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Impact of data trade restrictions on IT services export: A cross-country analysis

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ABSTRACT

Trade in digital goods and services have witnessed increasing growth in recent years, accompanied by a corresponding increase in data flows across national boundaries. At the same time, governments around the world have enacted data policies that restrict such cross border data flows in their effort to claim sovereignty over data generated from within their countries. However, scholars have long proclaimed that any restrictions to the Internet and associated digital trade will have serious economic consequences. Given this context, we analyze the impact of data policies that impose restrictions on digital trade, specifically on cross border data flows. We construct Market Data Restrictions Index (MDRI), that measures the data restrictions faced by an exporting country from their trade partners. We use a variation of random effect model on a panel data set consisting of 60 countries that contribute to more than 50 percent of IT services export during the period 2006–2017. The results indicate that apart from variables such as Foreign Direct Investment, and Service Value Added, the MDRI of partner countries has a moderate negative effect on IT services export. If countries move from liberal policies to stringent data restrictions, the economies of the country that exports its ICT services to these partner countries is affected substantially. Hence government regulators shall be cautious in imposing stringent data restrictions as it affects global digital trade.

1. Introduction

Global flows of goods and services that contribute to international trade have reached US$25 trillion as of 2019 (UNCTAD, 2020). Over the last two decades, financial flows including Foreign Direct Investment (FDI) have become significant across countries (UNCTAD, 2020). Recently there is a growing interest amongst researchers to look at digital information flows as another factor of importance in international trade and consequently on growth of the economies (MGI, 2014; MGI, 2016). Between 2004 and 2014, it is estimated that digital trade increased world GDP by more than 10 per cent, equivalent to US$7.8 trillion (Meltzer & Lovelock, 2018). International digital trade that comprises of import and export of digital goods and services, involves significant data flows across national borders.

Most of the data flows of the last decade were primarily attributable to Information and Communication Technology (ICT) services.

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IT outsourcing firms, especially in countries such as India, benefitted due to free flow of cross border data, thereby providing ICT services to business customers located mainly in the U.S. and Europe. For example, India - one of the world's leading ICT outsourcing destinations, witnessed exports of ICT services worth US$105 billion in 2019, with an annual compounded growth rate of about 10.23 percent since 2010. Ubiquitous Internet connectivity, digitization of business processes, and large availability of skilled technical manpower has contributed to the growth of ICT outsourcing services in India and has established the country firmly in the global digital supply chain (Carmel & Tjia, 2005; Edwards & Sridhar, 2005).

This is also augmented by Internet based services such as electronic commerce and other digital products and services that can be availed by consumers. Trade in services over the Internet has grown steadily in the last two decades and now represents a share of more than 20 percent of total trade worldwide (McKinsey Global Institute, 2016).

Since the time of the classical growth model proposed by Solow (1956), using the traditional Cobb-Douglas production function for estimating economic growth using factor accumulation of labor and capital, a number of researchers have included many other variables of interest including goods and services flows in the production functions. Notable ones are the inclusion of telecommunications and ICTs to provide associated policy prescriptions (refer Roller & Waverman, 2001; Rouvinen, 2006; Sridhar & Sridhar, 2007; Sridhar, 2010). Effect of the Internet on international trade has been well documented in Freund and Weinhold (2004). In an empirical study of a comprehensive panel data set, Sridhar (2016) indicates that there is a strong positive correlation between *trans*-border data flow and economic development, especially in low and middle income countries of the world.

The above developments in digital trade are also due to liberal regulations and policies of countries in the areas of telecom and ICT. Many countries including India had progressive telecom and ICT policies, including tax incentives for export of ICT services, and liberalization of the telecom sector for enabling telecom and internet connectivity. However, recently concerns have been raised by the governments and regulators on restricting data flows across borders. Giving due respect to the importance of data flows for international trade, Peitz and Waldfogel (2012), indicate that governments are restricting the Internet in ways that reduce the ability of businesses and entrepreneurs to use the internet as a place for international commerce.

The concept of "data nationalism" is not new and has been in existence in parts of the world since the 1970s (Kuner, 2015). However, post Snowden episode even democratic countries notably Brazil, Germany and India have been considering expansive data localization measures, thus restricting movement of certain types of data across national borders (Hill, 2014). Chander and Le (2014) provide an exhaustive historical perspective on data flow restrictions and recent trends. Taylor (2020) provides a historical perspective on data sovereignty. At its core, sovereignty refers to a state's supreme authority within a territory and over its population (Turner, 1997). Bauer et al. (2014) estimated that enactment of data localization measures in India, Indonesia, and Vietnam would reduce GDP in by 0.1, 0.5 and 1.7 percent respectively. Meltzer and Lovelock (2018) provide a detailed study of the data flow restrictions in Asian countries.

This Digital Economy Report 2021 of UNCTAD points to the complexities involved in governing data and data flows across borders for sustainable development benefits. It also stresses that the state of the international debate on how to regulate cross-border data flows is quite polarized leading to patchy policies and regulations (UNCTAD, 2020).

It is in this context that in this paper we provide a framework and empirically analyze the effect of data flow restrictions, specifically on ICT services exports that forms substantial portion of digital trade, since this contributes significantly to the economies of nations. In the next section, we review the data restriction measures in different countries; in section 3, we develop the model and illustrate the data set used; In section 4 we provide the empirical analysis of the proposed model. We conclude by presenting our key findings and policy measures.

