Data-Intensive Services in GVCs: The Role of Trade Agreements

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Abstract:

In a context of slowing globalisation with a decline in the ratio of trade in goods over GDP since the Great Recession, the ratio of trade in services over GDP is growing, with trade in data-intensive services particularly dynamic. Moreover, countries' exports are increasingly incorporating foreign data-intensive services. Simultaneously, a growing number of new trade agreements have included data-related provisions since the beginning of the new century. Using data from the Trade Agreement Provisions on Electronic-commerce and Data and OECD's Trade in Value Added databases, we estimate a gravity model to examine the impact of data-related commitments in trade agreements on digital-based globalisation and participation in global value chains. Our results show that deep trade agreements with data-dedicated provisions are facilitating data-intensive services flows, although the effects are asymmetric depending on the type of data-dedicated provisions, the data-intensive services and the country blocs included in the agreement.

Keywords: data-intensive services, global value chains, deep trade agreements, data-related provisions, gravity model.

1. Introduction

Trade globalisation in recent decades has been inextricably linked to the digitalisation processes that are emerging in all stages of the production chain, in both manufacturing and services (National Board of Trade, 2014). This has encouraged flows of digital services, which have expanded more rapidly than those of goods or any other type of services since the Great Recession of 2008 (van der Marel, 2021). The dynamism of trade in digital services is also seen in a growing incorporation of foreign digital services into countries' exports, suggesting a new channel for expansion of global value chains (GVCs) (Blázquez et al., 2023). Therefore, globalisation and GVC participation are now definitely more digital-based. In this context, firms of all sizes and sectors increasingly rely on data-intensive services for monitoring production systems or supply chains, managing global workforces and supporting products (National Board of Trade, 2014). Data flows and, specifically, cross-border data flows are particularly relevant for the proper functioning of GVCs, which require higher levels of coordination and information flows than any other production process.

There is no doubt that the use of data analytics in all sectors has streamlined business practices and increased efficiency, innovation, knowledge diffusion and economic growth (Castro and McQuinn, 2015; OECD, 2015). However, the transfer of massive amounts of data between companies and countries, in most cases without the knowledge or consent of the data subject, is prompting a growing number of countries concerned about the personal privacy of their citizens and even national security to draw up or revise data transfer regulations. Most countries recognise the need to strike a balance between business interests and user privacy. Among many others, the main barriers to digital commerce include impediments to the free flow of data across borders and the requirements to store data locally. These regulations end up affecting trade (Casalini and López-González, 2019) and particularly GVCs as they can have an impact on trade in goods, goods that incorporate services, services that incorporate other services, and digital enabled services (López-González and Ferencz, 2018). In this sense, it is important to bear in mind that the regulation of digital trade refers not only to goods or services that are provided digitally but also the data that are embedded in the different stages of the production cycle, from marketing, design, production, the product itself, distribution and after-sales services (Elsig and Klotz, 2021).

The growing difficulty of balancing efficiency and privacy as commerce becomes more digital is the main reason why, through the World Trade Organization (WTO) and plurilateral and bilateral trade agreements, countries have been endowed with provisions for international data flows. The aim is to provide countries with a basis for simple and safe cross-border data transfers since data regulations vary significantly across different countries. While progress in drawing up global data

rules at the WTO is very slow, it is within the framework of preferential trade agreements (PTAs) that these provisions on data flows are being developed most operationally (Elsig and Klotz, 2021; Wu, 2017). The scope of these agreements is very heterogeneous, and as a consequence, there is a wide variety of them. Agreements may include provisions that affect data protection or provisions that affect the flow of data between countries, or both. In turn, provisions that affect cross-border data flows may refer specifically to e-commerce trade or may be broader or refer to other types of flows beyond e-commerce trade, or both. Furthermore, the provisions of the agreements may refer specifically to certain data-intensive services. These many possibilities will result in the signing of more or less in-depth agreements, with depth understood as the number of provisions they include and the degree to which the signatories are obliged to comply with them. In addition, the positions in relation to data regulation that countries are unilaterally adopting vary widely, but in this diversity of data rules, it is possible to identify three models globally, each represented by a benchmark economy (van der Marel, 2021; Chen, 2021). There are countries such as the United States that are committed to more relaxed regulation. Others, such as China and other illiberal regimes, are more in line with high protection or restriction of data flows. Finally, there is the European Union, which is in an intermediate position with a model based on conditional transfers with safeguards in place. It is very likely that these positions will influence the content and depth of data-related provisions in the trade agreements in which countries engage. Hence, countries will tend to ensure their standards regarding data protection and cross-border data flows in the content of trade agreements signed with other countries. This is true especially when dealing with countries that belong to blocs with different strategic economic interests in a context of escalating geopolitical tensions and a scenario in which data has become the new oil.

Thus, this paper examines the effect of deep Preferential Trade Agreements (PTAs) with data-dedicated provisions on trade in data-intensive services embedded in GVCs. To do so, we first focus on the growth of trade flows associated with different data-intensive services within GVCs and the increasing number of trade agreements between diverse countries that include different data-dedicated provisions. Then, we estimate a structural gravity model to measure the impact of these agreements on cross-border flows of data-intensive services in GVCs, disentangling their heterogeneous effects depending on the type of data-intensive services, the depth of the commitment of the agreement relative to the data rules and the countries involved.

The paper is embedded within an extensive body of literature on the effects of trade agreements on bilateral trade flows, and more specifically, on the impact of the depth of the agreements on services trade flows. These studies have benefited from new databases that collect information on the

content of trade agreements, which is key to examining which type of provisions are more important for increasing trade flows. Among them are the World Bank Deep Trade Agreements 2.0 (WB-DTA) dataset, the Design of Trade Agreements (DESTA) dataset (Dür et al., 2014) and the Trade Agreements Provision on Electronic-commerce and Data (TAPED) dataset (Burri and Polanco, 2020). As the proliferation of PTAs that cover services trade has coincided with the emergence of GVC-related trade and advances in digital technology (Borchert and Di Ubaldo, 2021), a strand of the literature has focused on the effects of deep trade agreements with services provisions on GVC-related trade (Rubinová, 2017; Lee, 2019; Borchert and Di Ubaldo, 2021; Díaz-Mora et al., 2022). All these works find a positive and statistically significant impact although only the last two specifically examine GVC-related trade in services. Moreover, since the release of the TAPED dataset, a few recent papers have analysed how trade agreements with provisions on digital trade and data affect trade in services. As services are increasingly delivered digitally, services trade is likely to be particularly affected by data policies (Spiezia and Tscheke, 2020). Suh and Roh (2022) find that trade agreements that contain digital trade-related provisions tend to increase bilateral gross trade flows in both all services and digital services (proxied by information, computer and telecommunication services), with an even stronger effect for deeper trade agreements (those with a higher number of articles related to digital trade).[1] Wu et al. (2023) also conducted an analysis of the relationship between digital trade rules in trade agreements and bilateral trade in services, but using both gross and value-added trade flows. These authors find that both the scope and the depth (proxied by the number of provisions) of digital trade rules significantly promote GVC-related trade in services. The impact is greater for value-added trade in intermediates than in final services and greater for forward than for backward movements of services exports. Their results also indicate that bilateral agreements with developed countries and smaller differences in regulatory quality between countries help to better promote GVC forward services exports.[2]

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[1]Suh and Roh (2022) also analyse the impact of unilateral domestic regulations recognised as digital trade barriers on digital trade flows and find a negative effect which is greater when the regulations are implemented by the importing as opposed to the exporting country.

[2]Although they do not specifically refer to the impact of trade agreements or GVC-related trade, two other papers can be cited. Spiezia and Tscheke (2020) identify a set of international agreements, instruments, conventions, regulations, guidelines and mechanisms that concern cross-border data flows and data protection (privacy) in particular. They also estimate a gravity model to examine their impact on gross trade flows, considering goods and services trade flows separately. Their findings show high heterogeneity in the effect depending on the agreement. Ferracane and van der Marel (2024) identify which of the three aforementioned models each of 143 countries adheres to. Using a gravity model, they find that sharing the open model has a positive impact on gross trade flows in digital services, whereas sharing the conditional model has a negative impact, although the latter is offset by the positive impact that results from sharing a comprehensive data protection law. They use four definitions of digital services sectors which range from narrower to broader in sectoral scope.

Our research contributes to this literature in two ways. First, we focus on a specific type of digital services such as data-intensive services and on a specific type of trade such as GVC-related trade, linking them to further dissect the effects of trade agreements on digital-based globalisation and GVC participation. Second, we build indicators that measure the depth of trade agreements, relying on data-related provisions and distinguishing between data protection and data flows provisions. In this way, we can capture heterogeneity in the impact of trade agreements depending on the depth of their commitments related to each of these two types of provisions. We also explore heterogeneity across data-intensive services and country blocs to determine which types of agreements and countries pairs most stimulate GVC-related trade in data-intensive services and thereby strengthen digital-based GVC participation.

The rest of the paper is structured as follows. After this introduction, Section 2 describes and discusses the data used and provides a descriptive analysis of the key variables of our model. Section 3 presents the specification of the econometric model. Section 4 offers the results of the empirical analysis, focusing on the impact of the entry in force of PTAs with data-dedicated provisions on flows of data-intensive services in GVCs. Section 5 concludes.

2. Data and main facts

### 2.1. Flows of data-intensive services in GVCs

In our analysis, we first need to define which sectors are data-intensive services. Many digital services are data intensive as their production processes employ a large amount of electronic data that cross borders multiple times before the service is used. From the OECD's Trade in Value Added (TiVA) database (2023 edition) and following van der Marel and Ferracane (2021) and Cory and Dascoli (2021), four industries are identified as data-intensive: *publishing, audio-visual and broadcasting activities* (code J58T60, which corresponds to 58, 59 and 60 ISIC Rev.4 Divisions), *telecommunications* (code J61), *IT and other information services* (code J62_63) and *financial and insurance activities* (code K, which corresponds to 64, 65 and 66 ISIC Rev. 4 Divisions).

