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Bachelor Thesis

The effect of regulatory barriers on digital services trade

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Abstract

With the increase of global trade volume in digital services trade, the impact of policy measures in this area also garners more attention. By using a panel gravity model, this study examines the effect of domestic regulations implemented by countries on digital services trade. The measurement of digital trade barriers is based on the OECD DSTRI, bilateral digital services trade is approximated with data of ICT services trade. The analysis shows that regulatory barriers hinder digital services trade. More specifically, a significant negative impact is determined when the regulations are imposed in the importing country. Within the DSTRI, regulations on "Intellectual property rights" seem to hinder trade the most. The effect of barriers to digital trade is also composed for different continents. Domestic regulations on the importer side seem to have the most negative impact in bilateral services trade on countries in Africa and Europe.

Zusammenfassung

Mit der Zunahme des weltweiten Handelsvolumens im Bereich der digitalen Dienstleistungen wird auch den Auswirkungen politischer Maßnahmen in diesem Bereich mehr Aufmerksamkeit geschenkt. Mithilfe eines Panel-Gravitationsmodells werden daher in dieser Studie die Auswirkungen der von den Ländern eingeführten Regulierungen auf den Handel mit digitalen Dienstleistungen untersucht. Die Messung digitaler Handelshemmnisse basiert auf dem DSTRI der OECD, der bilaterale Handel von digitalen Dienstleistungen wird mit Daten aus dem ICT-Dienstleistungssektor approximiert. Die Analyse zeigt, dass regulatorische Barrieren den Handel von digitalen Dienstleistungen behindern. Insbesondere wird ein signifikanter negativer Einfluss festgestellt, wenn die Regulierungen im importierenden Land auferlegt werden. Innerhalb des DSTRI scheinen Vorschriften über "geistige Eigentumsrechte" den Handel am stärksten einzuschränken. Auch werden die Auswirkungen der Handelsbarrieren in verschiedenen Kontinente untersucht. Hier zeigt sich, dass Regulierungen auf der Seite des Importeurs den bilateralen Dienstleistungshandel von Ländern in Afrika und Europa am meisten beeinträchtigen.

Contents

List of Figures

List of Tables

Abbreviations

DSTRI	Digital Services TradeRrestrictiveness Index
STRI	Services Trade Restrictiveness Index
ITPD-E	International Trade and Production Database for Estimation
BaTiS	Balanced Trade in Services dataset
CEPII	Centre d'Études Prospectives et d'Informations Internationales
OECD	Organization for Economic Co-operation and Development
WTO	World Trade Organization
GATT	General Agreement on Tariffs and Trade
ECIPE	European Centre for International Political Economy
UNCTAD	United Nations Conference on Trade and Development
RTA	Regional Trade Agreement
ICT	Information, computer & telecommunication
GDP	Gross Domestic Product
OLS	Ordinary Least Squares
PPML	Poisson Pseudeo Maximum Likelihood

1 Introduction

Rapid technological developments have increased the scale, scope and speed of trade, allowing firms to bring their services to a greater number of digitally-connected customers across the globe. By facilitating payments, enabling collaboration and alternative funding mechanisms, it became easier for companies to grow internationally. This has led to a rise of international digitally enabled trade and especially digital service trade, due to an easier tradability of traditional services across borders and the emergence of new services that create value from data (Ferencz and Gonzales 2019). But the success of business models based on digital technologies is uneven. A small number of large, technologically powerful firms are associated with the perception that they operate in winner-takes-all markets, that it has inevitably linked the governance of digital technologies to national rivalries (Evenett and Fritz 2021). As a resulting action, governments around the world have responded with various policy interactions. Their aim is not only to facilitate trade in digital services, but also to address corresponding concerns such as protection of data, national security interests and others. Mostly, those regulatory barriers are said to be implemented to protect domestic markets, however, existing and emerging trade barriers risk reducing the benefits of digitization, holding back innovation and creating obstacles to the movement of digitally enabled services across borders (Unctad 2022).

Since 2014, the OECD has been trying to map and classify these trade barriers in a newly raised dataset on digital service trade restrictions, offering new possibilities for trade policy analysis in this specific field. The DSTRI is the extension of the services trade restrictiveness index (STRI) by adding a digital component. The aim of this index is to measure the restrictiveness of countries by collecting data on domestic regulations on digital services trade. In a quantitative approach, the DSTRI will be analyzed in a gravity model of trade to estimate the effect of digital trade barriers on digital service trade and if these barriers hinder digital trade indeed.

I begin with a brief overview of the existing literature (chapter 2). Then, in chapter 3, I present an overview of digital service trade and digital trade barriers. Subsequently, in chapter 4, the DSTRI and its composition is described in detail as our main focus of the analysis. In chapter 5, I explain the gravity model and the application of common tools in trade policy analysis. How the data were assembled and their main features is demonstrated in chapter 6. Chapter 7 presents the baseline specifications and further analysis. I will examine the effect of digital trade barriers and which of those hinder the most. Furthermore, a closer look will be taken on continental differences in effects of those barriers. For robustness checks, I will examine the impacts if GATT/WTO membership in chapter 8 and explain some limitations of the modeling. The paper finishes with a conclusion of the main findings of this study and gives an outlook on further possible research questions (chapter 9).

2 Literature Review

Mostly, empirical approaches using Gravity regressions on the effect of regulatory barriers have been made covering all services trade. Benz (2020) delivered a broad overview about the effects of the STRI on trade in services and found a robust negative relationship, although mentioning that it is beyond the scope of the paper to establish causality. In another empirical investigation, Nordas (2016) showed by analyzing the STRI heterogeneity index that on average a reduction in the regulatory heterogeneity by 0.05 points is associated with 2.5% higher services exports and that the impact is larger the lower the level of trade restricting regulation. These studies represent a negative effect of high barriers in all service trade, as I also expect to see for the DSTRI in digital services trade. This empirical approach will therefore be analog in some parts to empirical studies on the STRI and adds several additional components to the analysis.

As there is not yet a full set of data on digital service trade, the impact of the DSTRI seems to be quantitatively underinvestigated. Many studies so far in the area of digital trade policies have been done by Evenett (2021), publisher of the *Digital Policy Alert*[1]. His empirical studies are based on different datasets which use other classifications of digital trade policies than the OECD DSTRI (more on that in chapter 4.3).

3 Digital Services Trade

3.1 Trade Flows

Digital service trade is an emerging new type of trade activity whose importance has increased significantly in recent years. In the European Union, the ICT services sector expanded by 27,5% between 2014 and 2019 according to Eurostat (2019), underlining the accelerating growth. Complementary, Niebel (2018) found a positive correlation between ICT capital and GDP growth for developed as well as emerging and developing countries. Governments should therefore have a strong interest in expanding their ICT trade and encourage investment in this sector. However, the distribution of online service providers is very fragmented as shown in a study by Alaveras (2015), who pointed out that very few countries have a very large share of the world's ICT services trade. But digital trade is a great opportunity also especially for developing countries. Unctad (2022) highlighted that digital service trade can become an important catalyst for those, especially after the economically difficult post-covid years.

