following the methodology outlined in Annex B are regressed against the following determinants: (i) traditional gravity variables; (ii) digital connectivity; (iii) trade policy variables; and (iv) digital trade policy variables.

The baseline specifications include the standard gravity variables, digital connectivity, and RTA variables as these provide the widest time overlap with trade data from the TiVA database (namely, 1995 – 2018) (equation 1).

Standard gravity variables used include the log of bilateral distance ($lndist_{ij}$), contiguity ($contig_{ij}$), common official language ($comlang_{ij}$) and colonial history ($colony_{ij}$).

The minimum value of the log of percentage of the population with access to the Internet between the country pairs is used as a proxy for digital connectivity ($minlndigi_{ijt}$).

The presence of Regional Trade Agreements (RTAs) is used as a more general reflection of the trade policy environment.

To capture digital aspects in trade agreements, the specifications include a dummy variable for the coverage of a digital trade chapter in RTAs (based on the TAPED database).

The specifications include exporter-sector-year and importer-sector-year fixed effects ($\eta_{it}^{k}$ and $\mu_{jt}^{k}$) controlling for all time-varying country-specific unobservable variables, including multilateral resistance terms.

$$lntradecost_{ijt}^{k} = lndist_{ij} + domestic * minlndigi_{ijt} + border * minlndigi_{ijt} + RTA_{ijt} + RTA\_ecomm\_chapter_{ijt} + contig_{ij} + comlang_{ij} + colony_{ij} + \eta_{it}^{k} + \mu_{jt}^{k} + \varepsilon_{ijt}^{k} \quad (1)$$

In an alternative specification, the inclusion of a border dummy captures overall differences between domestic and international trade.

$$lntradecost_{ijt}^{k} = lndist_{ij} + border_{ij} + border * minlndigi_{ijt} + RTA_{ijt} + RTA\_ecomm\_chapter_{ijt} + contig_{ij} + comlang_{ij} + colony_{ij} + \eta_{it}^{k} + \mu_{jt}^{k} + \varepsilon_{ijt}^{k} \quad (2)$$

Robustness checks also include country-pair fixed effects, including to better capture the impact of RTAs and e-commerce chapters to avoid unobserved heterogeneity arising from selection into trade agreements.

To reflect the domestic policy environment for digital trade, the Digital STRI ($DSTRI_{it}$) is included (equation 3). Introducing the DSTRI leads to a shorter period covered in the regressions since availability of data for this indicator begins in 2014.

$$lntradecost_{ijt}^{k} = lndist_{ij} + border_{ij} + minlndigi_{ijt} + DSTRI_{it} + RTA_{ijt} + RTA\_ecomm\_chapter_{ijt} + contig_{ij} + comlang_{ij} + colony_{ij} + \eta_{it}^{k} + \mu_{jt}^{k} + \varepsilon_{ijt}^{k} \quad (3)$$

Trade costs specifications are ran using OLS (Ordinary Least Squares) with high dimensional fixed effects.

## Trade flows specification

Using a similar modelling framework, the analysis also looks at the impact of the above determinants on trade flows. This involves estimating trade flows in the following structural gravity model framework, where $X_{ijt}^{k}$ are the exports from country i to country j in sector k (including both cross-border trade and domestic trade flows):

$$X_{ijt}^{k} = \exp\left(lndist_{ij} + border_{ij} + minlndigi_{ijt} + DSTRI_{it} + RTA_{ijt} + RTA\_ecomm\_chapter_{ijt} + contig_{ij} + comlang_{ij} + colony_{ij} + \eta_{it}^{k} + \mu_{jt}^{k}\right) * \varepsilon_{ijt}^{k} \quad (4)$$

Trade flows specifications are ran using PPML with high dimensional fixed effects. PPML (Poisson Pseudo Maximum Likelihood) allows to account for hetereoscedasticity and for zero trade flows. Robustness checks also include country-pair fixed effects.

## Assessing the impact of RTAs with e-commerce chapters

The impact of RTAs with an e-commerce chapter on trade flows is assessed using the following specification:

$$X_{ijt}^{k} = \exp\left(minlndigi_{ijt} + EU_{ijt} + RTA\_no\_ecomm\_chapter_{ijt} + RTA\_ecomm\_chapter_{ijt} + RTA\_depth_{ijt} + \eta_{it}^{k} + \mu_{jt}^{k} + \nu_{ij}\right) * \varepsilon_{ijt}^{k} \quad (5)$$

The specifications include exporter-sector-year and importer-sector-year fixed effects ($\eta_{it}^{k}$ and $\mu_{jt}^{k}$) as well as exporter-importer fixed effects ($\nu_{ij}$) to account from unobserved heterogeneity in the selection of RTA partners.

$EU_{ijt}$ is a dummy variable that controls for whether the exporter *i* and importer *j* are both European Union members in year *t*.