We focus on flows of data-intensive services in GVCs. Specifically, we measure the foreign value-added (FVA) from data-intensive services that is embodied in the total gross exports of a destination country. To obtain a bilateral indicator, we disaggregate the value added by each source

country using the TiVA database, which offers statistical information on 76 countries (including all OECD, EU, G20 and ASEAN countries) for the period 1995 to 2020.[3]

To illustrate how flows of data-intensive services in GVCs have evolved in recent decades, Figure 1 shows the evolution of the share of FVA embodied in the world's total gross exports, disaggregating the FVA by source sector (total sectors, aggregate data-intensive sectors and each data-intensive service). While the share of total FVA increased just 13% from 2000 to 2020, the share of FVA from data-intensive services rose almost 50%. The most dynamic data-intensive service sector by far was IT services, which tripled its share in world gross exports. The strongest impulse to growth in these services came from 2013 onwards, once the international financial crisis was over. Far behind, but also much larger were publishing and audiovisual services (44%) and, more modestly, financial and insurance services (28%). By contrast, the share of FVA from telecom services declined by 20%. Therefore, data-intensive services (except for telecoms) have fuelled the globalisation of trade through their participation in GVCs in the last two decades.

Figure 1: Evolution of the share of foreign value added embodied in world gross exports, by source sector (Index number, 2000=100)
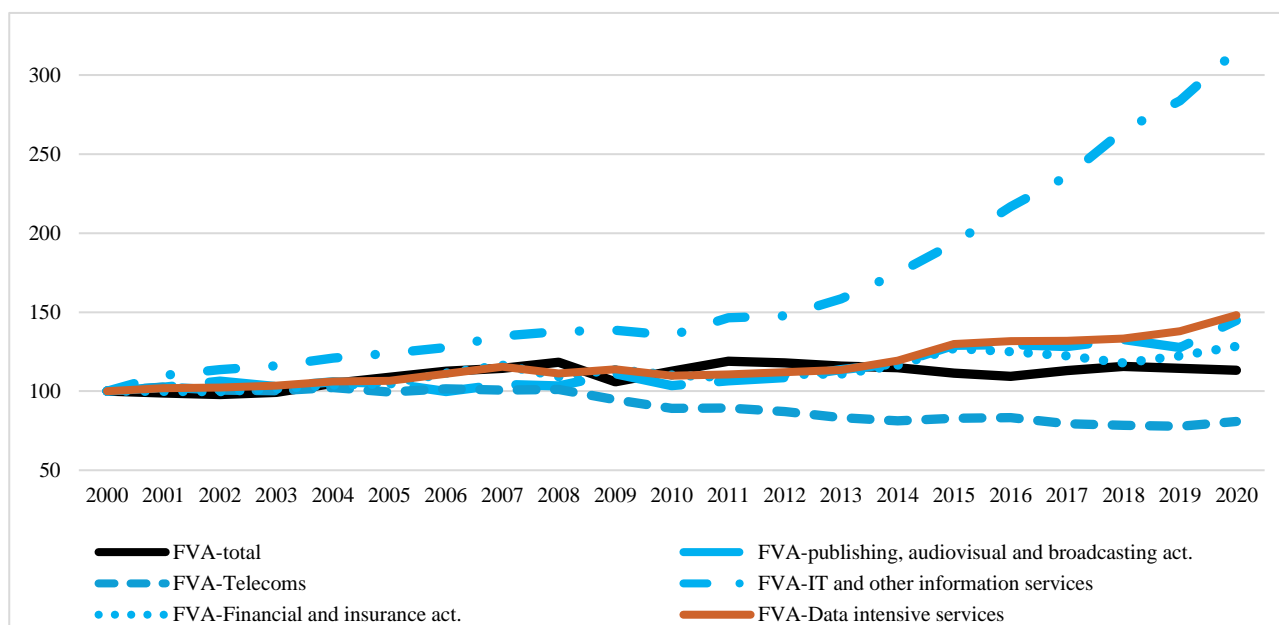
Source: Authors' calculation based on OECD-OMC TiVA Database 2023 edition.

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[3] The list of the countries is displayed in Table A.1 of the Statistical Appendix.

2.2. Preferential Trade Agreements with data-dedicated provisions

To define PTAs with data-dedicated provisions, we identify those provisions using the TAPED dataset.[4] Specifically, we select data-dedicated provisions that are related to data protection and cross-border data flows. The latter provisions can be in the e-commerce or digital trade chapter, they can be outside those chapters, or they can refer to a specific service chapter (audiovisual, telecommunications, computer and related services or financial services) (Table 1). The TAPED dataset includes an assessment of the extent of the legalisation of all coded provisions, distinguishing between 'soft' and 'hard' commitments (not enforceable and enforceable by another party, respectively). Of those included in Table 1, all are binding commitments except two which open the possibility to discuss a future provision or agreement on cross-border data flows. Only binding provisions (hard commitments) are included in the analysis.

Table 1. Data-dedicated provisions from TAPED dataset

DATA PROTECTION		
Does the agreement include provisions on data protection? [2.1.1]		
Does the agreement include provisions on data protection with no qualifications? [2.1.2]		
Does the agreement include provisions on data protection according to domestic law? [2.1.3]		
Does the agreement include provisions on data protection recognising certain key principles? [2.1.4]		
Does the agreement include provisions on data protection recognising certain international standards? [2.1.5]		
Does the agreement include provisions on data protection as a least restrictive measure? [2.1.6]		
FREE CROSS-BORDER DATA FLOWS		
In the e-commerce/digital trade	Outside the e-commerce /digital trade chapter	Reference to data flows in service chapters/provisions
Does the agreement include a provision on the free movement of data? [2.2.1; 2.3.1]		In the telecommunications chapter/provisions [2.4.1]
Does the agreement include a mechanism to address barriers to data flows? [2.2.2; 2.3.2]		In computer and related services chapter/provisions [2.4.2]
Does the agreement include a provision banning or limiting data localisation requirements? [2.2.3; 2.3.3]		In audiovisual services chapter/provisions [2.4.3]
Does the agreement contain a provision on a future discussion/provisions or agreement on the free flow of data? [2.2.4; 2.3.4]		In the financial services chapter/provisions [2.4.4]

Note: Item in Codebook TAPED in square brackets

Although the updated TAPED dataset offers information from 2000 to 2023, we focus on the period 2000-2020 since the last year of TiVA statistics (2023 edition) is 2020. During this period, 70

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[4] The dataset includes a detailed mapping and coding of all PTAs that cover chapters, provisions, annexes, and side documents that directly or indirectly regulate digital trade. Based on DESTA database, the latest version of TAPED (November 2023) covers more than 430 new PTAs agreed upon since the year 2000. A total of 124 different items were coded, including provisions on digital trade, intellectual property, key services sectors, government procurement, trade in goods, general and specific exceptions and new cross-cutting data economy issues. The dataset is used to describe how to classify the agreements according to their legal characteristics. Detailed information is available at https://www.unilu.ch/taped/.

of all the PTAs in force contain some data-dedicated provisions.[5] Figure 2 shows the evolution of the number of agreements which include data-dedicated provisions and the number of economies and country=pairs involved in such agreements. The former shows a year-on-year increase, with a very marked acceleration from 2009 onwards (see Table A2 in the Statistical Appendix). The latter also exhibits a drastic increase, exceeding 70 different economies involved in these agreements in the year 2020. The growing integration of economies in PTAs with data-dedicated provisions is also observed when we focus on the number of country pairs involved in these PTAs (green line in Figure 2). This number doubled between 2012 and 2014 and doubled again after that until 2020.

Figure 2. PTAs with data-dedicated provisions
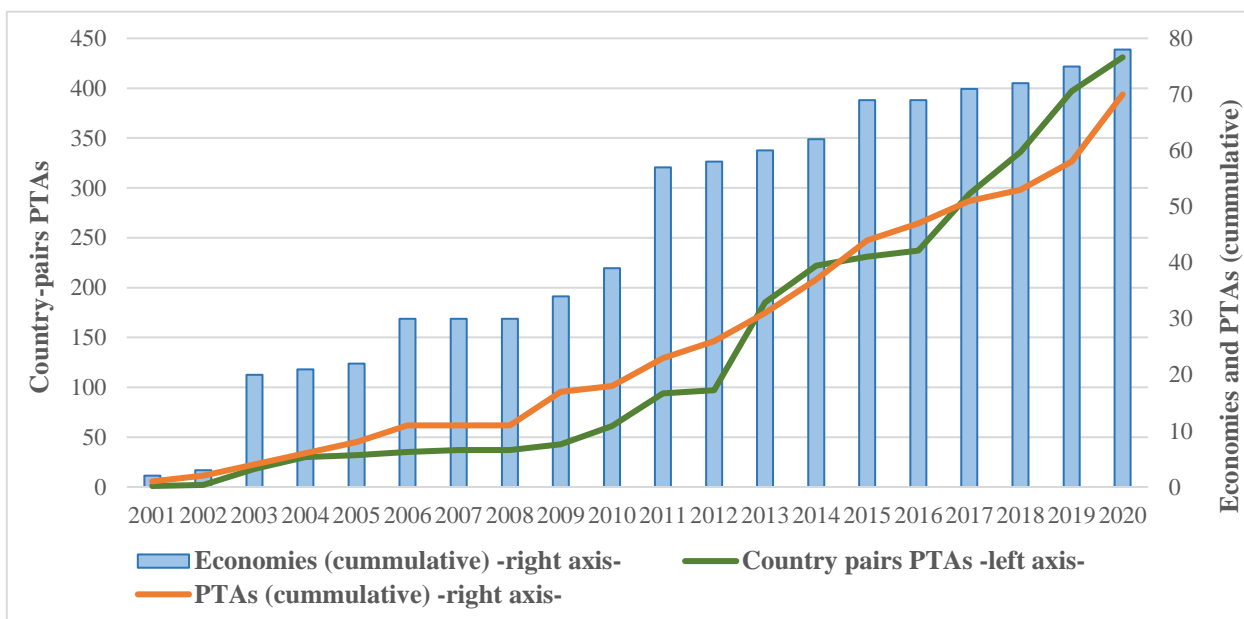
Source: Authors' calculation based on TAPED database.

By type of data-dedicated provision, around 70% of the PTAs contain provisions on data protection, and almost all of them contain at least one provision on free cross-border data flows. Around 70% contain a reference to data flows in the telecommunications and the financial services chapters, 36% in the audiovisual services chapter and 13% in the computer and related services chapter. By country pairs, the most frequent provisions are those which refer to data protection (Figure 3). Both types of provisions (data protection and free data flows) have experienced a robust increase, mainly since 2010. When considering country pairs involved in PTAs with a reference to data flows in service chapters/provisions, those in financial services chapters/provisions grew at a faster pace than the other three type of services in the last two decades, becoming the most frequent in 2020,

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[5] The list of PTAs with these specific data provisions is displayed in Table A.2 in the Statistical Appendix.

followed by those in telecom chapters/provisions. A much smaller but still significant–number of country pairs are involved in trade agreements with a reference to free data flows in computer and audiovisual services.