To approximate ICT service trade I use OECD-WTO Balanced Trade in Services (BaTiS) dataset. It follows the EBOPS 2010 classification, includes 202 countries over the period 2005-2019 and claims to cover over 88% of world trade in services (Fortanier et al. 2017). Bilateral trade is displayed here in three different transactional values: the official reported values by the countries, the reported values with estimates and final balanced values. In this study, I focus mainly on the reported values, as the literature recommends, since estimated parameters as dependent variables can lead to a significant and substantial change in the results (Saxonhouse 1976). Consequently, a major issue with this dataset is the large number of missing values. In my approach using 75 countries, we get 25686 out of 33750 missing reported values which make up 76,1%. The

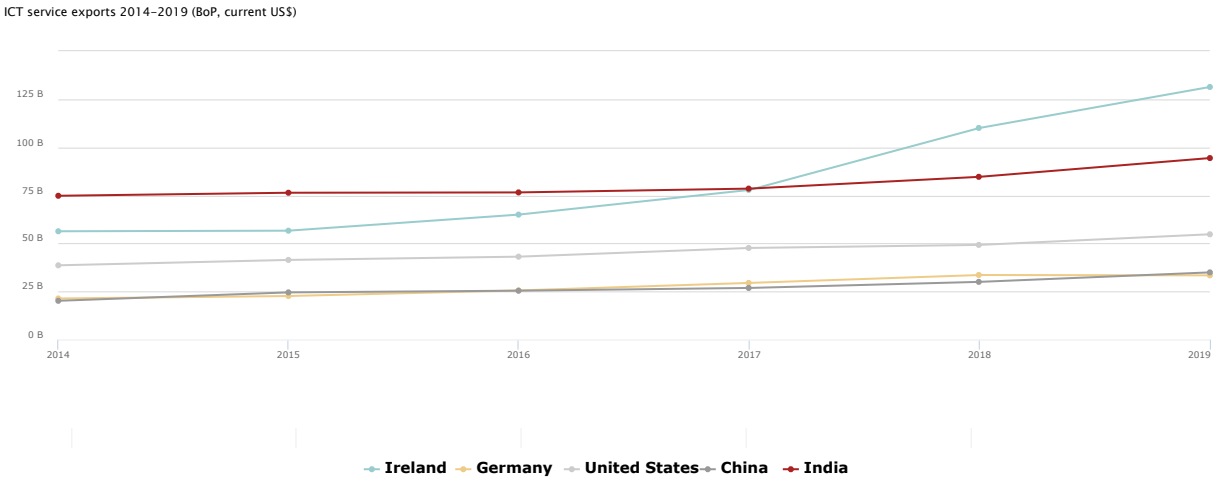
[1] Available at `https://digitalpolicyalert.org/`

authors claim that only 60 countries report full or at least partial bilateral information, but there is a significant improvement seen over time (Fortanier et al. 2017, p.7). The estimated values will therefore be used for robustness checks, as the estimates have the benefit to cover data on all countries by using derivations and backcasting techniques to predict missing bilateral trade flows and recalculate those values (Ferencz 2019).

3.1.1 ICT Service Trade Overview

The biggest ICT service exporter in 2019 is Ireland (131 bil. USD) , followed by India (94 bil. USD) and the United States ($55 BN) according to the World Bank. Closely behind are China, Germany and the United Kingdom. The OECD BaTiS dataset only includes 75 countries, so the ICT services export totals are lower here ($48.7 BN in reported values and $68.3 BN in final balanced values for Ireland and $51.6 BN in reported values and $56.2 BN in final balanced values for the U.S.). Unfortunately, the values for India are not reported in the dataset and only appear in the values with estimations. As can be seen in the chart, ICT service trade had a stable growth in recent years. The enormous rise of Ireland service exports is due to its tax advantages, which attracted many foreign companies.

Figure 1: ICT service exports



Source: Created by the author using data from the World Bank database available at https://databank.worldbank.org/reports.aspx?source=2\&series=BX.GSR.CCIS.CD\&country=

3.2 Trade Barriers

Digital services are transferred across electronic networks internationally. While transportation costs for those are approximately zero (Goldfarb and Tucker 2019), digital services regulations remain fragmented by borders and lack the agility to accommodate the increasing pace of technological developments. These regulatory frictions create trade costs for service providers (Ferencz 2019), which hinder the development of digital trade in services. In a study by Ferracane (2020), a negative and significant relationship between data policies and the performance of the firms reliant on electronic data has been found. Therefore, legitimate measures on digital services, domestically and internationally, need

to be adopted to set up an orderly framework in which sustainable, long-term growth can be ensured. Policymakers are challenged to find a compromise between high output, meaning a high GDP, to which companies interacting in digital service trade contribute, and high cyber, data and information sovereignty. Companies use the data to create value, but policymakers must also ensure that consumers' privacy is adequately protected. In addition, they must keep an eye on security threads by other nations or private organizations with mostly monetary intentions that attack a country's critical infrastructure or those of important businesses.

There are several reasons why to set up regulatory barriers on digital trade and especially also digital service trade. Policymakers need to find the right balance between those considerations. This paper will contribute to help identifying more appropriate regulations.

3.2.1 Regulatory Barriers Overview

It is the aim of organizations such as the OECD to map and aggregate regulatory barriers in digital service trade in order to keep track of countries' protectionist activities. The European Centre of International Political Economy (ECIPE) also started an initiative to track restrictions on digital trade, which contains a detailed mapping of implemented digital policies and can be seen on the Digital policy alert portal[2].

Taking a closer look in our dataset at the OECD member country Turkey, an increase of the DSTRI score from 0.061 in 2014 to 0.242 in 2019 is observable (detailed explanation in chapter 5.1), which consequently results in a range of new policy interactions in digital services trade. A presidential degree in 2019 for example installed new measurements on information and communication security. One of its aims is to prohibit the storage of data from public institutions and organizations in clouds that are not under the control of public institutions[3]. The Turkish government thus wants to protect critical data and prevent it from being transferred abroad. However, this makes it more difficult for foreign providers to gain access to this market, which hinders the trade in digital services. Another example also relates to data localization. In Romania, data from online games must be stored domestically and cannot leave the country's borders[4]. As a result, providers of this service have to operate their own servers in Romania, which involves additional costs for companies that want to this sector. Also in Kazakhstan, which has a very high DSTRI score of 0.647 in 2019, there are laws on data localization. All domestic registered domain names ("kz"-domain) need to operate on physical servers within the country[5], which makes market entry difficult for foreign companies, due to additional costs, and favors domestic companies.

[2] `https://digitalpolicyalert.org/`, accessed in 08/22

[3] `https://www.lexology.com/library/detail.aspx?g=8e18f85a-286f-4d29-b017-b17541c3c66b`, accessed in 08/22

[4] `https://www.nndkp.ro/articles/new-legislation-gaming-7/`, accessed in 08/22

[5] SE in `https://adilet.zan.kz/rus/docs/V1800016654`, accessed in 08/22

4 DSTRI

4.1 Composition

The DSTRI covers digital services trade restrictions since 2014 and is described as a new tool that identifies, catalogs and quantifies barriers that affect trade in digitally enabled services across 77 countries. It builds on the OECD STRI and aims to help policymakers identifying regulatory bottlenecks and design policies that foster more diversified and competitive markets for digital trade (Ferencz 2019).
The index assigns a score between 0 and 1 to each country. 0 indicates an open regulatory environment for digitally enabled trade and one indicates a completely closed regime. On average, the score of all countries takes a value of 0.17. The digital STRI covers cross-cutting barriers that inhibit companies from being able to deliver their services over electronic networks, regardless of the sector in which they operate (Ferencz and Gonzales 2019). The final index score is the sum of five subcategories, which the authors chose to be relevant for measuring digital trade restrictions (Ferencz 2019):

1. **Infrastructure and connectivity** with measures e.g. on limiting or blocking the use of communication services as well as cross-border data flows and data localization.

2. **Electronic transactions** covering e.g. discriminatory conditions for license issuing in e-commerce activities or the possibility of online tax registration and other facilitating measures.

3. **Payment systems** affecting the access to certain payment methods as well as restrictions on internet banking.

4. **Intellectual property rights** mapping the existence of appropriate enforcement mechanisms to address infringements related to copyrights and trademarks.

5. **Other barriers to trade** which cover performance requirements affecting cross-border digital trade like the mandatory use of local software, limitations on downloading and streaming as well as commercial or local presence requirements.