2. Restrictive data regulations: a review

Data restriction measures vary across countries. Ferracane, Lee-Makiyama, and van der Marel (2018) provide a restriction on data index for each country measured along three dimensions: data policies, intermediary liability and content access. Their data policy dimension consists of restrictions on cross border data flow, data retention, right to be forgotten and open government access to personal data collected. In Ferracane, Lee-Makiyama, and van der Marel (2018), it is indicated that while only 19 measures were imposed globally for cross border data flow restrictions until the year 2000, this number increased to more than double recently. In a recent follow-up study, van der Marel & Ferracane (2021) used a panel data set to conclude that data restriction policies indeed tend to lower levels of service trade, especially import of services.

Internet intermediaries are those that (i) do not initiate transmission of messages or transactions; (ii) do not select the receiver of the transmission; and that (iii) do not alter the content of the messages so transmitted. Such firms include Internet Service Providers (ISPs), and social media platforms. In most of the countries, these intermediaries are provided safe harbour protection and immunity from the harmful and unlawful transmission of messages and transactions performed by third parties through their platforms. Ferracane, Lee-Makiyama, and van der Marel (2018) indicate that China, Turkey and Thailand have a higher score indicating the liability laws on intermediaries whereas most of the other countries still follow safe harbour protection. However, recently, more countries including India are beginning to invoke liability of the intermediaries for content that is unlawful, fake and causes social unrest and against national interest (Forbes India, 14 Jul 2021). In a recent work, Cuntz and Sahli (2021) indicate that liability rules affect the incentives of intermediaries to disseminate and curate creative works, in particular when works build on the work of predecessors and they are potentially infringing copyright. Hence the enforcement of liability on intermediaries do act as disincentives for them to operate in designated countries and is expected to negatively affect data flows and corresponding trade.

Restrictions to access certain content online can increase the cost of offering services online and, in some Cases, even make it impossible (Ferracane, Lee-Makiyama, & van der Marel, 2018). China, Vietnam, Malaysia, Russia, Brunei, and Indonesia have stricter

restrictions on content. The restrictions include blocking of certain applications and web sites, enforcing licensing and associated regulations on Internet Content Providers, obligations on social media intermediaries to take down certain content at the request of governments. Hence restrictions on content access affect data flow across national boundaries and act as disincentives for the intermediaries to operate in the designated countries.

Potluri et al. (2020) classify data flow restrictions as belonging to one of the following types:

- **No restrictions**: Countries such as New Zealand and Thailand belong to this category wherein there are no localization requirements which in turn permits free and unconditional cross border data flow. Other countries in this category include Netherlands, Ireland and Iceland (Ferracane, Lee-Makiyama, & van der Marel, 2018). Apart from the U.S. and Canada, the Asian countries such as Taiwan, Thailand and Hong Kong share the open model with high digital trade links with other similar countries (Ferracane & van der Marel, 2021). In general, these countries support free trade and are often small countries. These countries have well developed ICT infrastructure and act as destinations for multinationals to host large data centres and processing centres. For example, Ireland has been the favorite destinations of large internet and software companies such as Google and Microsoft for their server farm locations.
- **Conditional restrictions**: The second category of countries have data localization regulations and rules that are less restrictive. For example, countries such as Japan, Malaysia, Hong Kong which belong to this category allow cross border data flow under certain conditions, referred to as "conditional data flow". Regulations of this type include mandating at least one serving copy of personal data of data subjects to be stored within the country. Some countries have stricter forms of data localization that mandate certain types of personal data to be stored only within the country.
- **Highly restrictive**: China, Russia and Turkey top the list amongst countries that have stringent data localization requirements. Thus they are highly restrictive and in some cases even ban cross border data flows (Ferracane, Lee-Makiyama, & van der Marel, 2018). In general, the economies of these countries are less open.

Ferracane and van der Marel (2021) show using an empirical investigation that pairs of countries sharing the open data model for cross-border data transfers is positively associated with trade in digital services, while sharing the conditional model for domestic data processing is also positively correlated with trade in digital services. However, they illustrate that country-pairs sharing the highly restrictive model, show negative trade correlations.

While regulations in most countries are specific to personal data, they also apply to data flow between data controllers and third-party data processors to whom processing of data is outsourced as specified in European Union General Data Protection Regulation (EU GDPR) (CEU, 2016). EU GDPR requires "data protection adequacy" of the third country outside the EU member countries, if there is cross border flow of personal data (Sridhar, 2018). Article 45 of the EU GDPR requires that the third country to which personal data of data subjects is transferred provide adequate level of data protection. Data adequacy is a status granted by the European Commission to countries outside the European Economic Area (EEA) who provide a level of personal data protection comparable to that provided in European law. The European Commission (as on July 2021) has recognised Andorra, Argentina, Canada, Faroe Islands, Guernsey, Israel, Isle of Man, Japan, Jersey, New Zealand, Switzerland and Uruguay as providing adequate protection.

In a recent work, Ferracane and van der Marel (2021) illustrates three models for regulating personal data: (1) the U.S. model that allows free and open flow of data across country borders; (2) the EU model that allows conditional cross border data flow including certain local data processing requirements; and (3) the China model that has very strict and limiting data flow restrictions. It is further indicated that 42 percent of countries follow the US model, 44 percent of the countries use the EU approach and about 14 percent adopt the China model that includes China, Russia, Iran and some of the African countries. However, Ferracane and van der Marel (2021) concludes that while the U.S. model nurtures innovation-led growth, the EU model encourages trade across countries.