Figure 3: Number of country-pairs with data-dedicated provisions in PTAs (cumulative)
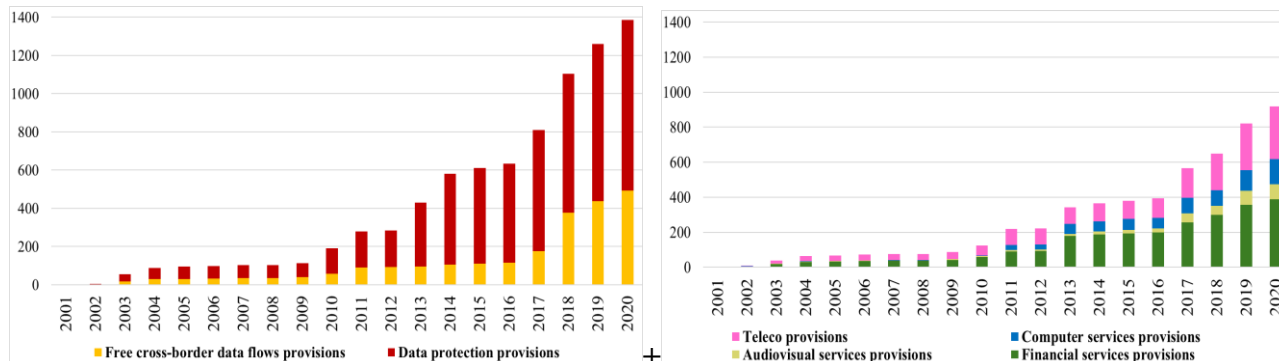
Source: Authors' calculation based on TAPED database.

Furthermore, we define the depth of each PTA using the information included in the agreement. As data protection and data flows provisions are highly correlated, their effect should be estimated separately, so we propose to measure the depth of PTA commitments related to each of the two groups of data-dedicated provisions. In addition, following Baccini et al. (2015), Dur et al. (2014), Orefice and Rocha (2014) and Elsig and Klotz (2021), we use two different measures to operationalise depth, each of which is built for the two types of provisions. The first measure of depth (Depth1) is an additive index that counts the different provisions related to data protection (six provisions) and those related to free data flows (12 provisions). The second measure of depth (Depth2) employs latent trait analysis[6] to treat highly correlated data on provisions and account for the fact that not all provisions are of equal importance in establishing the extent of countries' commitments. Specifically, we use the Rasch model, which assumes that all items capture one underlying latent dimension but with different discriminatory power. Consequently, the items contribute more or less to this latent dimension (that is, they have more or less discriminatory power).[7] Using this operationalisation, provisions that are relatively rare in PTAs contribute more to depth than provisions that are ubiquitous in PTAs (values range from 0 to 15.56 for data protection provisions and from 0 to 41.03 for free cross-border data flows provisions). To facilitate the comparison of results, both variables are normalised to take values between 0 and 1.

Therefore, we have four variables which capture the depth of PTAs: two to measure commitments related to data protection (Data_Protection_Depth1 and Data_Protection_ Depth2) and

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[6] Latent trait analysis is a type of factor analysis for binary data (Bartholomew et al., 2011).
[7] Figure A.1 in the Statistical Appendix illustrates the frequency of data-dedicated provisions in PTAs.

another two to measure commitments related to free cross-border data flows (Free_Data_Flows_Depth1 and Free_Data_Flows_ Depth2)[8]. These measures of depth clearly reveal that trade agreements differ in their commitments related to data-related provisions (Figure 4). For its part, the depth of PTA-commitments related to free data flows seems to have increased in recent years.

Figure 4. PTAs' depth in data-dedicated provisions over time

Source: Authors' calculation based on TAPED database.

To analyse the countries and regions involved in new PTAs with data-dedicated provisions in more detail, we will use tools from Social Network Analysis. Specifically, we draw the network of country pairs involved in these PTAs with each type of data-dedicated provision at two different moments of time: the agreements accumulated between 2001 and 2008 and those accumulated between 2001 and 2020 (Figure 5). In the networks built, the nodes are the signing countries of these PTAs, and the ties represent the existence of such agreements between countries. The thickness of the

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[8] Data protection depth and Free Data Flows depth variables are highly correlated with each other: r=0.89 for depth1 and r=0.93 for depth2.

tie represents the depth of the agreement measured by the number of data-dedicated provisions (Depth1). Within the networks, we have distinguished between countries which voted in favour of sanctions against Russia —UN General Assembly Resolution ES-11/3— and the remaining countries. This distinction is a way of proxying the difference between countries in terms of the sociopolitical values they share, which may influence their policy stance on data regulation. Countries that voted in favour of this resolution have been referred to as 'friendly countries', and those that voted against it as 'unfriendly countries' (Javorcik et al., 2024) (see Table A.1).

Figure 5: Country-pairs PTAs with data-dedicated provisions networks

Data protection networks	
2008	**2020**
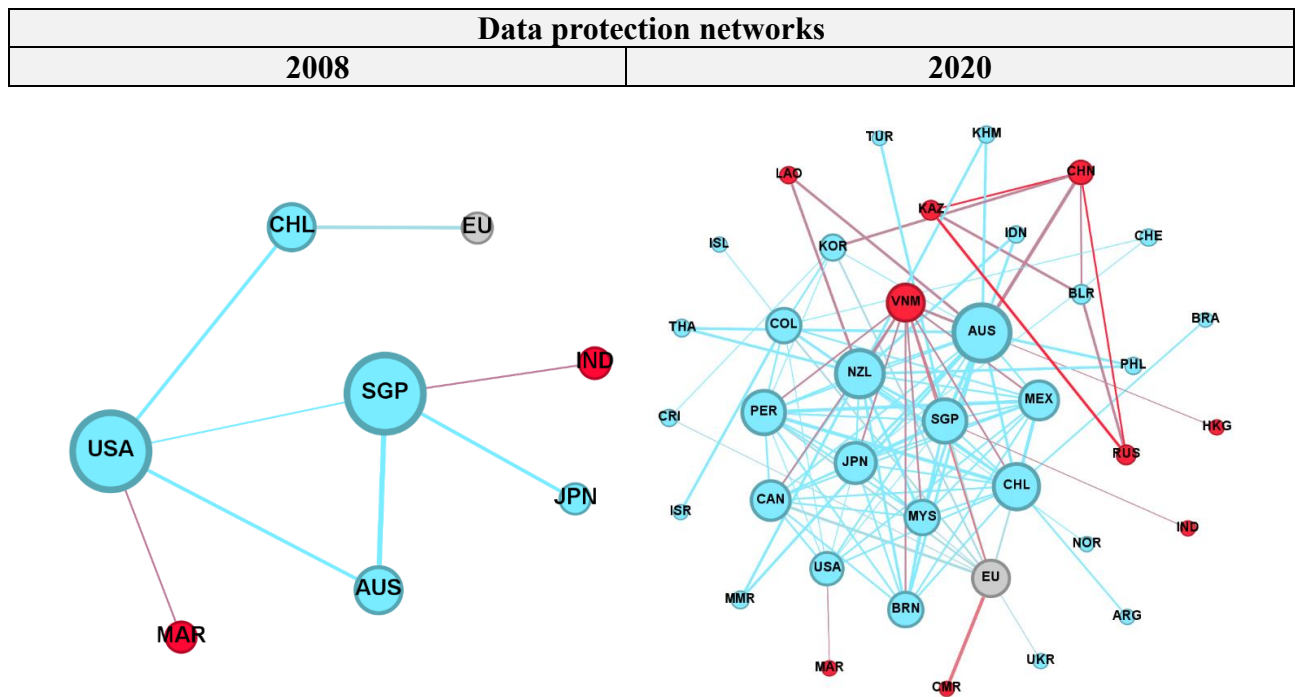
Free cross border data flows networks	
2008	**2020**
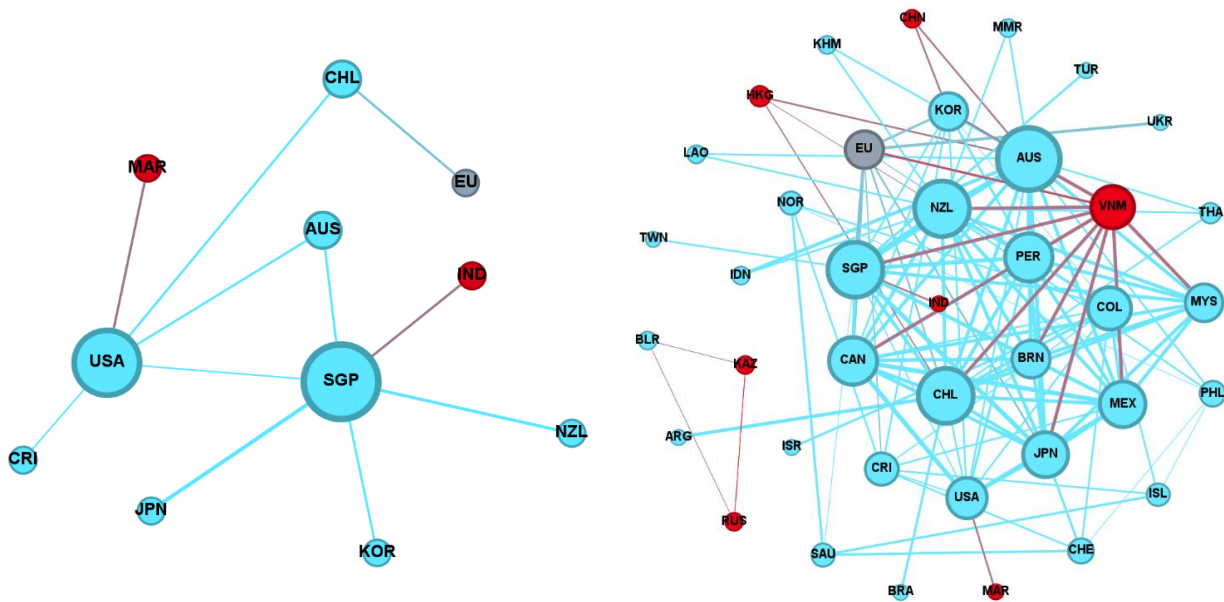
Note: The size of the nodes (countries) is related to their number of PTAs with data dedicated provisions (degree). The thickness of the tie represents the depth of agreement measured by the number of data-dedicated provisions. Nodes in blue refer to *Friend* countries and nodes in red refer to *Unfriend* countries. The EU countries as a bloc are represented in a single grey node.