To control for the fact that RTAs including e-commerce chapters could potentially be more likely to be 'deep' agreements (i.e., those agreements which are more extensive in the number of policy areas they cover beyond e-commerce), and that the coefficient of $RTA\_ecomm\_chapter_{ijt}$ does not over-estimate the trade impact of such a chapter, the specification controls for the depth of an RTA by including the variable $RTA\_depth_{ijt}$. This represents the depth of an RTA between countries *i* and *j* in year *t* and can take values from 0 (no trade agreement in force) to 52 (where all possible broad policy areas are included in the trade agreement). Information on the depth of RTAs is obtained from the World Bank Deep Integration Dataset (Mattoo, Rocha and Ruta, 2020[36]). One problem with this measure is that agreements are the sum of their provisions and so including depth can capture the significance of the RTA and E-commerce variables. A dummy where RTA depth was above average was also used delivering similar results. More analysis is needed to better disentangle the impact of e-commerce chapters on trade.

Trade flows specifications are ran using PPML with high dimensional fixed effects. PPML (Poisson Pseudo Maximum Likelihood) allows to account for hetereoscedasticity and for zero trade flows.

# Annex D. Data sources and overview of key variables

## OECD Trade-in-Value-Added (TiVA) database

The OECD TiVA database 2021 edition covers 66 economies (Table A D.1) and 45 sectors (Table A B.1) at the 2-digit ISIC Rev. 4 level. The database includes data on both cross-border trade flows and domestic trade flows. Bilateral gross exports represent gross exports of final demand and intermediate goods and services by industry *k* in country *i* to partner country *j*.

Data for standard gravity controls (distance, contiguity, common language, former colony) are drawn from the *Centre d'Études Prospectives et d'Informations* (CEPII). The *distance* variable indicates the distance between most populated city of each country in kilometers and *border* is a dummy variable which is equal to 1 for international trade and 0 otherwise. *Contiguity*, *common official language*, and *colony* variables are dummy variables which are equal to 1 if countries are contiguous, if countries share a common official or primary language and if they had a colonial relationship, respectively.

The percentage of Internet users proxying for *digital connectivity* is sourced from the International Telecommunications Union (ITU) database.

Regarding policies, a variable capturing the existence of Regional Trade Agreements (*RTAs*) is also provided by CEPII. The RTA indicator is a dummy variable which is equal to 1 if there is a regional trade agreement between the country pairs and to 0 otherwise.

The OECD *Digital STRI* identifies barriers that affect trade in digitally-enabled services across 74 countries. STRI indices range from 0 to 1, where a score of 0 represents complete openness to trade and investment, while being completely closed to foreign services providers yields a score of 1. The policy measures within the OECD Digital STRI are categorised under five areas: infrastructure and connectivity; electronic transactions; payment systems; intellectual property rights; other barriers affecting trade in digitally enabled services.

The dummy variable for the inclusion of a digital trade chapter in trade agreements is based on the TAPED (Trade Agreements Provisions on Electronic-commerce and Data) database. The TAPED dataset includes a detailed mapping and coding of all trade agreements that cover chapters, provisions, annexes, and side documents that directly or indirectly regulate digital trade. TAPED reviews more than 340 agreements concluded since 2000.

## Table A D.1. Country coverage with the TiVA database

| ISO 3 code | Country name | Country classification |
|---|---|---|
| ARG | Argentina | Upper middle income |
| AUS | Australia | High income |
| AUT | Austria | High income |
| BEL | Belgium | High income |
| BGR | Bulgaria | Upper middle income |
| BRA | Brazil | Upper middle income |
| BRN | Brunei Darussalam | High income |
| CAN | Canada | High income |
| CHE | Switzerland | High income |
| CHL | Chile | High income |
| CHN | China | Upper middle income |
| COL | Colombia | Upper middle income |
| CRI | Costa Rica | Upper middle income |
| CYP | Cyprus[1] | High income |
| CZE | Czech Republic | High income |
| DEU | Germany | High income |
| DNK | Denmark | High income |
| ESP | Spain | High income |
| EST | Estonia | High income |
| FIN | Finland | High income |
| FRA | France | High income |
| GBR | United Kingdom | High income |
| GRC | Greece | High income |
| HKG | Hong Kong, China | High income |
| HRV | Croatia | High income |
| HUN | Hungary | High income |
| IDN | Indonesia | Upper middle income |
| IND | India | Lower middle income |
| IRL | Ireland | High income |
| ISL | Iceland | High income |
| ISR | Israel[2] | High income |
| ITA | Italy | High income |
| JPN | Japan | High income |
| KAZ | Kazakhstan | Upper middle income |
| KHM | Cambodia | Lower middle income |
| KOR | Korea | High income |
| LAO | Lao People's Democratic Republic | Lower middle income |
| LTU | Lithuania | High income |
| LUX | Luxembourg | High income |
| LVA | Latvia | High income |
| MAR | Morocco | Lower middle income |
| MEX | Mexico | Upper middle income |
| MLT | Malta | High income |
| MMR | Myanmar | Lower middle income |
| MYS | Malaysia | Upper middle income |
| NLD | Netherlands | High income |
| NOR | Norway | High income |
| NZL | New Zealand | High income |
| PER | Peru | Upper middle income |

| ISO 3 code | Country name | Country classification |
|---|---|---|
| PHL | Philippines | Lower middle income |
| POL | Poland | High income |
| PRT | Portugal | High income |
| RUS | Russia | Upper middle income |
| SAU | Saudi Arabia | High income |
| SGP | Singapore | High income |
| SVK | Slovakia | High income |
| SVN | Slovenia | High income |
| SWE | Sweden | High income |
| THA | Thailand | Upper middle income |
| TUN | Tunisia | Lower middle income |
| TUR | Türkiye | Upper middle income |
| TWN | Chinese Taipei | High income |
| USA | United States | High income |
| VNM | Viet Nam | Lower middle income |
| ZAF | South Africa | Upper middle income |

1. Note by the Republic of Türkiye: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the "Cyprus issue".
Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.
2. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
Source: World Bank country classification by income.