Restrictions on data transfers affect all stakeholders namely: data subjects; data fiduciaries (aka data controllers and data processors in EU GDPR) - the firms that collect, process, store and disseminate data from subjects; and the governments. Sridhar et al. (2022) provide an exhaustive explanation of how these effects are varied across the different stakeholders. When data restrictions are enforced, a number of administrative regulatory barriers could be introduced through additional legal obligations that increase compliance costs, such as stricter consent requirements, the requirement to notify a market regulator and/or data subjects in case of potential security breaches. Overall, compliance with these measures increases the operational expenditure of firms which raises domestic prices and Non-Tariff barriers (NTB) on data flow across national borders (Bauer et al., 2014). This in turn can have a negative effect on ICT goods and services trade across national borders. Taylor (2020) provides an exhaustive analysis of *trans*-border data flow policies around the world and concludes that nations with the least amount of data localization and the most open flow of information will be the most successful in benefiting from new data-intensive embedded, networked technologies.

In addition to restrictions on cross border data flow that directly impact digital trade by restricting the flow of data across borders, policies that restrict the commercial use of data have also been shown to impact productivity. Such policies include regulations with regard to retention of data, rights of data subjects, requirements for compliance with privacy frameworks, penalty for non-compliance, etc. A study by Bauer et al. (2014) showed that such data restrictions negatively impact performance of downstream industries, particularly those that are more dependent on data services and in turn impact GDP, industry production and trade. Ferracane et al. (2018b) reach a similar conclusion using cross-country firm level and industry level data.

Other restrictive regulations on data and digital platforms pertaining to intermediary liability and content access are also considered to increase cost of doing business and restrict access to services. As per OECD "Internet intermediaries bring together or facilitate transactions between third parties on the Internet." As such intermediaries are companies such as internet service providers, web hosting and data processing providers, social networks, search engines and e-commerce companies among others. Intermediaries

are protected from being liable for content shared on their platform by "safe harbour" provisions. Perset (2010) cites the trade enhancing and facilitating role of internet intermediaries by "allowing the expansion, aggregation and globalisation of markets as well as the customisation of goods and services". Prohibitive regulations pertaining to intermediary liability which may include reduced safe harbor provisions, terms for notice and takedown, user identity requirement, monitoring requirements (Ferracane & van der Marel, 2020), can reduce the ability of and increase the cost to such service providers thus leading to negative economic impact. A study by Dippon (2017) estimated the impact of such reduction in safe harbor provisions on employment and GDP in the United States. Regulations related to content access such as filtering, blocking, monitoring and regulating access to internet and online content restrict the ability to provide services and information for companies. This again can lead to rise in cost for service providers and in extreme cases inability to operate. To our knowledge there is no study that explores the impact of restrictions pertaining to content access and intermediary liability on trade.

Though there have been some studies on the impact of cross border data restrictions on international trade volume (see Ferracane & van der Marel, 2021; UNCTAD, 2021), research on the impact of restrictions on data on ICT services exports is scarce and we try to fill this gap in this paper. In the following section, we develop a model to understand the effect of data flow restrictions on the export of ICT services.

3. Model for analyzing the impact of data restrictions on trade in digital services

The export of ICT services and ITeS contribute to substantial portion of GDP of many countries, as is evident in Ireland (23%), Israel (5.7%), Singapore (3.3%), Finland (3.1%), India (3.0%), Estonia (2.7%) and the U.S. (0.22%) (World Bank, 2021). The success story of ICT export sector in Ireland, Israel and India is well documented by Carmel (1999).

A notable work on an empirical analysis of export of services (not limited to ICT services export) is by Goswami et al., (2012), wherein the authors attempt to disentangle the determinants of developing-country participation in service exports and identify strategies for export success. Sharma (2015) provides an exhaustive historical account of India's ICT services industry and indicates the availability of technical manpower and the rise of entrepreneur culture as two most important factors for the success of the IT industry in India. Xing (2011) provides an account of China's ICT exports mainly to the U.S. and Japan and compares the performance of China's ICT industry with other South Asian nations.

However, there is a dearth of literature on the analysis of the export of ICT services, especially in the context of data flow restrictions. The only recent work that analyzes the effect of data restrictions on services is by Marel & Ferracane (2021) in which the authors show that strict data policies are negatively and significantly associated with imports of data-intense services. In another recent work, Ferracane and van der Marel (2021) infer that digital trade between nations that have high restrictions on *trans*-border data flows are affected negatively by their data restriction policies. The analysis is conducted using the gross services export data available in the Trade in Value Added (TiVA) database (OECD, 2022). However, the gravity model used by Ferracane and van der Marel (2021) does not have other variables indicated by prior research that impact ICT services export.

Given that data restrictions imposed by countries have an effect on digital trade in general, including both imports and exports, our objective in this paper is to determine how such restrictions affect the ICT services exports across the world. We build our model with variables that have been used in prior research and augment them with the data restriction index. This will help us analyze how the data restriction policies of nations affect ICT services export in the presence of all the other control variables as identified in the literature.

3.1. Model variables

3.1.1. Market data restriction index

The most significant work till date on measurement of cross border data flow restrictions was by Ferracane, Lee-Makiyama, and van der Marel (2018) who provided the Digital Trade Restrictiveness Index (DTRI) across 64 countries in the world. Ferracane, Lee-Makiyama, and van der Marel (2018) categorized the digital trade restrictiveness across four indices or clusters: (A) fiscal restrictions index; (B) establishment restrictions index; (C) data restrictions index (DRI); and (D) trading restrictions index. We include DRI, the index for cluster C that is specific to restrictions on data in our study. This index for restrictions on data is divided into three further sub sections: data policies, intermediary liability and content access as indicated earlier.