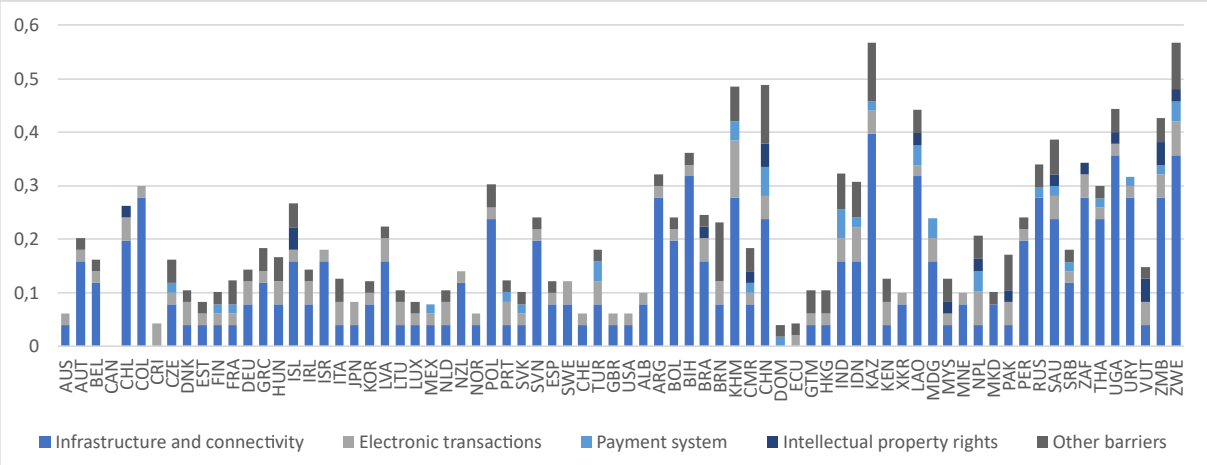
A binary system is used to get the final scoring values. Specific regulatory and market characteristics as well as linkages and hierarchies between measures are taken into account. To get the final DSTRI value, the indicators were then weighted by their relative importance in digital trade transactions. Therefore, an expert survey and a sensitivity analysis using random weights were conducted to get the final weights (Ferencz and Gonzales 2019).

4.2 DSTRI Overview

The following graph shows the DSTRI values in 2018 and how they are composed in the five subcategories. Measures in the areas of "Infrastructure and connectivity" account for the largest share contributing to the index total in almost all countries, followed by "Electronic transactions" and "Other barriers". Restrictions on "Intellectual property

rights" or "Payment systems" also appear frequently, but generally take a smaller share.

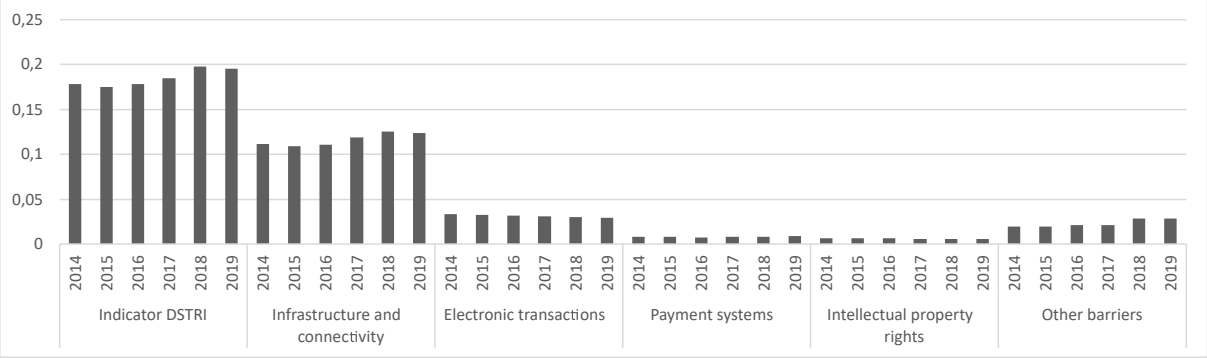
Figure 2: DSTRI scores and composition by country in 2018



Source: Created by the author using data from the OECD DSTRI database available at:
https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

A visualization of the development of the DSTRI is presented in Figure 3. An increase in "Indicator DSTRI" scores is clearly visible (from 0,17 in 2014 to 0.195 in 2019), confirming the ongoing trend of data protectionism and the rise of digital trade barriers. Particularly, measures in "Infrastructure and connectivity" seem to have risen substantially since 2014, as well as measures classified in "Other barriers". By contrast, the development of the mean values of "Electronic transactions", "Payment systems" and "Intellectual property rights" looks quite stable. It is also striking that the contribution of "Payment systems" and "Intellectual property rights" to the overall indicator is relatively low.

Figure 3: DSTRI development over time by subcategories

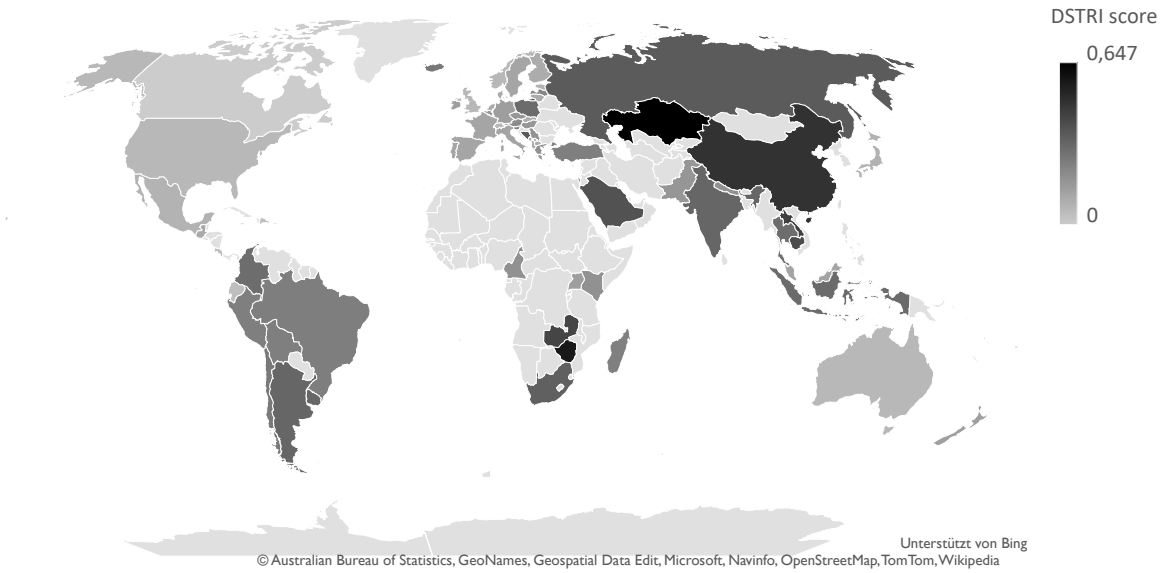


Source: Created by the author using data from the OECD DSTRI database available at:
https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

Looking at the period 2014 to 2019, the DSTRI score decreased in 17 countries, remained constant in 26 countries and increased in 31 countries. A particular increase was recorded for Poland (from 0.162 to 0.303) and Latvia (from 0.082 to 0.223), but also for Saudi Arabia (from 0.206 to 0.386).

As seen in Figure 4, under the DSTRI scoring system Kazakhstan (0.647), Zimbabwe (0.567) and China (0.488) take the highest DSTRI scores in 2018, whereas Canada (0), Costa Rica (0.043) and Norway with Switzerland (0.061) the lowest ones. It is noticeable that African, South American and Asian countries generally tend to have higher DSTRI scores, whereas European, Oceanian and North American countries lower ones.

Figure 4: DSTRI world map



Source: Created by the author using data from the OECD DSTRI database available at: https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

4.3 Evaluation of the DSTRI

The DSTRI appears to be a robust tool for assessing the regulatory barriers of individual countries. However, it is not very easy to categorize all the different policy restrictions that have been put in place as a sufficient reflection of the purpose of its information can be challenging. It is also noticeable that Asian, African and South American in particular have high DSTRI scores (average DSTRI of 0.26), whereas European, North American and Oceanian countries mostly have lower scores (average DSTRI of 0.13). The index values for African, South American and Asian countries are thus twice as high as those for the countries of the western world (see Table 12). In the comparative ECIPE dataset presented earlier, Evenett uses instead of the OECD scoring system the number of policy interventions as the main indicator of his investigation (Evenett and Fritz 2021) and shows that by using this, central European countries in particular have higher scores than presented in the OECD DSTRI. An evaluation of these different classification methods is beyond the scope of this paper, but the results can be seen as a contribution to further research in this area.