Source: Authors' elaboration based on TAPED dataset and using the program package *Gephi 0.10*.

In the data protection network, we see very significant progress between 2008 and 2020. First, we moved from a network of eight countries to one involving 38 countries, and the number of agreements consequently increased from eight to 112. Additionally, by 2020, the average number of provisions included in the agreements was six, while in 2008, it was two. In 2008, Singapore and the United States were the countries that had signed the most agreements: four each. They were followed by Australia and Chile, which had signed two. Morocco, the European Union, India and Japan completed the network with one. Interestingly, of the eight countries, only two are considered unfriendly: Morocco and India. Morocco had signed an agreement with the United States, and India had signed one with Singapore; i.e., both had signed with friendly countries. Considering the number of provisions included in the agreements, the ranking is the same: the country that had included the highest number was Singapore, with an average of seven, followed by the United States, with six, and Australia and Chile, with five and four, respectively.

By 2020, Australia had signed the most data protection agreements: 20, followed by New Zealand with 16 and Chile with 15. It had also signed agreements with more than 10 countries: Peru and Singapore (14), Japan (13), Canada and Mexico (12), Vietnam and the European Union (11). As in 2008, if we consider the average number of provisions included in the agreements, the top positions

in the ranking coincide with countries that had signed the most agreements. Of the 38 countries in the data protection agreements network in 2020, 10 are considered unfriendly, and most of the agreements are between friendly countries or between unfriendly and friendly countries. Very few are between unfriendly countries.

Changes in the free cross-border data flow network between 2008 and 2020 were also very significant between 2008 and 2020. The structural dynamics and the countries that played a leading role were very similar to those of the data protection network. In 2008, only 11 countries had signed such agreements. By 2020, there were already 39. In addition, the average number of agreements per country also increased substantially, from two in 2008 to 6.7 in 2020. We also observe that the average number of provisions included in the agreements also expanded, from 6.2 in 2008 to 29.5 in 2020. Therefore, we have more countries involved in signing more agreements, and these agreements are getting progressively deeper.

In 2008, the countries included in this network were the same as in the data protection network, plus Korea, Costa Rica and New Zealand. Singapore and the United States were once again the countries that had signed the most agreements: six and five, respectively. India and Morocco were also the unfriendly countries in this network that signed free data flows agreements, along with the United States and Singapore. The other agreements were between friendly countries. In 2020, Australia, Chile, New Zealand and Singapore were the countries that had signed the most agreements: 20 in Australia and 17 in the other countries. These are also the countries whose agreements contained the most provisions. After these countries comes a group of countries —Canada, Peru, Japan, Mexico, Vietnam, Colombia and the United States— which has agreements with more than 10 others. In this group, there are countries that have included many provisions, and others, such as Colombia and the United States, that have included far fewer. Ten of the 39 countries in the network are considered unfriendly. Vietnam signed the most agreements (12), all of them with friendly countries, and Hong Kong, China, Laos, Morocco, India and Taiwan signed very few agreements, also with friendly countries. Therefore, for the free cross-border data flow network as well, most of the agreements were signed between friendly countries or between friendly and unfriendly countries.

3. Model specification

The gravity equation has been widely employed to explore the factors that influence international trade flows. Specifically, it is used to measure the impact of PTAs on bilateral trade flows. We propose to estimate a gravity model to examine the impact of trade agreements including

data-related provisions on bilateral flows of intermediate data-intensive services for the period 2000-2019. The year 2020 is excluded from the econometric analysis to prevent any change in data-intensive services due to the Covid19 -pandemic.

We estimate the gravity equation in its multiplicative rather than logarithmic form using the Poisson Pseudo Maximum Likelihood (PPML) estimator with three types of (high-dimensional) fixed effects (exporter time, importer time, and country pair). This approach proficiently handles both instances of zero trade flows and the presence of heteroscedasticity. Specifically, our econometric specifications take the following forms:

$$X_{ij,t}^k = \exp\big(\beta_0 EIA\_woEU_{ij,t} + \beta_1 EU_{ij,t} + \beta_2 WTO_{ij,t} + \beta_3 Data\_Protection\_Depth_{ij,t}^k +$$

$$\sum_t \beta_t INTER_{ij,t}^k + \mu_{ij}^k + \chi_{i,t}^k + \lambda_{j,t}^k\big) \times \epsilon_{ij,t}^k \tag{1}$$

$$X_{ij,t}^k = \exp\big(\beta_0 EIA\_woEU_{ij,t} + \beta_1 EU_{ij,t} + \beta_2 WTO_{ij,t} + \beta_3 Free\_Data\_Flows\_Depth_{ij,t}^k +$$

$$\sum_t \beta_t INTER_{ij,t}^k + \mu_{ij}^k + \chi_{i,t}^k + \lambda_{j,i}^k\big) \times \epsilon_{ij,t}^k \tag{2}$$

The dependent variable $X_{ij,t}^k$ is the value added from data-intensive services sector k (in levels) from country i (reporter) that is embodied in exports of country j (partner) at time t. The sectoral superscript (k) in our setting is used to denote each of the four data-intensive services sectors (publishing, audio-visual and broadcasting activities; telecommunications; IT and other information services; and financial and insurance activities). We estimate both the aggregate effects for total data-intensive services by pooling the four main sectors together in a single gravity specification and the effects for each specific data-intensive services sector. As already explained, the data come from the TiVA database (2023 edition). Moreover, as suggested by Yotov et al. (2016) and Yotov (2022), the dependent variable includes both international and intranational trade flows to avoid bias in the estimation of the effect of bilateral trade policies. Among other reasons, the inclusion of intranational flows is consistent with gravity theory given that there are both domestic and foreign varieties that consumers choose from. Here, intranational flows are captured by incorporating the domestic services value added embodied in a country's exports. Hence, firms can choose between domestic and foreign intermediate data-related services to be embodied in their production.

The set of explanatory variables includes our main variables of interest (Data_Protection_Depth1$_{ij,t}$, Data_Protection_Depth2$_{ij,t}$, Free_Data_Flows_Depth1$_{ij,t}$ and Free_Data_Flows_Depth2$_{ij,t}$) and other control variables. Moreover, a set of three-way fixed effects

and globalisation effects are added following the state-of-the-art recommendations for estimating gravity models (Yotov et al., 2016). We discuss them in detail.

EIA_woEU$_{ij,t}$ is a binary variable that equals 1 if the country pair ij (excluding EU countries) has any economic integration agreement in force at time t according to information the NSF-Kellogg Institute Database on Economic Integration Agreements. Otherwise it has a value of zero.[9] EU$_{ij,t}$ is a time-varying bilateral EU dummy variable that takes the value 1 if both countries are members of the EU at time t and zero otherwise. In line with other previous works (Baier et al. 2018; Díaz-Mora et al., 2022), we introduce the distinction between EU membership and other PTAs in our specifications. Since many studies have found that the GATT/WTO has had a trade promoting effect (among the most recent are Larch et al., 2019; Esteve et al., 2020; and Felbermayr et al., 2024), our specifications of the gravity equation include a GATT/WTO variable because omitting it might lead to an omitted variable bias. WTO$_{ij,t}$ is a binary variable that takes the value 1 when both countries i and j belong to the WTO.

Data_Protection_Depth1$_{ij,t}$, Data_Protection_Depth2$_{ij,t}$, Free_Data_Flows_Depth1$_{ij,t}$ and Free_Data_Flows_Depth2$_{ij,t}$ capture the depth of PTAs with both types of data-dedicated provisions between countries i and j at time t. As explained above, the data for these variables come from the TAPED dataset. Since countries that adopt a PTA with data-dedicated provisions often already have a trade agreement, when the model controls for previous agreements, these depth variables capture the additional effect of deeper agreements with data-dedicated provisions. In our empirical analysis, we estimate each of the two specifications twice, in one case including the additive index as the measure of the depth of the PTA (Depth1), and in the other, calculating the depth from the Rash model (Depth2).

In our gravity estimations with panel trade data, we incorporate pair fixed effects (μ^k_{ij}), which also vary per data-intensive sector, to address the potential endogeneity of the trade policy variable (Baier and Bergstrand, 2007) and to account for all time-invariant bilateral trade costs (Egger and Nigai, 2015; Agnosteva et al., 2014). Furthermore, Anderson and van Wincoop (2003) emphasise the importance of considering multilateral resistance terms to prevent biased outcomes in gravity estimations. To manage these unobservable multilateral resistances and possibly any other observable or unobservable characteristics that fluctuate over time for each source and destination country and each data-intensive sector, we integrate time-varying country-sector specific fixed effects into our gravity estimation framework with panel data (Olivero and Yotov, 2012). Specifically, $\pi^k_{i,t}$ represents

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[9] The data is available at https://kellogg.nd.edu/nsf-kellogg-institute-data-base-economic-integration-agreements.

a vector of source country-sector-time fixed effects, and $\chi^k_{j,t}$ is a vector of destination country-sector-time fixed effects.

Finally, following Bergstrand et al. (2015), we include common globalisation effects. These authors argue that traditional estimates of trade agreements and other policy variables using the gravity equation may be biased (overestimated) as they might be capturing common globalisation trends. To account for these trends, domestic trade flows are included in the gravity equation, and the effects of globalisation are captured by a vector of time-varying border dummy variables (INTER$_{ij,t}$) which take the value of 1 for international trade flows ($i{\neq}j$) and are equal to zero for domestic trade flows in each year ($i{=}j$). Following Larch et al. (2022), as the gravity sample is pooled across different data-intensive services, these border effects should add a sectoral dimension to control for sector-specific globalisation trends (INTER$^k_{ij,t}$). Therefore, these dummy variables control for improvements in transportation, communication, technology and so on that impact the international trade flows (relative to internal trade flows) of all countries in a given data-intensive sector. Finally, the standard errors in all specifications are clustered by country pair following Larch et al. (2022), who argue that, given the rich structure of fixed effects in each of our specifications, it is safe to assume that the error term (ε_{ijt}) is just noise.