## USITC ITPD-E database

The United States International Trade Commission (USITC) International Trade and Production Database for Estimation (ITPD-E). The ITPD-E contains data on international and domestic trade for 243 jurisdictions, 170 sectors, and 17 years (Borchert et al., 2022[27]).

This allows to cover in the analysis here 29 low-income economies, 50 lower-middle income economies, 53 upper-middle income economies, and 66 high-income economies (Table A D.2). The sectors available in ITPD-E are matched to 33 sectors in 2-digit ISIC Rev. 4 level classification (Table A D.3).

The ITPD-E database uses a mirroring procedure for international trade flows to increase the coverage of information. Importer-reported values are primarily used for goods trade and exporter-reported values for services trade. Where data is available for gross value of production and total exports for a specific country-sector-time, domestic trade is calculated as this difference; in instances where this procedure results in negative domestic trade values, these observations are deleted (i.e. not replaced with anything). This leads to an unbalanced panel on the international trade data side; thus, a balanced international trade data panel is created in a first stage by first filling all missing values with 0. Then, to preserve 0 values only in cases where no bilateral trade occurred, a PPML estimation is employed with the trade value as dependant variable regressed against exporter-time, importer-time, and country-pair fixed effects. If a country does not export in a specific industry in a specific year, the corresponding zeroes would be captured by the country's exporter-time fixed effect. The corresponding pairs that were initially filled with 0 and have this indication for the exporter-year fixed effects would be kept, the rest of the filled 0 ones would be dropped. The PPML estimation is used here to flag 'unreal' versus 'real' zeroes that were manually filled in during the second stage and eliminate the 'unreal' filled in zeroes. This leads again to an unbalanced set on the international trade data side.

## Table A D.2. Economy coverage with the ITPD-E database

Economy groupings by income

| Income group | ISO3 country code |
|---|---|
| Low-income economies | AFG; BDI; BFA; CAF; COD; ERI; ETH; GIN; GMB; GNB; HTI; LBR; MDG; MLI; MOZ; MWI; NER; PRK; RWA; SDN; SLE; SOM; SSD; SYR; TCD; TGO; TJK; UGA; YEM |
| Lower middle-income economies | AGO; BEN; BGD; BOL; BTN; CIV; CMR; COG; COM; CPV; DJI; DZA; EGY; FSM; GHA; HND; IND; KEN; KGZ; KHM; KIR; LAO; LKA; LSO; MAR; MDA; MMR; MNG; MRT; NGA; NIC; NPL; PAK; PHL; PNG; PSE, SEN; SLB; SLV; STP; SWZ; TLS; TUN; TZA; UKR; UZB; VNM; VUT; ZMB; ZWE |
| Upper middle-income economies | ALB; ARG; ARM; AZE; BGR; BIH; BLR; BLZ; BRA; BWA; CHN; COL; CRI; CUB; DMA; DOM; ECU; FJI; GAB; GEO; GNQ; GRD; GTM; GUY; IDN; IRN; IRQ; JAM; JOR; KAZ; LBN; LBY; LCA; MDV; MEX; MHL; MKD; MNE; MYS; NAM; PER; PRY; RUS; SRB; SUR; THA; TKM; TON; TUR; TUV; VCT; VEN; WSM; ZAF |
| High-income economies | ABW; AND; ARE; ATG; AUS; AUT; BEL; BHR; BHS; BMU; BRB; BRN; CAN; CHE; CHL; CUW; CYM; CYP; CZE; DEU; DNK; ESP; EST; FIN; FRA; GBR; GRC; GRL; HKG; HRV; HUN; IRL; ISL; ISR; ITA; JPN; KNA; KOR; KWT; LIE; LTU; LUX; LVA; MLT; MUS; NLD; NOR; NZL; OMN; PAN; PLW; POL; PRI; PRT; QAT; ROU; SAU; SGP; SMR; SVK; SVN; SWE; SYC; TTO; TWN; URY; USA |

Note: Based on the World Bank country classification by income.
Source: USITC ITPD-E.