We only have country ranking for the three individual measures, namely Data Policies, Intermediary Liabilities and Content Access (Ferracane et al., 2018). Since the ordinal values do not specifically illustrate the extent of impact of the corresponding dimensions, we did not include them individually in the model. Since the DRI is a composite measure that is indicative of the data restrictions across all the three sub clauses, we use DRI as the basic measure in our study.

Data localization trends are encapsulated in the data policies of each country that restrict certain types of data from crossing borders based on defined objectives. Ferracane, Lee-Makiyama, and van der Marel (2018) acknowledge that in the past decades the trends on data localization have been troubling, as countries embark on restricting cross border data flows more than ever before. Recently Marel & Ferracane (2021) have disaggregated the data policies sub-section into those that affect cross border data flow and those that place restrictions on the domestic use of data.

The DTRI as a measure of data restrictions imposed by countries is internal to that specific country. However, when a country exports its ICT services, it faces data restrictions from the other countries to which the export is targeted. In order to take in to account this external effect, we construct a Market Data Restrictions Index (MDRI) which is a normalized measure of restrictions faced by an exporting country from all the other $(n-1)$ partner countries, as specified in Equation (1)

$$MDRI_k = \frac{\sum_{i=1,\ i\neq k}^{n} DRI_i}{(n-1)} \quad (1)$$

3.1.2. Service Value Added

In their recent research, Haddad and Araújo (2020) analyzed the contribution of services value added to exports in Latin American countries and the key role of services' value-added in development, given their direct and indirect contributions to production, trade, and employment. A study by Ahmad et al. (2017) on the export performance of Asian countries indicates that the value added by services and communication facilities are likely to influence services exports. The value of direct and indirect value added content to exports has been analyzed by Francois et al. (2015) using a panel data set and they find that the value added has been increasing in services and that it is higher than the value of gross exports indicating the importance of services in trade. Given the importance of value added content, especially in services, we include Service Value Add (SVAD) as one of the explanatory variables for ICT services export in our model. It can also be considered as a measure of supply of services. Instead of taking absolute value of SVAD, we use it as a proportion of GDP of the country as the explanatory variable for normalization across countries.

3.1.3. Foreign direct investment

Foreign direct investment (FDI) plays a vital role in international trade. For the host country that receives foreign investment, FDI can increase its capital in various ways. The impact of FDI on trade is mixed in the existing literature. Santos-Paulino (2005) and Van Dijk (2002) have found that FDI exerts a positive influence on exports. Sahoo and Dash (2017) explain how further trade and financial liberalization and removal of FDI caps in areas like health, education and financial sectors are required to achieve sustained export growth in services. Latorre et al. (2018) indicate using a computable general equilibrium model the impact of FDI accruing to advanced services sectors in China. In another work, Doytch and Uctum (2019) take a sectoral level approach to analyzing the effects of foreign direct investment (FDI) inflows in services such as financial, trade, and business services. In a recent work, Sass, et al. (2018), analyzes the effect of FDI in the services sector in the Visegrad countries of Czech Republic, Hungary, Poland and Slovakia indicate the effect of FDI on exports and employment. Popovici (2018) explains the export capacity in the EU countries based on FDI and domestic investment. Given the extensive research on the use of FDI as a predictor of exports and growth of countries, we include this as an explanatory variable in our model.

3.1.4. Real effective exchange rate

The Real Effective Exchange Rate (REER) is a measure of the value of a currency against a weighted average of several foreign currencies divided by a price deflator or index of costs. An increase in REER implies that exports become more expensive and imports become cheaper; therefore, an increase indicates a loss in trade competitiveness of a country.

There has been extensive research on the effect of exchange rate of currencies on international trade as pointed out in (Auboin & Ruta, 2013). The effect of cross border production linkages on REER elasticity of exports is explained by Ahmed et al., (2015). Begović and Kreso (2017) in their analysis of European transition countries that strongly rely on exports as a source of revenue indicate that there is an adverse effect of the REER on trade balance in these countries during the period 2000–2015. Using data from World Trade Organization and Reserve Bank of India, Veeramani (2008) concludes that appreciation of REER led to a fall in the dollar value of India's merchandise exports. Gupta et al. (2015) also include REER in their empirical analysis of determinants of IT exports for India. Cheung and Sengupta (2013) in their analysis of effects of REER on the share of exports of Indian non-financial sector firms conclude that there has been a strong and significant negative impact from currency appreciation and currency volatility on market shares of India's exporting firms. There have been recent studies on the effect of REER on exports in different countries: Turkey (Meterelliyoz & Batman, 2021); Azerbaijan (Niftiyev, 2020); Latin America (Goda et al., 2021) to name a few. Gupta et al., (2015) analyzed the determinants of exports of IT companies of India from 2000 to 2012 and found that world demand and REER have expected positive and negative impacts on a company's exports. Freund and Weinhold (2004) included REER in their estimation of US services import with the advent of Internet technologies.

Given its influence on international trade as proven in the above literature, we include REER with one-year lag, as one of the explanatory variables of ICT exports. We use lagged REER because demand for exports would take some time to adjust to price change due to movement in exchange rate.