5 Methodology

5.1 Gravity Model of Trade

In this quantitative approach, a Gravity Model will be the workhouse framework to determine the effect of digital trade barriers on international trade in digital services. Deriving from Newton's Law of Gravitation, it has been firstly introduced by Tinbergen (1962) and is empirically one of the most successful models in economics (Anderson 2011). The theoretical derivation of a gravity model follows the standard procedure outlined in the international trade literature. According to Linnemann (Sawyer 1967) a gravity model is a reduced-form equation of a general equilibrium of demand and supply systems. In its general form, the value of trade flows ($Trade_{ij}$) is explained by the economic size (GDP) of the trading partners (i and j) and the distance ($Distance_{ij}$) between them. While the trade between two countries is proportional to their economic sizes, it is inversely proportional to the distance between them (Head and Mayer 2014), meaning that GDP has a positive and distance a negative impact on trade. As a result, countries with large GDPs trade more as they have more buying power and countries far apart trade less due to higher trade costs. In its original form, the gravity model's equation is following:

$$Trade_{ij} = G\frac{GDP_i^{\beta_1} GDP_j^{\beta_2}}{Distance_{ij}^{\beta_3}}\mu_{ij} \tag{1}$$

The standard procedure for estimating the multiplicative form of the gravity equation is to take the natural logarithm, which brings us to the following log-linear estimation equation:

$$ln(Trade_{ij}) = \beta_0 + \beta_1(GDP_i) + \beta_2(GDP_j) - \beta_3 ln(Distance_{ij}) + \epsilon_{ij} \tag{2}$$

$Trade_{ij}$ is our dependent variable, while GDP_i and GDP_j, each countries domestic product, and D_{ij}, an "observable proxy for trade costs" (Shepherd et al. 2013) are our independent variables. The error term ϵ_{ij} is added, while $\beta_0 = ln(G)$ is a constant. ß$_1$, ß$_2$ and ß$_3$ are the coefficients to be estimated. Further variables can be added to extend the model.

5.1.1 Modifications

As this paper aims to investigate the effectiveness of regulatory barriers on digital service trade, $DSTRI_i$ and $DSTRI_j$ are included as independent variables into the model, to measure the effect of those barriers hindering digital trade. Additionally, I will also account for a language effect, a border effect and the effect of shared colonial ties. Research by Blum and Goldfarb (2006) shows that segmentation factors observed in traditional offline trade, such as geographical distance, consumer home bias, shared borders and language, remain also important in digital trade, highlighting the relevance of our modeling. I will present detailed information about those variables in chapter 6.2.

This empirical analysis claims to estimate the effects and to differentiate between simple correlations and causal effects of the results. Consequently, I will use different panel data methods to establish causality in the models. Santos Silva and Tenreyro

(2006) discussed several problems with standard OLS methods and suggested the Poisson Pseudo Maximum Likelihood estimator (PPML) to solve these problems. This model has some clear advantages, which are presented below.

5.1.2 PPML Estimator

In standard OLS regression models, there is a problem with including zero trade flows, which are an issue in our specific digital service modeling, since the natural logarithm of zero is not defined (Silva and Tenreyro 2006). To solve this problem, there are three different approaches. Firstly, zero trade flows can simply be dropped. Secondly, the zero trade flows can be replaced by very small numbers, to ensure having them included in the model by making it possible to take the natural logarithm. If the zeros are random missing data, they do not have to be included, as they could take any value. But if the trade flows are zero you would lose information by dropping them. In this dataset, there are actually 452 zero trade flows, which may happen because of a small penetration of digital trade due to the lack of internet accessibility in certain countries or due to non-existing trade ties because of geographical distance. Thus, better results would be achieved using the second method (Bacchetta et al. 2012). Introducing the PPML estimator, a third method has been proved to deal reliably with the issue of zero trade flows. PPML is commonly used in estimations using gravity equations, Silva (2006) highlighted that PPML is a robust approach, especially if there is heteroskedasticity in the data.

5.1.3 Fixed Effects

Fixed effects methods are standard applications in trade analysis. By accounting for multilateral resistance, they provide consistent estimators in gravity models (Shepherd et al. 2013). The fixed effects are dummy variables added as explanatory variables to the model. In theory, they smooth certain effects, such as shocks, and can be applied to the model over time, in pairs, country-pair or country-wise. As I am controlling for the effects of variables that vary unilaterally, I cannot control for country-time fixed effects. They would be perfectly collinear with the DSTRI scores, which are constant across all countries (Shepherd et al. 2013). Therefore, just time fixed effects are subject in this analysis. The inclusion of country-time fixed effects would only be possible when having DSTRI scores that vary bilateral. A method would be to multiply those scores together and include those fixed effects which produces results that are more difficult to interpret (Shepherd et al. 2013). It would become harder to distinguish between the impact of importer and exporter policies, which is one of the main subjects of this investigation. Agnosteva et al. (2014) show that symmetric pair-fixed effects are a better measure of bilateral trade costs.

6 Data

6.1 Datasets

Four different datasets are used in this approach. As mentioned earlier, ICT service trade flows are used to approximate digital services trade, which are obtained from the OECD BaTiS dataset[6]. The dataset covers 202 economies from 2005-2019 and follows the EBOPS 2010 classification. By using estimates and leveraging official statistics the authors reconciled the asymmetries between reported and mirror flows (Fortanier et al. 2017). As BaTiS is bilateral, domestic trade flows were added following Yotov (2022), who argued that the use of domestic trade flows allows for estimation of the effect of international borders and home biases as well as country-specific effects of trade policies. The data on domestic trade is provided by the ITPD-E dataset[7], which covers 243 countries over the period from 2000-2019 for services trade flows (Borchert et al. 2022) and follows also the EBOPS 2010 classification, meaning that it also contains an ICT services sector. The source of the data on trade restrictions, the DSTRI, is also provided by OECD[8]. It ranges from 2014 until 2021 by covering 77 countries. Overall this results in an overlap of 75 countries between the datasets and an overlapping period of six years from 2014 to 2019. Taking the square of the amount of countries and multiplying it by the years there are in theory a total of 33750 country pairs (without domestic trade 33300). Lastly, the gravity variables are taken from CEPII dataset[9], which proofed to be a reliable source for gravity estimations and is constantly updated. The CEPII database contains also information about GATT/WTO membership and the existence of RTA's, which will be relevant for our robustness checks. The datasets were merged in Stata by countrypair-year specific codes using the Iso3 codification to create unique identifiers.

[6] Available at `https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010`
[7] Available at `https://www.usitc.gov/data/gravity/itpde.htm`
[8] Available at `https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#`
[9] Available at `http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8`

6.2 Data Description

In the following a list of all used variables is provided:

Table 1: Descriptive statistics

Variable name	Description	Unit	Data source
Exporter	Exporting country	Name	
Importer	Importing country	Name	
Dependent variables			
rv_trade	Reported value by importing country	USD	OECD BaTiS
rve_trade	With estimation of missing values	USD	OECD BaTiS
fb_trade	Final balanced value	USD	OECD BaTiS
Domestic trade	Added to values above	USD	ITPD-E
Key ind. variables			
ind_dstri_exp	Indicator DSTRI for exporter	$0 \leq X \leq 1$	OECD DSTRI
ind_dstri_imp	Indicator DSTRI for importer	$0 \leq X \leq 1$	OECD DSTRI
Gravity variables			
ln_DIST	Log of distance between countrypairs	Km	CEPII
LANG	If countrypairs have a same official language	Binary	CEPII
CLNY	If countrypairs share a colonial relationship	Binary	CEPII
CNTG	If countrypairs have a border	Binary	CEPII
ln_GDP	Log of GDP for each country	USD	CEPII
rta	Existance of Regional Trade Agreement	Binary	CEPII
both_gattwto	If both are in GATT and/or WTO	Binary	CEPII