## Table A D.3. Sector coverage with the ITPD-E database

| ISIC sector code | ISIC sector name |
|---|---|
| D01T02 | Agriculture, hunting and forestry |
| D03 | Fishing and aquaculture |
| D05T09 | Mining and quarrying, energy production products<br>Mining and quarrying, non-energy production products<br>Mining support service activities |
| D10T12 | Food products, beverages and tobacco |
| D13T15 | Textiles, wearing apparel, leather and related products |
| D16 | Wood and products of wood and cork |
| D17T18 | Paper products and printing |
| D19 | Coke and refined petroleum products |
| D20 | Chemical and chemical products |
| D21 | Pharmaceuticals |
| D22 | Rubber and plastics products |
| D23 | Other non-metallic mineral products |
| D24 | Basic metals |
| D25 | Fabricated metal products |
| D26 | Computer, electronic and optical products |
| D27 | Electrical equipment |
| D28 | Machinery and equipment nec |
| D29 | Motor vehicles, trailers, and semi-trailers |
| D30 | Other transport equipment |
| D31T33 | Manufacturing nec; repair and installation of machinery and equipment |
| D41T43 | Construction |
| D45T47 | Wholesale and retail trade; repair of motor vehicles |
| D49D52 | Land transport<br>Water transport<br>Air transport<br>Warehousing and support activities for trans. |
| D58T60 | Publishing and broadcasting |
| D61TD63 | Telecommunications, computer, and information services |
| D64T66 | Financial and insurance activities |
| D77TD82 | Administrative and support services |
| D84 | Public administration and defense |
| D85 | Education |
| D86T88 | Human health and social work |
| D94T96 | Activities of households |

Note: Sectors in USITC ITPD-E are matched to ISIC Rev.4.
Source: USITC ITPD-E.

# Annex E. Supporting tables and figures

## Table A E.1. Impact of digital connectivity on trade costs by year (1995-2018)

| Independent variables | Trade costs | | (cont.) |
|---|---|---|---|
| Log of distance | 0.274*** | | |
| | -1020.59 | | |
| Log of minimum digital connectivity 1995 | 0.164*** | Border*Log of minimum digital connectivity 1995 | -0.0435*** |
| | -49.39 | | (-35.68) |
| Log of minimum digital connectivity 1996 | 0.0018 | Border*Log of minimum digital connectivity 1996 | -0.0594*** |
| | -0.56 | | (-47.85) |
| Log of minimum digital connectivity 1997 | -0.142*** | Border*Log of minimum digital connectivity 1997 | -0.0682*** |
| | (-45.68) | | (-55.10) |
| Log of minimum digital connectivity 1998 | -0.253*** | Border*Log of minimum digital connectivity 1998 | -0.0738*** |
| | (-87.18) | | (-55.68) |
| Log of minimum digital connectivity 1999 | -0.302*** | Border*Log of minimum digital connectivity 1999 | -0.0961*** |
| | (-111.95) | | (-66.82) |
| Log of minimum digital connectivity 2000 | -0.322*** | Border*Log of minimum digital connectivity 2000 | -0.0961*** |
| | (-125.54) | | (-60.97) |
| Log of minimum digital connectivity 2001 | -0.337*** | Border*Log of minimum digital connectivity 2001 | -0.101*** |
| | (-131.81) | | (-57.50) |
| Log of minimum digital connectivity 2002 | -0.337*** | Border*Log of minimum digital connectivity 2002 | -0.0979*** |
| | (-132.96) | | (-52.15) |
| Log of minimum digital connectivity 2003 | -0.331*** | Border*Log of minimum digital connectivity 2003 | -0.0756*** |
| | (-128.63) | | (-36.00) |
| Log of minimum digital connectivity 2004 | -0.328*** | Border*Log of minimum digital connectivity 2004 | -0.0780*** |
| | (-123.73) | | (-34.66) |
| Log of minimum digital connectivity 2005 | -0.322*** | Border*Log of minimum digital connectivity 2005 | -0.0733*** |
| | (-119.25) | | (-30.92) |
| Log of minimum digital connectivity 2006 | -0.315*** | Border*Log of minimum digital connectivity 2006 | -0.0681*** |
| | (-111.93) | | (-26.65) |
| Log of minimum digital connectivity 2007 | -0.312*** | Border*Log of minimum digital connectivity 2007 | -0.0683*** |
| | (-105.67) | | (-25.00) |
| Log of minimum digital connectivity 2008 | -0.307*** | Border*Log of minimum digital connectivity 2008 | -0.0664*** |
| | (-97.67) | | (-22.33) |
| Log of minimum digital connectivity 2009 | -0.311*** | Border*Log of minimum digital connectivity 2009 | -0.0708*** |
| | (-92.48) | | (-22.00) |
| Log of minimum digital connectivity 2010 | -0.346*** | Border*Log of minimum digital connectivity 2010 | -0.109*** |
| | (-86.98) | | (-27.94) |
| Log of minimum digital connectivity 2011 | -0.348*** | Border*Log of minimum digital connectivity 2011 | -0.112*** |
| | (-77.24) | | (-24.84) |
| Log of minimum digital connectivity 2012 | -0.349*** | Border*Log of minimum digital connectivity 2012 | -0.115*** |
| | (-71.97) | | (-23.45) |
| Log of minimum digital connectivity 2013 | -0.340*** | Border*Log of minimum digital connectivity 2013 | -0.107*** |
| | (-67.78) | | (-21.16) |
| Log of minimum digital connectivity 2014 | -0.317*** | Border*Log of minimum digital connectivity 2014 | -0.0831*** |
| | (-56.44) | | (-14.57) |
| Log of minimum digital connectivity 2015 | -0.325*** | Border*Log of minimum digital connectivity 2015 | -0.0950*** |
| | (-51.11) | | (-14.63) |
| Log of minimum digital connectivity 2016 | -0.343*** | Border*Log of minimum digital connectivity 2016 | -0.117*** |