3.1.5. Networked readiness index

The Networked Readiness Index (NRI) seeks to better comprehend the impact of ICT on the competitiveness of nations. The NRI is a composite of three components: (i) the environment for ICT offered by a given country or community, (ii) the readiness of the community's key stakeholders (individuals, businesses, and governments) to use ICT, and (iii) the usage of ICT amongst these stakeholders. The World Economic Forum (WEF) measures the propensity for countries to exploit the opportunities offered by information and communication technology using NRI and have been publishing it since 2002 (WEF, 2020). In a recent work, Afonasova, et al. (2019) use NRI as one of the variables to explain the difference in high-tech exports between Russia and European Union (EU) countries. The NRI is used to model the variables that drive global Business to Business (B2B) e-commerce across countries by (Alsaad et al., 2018). Marel & Ferracane (2021) also use NRI as one of the determinants of digital imports in their study. Since ICT exports depend on the infrastructure, business preparedness of various stakeholders and the adoption of ICT, we use the NRI in our model as one of the determinants of ICT exports. The effect of NRI on general economies and specifically on ICT exports have been analyzed by research across various countries: Russia (Kobzev, et al., 2020; Central and East European Countries (Akhvlediani, 2021); India

(Takkar & Sharma, 2021) to name a few. Given the importance of ICT as an infrastructure and enabler for digital goods and services, we include as pointed out in previous research as one of the explanatory variables in our model. Nasir and Kalirajan (2016) examine the ICT services export performances of emerging and developed Asian economies and find that the performances of these economies in terms of realization of export potential, are considerably weaker than those of developed economies in North America and Europe. They also show that the number of graduates and the quality of ICT infrastructure in emerging economies are among the key factors in realizing services export potential.

3.1.6. World demand for ICT services import

World demand for import of ICT services (SIMP) is a demand side variable that has been constructed for the purposes of this study. The measurement of world demand variable has varied across different studies, Sahoo, et al., (2013) list variables such as GNP or GDP, industrial production or the world demand for real import of services as various measures used across other studies. In this study we have considered the world demand for ICT services import as a measure of the demand for a country's export services as has been modeled in some of the recent research (Wang, 2021). To remove any possible endogenity between this variable and the country's ICT services export, we subtract the respective country's import from the World ICT Services import and include it as an explanatory variable in the model. In a related study, Sahoo, et al. (2013) have also used world demand for services import to explain services export.

3.2. The model and panel data

We constructed a panel data of the above dependent and independent variables collated from various sources for our analysis, the details of which are presented in Table 1. We did prior estimations with explanatory variables such as Tertiary Enrollment Ratio (TER), International Internet Bandwidth (IIB), and Employment Rate as pointed out in some of the previous research in this area. However, in all these models, none of the stated variables were significant and the model fit was poor. Hence we decided not to include these variables in our final model.

It is to be noted that the DTRI index is available only for one year and hence MDRI constructed from components of DTRI, is time invariant. This precluded the use of a fixed effects estimation of the panel data. Instead, we use the Correlated Random Effects (CRE) model as proposed in (Wooldridge, 2019). There are two reasons for using this approach of estimation: (i) it allows the inclusion of time invariant variables such as MDRI in the model; and (ii) it relaxes the assumption of no correlation between level 2 error and level 1 explanatory variables in the model as given below. The CRE model has been applied by a number of researchers where there is a variable that does not vary between clusters much like the MDRI in our case (Schunck, 2013; Roy, 2017).

The leading competitor to CRE model is the Fixed Effect (FE) model that treat heterogeneity as parameters to be estimated (Wooldridge, 2019). In FE model, time and group dummies are included for estimating the relevant parameters. Since we choose CRE over FE as preferred methodology, given the above reasons, we do not include any dummies in the CRE model.

Equation (2) below represents a CRE model:

$$Y_{it} = \beta_0 + \beta_1 x_{it} + \beta_2 c_i + \pi \overline{x_i} + v_i + \varepsilon_{it} \quad (2)$$

Table 1
Model variables and data sources.

Variable	Explanation	Source
I	Set of all countries ($\|I\| = 60$)	
T	Set of all time periods in years; $\|T\| = \{2006–2017\}$	
ICT services export$_{it}$	Information and Communications Technology (ICT) service exports of country *i* in time period *t* (USD million, inflation adjusted). ICT services are an aggregation of computer and telecommunications services. ICT services were defined by UNCTAD in a technical note in 2015 as well as in a report of the 47th United Nations Statistical Commission in 2016. The statistics presented correspond to the concepts and definitions of the IMF Balance of Payments and International Investment Position Manual, Sixth Edition (IMF, 2009). The data reported according to the fifth edition of the Manual (BPM5) have been adjusted to the BPM6 definitions, provided that such adjustment was possible.	UNCTAD (2020)
Market Data Restrictions Index$_i$	For each exporting country i, the index comprises of i-1 countries besides the exporting country *i* itself. MDRI from equation (1) has been rescaled on a 0 to 1 scale for ease of interpretation.	Authors' calculations as per Equation (1) (Ferracane, Lee-Makiyama, & van der Marel, 2018)
SVAD$_{it}$/GDP$_{it}$	Services value added (SVAD) (USD million) of country i at time t divided by GDP (USD million) of country i at time t	SVAD from UNCTAD (2020) and GDP from World Bank (2020)
FDI$_{it}$	Total Foreign Direct Investment (FDI) in country *i* at time *t* (USD million, inflation adjusted)	UNCTAD (2020)
REER$_{t-1}$	Real Effective Exchange Rate (REER) at time *t*-1	IMF (2020)
NRI$_{it}$	Networked Readiness Index of country *i* at time *t*	World Economic Forum (2020)
SIMP$_{it}$	World demand for ICT services import ((Total world imports of ICT services less the imports of the exporting country) (USD million, inflation adjusted)	Authors' calculations (UNCTAD, 2020)

The summary statistics of the independent and dependent variables are presented in Table 2.

Table 2
Summary statistics of dependent and explanatory variables.