In our empirical analysis, we obtain average effects of data-dedicated provisions in PTAs for total data-intensive services by pooling the four data-intensive services sectors together in a single gravity specification. That is, the β_3 estimated coefficients do not vary across data-intensive services sectors. In addition, using pooled estimators, we focus on differences in gravity estimates across the four data-intensive services sectors by allowing for underlying sectoral differences (β_3 estimated coefficients can vary across sectors). According to French (2019), unless heterogeneity is a primary concern, the pooled estimators are preferred to sector-by-sector estimators because of the relative parsimony, pragmatic usefulness, and other desirable properties of the former. Moreover, we explore heterogeneous effects by country blocs and the direction of flows (Friendly→Friendly, Friendly→Unfriendly, Unfriendly→Friendly, and Unfriendly→Unfriendly).

4.   Estimation results

4.1.   Baseline results

We present our empirical findings in Table 2 and Table 3. Table 2 reports average effects across the four data-intensive services sectors, which are obtained from estimating specifications (1) and (2) by pooling the four sectors together in each gravity specification. Table 3 displays the econometric

results when we allow for the effects of the PTA's depth to be heterogeneous across the depth of the data protection provisions of the PTA (Specification 1) and the second two for the depth of the provisions on free data flows in the PTA (Specification 2). In turn, Columns (1a) and (2a) report the estimation results using the additive index of depth (Depth1), and Columns (1b) and (2b) show the results using the Rasch model (Depth2).

Regarding the control variables, both EU and WTO membership show statistically significant positive coefficients in all regressions, which suggests an enhancing effect on bilateral flows of data-intensive services from country i to be embodied in exports of country j. The estimated increase is around 17% ([exp (0.016)-1]*100=17). Our estimates do not find a statistically significant impact of the remaining economic integration agreements.

All explanatory variables that capture the agreed commitments of PTA members in data-related rules exhibit positive and statistically significant coefficients. Once other economic integration agreements are controlled for, these variables capture the additional effect of the entry into force of trade agreements with data-dedicated provisions. A one-unit increase in the depth of PTA commitments related to data protection (using the additive index) is associated with an 8.7% increase in bilateral data-intensive services flows (Column 1a). The increase is 10.6% for PTA commitments related to free data flows (with the additive index) (Column 2a). Deeper PTAs with data provisions using the Rasch model (Data_Protection_Depth2 and Free_Data_Flows_ Depth2) also promote these trade flows, and the effect is greater (Columns 1b and 2b). Hence, our findings show that PTA commitments related to not only free movement of data but also data protection stimulate intermediate data-intensive services between partner countries. The latter is an interesting result that suggests that data protection provisions are not perceived as restrictive for this new form of globalisation. These results are in line with those of Ferracane and van der Marel (2024) who study whether the regulatory model that governs the cross-border transfer of personal data affects trade in digital services with data from the International Trade and Production Database for Estimation (Borchert et al., 2021). They find that country pairs that share an open model for cross-border data transfers exhibit higher digital services trade than those with regulatory models based on conditional transfers with safeguards in place and those based on government-controlled transfers. Moreover, their results suggest that data models that combine an open regime for cross-border data transfers with strong regulatory safeguards for domestic processing of personal data appear to be the most conducive to digital services trade.

Table 2. The impact of PTAs data-dedicated provisions on (pooled) data-intensive services in GVCs. PPML estimates.

VARIABLES	(1a)	(1b)	(2a)	(2b)
	Data Protection Provisions		**Free Data Flows Provisions**	
EIA_woEU	-0.0210	-0.0207	-0.0233	-0.0198
	(0.0209)	(0.0217)	(0.0221)	(0.0224)
EU	0.160***	0.160***	0.157***	0.161***
	(0.0375)	(0.0381)	(0.0386)	(0.0389)
WTO	0.167***	0.167***	0.166***	0.165***
	(0.0308)	(0.0308)	(0.0307)	(0.0307)
Data_Protection_Depth1	0.0831**			
	(0.0342)			
Data_Protection_Depth2		0.177***		
		(0.0644)		
Free_Data_Flows_Depth1			0.101***	
			(0.0352)	
Free_Data_Flows_Depth2				0.132***
				(0.0429)
Constant	8.645***	8.645***	8.647***	8.647***
	(0.0352)	(0.0353)	(0.0353)	(0.0353)
Observations	461480	461480	461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, $INTER^{k}ij,t$ dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

In the next step, we allow for the effects of the depth of the PTA to be heterogeneous across data-intensive services sectors by interacting the depth variables with services sector dummies. The PPML estimates, which are displayed in Table 3, show that the estimated coefficients are positive and statistically significant mostly for financial services. This positive effect results for both data protection (Columns 1a and 1b) and free data flow provisions (Columns 2a and 2b) and for both measures of depth (additive index and Rasch model). Again, the coefficients of depth using the Rasch model (Depth 2, Columns 1b and 2b) are higher than those from the additive index (Depth 1, Columns 1a and 2a). Only in the case of PTA commitments related to free data flows and measured by the Rasch model is the impact also positive and statistically significant for IT and other information services (Column 2b). The estimates of the variables that capture EU, WTO and other economic integration agreements are constrained to be common across data-intensive services sectors and, consequently, aggregate sector-specific estimates for these variables are obtained.

Table 3. The impact of PTAs data-related provisions on (each) data-intensive services in GVCs. PPML estimates.

VARIABLES	Data-intensive sector	(1a)	(1b)	(2a)	(2b)
		Data Protection Provisions		**Free Data Flows Provisions**	
		Depth1	**Depth2**	**Depth1**	**Depth2**
EIA_woEU		-0.0208	-0.0205	-0.0230	-0.0194
		(0.0211)	(0.0219)	(0.0222)	(0.0225)
EU		0.160***	0.159***	0.157***	0.161***
		(0.0376)	(0.0383)	(0.0386)	(0.0389)
WTO		0.167***	0.167***	0.166***	0.165***
		(0.0308)	(0.0308)	(0.0306)	(0.0306)
	#D_Publishing	0.00928	0.0332	-0.0427	0.0437
		(0.0542)	(0.119)	(0.0750)	(0.0989)
	#D_Telecoms	0.0178	0.0422	0.0559	0.0578
		(0.0441)	(0.0810)	(0.0502)	(0.0650)
Depth	#D_IT	0.0417	0.0564	0.110	0.151*
		(0.0743)	(0.171)	(0.0678)	(0.0779)
	#D_Financial	0.115**	0.248***	0.127**	0.149**
		(0.0467)	(0.0808)	(0.0509)	(0.0633)
Constant		8.645***	8.645***	8.647***	8.647***
		(0.0352)	(0.0353)	(0.0353)	(0.0353)
Observations		461480	461480	461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, $INTER^k_{ij,t}$ dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

As we explained in Section 2, PTA provisions on free movement of data can be included in the e-commerce or digital trade chapter, can be outside that chapter or can refer to a specific service chapter (audiovisual, telecommunications, computer and related services and financial services). In both depth indicators related to free data flows, provisions that refer to a specific service chapter are treated like any other provisions, so their impact on any type of data-intensive services sector is measured regardless of the data-intensive services they refer to. To try to capture the heterogeneous impact of provisions of free data flows depending on which service chapter or provisions are referred to, we modify the two measures of depth (the additive index and that of the Rash model) by excluding provisions that refer to a specific service chapter. Moreover, we create four dummy variables, one for each type of data-intensive service, that take the value 1 for data flow provisions that refer to each service chapter and 0 otherwise (Prov_Publishing, Prov_Telecom, Prov_IT, Prov_Financial).

We re-estimate the model specification (2) by interacting these modified depth variables with the dummy variable for data flow provisions that refer to each service chapter. In this way, we explore whether there are differences in the impact of free data provisions across the four data-intensive services sectors depending on which services sector chapter refers to those free data flows.

The results of these estimates are reported in Table 4. According to them, the positive impact of PTA depth related to free data flows on flows of each data-intensive service sector is more significant when the reference to free data flows is included in the corresponding service chapter (audio-visual, telecommunications, computer and related services or financial services). These positive and statistically significant estimated coefficients are found for all data-intensive services except the telecom sector. In the case of publishing and IT services, the impact of the commitment of PTAs in free data flows becomes positive and statistically significant. Therefore, our results suggest that the service chapter which the data flow provisions refer to matters.

Table 4. The impact of PTAs data-related provisions on each data-intensive services in GVCs, by type of service sector to which the provisions refer to. PPML estimates.

VARIABLES	Data-intensive sector	(1a)	(1b)
		Free Data Flows Provisions	
		Depth1	**Depth2**
EIA_woEU		-0.0128	-0.0015
		(0.0223)	(0.0228)
EU		0.169***	0.181***
		(0.0388)	(0.0393)
WTO		0.164***	0.163***
		(0.0306)	(0.0306)
	#Prov_Publishing#D_Publishing	0.252***	0.249***
		(0.0743)	(0.0729)
	#Prov_Telecoms#D_Telecoms	-0.0171	-0.0915
		(0.0512)	(0.0699)
(Modified) Depth	#Prov_IT#D_IT	0.312***	0.271**
		(0.110)	(0.120)
	#Prov_Financial#D_Financial	0.0859*	0.00665
		(0.0494)	(0.0698)
Constant		8.645***	8.641***
		(0.0353)	(0.0353)
Observations		461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

4.2.1 Heterogeneous effects by country groups and direction of trade flows.

Next, we investigate whether the impact of PTAs with data-related provisions on data-intensive services value added from a partner country is affected by the trading countries (whether they are friends or not) and the direction of trade flows.

First, we estimate specifications (1) and (2), pooling the four sectors together in each gravity specification. Table 5 reports the average effects across the four data-intensive services sectors. Our

results show heterogeneity in the impact of PTA depth in data-dedicated provisions across country blocs and direction of trade flows. Deeper PTAs between friendly and unfriendly countries seem to advance the incorporation of data-intensive services from friendly countries into unfriendly countries' exports. This happens for both types of data-dedicated provisions (data protection and free data flows) and both depth indicators (Depth 1 and Depth 2). Flows of data-intensive services between other blocs of countries are not significantly affected by PTA commitments related to data protection. That is, PTA commitments related to data protection are particularly relevant to boosting data-intensive services from friendly to unfriendly countries. These deeper PTAs related to data protection between friendly and unfriendly countries are the ASEAN-Australia-New Zealand FTA (2010), the Cameroon-EC Interim EPA (2014), the Australia-China FTA (2015), the China-Korea FTA (2015) and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (2018). Australia, New Zealand and developing Asian countries are the countries most frequently involved in those PTAs (Table A.2 and Figure 6). Moreover, PTA depth in free data flows provisions also encourages data-intensive services value added from unfriendly to friendly countries and, when the Depth2 indicator is used, between friendly countries. That is, deeper commitments to free data flows positively affect all country bloc flows except those between unfriendly countries.