| Independent variables | Trade costs | | (cont.) |
|---|---|---|---|
| | (-47.33) | | (-15.82) |
| Log of minimum digital connectivity 2017 | -0.350*** | Border*Log of minimum digital connectivity 2017 | -0.127*** |
| | (-42.79) | | (-15.18) |
| Log of minimum digital connectivity 2018 | -0.354*** | Border*Log of minimum digital connectivity 2018 | -0.132*** |
| | (-37.67) | | (-13.77) |
| Regional trade agreement | 0.0172*** | Official common language | -0.0899*** |
| | -32.57 | | (-130.22) |
| Contiguity | -0.0397*** | Colony | -0.143*** |
| | (-44.25) | | (-146.40) |
| Constant | -2.012*** | N | 3 033 895 |
| | (-444.10) | R-sq | 0.587 |

Note: Overall impact on international trade costs identified as sum of digital connectivity variables by year.
Source: Own calculations using TiVA 2021 database.

## Table A E.2. Impact of digital connectivity on trade costs (1995-2018)

| | All | High income | Emerging | All | High income | Emerging |
|---|---|---|---|---|---|---|
| Log of distance | 0.278*** | 0.246*** | 0.334*** | 0.211*** | 0.216*** | 0.219*** |
| | (1043.5) | (742.97) | (675.08) | (773.86) | (639.26) | (428.98) |
| Domestic*digital connectivity | -0.307*** | -0.324*** | -0.385*** | | | |
| | (-502.79) | (-332.45) | (-276.87) | | | |
| Border*digital connectivity | -0.0869*** | -0.0740*** | -0.171*** | -0.0187*** | -0.0309*** | -0.0102*** |
| | (-198.28) | (-87.61) | (-172.20) | (-62.47) | (-51.43) | (-19.75) |
| RTA | 0.0355*** | -0.0258*** | 0.0560*** | -0.0480*** | -0.0709*** | -0.0577*** |
| | (69.05) | (-35.83) | (61.75) | (-95.35) | (-98.65) | (-67.65) |
| E-commerce chapter | -0.0456*** | -0.0604*** | -0.0679*** | -0.0645*** | -0.0641*** | -0.0862*** |
| | (-62.19) | (-75.18) | (-23.36) | (-93.13) | (-81.75) | (-32.99) |
| Border*contiguity | -0.0341*** | -0.113*** | 0.0661*** | -0.127*** | -0.153*** | -0.112*** |
| | (-37.91) | (-107.15) | (38.41) | (-147.62) | (-147.95) | (-70.02) |
| Border*common language | -0.0853*** | -0.0873*** | -0.0592*** | -0.114*** | -0.0948*** | -0.136*** |
| | (-123.28) | (-108.95) | (-44.89) | (-173.77) | (-121.19) | (-113.88) |
| Border*colony | -0.146*** | -0.127*** | -0.193*** | -0.150*** | -0.134*** | -0.157*** |
| | (-149.14) | (-118.58) | (-91.30) | (-162.13) | (-128.36) | (-82.64) |
| Border | | | | 1.311*** | 1.260*** | 1.472*** |
| | | | | (804.28) | (458.76) | (551.73) |
| _cons | -2.072*** | -1.742*** | -2.567*** | -2.950*** | -2.851*** | -3.274*** |
| | (-744.52) | (-430.68) | (-485.82) | (-1664.00) | (-1359.94) | (-925.57) |
| N | 3 032 550 | 2 066 733 | 964 576 | 3 032 550 | 2 066 733 | 964 576 |
| R-sq | 0.582 | 0.615 | 0.602 | 0.629 | 0.633 | 0.678 |

Note: Estimations use reporter-sector-year and partner-sector-year fixed effects. Digital connectivity defined as the minimum, across a dyad of the share of people connected to the Internet. Sample uses data from 1995 to 2018.
Source: Own calculations using TiVA 2021 database.

## Table A E.3. Impact of digital connectivity and digital trade regulation on trade costs (2014-2018)

| | All | High income | Emerging |
|---|---|---|---|
| Log of distance | 0.206*** | 0.215*** | 0.212*** |
| | -295.68 | -240.37 | -155.57 |
| Domestic*digital connectivity | -0.259*** | -0.263*** | -0.337*** |
| | (-66.29) | (-26.80) | (-47.31) |
| Border*digital connectivity | -0.0224*** | -0.0172* | -0.0366*** |
| | (-6.17) | (-1.76) | (-5.76) |
| Border*Average DSTRI | 1.461*** | 0.464*** | 0.937*** |
| | -69.06 | -9.96 | -28.38 |
| RTA | -0.0322*** | -0.0700*** | -0.0127*** |
| | (-20.29) | (-27.98) | (-4.54) |
| E-commerce chapter | -0.0147*** | -0.0368*** | 0.0334*** |
| | (-9.01) | (-19.64) | -7.16 |
| RTA depth | -0.00239*** | -0.00103*** | -0.00441*** |
| | (-32.33) | (-9.86) | (-24.80) |
| Contiguity | -0.133*** | -0.138*** | -0.150*** |
| | (-66.90) | (-57.86) | (-40.58) |
| Common language | -0.108*** | -0.0951*** | -0.128*** |
| | (-69.19) | (-50.86) | (-43.61) |
| Colony | -0.137*** | -0.114*** | -0.188*** |
| | (-62.08) | (-45.81) | (-39.74) |
| Constant | -1.792*** | -1.664*** | -1.858*** |
| | (-100.35) | (-38.78) | (-60.29) |
| | | | |
| N | 541 407 | 373 329 | 1 67 983 |
| R-sq | 0.642 | 0.643 | 0.701 |