*S*ource: Created by the author

6.3 Summary statistics

Table 2: Summary statistics

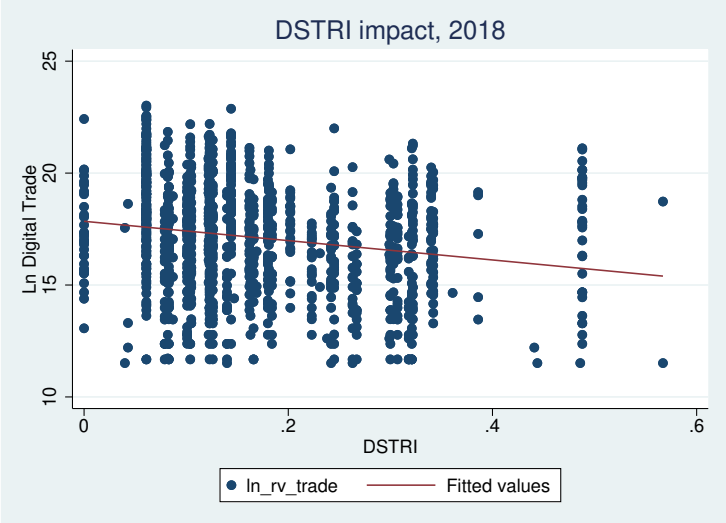
Variable	Obj.	Mean	Std. Dev.	Min	Max
Reported value (million USD)	7765	208.40	656.09	-5.07	12355.86
Reported est. value (million USD)	33599	84.04	447.53	0	14034.37
Final balanced value (million USD)	33599	66.49	353.01	0	14518.18
Domestic trade (million USD)	299	88636.28	291475.77	318.11	231539.61
DSTRI	75	0.19	0.12	0	0.65
Distance	5550	7695	4859	10	19819
ln distance	5550	8.60	1.40	2.3	9.89
Common langauge	5550	0.09	0.29	0	1
CLNY	5550	0.01	0.10	0	1
CNTG	5550	0.03	0.18	0	1
GDP (billion USD)	75	990.38	267.51	0.74	21433.22
ln GDP	75	19.10	1.91	13.52	23.79

*S*ource: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

6.4 Stylized Facts

The relationship of the DSTRI and digital trade as the main object of our investigation is shown to be negative in the next graph. The constant β_0 takes a value of 17.85 and the DSTRI estimator a value of -4.3177 (simple OLS regression). This leads to a simplified interpretation that if the DSTRI rises by 0.01 points the digital trade reduces by 4.32%. A further and more specific analysis will be provided in the following chapters.

Figure 5: DSTRI on digital trade

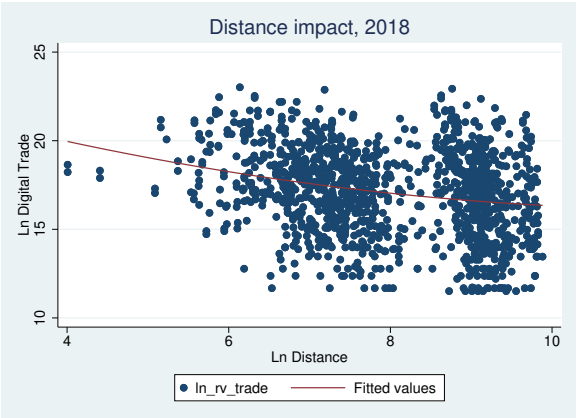


Source: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL# and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

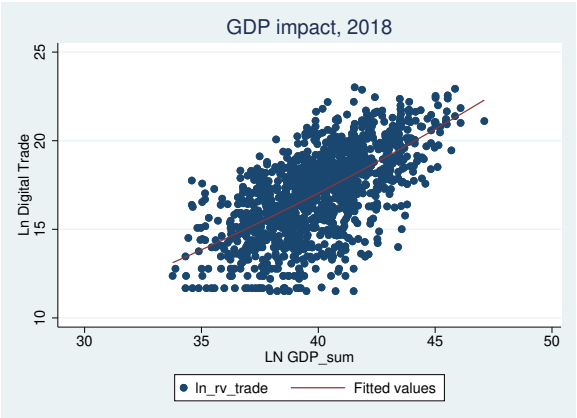
Figure 6 describes the impact of the two most important gravity variables on digital services trade measured by the natural logarithm of digital trade. As expected there is a negative relationship between distance and digital trade shown in a) and a positive relationship between GDP and digital trade in b).

Figure 6: Gravity variables impact

(a) Digital trade and distance



(b) Digital trade and GDP



Source: Created by the author using data from the CEPII Gravity database at http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

7 Empirical Analysis

7.1 Estimation Specification

My baseline specification is following:

$$X_{ij,t} = exp[\gamma_0 + \gamma_1 DSTRI_{it} + \gamma_2 DSTRI_{j,t} + \gamma_3 GRAV_{ij} + \mu_t] + \epsilon_{ij} \quad (3)$$

Where $X_{ij,t}$ is bilateral digital service trade from country i to country j in year t, $DSTRI_{i,t}$ the index score for the exporting country in year t and $DSTRI_{j,t}$ the same for the importing country. $GRAV_{ij}$ controls for bilateral gravity variables and mu_t for year fixed effects, while ϵ_{ij} is the error term.
The following table describes my baseline specification and presents several OLS and PPML regressions:

Table 3: Baseline specifications

	(1) OLS	(2) PPML	(3) PPML	(4) PPML	(5) PPML	(6) PPML
ind_dstri_exp	-6.151***	-0.428	1.235	1.309***	0.794	1.441***
	(-11.85)	(-0.69)	(0.72)	(3.58)	(1.28)	(3.80)
ind_dstri_imp	-3.151***	-2.876***	-1.222	-0.0949	-2.775***	0.385
	(-7.50)	(-6.12)	(-0.78)	(-0.27)	(-4.74)	(0.82)
ln_DIST	-1.130***	-0.696***	-1.508***	0	0	-0.725***
	(-24.50)	(-11.78)	(-16.56)	(.)	(.)	(-14.06)
LANG	0.884***	0.743***	-0.300	0	0.0365	0.0843
	(6.11)	(4.78)	(-0.89)	(.)	(0.08)	(0.53)
CNTG	-0.262	-0.467*	-2.577***	0	-0.0508	-0.00466
	(-1.62)	(-2.10)	(-7.91)	(.)	(-0.08)	(-0.03)
CLNY	0.835*	-0.508	-2.349**	0	0.600	0.166
	(2.07)	(-1.07)	(-2.59)	(.)	(0.86)	(0.71)
ln_gdp_exp	0.830***	0.576***	1.107***	1.193***	0.563*	0.831***
	(37.19)	(13.94)	(14.22)	(9.63)	(2.29)	(3.79)
ln_gdp_imp	0.872***	0.737***	1.166***	0.676***	0.741**	0.470**
	(30.51)	(17.83)	(14.90)	(4.57)	(2.98)	(2.86)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	No	No	No	No	No	Yes
Importer FE	No	No	No	No	No	Yes
assym. Pair FE	No	No	No	Yes	No	No
sym. Pair FE	No	No	No	No	Yes	No
N	7311	7763	8062	7492	7538	7762
R^2	0.642					
pseudo R^2		0.694	0.888	0.990	0.945	0.912

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

Specification (1) describes a standard OLS regression with year-fixed effects. It can be seen that the effects of the DSTRI's are relatively large and significant at the 0.1% level (p-value 0.001), especially those of the exporter DSTRI (-6.151). The following specification (2) describes the PPML regression already presented in equation (3). The number of observations has increased here because zero trade flows are included. The estimators of the two DSTRI's become smaller, especially that of the exporter DSTRI (-0.428), which now also becomes insignificant, in contrast to the importer DSTRI. In the next specification (3), domestic trade flows are included, resulting in a further increase in observations. The estimates of the DSTRI variables change strongly and become insignificant, the exporter DSTRI becomes positive, as does the influence of the language variable. However, it is striking that the effects of border and colonial background increase significantly. In the next specifications (4), asymmetric pair-fixed effects are applied. This omits the bilateral and time-invariant gravity variables since they vary in the same dimension. The effect of the importer DSTRI decreases further (to -0.0949) and that of the exporter becomes significant. Regression (5) is now estimated with symmetric pair fixed effects, which leads to a big change compared to asymmetric pair fixed effects. Here, the effects of the gravity variables are still present, even if only very small. The variable of interest, the importer DSTRI (-2.775), is strongly significant here and remains very similar to Specification (2). Next, exporter and importer fixed effects are included (specification (6)). Both DSTRI's are positive (only the exporter DSTRI is significant). All regressions are clustered by their pair ID, to avoid autocorrelation and heteroskedasticity.

For my analysis, specification (2) and specification (5) will be of particular relevance, which I will explain below.