Table 5. The impact of PTAs data-dedicated provisions on (pooled) data-intensive services in GVCs by country-blocs and by the direction of flows. PPML estimates.

VARIABLES	Trade direction	(1a)	(1b)	(2a)	(2b)
		Data Protection Provisions		Free Data Flows Provisions	
		Depth1	Depth2	Depth1	Depth2
EIA_wo_EU		-0.0193	-0.0182	-0.0202	-0.0194
		(0.0204)	(0.0213)	(0.0212)	(0.0217)
EU		0.161***	0.162***	0.160***	0.161***
		(0.0370)	(0.0377)	(0.0377)	(0.0382)
WTO		0.165***	0.165***	0.163***	0.162***
		(0.0307)	(0.0307)	(0.0306)	(0.0307)
Depth	Friend→Friend	0.0403	0.0782	0.0574	0.0926*
		(0.0371)	(0.0782)	(0.0382)	(0.0484)
	Friend→Unfriend	0.248**	0.382**	0.405**	0.457**
		(0.0973)	(0.148)	(0.159)	(0.210)
	Unfriend→Friend	0.0378	0.115	0.232*	0.446***
		(0.0499)	(0.105)	(0.130)	(0.168)
	Unfriend→Unfriend	0.0210	0.0448	-0.107	-0.0965
		(0.0624)	(0.0811)	(0.417)	(0.359)
Constant		8.647***	8.646***	8.649***	8.650***
		(0.0351)	(0.0351)	(0.0352)	(0.0352)
Observations		461480	461480	461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

Table 6 reports the estimates of the impact of the data-dedicated provisions of PTAs on each data-intensive service by country blocs and direction of flows. Positive and statistically significant effects of deeper agreements between friendly and unfriendly countries are found for telecommunications and financial services from friendly countries to be incorporated into unfriendly countries' exports. This result is found for deeper agreement commitments on both data protection and free data flows. For their part, deeper commitments related to free data flows boost financial services flows also in the opposite direction, specifically, financial services from unfriendly countries to be incorporated into friendly countries' exports, at least when the Depth2 indicator is used. The effect of deeper commitments related to free data flows is also positive for IT services between friendly countries. These deeper agreements in terms of free data flows are the SAFTA (Singapore-Australia FTA) Amendment Agreement (2017), the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (2018), the Argentina-Chile FTA (2019), the EU-Singapore FTA Agreement, the Investment Protection Agreement and Digital Trade Agreement (2019) and the Japan-Singapore FTA (2002), in which Singapore, Australia, Japan, Chile and the EU are the countries most frequently involved (Table A.2 and Figure 6). Unexpectedly, however, our results find that deeper PTAs related to both data protection and free data flows adversely affect flows of intermediate publishing services between unfriendly countries.

Table 6. The impact of PTAs data-dedicated provisions on each data-intensive services in GVCs, by country-blocs and by direction of flows. PPML estimates.

VARIABLES	Data-intensive sector	Trade direction	(1a)	(1b)	(2a)	(2b)
			Data Protection		Free Data Flows	
			Depth1	Depth2	Depth1	Depth2
EIA_woEU			-0.0195	-0.0184	-0.0198	-0.0190
			(0.0203)	(0.0211)	(0.0209)	(0.0216)
EU			0.160***	0.161***	0.160***	0.161***
			(0.0369)	(0.0376)	(0.0374)	(0.0381)
WTO			0.165***	0.165***	0.162***	0.162***
			(0.0307)	(0.0306)	(0.0305)	(0.0306)
Depth	#D_Publishing	Friend→Friend	0.0237	0.165	-0.0502	0.0421
			(0.0637)	(0.149)	(0.0813)	(0.105)
		Friend→Unfriend	0.0354	0.0682	0.188	0.294
			(0.132)	(0.202)	(0.222)	(0.286)
		Unfriend→Friend	-0.185	-0.488*	-0.480	-0.490
			(0.186)	(0.275)	(0.299)	(0.422)
		Unfriend→Unfriend	-0.202**	-0.284**	-1.129*	-0.961*
			(0.0964)	(0.128)	(0.637)	(0.547)
	#D_Telecoms	Friend→Friend	-0.0196	-0.0741	0.0215	0.0269
			(0.0499)	(0.117)	(0.0520)	(0.0690)
		Friend→Unfriend	0.199**	0.303**	0.389**	0.399*
			(0.0963)	(0.149)	(0.166)	(0.226)
		Unfriend→Friend	-0.107	-0.107	-0.0940	-0.0283
			(0.0825)	(0.151)	(0.193)	(0.303)

		Unfriend→Unfriend	0.0508	0.0596	0.410	0.346
			(0.0708)	(0.0961)	(0.466)	(0.401)
	#D_IT	Friend→Friend	0.0803	0.0837	0.113*	0.143*
			(0.0595)	(0.134)	(0.0625)	(0.0812)
		Friend→Unfriend	-0.156	-0.270	-0.236	0.0116
			(0.306)	(0.471)	(0.454)	(0.442)
		Unfriend→Friend	0.119	0.503	0.663	0.865
			(0.189)	(0.508)	(0.549)	(0.625)
		Unfriend→Unfriend	0.0777	0.0884	0.631	0.542
			(0.0716)	(0.0979)	(0.455)	(0.391)
	#D_Financial	Friend→Friend	0.0417	0.0908	0.0617	0.0910
			(0.0567)	(0.117)	(0.0561)	(0.0718)
		Friend→Unfriend	0.382***	0.593***	0.580***	0.571**
			(0.0718)	(0.110)	(0.185)	(0.290)
		Unfriend→Friend	0.0473	0.120	0.264	0.543***
			(0.0597)	(0.123)	(0.166)	(0.209)
		Unfriend→Unfriend	0.0203	0.0570	-0.314	-0.278
			(0.0912)	(0.117)	(0.599)	(0.515)
Constant			8.647***	8.646***	8.649***	8.650***
			(0.0350)	(0.0351)	(0.0351)	(0.0352)
Observations			461480	461480	461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, $INTER^k_{ij,t}$ dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2020.

As a last step, specification (2) is re-estimated to explore whether there are differences in the impact of free data provisions across the four data-intensive services sectors depending on which services sector chapter refers to those free data flows. These estimation results are displayed in Table 7. Estimates for PTAs between unfriendly countries cannot be obtained because there are no agreements that contain provisions in specific services chapters for any of the four types of data-intensive services. The absence of cases also occurs for other blocs of countries, which explains why coefficients cannot be estimated for those cases. Positive impacts similar to those in the previous table (Table 5) are found for IT services and financial services. That is, the sector to which the free data flows provisions refer does not change the impact of the provisions on those two data-intensive service flows. The results for telecom and publishing services do change. The coefficients for telecommunication services become non-significant regardless of the group of countries and direction of trade flows, and the coefficients for publishing services become statistically significant for flows between friendly countries and for value added from friendly countries to be incorporated into unfriendly countries' exports.

Table 7. The impact of PTAs data-related provisions on each data-intensive services in GVCs, by type of service sector to which the provisions refer to, by country-blocs and by direction of flows. PPML estimates.

VARIABLES	Data-intensive sector	Trade direction	(1a) Free Data Flows Depth1	(1b) Free Data Flows Depth2
EIA_woEU			-0.0117	-0.00149
			(0.0216)	(0.0228)
EU			0.170***	0.181***
			(0.0381)	(0.0393)
WTO			0.161***	0.162***
			(0.0305)	(0.0306)
Modified Depth	#Prov_Publishing#D_Publishing	Friend→Friend	0.234***	0.249***
			(0.0773)	(0.0729)
		Friend→Unfriend	1.444***	-
			(0.217)	
		Unfriend→Friend	-0.0813	-
			(0.322)	
	#Prov_Telecoms#D_Telecoms	Friend→Friend	-0.0389	-0.100
			(0.0558)	(0.0767)
		Friend→Unfriend	0.173	-0.0874
			(0.111)	(0.146)
		Unfriend→Friend	-0.0788	0.247
			(0.241)	(0.294)
	#Prov_IT#D_IT	Friend→Friend	0.311***	0.271**
			(0.110)	(0.120)
		Friend→Unfriend	-	-
		Unfriend→Friend	-	-
	#Prov_Financial#D_Financial	Friend→Friend	0.0214	0.00422
			(0.0562)	(0.0779)
		Friend→Unfriend	0.385*	-0.0958
			(0.209)	(0.119)
		Unfriend→Friend	0.392**	0.491**
			(0.179)	(0.195)
Constant			8.647***	8.642***
			(0.0350)	(0.0353)
Observations			461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and service sector, are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

To facilitate the comparison of previous estimation results from all regression models, we include the key findings in a single table (Table 8).

Table 8: Summary estimations results of the impact of PTAs data-dedicated provisions on data-intensive services in GVCs.

Depth	Data Protection Provisions	Free Data Flows Provisions	
		Regardless of which chapter provisions are included in	Referred to a specific service chapter
Pooled data-intensive services	+	+	
Friend-->Friend	n.s.	+	
Friend-->Unfriend	n.s.	+	
Unfriend-->Friend	+	+	
Unfriend-->Unfriend	n.s.	n.s.	
Each type of data-intensive services			
Publishing	n.s.	n.s.	+
Friend-->Friend	n.s.	n.s.	+
Friend-->Unfriend	n.s.	n.s.	+
Unfriend-->Friend	-	n.s.	
Unfriend-->Unfriend	-	-	
Telecoms	n.s.	n.s.	n.s.
Friend-->Friend	n.s.	n.s.	n.s.
Friend-->Unfriend	+	+	n.s.
Unfriend-->Friend	n.s.	n.s.	n.s.
Unfriend-->Unfriend	n.s.	n.s.	
IT	n.s.	+	+
Friend-->Friend	n.s.	+	+
Friend-->Unfriend	n.s.	n.s.	
Unfriend-->Friend	n.s.	n.s.	
Unfriend-->Unfriend	n.s.	n.s.	
Financial	+	+	+
Friend-->Friend	n.s.	n.s.	n.s.
Friend-->Unfriend	+	+	+
Unfriend-->Friend	n.s.	n.s.	+
Unfriend-->Unfriend	n.s.	n.s.	

Note: The sign of the coefficient is included for statistically significant coefficients when at least one of two depth measures obtain a statistically significant coefficient. n.s. denotes not significant.