Note: Estimations use reporter-sector-year and partner-sector-year fixed effects. Digital connectivity defined as the minimum, across a dyad of the share of people connected to the Internet.
Source: Own calculations using TiVA 2021 database.

## Table A E.4. Impact of digital connectivity on trade using TiVA database (1995-2018)

| | All | High income | Emerging |
|---|---|---|---|
| Log of distance | -1.141*** | -0.915*** | -1.867*** |
| | (-237.51) | (-186.17) | (-250.26) |
| Domestic*digital connectivity | 2.126*** | 2.654*** | 2.102*** |
| | -155.17 | -112.5 | -84.49 |
| Border*digital connectivity | 1.551*** | 2.006*** | 1.636*** |
| | -120.24 | -88.79 | -69.47 |
| RTA | -0.841*** | -0.935*** | -0.0629*** |
| | (-58.87) | (-50.04) | (-3.45) |
| E-commerce Chapter | 0.155*** | 0.106*** | -0.286*** |
| | -11.11 | -8.58 | (-8.23) |
| RTA Depth | 0.379*** | 0.352*** | 0.423*** |
| | -20.24 | -17.57 | -16.45 |
| Contiguity | -0.606*** | -0.118*** | -0.984*** |
| | (-40.00) | (-8.22) | (-55.97) |
| Common language | 0.162*** | 0.0794*** | 0.335*** |
| | -10.8 | -6.04 | -16.52 |
| Colony | 0.214*** | 0.115*** | 0.352*** |
| | -16.95 | -8.28 | -15.21 |
| Constant | 11.22*** | 7.139*** | 18.07*** |
| | -157.27 | -65.13 | -157.77 |
| | | | |
| N | 4 509 707 | 2 891 873 | 1 572 965 |

Note: Estimated using ppml and reporter-sector-year and partner-sector-year fixed effects. Digital connectivity defined as the minimum, across a dyad of the share of people connected to the Internet.
Source: Own calculations using TiVA 2021 database.

## Table A E.5. Impact of digital connectivity on trade using ITPD-E database (1995-2019)

| | All | Low and lower-middle income | Upper-middle income |
|---|---|---|---|
| Log of distance | -0,994*** | -2,060*** | -1,432*** |
| | (0,008) | (0,010) | (0,013) |
| Domestic*digital connectivity | 1,452*** | 1,257*** | 1,363*** |
| | (0,014) | (0,028) | (0,031) |
| Border*digital connectivity | 0,864*** | 0,853*** | 0,814*** |
| | (0,012) | (0,026) | (0,031) |
| RTA | -0,198*** | -0,468*** | 0,368*** |
| | (0,010) | (0,019) | (0,018) |
| Contiguity | -0,002 | -0,631*** | -0,171*** |
| | (0,014) | (0,030) | (0,022) |
| Common language | 0,524*** | -0,154*** | -0,005 |
| | (0,013) | (0,022) | (0,033) |
| Colony | 0,439*** | 1,003*** | 0,892*** |
| | (0,022) | (0,031) | (0,039) |
| Constant | 12,650*** | 21,146*** | 17,059*** |
| | (0,094) | (0,115) | (0,156) |
| | | | |
| N | 22 552 467 | 7 113 853 | 5 451 652 |
| R-sq | 0.959 | 0.971 | 0.977 |

Note: Estimations using ppml and reporter-sector-year and partner-sector-year fixed effects. Digital connectivity defined as the minimum, across a dyad of the share of people connected to the Internet.
Source: Own calculations using ITPD-E database.