S. No.	Variables	Descriptive Statistics			VIF
		Mean	Median	Standard Deviation	
1.	ICT Services Export (USD million)	159,709	71.142	2,42,000	–
2.	Market Data Restrictions Index	0.73	0.76	0.174	1.44
3.	SVAD/GDP	0.60	0.60	0.099	1.04
4.	FDI (USD million)	28,768	26,778	52,700	1.01
5.	Lagged REER	99.16	99.73	9.63	1.01
6.	NRI	4.51	4.42	0.873	1.01
7.	SIMP (USD million)	1,892,177	2,317,690	2,650,000	1.01

Here x_{it} is as a level 1 variable that varies across both countries I and time period T, c_i is a level 2 variable which is time invariant and varies only across countries. In our model, level 2 variable is MDRI while all the other explanatory variables are level 1 variables. $\bar{x}_i$ is the mean value of independent variable for a cluster i over time; v_i is the level 2 error and the random intercept and ε_{it} is the level 1 error. β_1 provides parameter estimates for within variation, β_2 provides estimates for the effect of time invariant variables and π is the parameter estimate of the between effect.

We also checked for multi-collinearity using Variance Inflation Factor (VIF) as indicated in Table 2. The values of VIF indicate the absence of multi-collinearity. The complete list of countries in our data set along with ranking based on their IT Services Export (World Bank, 2021) and their DTRI (Ferracane et al., 2018), is provided in Appendix 1. In addition, we have also included for each country, the income level and region of each country (World Bank, 2022), Internet freedom score (Freedom House, 2022), and the global freedom score ((World Bank, 2022).

3.3. Model estimation

We estimated the model specified in Equation (2) using a log-lin transformation (for details on log-lin transformations, please refer to Gujarati, 2012). We take the log transformation of the dependent variable – ICT Services Exports-so that we can estimate the percentage change in exports for a variation in the independent variables. Similarly, we apply log transformation to the numeric real independent variables, namely SIMP and FDI, so that we can estimate how a percentage change in these variables affect ICT services exports. However, for the ratio variable (i.e. SVAD/GDP) and the indices such as REER, NRI and MDRI, we use linear transformation so that we can estimate changes in the dependent variable due to unit increase in the value of these indices. As indicated earlier, we apply one-year lag for REER to account of delay in the effect of REER on the dependent variable.

Table 3 below presents the results of our model estimation. Apart from the high values of R^2 values that are indicative of a good model fit, two other important metrics namely Akaike's Information Criteria (AIC) and Bayesian information criteria (BIC) are also presented. These are unbiased estimates of the model prediction error and have been used by Goetghebeur et al., (2000) and Zhang and Davidian (2001) for validating the model fit. The lower the values of AIC and BIC, better are the model fits. The intra-class correlation coefficient (ICC) is a related statistic that quantifies the proportion of variance explained by a grouping (random) factor in multi-level/hierarchical data (Musca et al., 2011). Higher values of ICC in our model estimation indicates the total variation in the data that is accounted for by between-group (in our case, the between-country) variation.

Parameter estimates of within effects are positive and significant for lagged REER, SIMP, SVAD/GDP and FDI. It is to be noted that since MDRI is a level-2 variable, there is no parameter estimate for the same in within group effects. Between group effect estimates are positive and significant for SVAD/GDP, FDI and NRI at different levels of significance. The Market Data Restrictions Index is highly significant with a negative sign. This implies that a country facing higher data restrictions in the market, would have lower exports of ICT services, while countries that face fewer restrictions will have higher exports.

4. Results and discussion

Variables that are considered as traditional determinants of cross-border trade such as REER, SIMP, SVAD/GDP, FDI and NRI have significant effects on ICT exports either within or between countries. By incorporating all the variables that can have possible effect on ICT exports as supported by prior research, we control for these so that the effect of data policy restrictions can be accurately studied.

The MDRI has a significant negative influence on ICT exports as shown in the "between effects" column. Based on this, it can be concluded that countries facing higher data restrictions from their partner countries have lower exports than countries facing lower data restrictions. A detailed analysis indicates that a unit increase in the MDRI index decreases ICT services export by around 90 percent.[1] Since MDRI takes a value between 0 and 1, if importing partner countries move from free flow to highly restrictive regime, then the ICT services exports of the exporting country to importing partner countries are expected to hugely fall by around 90 percent. There are some limitations to the argument as MDRI is an index and hence unless all the importing partners of the exporting country increase in unison in MDRI, the effect on the exporting country will be minimal as found in our study. Nevertheless, the effect is

[1] % change in ICT Services Export = $(e^{(\text{regression coefficient of MDRI} \times \text{change in MDRI})} - 1) \times 100$.

Table 3
Model Results.

Correlated Random Effect model				
|I| = 60				
T = {2006–2017}				
Dependent variable: Log (ICT Services Exports)				
Model fit: Pseudo-R^2 (fixed effects) = 0.60; Pseudo-R^2 (total) = 0.99 AIC = −228.30; BIC = −164.19; ICC = 0.97				
Within Group Estimates				
Independent Variable	**Estimate**	**Standard Error**	**t-value**	**p-value**
Lagged REER	0.00***	0.00	4.49	0.00
SVAD/GDP	0.36**	0.19	1.89	0.05
Log (SIMP)	0.01***	0.00	3.01	0.00
Log (FDI)	0.00***	0.00	0.68	0.00
NRI score	−0.01	0.01	−0.50	0.62
Contextual/Between Group (between-country) Estimates				
Independent Variable	**Estimate**	**Standard Error**	**t-value**	**p-value**
Intercept	7.19	2.94	2.45	0.02
Lagged REER	−0.02	0.02	−0.95	0.34
SVAD/GDP	6.16***	1.60	3.84	0.00
Log (SIMP)	−0.09	0.08	−1.22	0.23
Log (FDI)	0.35***	0.09	4.15	0.00
NRI score	0.31*	0.19	1.64	0.10
Market Data Restrictions Index	−2.26***	0.83	−2.72	0.01

Level of significance *** (1%), **(5%), *(10%).

profound indicating the importance of data restrictions on ICT services export. Though our results are similar to the other recent published work such as Ferracane and van der Marel (2021) and UNCTAD (2021), we show evidence for the large ICT export services sector around the world.