The estimators of the standard OLS regression in (1) appear to be very large. Especially the effect of the exporter DSTRI is in danger of being overestimated. One reason for this may be heteroskedasticity in OLS estimates, described by Silva (2006), which distorts the estimators and makes them inconsistent. Therefore, and also to be able to include zero trade flows, the PPML estimator with year fixed effects is introduced in specification (2). This estimation is analogous to other estimations performed at STRI analysis (see Nordas 2016). The interpretation of the values are as following for an estimated importer DSTRI: For every one unit increase in the importing country's DSTRI index (increase of 0.01 as the score takes values between 0 and 1), bilateral trade decreases by 0.94% $[e^{-2.876} - 1]$. The effect of the exporter's DSTRI is smaller here and insignificant, which seems plausible due to the fact that trade barriers by the exporting country trade generally hinder trade less than those of the importing country. Looking now at specification 3, the inclusion of domestic trade changes the estimators a lot. This is not consistent with the mainstream literature, since domestic trade is actually supposed to fix the border and distance puzzles and other effects (Yotov 2022). The problem here is the high number of missing values in my data (see Table 8), since I estimate with reported values. The inserted data for domestic trade, on the other hand, occur for almost all countries and are much more consistent than those of the reported values, which is why they bias the estimation. My following specifications try do deal with the problems of endogeneity and multilateral resistance terms. Therefore, pair fixed effects (specifications (4), (5)) and country fixed effects (specification (6) are applied. The application of

pair fixed effects helps when accounting for time-variant trade costs (Yotov, Piermartini, Larch, et al. 2016) like trade agreements and will therefore be a significant tool when measuring for GATT/WTO effects in chapter 8.1. A disadvantage of pair fixed effects is they cannot identify time-invariant trade costs, because they will be absorbed by those (Yotov, Piermartini, Larch, et al. 2016). This leads us to another problem in our dataset: The variation of the unilateral DSTRI is not very large over time (see Figure 2 and Table 10). As already discussed in chapter 5.1.3 and with referring to Shepherd (2013), the almost non-variation leads to a high correlation with asymmetric pair fixed effects, which can be observed by the big change in our DSTRI variables when applying asymmetric pair fixed effects. Therefore, I use symmetric pair fixed effects, which are grouped by the distance, referring to Agnosteva (2014), who particularly emphasizes the strength of this method in the case of missing or zero trade flows, which is a weakness of this dataset as described above. The application of exporter and importer fixed effects in specification (6) also leads to positive DSTRI impacts, which do not appear to be plausible. It seems they absorb those time invariant effects too much as shown above. By and large the estimations show a negative impact of the main subject of this analysis, the importer DSTRI. Following the results in specifications (2) and (5), regulatory barriers in digital services trade by the importing country hinder trade significantly. The impact of the exporter's DSTRI, however, is not as unambiguous as its component, represented by inconsistent positive and negative values. A detailed analysis on the limitations on the model will be presented in chapter 8.2.

7.2 DSTRI Subcategories

To identify which digital service trade barriers hinder bilateral trade the most, I estimate for the single subcategorial indicators, which have been presented in chapter 4.1. Each subcategory is presented separately in a single line. For this analysis, I use baseline specification (2), introduced in Table 3, with year fixed effects. It provides the best filtering of the DSTRI effects, although keeping in mind endogeneities in these estimations. It is clearly visible, that all DSTRI subcategories negatively affect digital service trade, but just four of them significantly. Restrictions on "Intellectual property rights" have the greatest negative impact (-26.45), followed by restrictions on "Payment systems" (-22.24) and "Other barriers" (-13.61). While restrictions on "Infrastructure and connectivity" also have a significant negative, but smaller, impact (-3.622), those on "Electronic transactions" are also negative (-3.747), but not significant on a 5% level. Note that although the average estimator of all subcategories seems to have a bigger impact than the one from the baseline specification, the contribution of the single subcategories to the indicator DSTRI differs as visualized in Figure 3. Thus, restrictions on "Intellectual property rights" and "Payment systems" make the smallest share in our DSTRI index, which explains the high estimators but their small contribution to the final score.

Table 4: DSTRI subcategories

	(1) PPML	(2) PPML	(3) PPML	(4) PPML	(5) PPML
ind_dstri_exp	-0.240	-0.372	-0.409	-0.386	-0.355
	(-0.37)	(-0.60)	(-0.65)	(-0.62)	(-0.56)
e_tran_imp	-3.747				
	(-0.78)				
int_prop_imp		-26.45***			
		(-4.33)			
infra_conn_imp			-3.622***		
			(-4.98)		
pay_sys_imp				-22.24***	
				(-6.33)	
other_barr_imp					-13.61***
					(-6.71)
ln_DIST	-0.744***	-0.720***	-0.706***	-0.715***	-0.714***
	(-11.68)	(-12.13)	(-11.72)	(-12.46)	(-12.47)
LANG	0.857***	0.809***	0.794***	0.804***	0.746***
	(5.35)	(5.29)	(5.05)	(5.28)	(4.92)
CLNY	-0.515	-0.580	-0.532	-0.519	-0.475
	(-1.25)	(-1.34)	(-1.16)	(-1.06)	(-0.99)
CNTG	-0.518*	-0.507*	-0.485*	-0.511*	-0.471*
	(-2.29)	(-2.39)	(-2.20)	(-2.37)	(-2.19)
ln_gdp_exp	0.582***	0.588***	0.577***	0.585***	0.582***
	(14.14)	(14.87)	(13.88)	(15.04)	(14.74)
ln_gdp_imp	0.738***	0.777***	0.731***	0.770***	0.749***
	(16.33)	(17.20)	(17.34)	(17.71)	(17.66)
Year FE	Yes	Yes	Yes	Yes	Yes
N	7763	7763	7763	7763	7763
pseudo R^2	0.670	0.686	0.685	0.697	0.699

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

7.3 Continent Specific Analysis

In the following table the DSTRI is analyzed by specific continents to measure the impact of trade restrictions in digital services trade for different regions. Countries from North America, Europe, Oceania are on average substantially stronger in digital services trade than countries from Africa, South America and partly Asia and generally take a lower DSTRI score (see Table 12). Each estimation classifies the countries as importer of digital services trade by continent. This analysis is based on PPML regressions with year and symmetric pair fixed effects, which is relevant here, since time is not the main subject of this examination.

Table 5: Continent-specific analysis

	(1) Africa	(2) South America	(3) Asia	(4) Europe	(5) North America	(6) Oceania
ind_dstri_exp	-1.457	1.306	3.708***	0.251	1.545	-2.614
	(-0.60)	(1.11)	(5.61)	(0.31)	(0.50)	(-1.37)
ind_dstri_imp	-3.965***	-1.604*	-1.116	-4.516***	-1.681	-53.42*
	(-10.74)	(-2.25)	(-1.71)	(-3.55)	(-1.31)	(-2.16)
rta	0	-0.241*	-0.577	-0.220	0	0.466
	(.)	(-2.02)	(-1.47)	(-0.26)	(.)	(1.42)
ln_gdp_exp	0.364	1.373***	0.947***	0.449*	0.118	1.467*
	(0.36)	(5.35)	(10.59)	(2.46)	(0.33)	(2.13)
ln_gdp_imp	3.013*	1.514***	1.034***	0.765***	0.928**	-0.402
	(1.98)	(5.96)	(10.33)	(4.05)	(2.83)	(-0.49)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
sym. Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
N	186	559	1721	4225	535	282
pseudo R^2	0.980	0.989	0.973	0.949	0.993	0.988

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

The impact of the importers DSTRI's is negative on all continents but differs in size and significance. In contrast, the exporters DSTRI's seem to have greater variations and also take positive values, but generally appear to be insignificant. In the analysis, it should be kept in mind that the number of observations is quite low in some continents, because e.g. countries in Africa do not report their trade values as regular as e.g. European countries. When looking at digital services trade importing countries in Africa, a very high importer DSTRI stands out (-3.965). Regulations in African countries seem to hinder significantly on a 0.1% level. An influence of RTA's is not present here, probably because of the low occurrence of these. The high influence of the importer GDP is also noticeable, which seems plausible. The economic size of a country seems to be comparatively more important for digital trade here than on other continents. In South America, the importer DSTRI takes a value of -1.604 and is significant on the 5% level. The influence of the importer GDP is also relatively high here, which reflects the economic situation. Coming to Asia, there is a negative influence of the importers DSTRI, which is, however, insignificant and takes the lowest score of all continents. Regulatory barriers do not seem to hinder trade here as much as for countries on other continents. Although, the exporter's DSTRI seems to be significantly trade promoting, which is must be strongly connected to the high digital trade volume of China, which takes the third highest of worldwide DSTRI scores (0.488). In Europe, the importer DSTRI has a low estimator (-4.516) and is highly significant. Barriers to trade seem to hinder countries in Europe a lot, compared to countries in other continents. The economic level of the importer and exporter economy is not affecting digital trade here as much as elsewhere, the high number

of observations could be a reason here but also the potentially higher number of trading partners in this agglomeration area. Countries in North America are also negatively affected when having higher DSTRI scores, but not significantly. The low scores of the exporter's GDP highlight the dominance of the US in digital services trade. Estimates for countries in Oceania show a very high impact of importer DSTRI, but should be treated with caution due to the low number of countries.