## Table A E.6. Impact of digital connectivity on trade by sector (1995-2018)

| | All | Agriculture and food | Services | Manufacturing | ICT goods | ICT services | Digitally-deliverable services |
|---|---|---|---|---|---|---|---|
| Log of distance | -1.141*** | -1.426*** | -1.015*** | -1.141*** | -0.789*** | -1.032*** | -0.906*** |
| | (-237.51) | (-124.00) | (-184.10) | (-175.49) | (-61.63) | (-66.12) | (-86.10) |
| Domestic*digital connectivity | 2.126*** | 2.206*** | 1.706*** | 2.787*** | 1.035*** | 2.660*** | 3.165*** |
| | -155.17 | -73.44 | -119.73 | -138.25 | -33.58 | -64.95 | -107.5 |
| Border*digital connectivity | 1.551*** | 1.712*** | 1.261*** | 2.129*** | 0.744*** | 1.960*** | 2.465*** |
| | -120.24 | -59.8 | -93.52 | -107.9 | -25.87 | -50.16 | -87.97 |
| RTA | -0.841*** | -1.105*** | -0.806*** | -1.206*** | -0.334*** | -1.114*** | -1.318*** |
| | (-58.87) | (-37.67) | (-58.87) | (-64.91) | (-10.09) | (-19.38) | (-32.13) |
| E-commerce chapter | 0.155*** | 0.553*** | 0.164*** | 0.189*** | -0.121*** | 0.197*** | 0.121*** |
| | -11.11 | -15.51 | -10.41 | -9.35 | (-3.20) | -5.06 | -4.28 |
| RTA depth | 0.379*** | 0.625*** | 0.794*** | 0.503*** | 0.333*** | 0.768*** | 0.805*** |
| | -20.24 | -15.14 | -42.71 | -19.82 | -7.7 | -10.75 | -16.71 |
| Contiguity | -0.606*** | -0.843*** | -0.246*** | -0.898*** | -0.121*** | -1.147*** | -1.086*** |
| | (-40.00) | (-21.85) | (-14.35) | (-38.05) | (-2.88) | (-23.04) | (-33.13) |
| Common language | 0.162*** | 0.0258 | 0.108*** | 0.401*** | 0.305*** | 0.620*** | 0.695*** |
| | -10.8 | -0.74 | -6.84 | -20.68 | -8.23 | -14.9 | -28.45 |
| Colony | 0.214*** | 0.392*** | 0.276*** | 0.128*** | -0.0526 | -0.0314 | 0.193*** |
| | -16.95 | -11.58 | -17.83 | -7.06 | (-1.53) | (-0.84) | -7.01 |
| Constant | 11.22*** | 13.36*** | 11.56*** | 8.762*** | 12.45*** | 7.558*** | 5.689*** |
| | -157.27 | -88.69 | -154.56 | -87.97 | -74.96 | -34.24 | -35.84 |
| | | | | | | | |
| N | 4 509 707 | 302 108 | 1 412 263 | 2 202 032 | 202 642 | 202 642 | 405 284 |

Note: Estimated using ppml and reporter-sector-year and partner-sector-year fixed effects. Digital connectivity defined as the minimum, across a dyad of the share of people connected to the Internet.
Source: Own calculations using TiVA 2021 database.

## Table A E.7. Impact of digitalisation and e-commerce chapters in RTAs on trade

| | All | High income | Emerging | All | High income | Emerging |
|---|---|---|---|---|---|---|
| Log of minimum bilateral digital connectivity | 0.172*** | 0.0701*** | 0.285*** | 0.171*** | 0.0592*** | 0.284*** |
| | (16.55) | (4.09) | (13.63) | (16.45) | (3.43) | (13.67) |
| EU | 0.346*** | 0.343*** | 0.701*** | 0.320*** | 0.159*** | 0.807*** |
| | -15.63 | -16.13 | -10.71 | -5.38 | -4.44 | -10.39 |
| No e-commerce RTA | 0.0635*** | 0.0404** | 0.197*** | 0.0508 | -0.0572*** | 0.236*** |
| | -4.28 | -2.35 | -10.02 | -1.59 | (-2.59) | -9.43 |
| RTA with an e-commerce provision | 0.0969*** | 0.0983*** | 0.156*** | 0.0805* | -0.0201 | 0.224*** |
| | -3.83 | -4.51 | -3.09 | -1.72 | (-0.71) | -4.29 |
| Depth of RTA | | | | 0.00089 | 0.00617*** | -0.00381*** |
| | | | | -0.46 | -6.2 | (-3.29) |
| Constant | 10.85*** | 11.24*** | 10.59*** | 10.86*** | 11.29*** | 10.59*** |
| | -287.47 | -168.67 | -164.8 | -286.82 | -168.08 | -165.82 |
| N | 4 650 388 | 3 007 349 | 1 597 170 | 4 650 388 | 3 007 349 | 1 597 170 |

Note: Results from a gravity model for the period 1995-2018 using ppml and reporter-partner, reporter-sector-year and partner-sector-year fixed effects.
Source: Own calculations using TiVA 2021 database.