The ICT exports are mainly Business-to-Business transactions that are contractual in nature between the client firm and the third-party firm that processes data. The data captured, stored and processed that use bilateral contracts for transfer between the entities of interest do not normally come under the scope of most of the data protection and data localization regulations (Sridhar, 2018). Hence, we expect that the impact of market data restrictions is expected to be more pronounced with the Business-to-Consumer (B2C) business growth. Unfortunately, due to lack of available accurate data on B2C business volume, we are constrained not to be include this in our analysis. However, It is estimated that global B2B e-commerce trade contributes to about 82 percent of the global e-commerce trade, with the rest contributed by B2C e-commerce, indicating thereby the larger contribution of B2B trade as compared to B2C trade (NTIA, 217).

Further, there can also be a lagged effect of the restrictions on data as has been seen in REER as well. Due to the lack of available data, we could not include time-series data for the market data restrictions variable with lagged values to account for the same. Lastly, as countries seek to regulate data in different ways, many other provisions in the purview of domestic regulations as well as intermediary liability and content access are being debated. As more of these are implemented their impact may also become more apparent and significant. The results of this study contribute towards a directional understanding of the probable impact of such measures.

Cross border data flow plays important role in digital economy, providing varied services in e-commerce, digital finance, education, transportation, healthcare, agriculture and so on. Despite the growth in digital economy driven by data oriented goods and services, it is pointed out in UNCTAD (2021) that appropriate data governance and an international data governance framework are still lacking. It is towards this that our work contributes to the existing literature on the effect of data policies on one of the important components of digital trade, namely ICT services export.

5. Conclusions and future research directions

This paper makes two unique contributions to the literature on impact of data related policies on trade, more specifically digital services exports. One, the paper has constructed an index to measure the data policy restrictions a country faces in the market using the restrictions on data cluster of the existing DTRI index. Two, the paper then estimates the impact of such restrictions on the digital services exports of a country along with the traditional variables that have been used in prior literature. The results indicate a negative impact of data policy restrictions on digital services exports.

Since DTRI as a measure of restrictions on digital trade that is time invariant, further research into the impact of a time varying measure of data policy restrictions would add more rigor to the understanding the impact of data restrictions on trade. Furthermore, trade being a bilateral process, regulations imposed by both the trading partners have a bearing on the volume of trade. As such it would be valuable to understand such interactions.

There are some limitations of this study. Since the DTRI is time-invariant and is available only as per Ferracane, Lee-Makiyama, and

van der Marel (2018), we could not take into account the lagged effect of data restrictions on the ICT services export. As European Centre for International Political Economy (ECIPE) regularly updates the Digital Trade Estimates dataset, it may be possible to include the market data restrictions as we have calculated over a time period and model the lagged effect for more accurate results. The set of countries for which the DTRI is available is also limited to 60. It is to be noted that these 60 countries contribute to about 51.3 percent if the world ICT trade and hence are good candidates for a detailed analysis on the impact of DTRI on ICT services export. Hence as data protection and data localization regulations are being embraced in many countries, the set of countries over which we can estimate the model can also expand and more accurate predictions of the impact can be determined.

The data trade restrictions affect consumer and producer surplus, either directly or indirectly. Study by Potluri et al. (2020) indicate that cross-border data flow restrictions limit choice of customers for services, but at the same time encourage development of local firms to compete with global firms. Further research is required to extend this work and understand the wider societal ramifications of cross border data restrictions.

It must be pointed out that there can be flow of raw data that are not linked to a specific exchange of good or service and shall not to be considered as part of digital trade (UNCTAD, 2021). On the other hand, some of the digital trade, especially in Information Technology services across countries may not be accompanied by large cross border data flows. Hence, our findings that the data restrictions impact negatively the ICT services export may not hold good for all types of services and needs to be explored further. Since such granular level of data on ICT exports is not available, our findings provide a first order explanation of the underlying phenomenon.

5.1. *Implications for public policy*

Recent Digital Economy Report 2021 by the United Nations Conference on Trade and Development (UNCTAD) states that data flows, either domestic or international, can bring many benefits and contribute to solving societal challenges, including those related to the Sustainable Development Goals (United Nations Conference on Trade and Development, 2021). The report also mentions that public policies regarding data flows including those related to data restrictions and localization are still evolving. It is also noted that the state of the international debate on how to regulate cross-border data flows is at an impasse, and positions tend to be polarized.

Data restrictions can also be considered as non-tariff barriers to trade and may invite retaliatory measures from trading partners. As more countries around the world are seeking to regulate the digital economy it is important to create an evidence base that informs policy makers on possible tradeoffs between free flow of data across borders and national data sovereignty. This paper is an attempt to contribute to the evidence base and identify areas of possible research. Our research in support of previous research shows that data restriction polices negatively affect ICT services export. However, as UNCTAD (2021) mentions, the nations adopt certain policies governing digital economy based on various factors such as: (i) encouraging innovation and creation of intellectual property; (ii) promotion of local economy and innovation; (iii) protecting individuals' freedom and privacy. Excessive data restrictions as pointed out by our study affect negatively ICT services export and in turn affect the economy of the countries.