Several robustness checks are performed. Considering that the dependent variable includes intra-EU trade flows, we introduce an EU-specific trend in the gravity equations to capture the long-term patterns prevalent among European countries. These patterns are likely a consequence of the ongoing process of economic integration within EU nations (Esteve-Pérez et al., 2020). The estimation results for the impact of the depth of trade agreements in relation to data protection and the free movement of data on cross-border flows of intermediate data-intensive services are strikingly similar, and the conclusions about the positive relationship between them remain consistent. The results are reported in the appendix (Tables A.3, A.5 and A.7). Additionally, in previous estimates, intra-EU flows are included, treating them like any other trade flows. It might be that costs associated with intra-EU trade flows are lower than those associated with extra-EU trade flows because the EU operates as a single common market with free movement of goods, capital and services, although the common market remains incomplete and fragmented (Letta, 2024). Therefore, we re-estimate the

model excluding intra-EU flows. The results, which are displayed in the appendix (Tables A.4, A.6 and A.8), confirm that the commitments of PTAs in terms of data protection and free data movement boost the incorporation of data-intensive services from partners into countries' exports.

5.   Concluding remarks

In this paper, we have estimated a gravity model to examine the effect of trade agreements with data-related provisions on trade flows of data-intensive services embodied in countries' gross exports for the period 2000-2019. The main reason is that, since the beginning of the new century, we have witnessed a proliferation of new trade agreements that include such provisions. These provisions are of a more comprehensive nature and refer specifically to data-intensive services such as financial services, IT services, computer and related services and audiovisual services. An increasing number of countries are involved in these trade agreements, which reflects deeper commitments regarding data protection and free data flows between PTA partners. Additionally, we observe that countries' exports increasingly incorporate foreign data-intensive services, particularly programming, consulting and other telecommunications and information services activities. This occurs in a context of declining foreign added value from goods incorporated into exports, which contrasts with the increase in foreign added value from services, particularly data-intensive services. This suggests a shift towards a more digital globalisation and a new channel of GVC participation through data-intensive services. Using data from the TAPED and OCDE's TiVA databases, our estimates show a positive impact of the depth of PTA commitments related to data on this new, digital channel of globalisation and participation in GVCs.

Specifically, we find evidence of a significant positive impact of PTAs with data-dedicated provisions (both data protection and free data flows) on boosting aggregate data-intensive services from partner countries to be incorporated into exports. Moreover, we find asymmetric effects by type of data-intensive service and by type of data-dedicated provision. Deeper PTA commitments to data protection encourage one specific type of data-intensive service flow such as financial services. When we focus on free data flow provisions, the positive effect of deeper PTAs is found not only for financial services but also for publishing and for IT services.

Our findings suggest that there is also heterogeneity in the impact of PTAs with data-dedicated provisions on data-intensive services flows across country blocs. Deeper trade agreements in terms of data protection foster mainly data-intensive services value added from friendly countries to be incorporated into unfriendly countries' exports. By type of data-intensive services, this positive effect

is found for telecoms and for financial services. The positive and statistically significant impact of PTA commitments related to free data flows is wider and extends to flows from unfriendly to friendly countries for financial services and flows between friendly countries for IT services and publishing services. This evidence of asymmetric effects by country groups is probably due to differences in countries' modes of GVC participation and comparative advantages in those data-intensive services.

Therefore, our research finds that PTAs with data-dedicated provisions are facilitating data-intensive services flows, although the effects are asymmetric depending on the type of data-dedicated provisions, the data-intensive services and the country blocs included in the trade agreements. It appears evident that these trade agreements present an opportunity for countries to enhance their involvement in GVCs by providing data-intensive services. This opportunity explains the heightened interest and active participation of these countries in signing these deep agreements with data-dedicated provisions in the last two decades. Indeed, in recent years, there has been an increase in the signing of bilateral agreements, specifically for digital issues. This aligns with recent changes in countries' trade policies regarding the adoption of new trade agreements whereby countries are shifting from plurilateralism to bilateralism and from broad agreements to mini-deals on specific issues (Cernat, 2023). However, because of their very recent adoption, we cannot evaluate the impact of specific digital agreements on flows of data-intensive services.

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Statistical Appendix

Table A.1. Countries included in the sample.

Friend countries	Australia (AUS), Austria (AUT), Belgium (BEL), Brazil (BRA), Brunei Darussalam (BRN), Canada (CAN), Switzerland (CHE), Côte d'Ivoire (CIV), Colombia (COL), Costa Rica (CRI), Chile (CHL), Cyprus(CYP), Czech Republic (CZE), Germany (DEU), Denmark (DNK), Egypt (EGY), Spain (ESP), Estonia (EST), Finland (FIN), France (FRA), United Kingdom (GBR), Greece (GRC), Croatia (HRV), Hungary (HUN), Indonesia (IDN), Ireland (IRL), Iceland (ISL), Israel (ISR), Italy (ITA), Jordan (JOR), Japan (JPN), Cambodia (KHM), Korea (KOR), Lithuania (LTU), Latvia (LVA), Luxembourg (LUX), Mexico (MEX), Malta (MLT), Myanmar (MMR), Malaysia (MYS), Nigeria (NGA), Netherlands (NLD), Norway (NOR), New Zealand (NZL), Peru (PER), Philippines (PHL), Poland (POL), Portugal (PRT), Romania (ROU), Saudi Arabia (SAU), Singapore (SGP), Slovakia(SVK), Slovenia(SVN), Sweden(SWE), Thailand (THA), Tunisia (TUN), Turkey (TUR), Ukraine (UKR), USA (USA).
Unfriend countries	Bangladesh (BGD), Belarus (BLR), China (CHN), Chinese Taipei (TWN), Cameroon (CMR), Hong Kong SAR (HKG), India (IND), Kazakhstan (KAZ), Lao (LAO), Morocco (MAR), Pakistan (PAK), Russian Federation (RUS), Senegal (SEL), Viet Nam (VNM), South Africa (ZAF).

Note: The blocs are based on the UN General Assembly Resolution ES-11/1 (https://digitallibrary.un.org/record/3959039). Countries who voted "yes" are in bloc "Friend countries" and rest of the counties are in bloc "Unfriend countries".

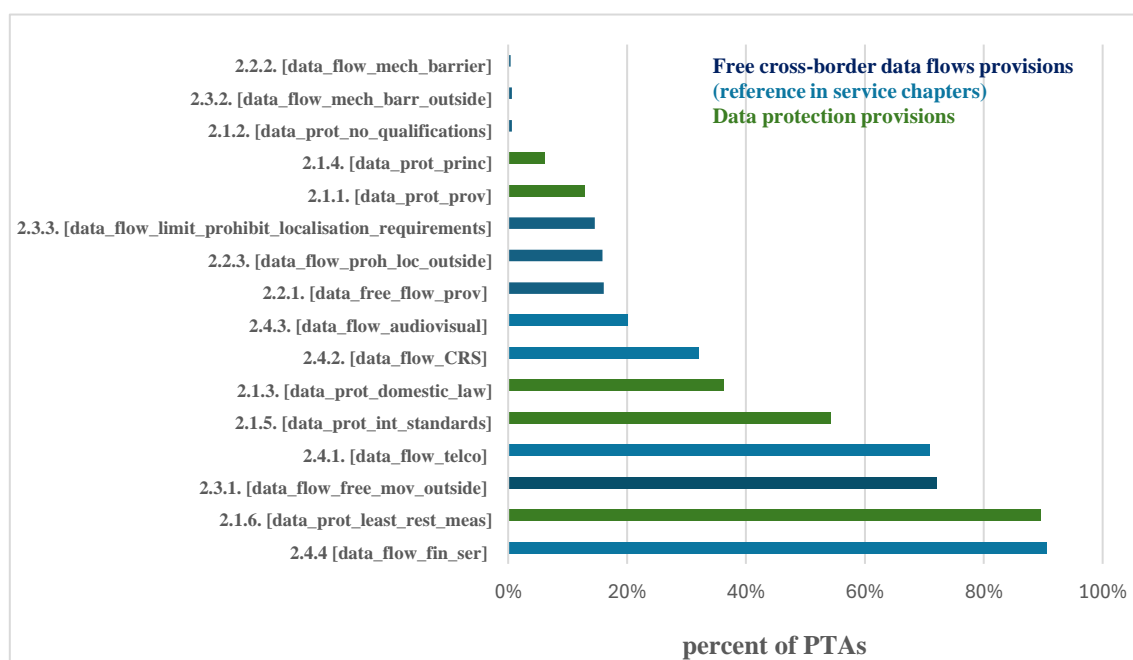## Table A.2. PTA´s with data-dedicated provisions by country-blocs