## Table A E.8. Impact of digital connectivity and digital trade policies on trade (2014-18)

| | All | Agriculture | Manufacturing | ICT goods | ICT services | DD Services | Other services |
|---|---|---|---|---|---|---|---|
| Log of distance | -1.437*** | -1.452*** | -1.140*** | -0.971*** | -1.416*** | -1.246*** | -1.551*** |
| | (-128.08) | (-102.52) | (-162.23) | (-48.36) | (-72.65) | (-90.22) | (-126.40) |
| Minimum digital connectivity | 0.218*** | 0.432*** | 0.360*** | 0.749*** | 0.337 | 0.530*** | 0.275*** |
| | (4.98) | (3.57) | (8.08) | (7.61) | (1.39) | (4.39) | (2.95) |
| Border*digital STRI of reporter | -8.964*** | -10.16*** | -7.784*** | -3.067*** | -9.482*** | -13.28*** | -11.21*** |
| | (-40.48) | (-40.70) | (-60.30) | (-11.59) | (-19.47) | (-50.84) | (-39.97) |
| RTA | -1.012*** | -0.779*** | -0.356*** | -0.186*** | -1.024*** | -1.183*** | -1.445*** |
| | (-65.68) | (-22.67) | (-21.17) | (-4.49) | (-21.10) | (-38.28) | (-51.48) |
| Contiguity | -0.816*** | -0.525*** | -0.138*** | -0.171** | -1.797*** | -1.815*** | -1.003*** |
| | (-19.09) | (-7.47) | (-4.20) | (-2.28) | (-10.11) | (-14.53) | (-10.60) |
| Common language | -0.736*** | -0.914*** | -0.441*** | 0.0135 | -0.001 | 0.242*** | -0.897*** |
| | (-15.34) | (-7.04) | (-8.37) | -0.21 | (-0.01) | -3.76 | (-9.50) |
| Colony | -0.294*** | -0.0779 | -0.183*** | -0.403*** | -0.551*** | -0.493*** | -0.552*** |
| | (-9.61) | (-0.84) | (-5.22) | (-4.86) | (-5.83) | (-7.59) | (-10.16) |
| Constant | 20.60*** | 20.10*** | 17.67*** | 14.94*** | 19.12*** | 18.17*** | 21.19*** |
| | -102.65 | -40.23 | -92.58 | -31.88 | -18.38 | -33.32 | -53.23 |
| N | 822 984 | 55 250 | 257 984 | 37 050 | 37 050 | 74 100 | 290 375 |

Note: Estimated using ppml and reporter-sector-year and partner-sector-year fixed effects. Digital connectivity defined as the minimum, across a dyad of the share of people connected to the Internet.
Source: Own calculations using TiVA 2021 database.

## Table A E.9. Coefficient of domestic DSTRI across countries at different levels of development, trade flows

| | All | Agriculture | Manufacturing | ICT goods | ICT services | DD Services | Other services |
|---|---|---|---|---|---|---|---|
| High-income | -9.920*** | -9.900*** | -8.830*** | -5.153*** | -9.554*** | -13.34*** | -10.28*** |
| | (-49.64) | (-30.19) | (-44.45) | (-10.80) | (-8.60) | (-38.12) | (-33.04) |
| Emerging | -15.82*** | -14.31*** | -11.82*** | -10.47*** | -15.15*** | -17.73*** | -17.52*** |
| | (-51.71) | (-16.55) | (-31.84) | (-19.72) | (-17.83) | (-23.66) | (-31.06) |

Note: Reporter-sector-year and partner-sector-year fixed effects used throughout.
Source: Own calculations using TiVA 2021 database.

## Table A E.10. Impact of different barriers on trade (2014-18)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Log of distance | -1.437*** | -1.774*** | -1.461*** | -1.783*** | -1.131*** | -1.720*** |
| | (-128.08) | (-216.54) | (-179.31) | (-251.13) | (-86.95) | (-233.01) |
| Minimum digital connectivity | 0.218*** | 2.246*** | 0.863*** | 1.612*** | 0.297*** | 1.388*** |
| | -4.98 | -37.11 | -18.06 | -20.62 | -5.76 | -22.23 |
| Domestic digital STRI | -8.964*** | | | | | |
| | (-40.48) | | | | | |
| RTA | -1.012*** | -1.263*** | -1.083*** | -1.196*** | -0.343*** | -1.191*** |
| | (-65.68) | (-64.61) | (-69.44) | (-67.42) | (-17.37) | (-68.25) |
| Contiguity | -0.816*** | -1.398*** | -0.842*** | -1.391*** | -0.585*** | -1.270*** |
| | (-19.09) | (-32.46) | (-20.62) | (-33.10) | (-14.36) | (-30.38) |
| Common language | -0.736*** | -0.450*** | -0.674*** | -0.537*** | -0.529*** | -0.619*** |
| | (-15.34) | (-9.46) | (-13.90) | (-11.12) | (-12.07) | (-12.87) |
| Colony | -0.294*** | -0.264*** | -0.316*** | -0.159*** | -0.0257 | -0.221*** |
| | (-9.61) | (-8.22) | (-10.07) | (-5.13) | (-0.86) | (-7.13) |
| DSTRI - IPR | | -34.62*** | | | | |
| | | (-21.79) | | | | |
| DSTRI - Infrastructure | | | -13.61*** | | | |
| | | | (-60.62) | | | |
| DSTRI - ePayments | | | | -30.84*** | | |
| | | | | (-25.58) | | |
| DSTRI - eTransactions | | | | | -83.60*** | |
| | | | | | (-66.54) | |
| DSTRI - Other measures | | | | | | -22.78*** |
| | | | | | | (-28.04) |
| Constant | 20.60*** | 14.12*** | 18.02*** | 16.86*** | 18.34*** | 17.42*** |
| | -102.65 | -53.52 | -78.72 | -49.33 | -76.26 | -63.01 |
| N | 822 984 | 822 984 | 822 984 | 822 984 | 822 984 | 822 984 |

Note: Reporter-sector-year and partner-sector-year fixed effects used throughout.
Source: Own calculations using TiVA 2021 database.

## OECD TRADE POLICY PAPERS

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