8 Robustness Checks

8.1 GATT/WTO Effects

For robustness checks with GATT/WTO membership another element is included into the estimation, following Larch et al. (2019), who argue that GATT/WTO membership promotes bilateral trade significantly. Also, Nordas (2016) found a trade promoting effect of RTA's which include agreements on services trade on bilateral all services trade. I use estimations with year fixed effects and also apply symmetric pair fixed effects, both introduced in the baseline specifications.

Table 6: GATT/WTO effects

	(1) PPML	(2) PPML	(3) PPML	(4) PPML	(5) PPML
ind_dstri_exp	-0.428	-0.392	-0.314	1.367*	0.920
	(-0.69)	(-0.63)	(-0.50)	(1.99)	(1.45)
ind_dstri_imp	-2.876***	-2.878***	-2.848***	-1.401*	-2.668***
	(-6.12)	(-6.15)	(-6.04)	(-2.54)	(-4.73)
ln_DIST	-0.696***	-0.695***	-0.647***	-0.705***	0
	(-11.78)	(-11.80)	(-10.15)	(-12.28)	(.)
LANG	0.743***	0.743***	0.755***	0.749***	0.171
	(4.78)	(4.79)	(4.78)	(5.22)	(0.39)
CNTG	-0.467*	-0.466*	-0.479*	-0.500*	-0.00475
	(-2.10)	(-2.11)	(-2.15)	(-2.38)	(-0.01)
CLNY	-0.508	-0.509	-0.435	-0.566	0.278
	(-1.07)	(-1.07)	(-0.99)	(-1.18)	(0.60)
ln_gdp_exp	0.576***	0.570***	0.585***	0.593***	0.492*
	(13.94)	(13.37)	(13.89)	(14.06)	(2.20)
ln_gdp_imp	0.737***	0.736***	0.747***	0.763***	0.673**
	(17.83)	(17.80)	(16.80)	(19.02)	(3.00)
both_gattwto		0.817**			2.618***
		(3.27)			(4.30)
rta			0.179		-0.609
			(1.03)		(-1.63)
both_wto				0.0484	
				(0.18)	
both_gatt				0.981***	
				(5.29)	
Year FE	Yes	Yes	Yes	Yes	Yes
sym. Pair FE	No	No	No	No	Yes
N	7763	7763	7763	7763	7538
pseudo R^2	0.694	0.695	0.695	0.708	0.945

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

*S*ource: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

You can observe there is a significant, positive impact of the variable both_gattwto. However, this does not greatly affect the DSTRI of the importing countries, indicating that the two variables are only weakly correlated. The effect of RTA's in specification (3) on the other hand is not very large and insignificant. When considering the two individual variables both_wto and both_gatt, there is a slight shift in estimations observable. Both_gatt has a comparatively high estimator of 0.981, which seems to be very significant. The inclusion of this variable also changes the influence of the DSTRIs considerably. In contrast, if both countries are WTO members, this has almost no influence on our estimation. The greater impact of GATT membership is also complementary to findings in Larch (2019). An additional application of symmetric pair fixed effects seems to promote the positive impact of GATT/WTO membership. As can be seen by analyzing the variable both_gattwto, memberships have a positive impact on digital service trade. However, since they hey are not strongly correlated with either DSTRI, this suggests other omitted variables. A better specification here would be the inclusion whether there is a digital trade agreement (DTA) between the two countries or the existence of a chapter on it in other trade agreements. This variable would correlate with the DSTRI while promoting digital services trade at the same time. Unfortunately, to the best knowledge, there is no data collection on this yet.

8.2 Limitations of the Model

This subsection will provide a short overview about (in)consistency and (un)biasedness of the estimations:

The frequently occurring missing values already mentioned can lead to a distortion of our estimate. In another specification (see Table 7), the influence of the important importer DSTRI variable becomes smaller (from -2.87 to -1.73) with the inclusion of estimates (reported values with estimates) and the smoothing of all values (final balanced values), which confirms this. There is also a suspicion of omitted variables and endogeneity. When analyzing the GATT/WTO effect, the inclusion of a variable covering DTA's could for example improve the estimation and reduce the correlation with the error term, since it is a determinant of digital trade and correlated with the DSTRI. Also, misreporting of countries can lead to misspecification. E.g. trade flows from Ireland to Iceland and from Poland to Russia are negative in the OECD BaTiS dataset. Moreover, it is interesting to look at reverse causality. For example, a given country is more likely to liberalize its trade with another country that is already a major trading partner (Yotov, Piermartini, Larch, et al. 2016). I have tried to rule out the problem of inconsistent standard errors due to autocorrelation and heteroskedasticity by using standard errors (option cluster) consistent in these. Data on domestic trade is mostly not included in our model (see chapter 7.1) because I estimate with the reported values, which have many missing values and therefore too many gaps in contrast to the data on domestic trade, which would make the effect of domestic trade appear too significant. Summarizing this, the effects of the DSTRI may be overestimated. In a study over a longer period of time, the model would be more meaningful, since so far the DSTRI scores still vary too little over time and are therefore almost time-invariant, which is why they are absorbed by many fixed effects that for example control for multilateral resistance.

9 Conclusion

Summarizing the results, a general, significant negative influence of regulatory barriers in the importing country measured by the DSTRI can be observed in bilateral digital service trade flows. Following my baseline (Table 3) PPML specifications (2) with year fixed effects and (5) with year and symmetric pair fixed effects, an increase of the DSTRI by 0.01 implies a decrease in bilateral digital trade flow by roughly 0.94%. However, as already highlighted in chapter 8.2, the real effect should be smaller, mainly due to omitted variables biases and missing reported values in our data. Nevertheless, according to these results, the lowering of regulatory barriers can be shown to be trade-enhancing here. Within the DSTRI, restrictions on "Intellectual property rights" and "Electronic transactions" seem to hinder trade the most. When analyzing the DSTRI by continents, strong significant negative impacts of digital services trade barriers are especially found for countries in Africa and Europe. Here in particular, a lowering of barriers could be conducive to trade in digital services. Findings when measuring GATT/WTO effects show, that a membership can promote digital services trade. Although, special agreements on digital trade are recommended and can be subject of further analysis in this field. By and large, governments are advised to review and, if necessary, correct their regulatory barriers if they want to participate as active players in digital service trade. However, national security interests and the protection of the domestic market should not be neglected.

9.1 Outlook

Further analysis in digital services trade is strongly recommended as a growing volume in ICT services trade is measured and also more digital trade barriers are implemented by governments worldwide. Global trends such as the growing fragmentation of the sector due to the extreme market shares of single companies or the change in trade flows during the Covid-19 pandemic with an associated surge in digitalization and changes in people's digital usage habits are also areas of interest for future research at the DSTRI. It will also be important to analyze the DSTRI over a longer period of time , as its levels do not yet vary too much over time as of right now and effects are therefore easier to filter out when having long term data. Nevertheless, DSTRI proved to be a useful tool in my analysis and is recommended for further approaches.