SORT TITLE	Year in force	Country-blocs
New Zealand Singapore Closer Economic Partnership (CEPA)	2001	Friend-Friend
Japan Singapore FTA	2002	Friend-Friend
Singapore Australia FTA (SAFTA)	2003	Friend-Friend
Chile EC Association Agreement	2003	Friend-Friend
Chile US FTA	2004	Friend-Friend
Singapore US FTA	2004	Friend-Friend
Australia US FTA	2005	Friend-Friend
India Singapore ECA	2005	Friend-Unfriend
Central American Free Trade Agreement (CAFTA), or Dominican Republic U.S. (DR-CAFTA)	2006	Friend-Friend
Korea Singapore FTA	2006	Friend-Friend
Morocco US FTA	2006	Friend- Unfriend
Australia Chile FTA	2009	Friend-Friend
Canada Peru FTA	2009	Friend-Friend
Chile Colombia FTA	2009	Friend-Friend
Japan Switzerland FTA	2009	Friend-Friend
Peru Singapore FTA	2009	Friend-Friend
Peru US FTA	2009	Friend-Friend
ASEAN-Australia-New Zealand FTA (AANZFTA)	2010	Friend- Unfriend
Canada Colombia FTA	2011	Friend-Friend
Colombia EFTA FTA	2011	Friend-Friend
EC Korea FTA	2011	Friend-Friend
Hong Kong New Zealand FTA	2011	Friend- Unfriend
Korea Peru FTA	2011	Friend-Friend
Colombia US FTA	2012	Friend-Friend
Korea US FTA	2012	Friend-Friend
Mexico Peru EIA	2012	Friend-Friend
Australia Malaysia FTA	2013	Friend-Friend
Central America EU Association Agreement	2013	Friend-Friend
Central America Mexico FTA	2013	Friend-Friend
Colombia Perú Ecuador EU FTA	2013	Friend-Friend
GCC Singapore FTA	2013	Friend-Friend
Australia Korea FTA	2014	Friend-Friend
Cameroon-EC Interim EPA	2014	Friend- Unfriend
Central America EFTA FTA	2014	Friend-Friend
Chile Hong Kong FTA	2014	Friend- Unfriend
EFTA GCC FTA	2014	Friend-Friend
Singapore Taipei (Taiwan) FTA	2014	Friend- Unfriend
Australia China FTA	2015	Friend- Unfriend
Australia Japan FTA	2015	Friend-Friend
Canada Korea FTA	2015	Friend-Friend
Chile Thailand FTA	2015	Friend-Friend
China Korea FTA	2015	Friend- Unfriend
Eurasian Economic Union (EAEU)	2015	Unfriend-Unfriend
Korea Vietnam FTA	2015	Friend- Unfriend
Colombia Korea FTA	2016	Friend-Friend
Colombia Costa Rica FTA	2016	Friend-Friend
Pacific Alliance Additional Protocol (PAAP)	2016	Friend-Friend
SAFTA Amendment Agreement	2017	Friend-Friend
Canada EU (CETA)	2017	Friend-Friend
EC Ukraine Association Agreement	2017	Friend-Friend
Singapore Turkey FTA	2017	Friend-Friend
Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)	2018	Friend- Unfriend
EFTA Philippines FTA	2018	Friend-Friend
Argentina Chile FTA	2019	Friend-Friend
Central America Korea FTA	2019	Friend-Friend
China Eurasian Economic Union FTA	2019	Unfriend- Unfriend
EU-Japan Economic Partnership Agreement	2019	Friend-Friend
EU-Singapore FTA Agreement, Investment Protection Agreement and Digital Trade Agreement	2019	Friend-Friend
Australia Peru FTA	2020	Friend-Friend
Australia Singapore Digital Economy Agreement (ASDEA)	2020	Friend-Friend
Australia-Hong Kong FTA	2020	Friend- Unfriend
Australia-Indonesia CEPA	2020	Friend-Friend
Brazil Chile FTA	2020	Friend-Friend
Chile - New Zealand - Singapore Digital Economy Partnership Agreement (DEPA)	2020	Friend-Friend
Colombia Israel FTA	2020	Friend-Friend
EU-Vietnam Trade Agreement and Investment Protection Agreement	2020	Friend- Unfriend
First Protocol modifying the Additional Protocol of the Pacific Alliance Framework Agreement	2020	Friend-Friend
Japan US Digital Trade Agreement (DTA)	2020	Friend-Friend

Ukraine - UK FTA	2020	Friend-Friend
United States-Mexico-Canada Agreement (USMCA)	2020	Friend-Friend

Figure A.1. Operationalizing Rasch' depth

Table A.3 The impact of PTAs data-dedicated provisions on (pooled) data-intensive services in GVCs with UE-trend. PPML estimates

VARIABLES	(1a)	(1b)	(2a)	(2b)
	Data Protection Provisions		Free Data Flows Provisions	
EIA_woEU	-0.0173	-0.00856	-0.0195	-0.0185
	(0.0211)	(0.0227)	(0.0222)	(0.0219)
EU	0.216***	0.228***	0.213***	0.216***
	(0.0471)	(0.0481)	(0.0475)	(0.0478)
WTO	0.161***	0.158***	0.160***	0.162***
	(0.0309)	(0.0308)	(0.0308)	(0.0310)
EUtrend	-0.0065**	-0.0068**	-0.0065**	-0.0068**
	(0.0029)	(0.0029)	(0.0029)	(0.0029)
Data_Protection_Depth1	0.0759**			
	(0.0344)			
Data_Protection_Depth2		0.0673**		
		(0.0336)		
Free_Data_Flows_Depth1			0.0932***	
			(0.0346)	
Free_Data_Flows_Depth2				0.177***
				(0.0648)
Constant	8.658***	8.658***	8.660***	8.658***
	(0.0354)	(0.0355)	(0.0355)	(0.0355)
Observations	461480	461480	461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

Table A.4. The impact of PTAs data-dedicated provisions on (pooled) data-intensive services in GVCs without intra-EU trade flows. PPML estimates.

VARIABLES	(1a)	(1b)	(2a)	(2b)
	Data Protection Provisions		**Free Data Flows Provisions**	
EIA_woEU	0.0437*	0.0439*	0.0413	0.0462*
	(0.0249)	(0.0256)	(0.0260)	(0.0266)
WTO	0.196***	0.197***	0.195***	0.193***
	(0.0293)	(0.0294)	(0.0292)	(0.0292)
Data_Protection_Depth1	0.114***			
	(0.0356)			
Data_Protection_Depth2		0.253***		
		(0.0640)		
Free_Data_Flows_Depth1			0.136***	
			(0.0357)	
Free_Data_Flows_Depth2				0.177***
				(0.0435)
Constant	8.641***	8.639***	8.642***	8.644***
	(0.0295)	(0.0296)	(0.0294)	(0.0293)
Observations	410932	410932	410932	410932

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

Table A.5. The impact of PTAs data-related provisions on each data-intensive services in GVCs with EU-trend. PPML estimates.

VARIABLES	Data-intensive sector	(1a)	(1b)	(2a)	(2b)
		Data Protection Provisions		**Free Data Flows Provisions**	
		Depth1	Depth2	Depth1	Depth2
EIA_woEU		-0.0170	-0.0183	-0.0192	-0.0163
		(0.0213)	(0.0221)	(0.0223)	(0.0227)
EU		0.216***	0.216***	0.213***	0.217***
		(0.0473)	(0.0479)	(0.0476)	(0.0479)
WTO		0.161***	0.161***	0.160***	0.159***
		(0.0309)	(0.0310)	(0.0308)	(0.0308)
EUtrend		-0.0065**	-0.0068**	-0.0065**	-0.0066**
		(0.0029)	(0.0029)	(0.0029)	(0.0029)
Depth	#D_Publishing	0.00233	0.0344	-0.0469	0.0404
		(0.0540)	(0.119)	(0.0735)	(0.1000)
	#D_Telecoms	0.0119	0.0438	0.0488	0.0514
		(0.0436)	(0.0803)	(0.0494)	(0.0646)
	#D_IT	0.0296	0.0497	0.0972	0.140*
		(0.0731)	(0.169)	(0.0671)	(0.0781)
	#D_Financial	0.108**	0.248***	0.120**	0.143**
		(0.0471)	(0.0812)	(0.0506)	(0.0629)
Constant		8.658***	8.659***	8.660***	8.660***
		(0.0354)	(0.0354)	(0.0354)	(0.0355)
Observations		461480	461480	461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

Table A.6. The impact of PTAs data-related provisions on each data-intensive services in GVCs without intra -trade flows. PPML estimates.

VARIABLES	Data-intensive sector	(1a)	(1b)	(2a)	(2b)
		Data Protection Provisions		Free Data Flows Provisions	
		Depth1	Depth2	Depth1	Depth2
EIA_woEU		0.0439*	0.0440*	0.0416	0.0466*
		(0.0250)	(0.0257)	(0.0261)	(0.0266)
WTO		0.195***	0.196***	0.194***	0.193***
		(0.0293)	(0.0293)	(0.0291)	(0.0292)
Depth	#D_Publishing	0.0744*	0.152	0.0442	0.159*
		(0.0436)	(0.102)	(0.0632)	(0.0863)
	#D_Telecoms	0.0453	0.136*	0.0813	0.0914
		(0.0470)	(0.0811)	(0.0509)	(0.0667)
	#D_IT	0.0975	0.168	0.167***	0.222***
		(0.0653)	(0.155)	(0.0588)	(0.0726)
	#D_Financial	0.135***	0.307***	0.148***	0.177***
		(0.0503)	(0.0821)	(0.0539)	(0.0654)
Constant		8.641***	8.640***	8.642***	8.644***
		(0.0295)	(0.0295)	(0.0294)	(0.0293)
Observations		4109320	4109320	4109320	4109320

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

Table A.7. The impact of PTAs data-related provisions by services chapter on each data-intensive services in GVCs with EU-trend. PPML estimates

VARIABLES	Data-intensive sector	(1a)	(1b)
		Free Data Flows Provisions	
		Depth1	Depth2
EIA_woEU		-0.0105	0.0004
		(0.0225)	(0.0231)
EU		0.225***	0.238***
		(0.0481)	(0.0487)
WTO		0.158***	0.157***
		(0.0308)	(0.0308)
EUtrend		-0.0067**	-0.0068**
		(0.0029)	(0.0029)
(Modified) Depth	#Prov_Publishing#D_Publising	0.258***	0.261***
		(0.0746)	(0.0724)
	#Prov_Telecoms#D_Telecoms	-0.0168	-0.0808
		(0.0508)	(0.0699)
	#Prov_IT#D_IT	0.291***	0.280**
		(0.107)	(0.122)
	#Prov_Financial#D_Financial	0.0863*	0.0173
		(0.0498)	(0.0702)
Constant		8.658***	8.655***
		(0.0354)	(0.0355)
Observations		461480	461480

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, INTER^{k}ij,t dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.

Table A.8. The impact of PTAs data-related provisions by services chapter on each data-intensive services in GVCs without intra-EU trade flows. PPML estimates

VARIABLES	Data-intensive sector	(1a)	(1b)
		Free Data Flows Provisions	
		Depth1	Depth2
EIA_woEU		0.0560**	0.0714***
		(0.0263)	(0.0268)
WTO		0.191***	0.189***
		(0.0292)	(0.0292)
(Modified) Depth	#Prov_Publishing#D_Publising	0.348***	0.351***
		(0.0676)	(0.0661)
	#Prov_Telecoms#D_Telecoms	0.0374	-0.00788
		(0.0537)	(0.0703)
	#Prov_IT#D_IT	0.341***	0.356**
		(0.112)	(0.142)
	#Prov_Financial#D_Financial	0.119**	0.0560
		(0.0527)	(0.0746)
Constant		8.645***	8.647***
		(0.0294)	(0.0294)
Observations		410932	410932

Notes. The regressand is the value added from country i' data-related services embodied in country j' exports, measured by dyad-year. Robust standard errors, clustered by dyad and sector are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All regressions include country-sector-pair fixed effects, as well as exporter-sector-time and importer-sector-time fixed effects. To control for global trends in international trade, $INTER^k_{ij,t}$ dummies are also included. All fixed effects and globalization dummies are not reported for brevity. The sample includes annual data for consecutive years over the period 2000-2019.