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Appendices

Table 7: List of countries

Europe		**Asia**		**North America**	
Albania	ALB	Brunei Darussalam	BIH	Canada	CAN
Austria	AUT	Cambodia	KHM	Costa Rica	CRI
Belgium	BEL	China	CHN	Dominican Republic	DOM
Bosnia and Herzegovina	BIH	Hong Kong, China	HKG	Guatemala	GTM
Denmark	DNK	India	CHN	Mexico	USA
Estonia	EST	Indonesia	IND	United States	USA
Finland	FIN	Kazakhstan	KAZ	**South America**	
France	FRA	Japan	JPN	Argentina	ARG
Germany	DEU	Korea	KOR	Bolivia	BOL
Greece	GRC	Kazakhstan	KAZ	Brazil	BRA
Hungary	HUN	Laos	LAO	Chile	CHL
Iceland	ISL	Malaysia	MYS	Colombia	COL
Ireland	IRL	Nepal	NPL	Ecuador	ECU
Israel	ISR	Pakistan	PAK	Peru	PER
Italy	ITA	Russia	RUS	Uruguay	URY
Montenegro	MNE	Saudi Arabia	SAU	**Oceania**	
Latvia	LVA	Thailand	THA	Australia	AUS
Lithuania	LTU	Türkiye	TUR	New Zealand	NZL
Luxembourg	LUX	**Africa**		Vanuatu	VUT
Netherlands	NLD	Cameroon	CMR		
North Macedonia	MKD	Kenya	KEN		
Norway	NOR	Madagascar	MDG		
Poland	POL	Uganda	UGA		
Portugal	PRT	Zambia	ZMB		
Russia	RUS	Zimbabwe	ZWE		
Serbia	SRB				
Slovak Republic	SVK				
Slovenia	SVN				
Spain	ESP				
Sweden	SWE				
Switzerland	CHE				
United Kingdom	GBR				

Table 8: Data comparison of reported values and estimates

	(1) Reported values	(2) Reported v. with estimates	(3) Balanced values
ind_dstri_exp	-0.437	0.384	-0.890
	(-0.70)	(0.85)	(-1.61)
ind_dstri_imp	-2.870***	-2.454***	-1.731***
	(-6.13)	(-5.60)	(-3.94)
ln_DIST	-0.690***	-0.744***	-0.788***
	(-11.64)	(-13.29)	(-14.76)
LANG	0.740***	1.089***	1.003***
	(4.78)	(7.36)	(4.93)
CNTG	-0.456*	-0.717**	-0.705**
	(-2.07)	(-2.85)	(-2.69)
CLNY	-0.510	0.107	-0.269
	(-1.08)	(0.22)	(-0.59)
ln_gdp_exp	0.572***	0.631***	0.676***
	(13.77)	(19.46)	(20.35)
ln_gdp_imp	0.733***	0.734***	0.730***
	(17.68)	(21.84)	(18.35)
Year FE	Yes	Yes	Yes
N	7311	31656	32859
pseudo R^2	0.685	0.688	0.732

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

*S*ource: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

Table 9: Correlation matrix

(1)

	rv_trade	ind_dstri_exp	ind_dstri_imp	ln_DIST	LANG	CNTG	CLNY	ln_gdp_exp	ln_gdp_imp	both_gattwto	rta
rv_trade	1										
ind_dstri_exp	-0.0316**	1									
ind_dstri_imp	-0.0353**	0.0738***	1								
ln_DIST	-0.0780***	0.00777	0.242***	1							
LANG	-0.0142	-0.0656***	-0.0471***	0.0256*	1						
CNTG	-0.0130	0.0354**	-0.0171	-0.347***	0.239***	1					
CLNY	-0.00646	0.0188	0.0268*	-0.0175	0.124***	0.155***	1				
ln_gdp_exp	0.0887***	-0.109***	0.0261*	0.166***	0.150***	0.0547***	0.0316**	1			
ln_gdp_imp	0.0847***	-0.105***	0.0325**	0.246***	0.0714***	-0.00659	-0.00145	0.0229*	1		
both_gattwto	0.0129	-0.233***	-0.0190	0.0445***	0.0644***	0.0438***	-0.0109	0.283***	0.0393***	1	
rta	-0.0602***	-0.0645***	-0.247***	-0.491***	-0.0157	0.176***	-0.0764***	-0.199***	-0.188***	-0.0575***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

*S*ource: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

Table 10: DSTRI annual impact

	2014	2015	2016	2017	2018	2019
ind_dstri_exp	-1.466	0.0500	-0.149	-0.725	-0.136	-2.050***
	(-1.88)	(0.06)	(-0.19)	(-1.20)	(-0.21)	(-4.06)
ind_dstri_imp	-2.518***	-2.927***	-3.045***	-3.126***	-2.929***	-2.617***
	(-4.38)	(-5.08)	(-6.28)	(-6.17)	(-5.98)	(-5.59)
ln_DIST	-0.730***	-0.706***	-0.694***	-0.711***	-0.684***	-0.638***
	(-12.35)	(-10.25)	(-11.46)	(-11.67)	(-11.38)	(-8.33)
LANG	0.654***	0.738***	0.777***	0.699***	0.817***	0.722***
	(3.55)	(4.13)	(4.75)	(4.30)	(5.07)	(4.02)
CNTG	-0.468*	-0.427	-0.436	-0.520*	-0.533*	-0.342
	(-2.14)	(-1.80)	(-1.83)	(-2.13)	(-2.17)	(-1.43)
CLNY	-0.611	-0.642	-0.558	-0.661	-0.345	-0.311
	(-1.12)	(-1.40)	(-1.16)	(-1.26)	(-0.59)	(-0.95)
ln_gdp_exp	0.547***	0.590***	0.592***	0.600***	0.573***	0.506***
	(12.75)	(12.77)	(14.02)	(15.35)	(15.44)	(10.37)
ln_gdp_imp	0.733***	0.742***	0.739***	0.747***	0.721***	0.725***
	(17.17)	(14.49)	(15.48)	(16.59)	(16.55)	(17.16)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1303	1374	1486	1506	1348	746
pseudo R^2	0.658	0.691	0.717	0.718	0.697	0.651

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

Table 11: DSTRI impact on different Trade Levels

	(1) 0-10M	(2) 10M-100M	(3) 100M-1Bn	(4) 1Bn ⟨
ind_dstri_exp	-2.586***	-0.710**	-0.133	-0.0170
	(-8.23)	(-2.59)	(-0.35)	(-0.02)
ind_dstri_imp	-1.610***	-0.352	-0.916***	-1.641*
	(-5.22)	(-1.67)	(-3.36)	(-1.97)
ln_DIST	-0.411***	-0.178***	-0.219***	-0.164**
	(-10.25)	(-6.47)	(-5.49)	(-2.72)
LANG	0.274	0.121	0.281***	0.391**
	(1.80)	(1.45)	(3.44)	(2.90)
CNTG	0.0110	-0.155	0.0681	-0.288
	(0.06)	(-1.66)	(0.55)	(-1.62)
CLNY	0.189	0.0851	-0.173	-0.0777
	(0.52)	(0.56)	(-0.82)	(-0.37)
ln_gdp_exp	0.256***	0.150***	0.186***	0.0790
	(11.76)	(9.42)	(6.82)	(1.26)
ln_gdp_imp	0.241***	0.154***	0.250***	0.235***
	(10.32)	(9.16)	(9.01)	(5.02)
Year FE	Yes	Yes	Yes	Yes
N	2618	2564	1729	397
pseudo R^2	0.266	0.136	0.244	0.237

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, CEPII Gravity database at http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=8, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010

Table 12: Continent DSTRI means

Continents	DSTRI	count	mean	sd	min	max
AF, AS, SA	ind_dstri_imp	35	.2579837	.1222521	.0535	.5685
EU, NA, OC	ind_dstri_imp	43	.1312545	.0816402	.0105	.40764365

Source: Created by the author using data from the DSTRI database at https://stats.oecd.org/Index.aspx?DataSetCode=STRI_DIGITAL#, ITPD-E database at https://www.usitc.gov/data/gravity/itpde.htm and BaTiS database at https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

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Johannes Gutenberg-Universität Mainz

Sommersemester 2022

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