Sridhar (2022) in a collection of essays point out that Datafication - the process of collecting and analyzing large amounts of digital data - is fueled by the extensive deployment and use of digital technologies in our daily lives. A pandemic such as COVID-19 that had devastated the whole world has further accelerated this process, as more and more people have continued, to the extent possible, with their activities through online channels – for example, for working, studying, communicating, selling and buying, or entertainment. Digital finance is playing larger role in the livelihoods of individuals not only in developed countries but also across the developing world as well (Srinivasan, 2022).

At this critical juncture, nations need to do a balancing act of preserving national security especially when international cyber-attacks loom, against promoting enablers of digital economy for the welfare of their societies. It is in this context, that our work provides a tool and data based evidence for and against excessive data restrictive policies for meeting sustainable development goals as pointed out in UNCTAD (2021).

A breakthrough in multilateral agreements in incorporating data policies in trade negotiations is the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) framework. Hodson (2019) argues that the CPTPP represents a significant advance on the General Agreement on Trade in Services (GATS) and strikes an appropriate balance between facilitating businesses' growing need to transfer and store data across national borders while preserving governments' right to regulate in the public interest. Hodson (2019) while acknowledging the limited nature of CPTPP that has only 12 of the 164 World Trade Organization (WTO) members, advocates for incorporating its framework for incorporating national data policies in GATS for wider reach of trading nations across the world.

5.2. *Other impact of data policies*

Data policies that place some restrictions on cross border data flow have substantial effects on non-trade dimensions as well. Governments that propose data flow restrictions in their data policies, often claim that forcing the global Internet firms to store personal information of consumers locally, would prevent foreign surveillance of their data subjects (Potluri et al., 2020). However, it is argued by Bauer et al., (2014) that privacy and security threats are often domestic, and that storing information in one physical location could potentially increase the vulnerability of digital services and their users. As Hill notes, storing data locally may give domestic intelligence agencies of the home country, increased power over their citizens' data including even coercion of its residents (Hill, 2014).

The free flow of information across the national boundaries enabled by the Internet, has also weakened the state control over

communication that cross national boundaries. The power of the citizen journalist and the online dissident as was witnessed during the Arab Spring in 2011, and their effects on state sovereignty are well studied (Lamer, 2012). The states often retort to restricting the communication flow across borders, showing thereby their communication sovereignty, as was evident in Internet shutdowns. India – one of the largest democracies in the world, witnessed 134 Internet shut-downs in 2018 alone (InternetShutDown.in, 2020). Such restrictions often impede freedom of speech and might violate the constitutional rights of citizens.

Apart from the economic indicators for economic development, Heeks and Renken (2018) point out issues regarding "data injustices" that lead to inequality and discrimination based on collection and processing of data. For example, discrimination based on data on social structure and religious beliefs violate basic human rights. Researchers have pointed out that there have been concerns, especially in developing countries, about the way that data infrastructure is used for generating data about low-income groups and communities, potentially leading to exploitation and economic and social exclusion (Flyverbom et al., 2017).

It is also advocated that given the importance of cross border data flows in the digital economy, formulation of adequate policies both at the national and international level is needed for the attainment of Sustainable Development Goals (United Nations Conference on Trade and Development, 2021). Since data has become a key economic resource for capturing value, its movement across borders, and the way in which data sovereignty is enforced by governments will play a very important role in developing both economic and social well-being of countries.

While data restriction policies of a country are self-imposed isolation from the rest of the world, "cyber sanctions" deal with partner countries restricting certain "flagged" data from or to a target country, thereby causing forced digital isolation of the target country. There are various levels of cyber sanctions that include a "cyber embargo" in the form of multilateral cyber sanctions against terrorist groups ((McNeal, 2006) to unilateral sanctions on "cyber diplomacy" (Hocking, 2005, pp. 28–43). It is pointed out by Iftimie (2019) that more research is needed to analyze cyber sanctions outside the purview of counter terrorism framework, especially as cyber space frees States from the many geographical and physical constraints. Recognizing the challenges in responding to cyber-attacks in June 2017, the European Union (EU) ministers of foreign affairs decided to endorse the development of a framework for a joint EU diplomatic response to malicious cyber activities – the so-called Cyber Diplomacy Toolbox (CDT). The primary intention behind the CDT is to develop reactive capacities at an EU and member state level with the aim to influence the behaviour of potential aggressors, taking into account the necessity and proportionality of the response (Moret & Pawlak, 2017). A detailed account of U.S. cyber sanctions and associated policies are documented in (Peters & MacConaghy, 2021).

Recognizing these multi-dimensional nature of cross border data flows and trade, UNCTAD (2021) indicates that taking extreme positions on free flow of data on one hand and severe restrictions on the other hand are not meaningful. A well thought out middle ground solutions are needed. UNCTAD (2021) advocates for the data policies to take holistic view by incorporating the diverse viewpoints of different stakeholders.

Data availability

Data will be made available on request.

Appendix

Table A1
Set of all countries included in our estimation

S. No.	Country	Income Level (World Bank, 2022)	Region (World Bank, 2022)	ICT Services Export Rank (World Bank, 2021)	DTRI Index (Ferracane et al., 2018) (low: less restrictive; high: highly restrictive)	Internet Freedom Score (0: least free; 100: most free) (Freedom House, 2022)	Global Freedom Score (low: not free; high: free) (Freedom House, 2022)
1	Argentina	Upper Middle	Latin America & Caribbean	43	0.17	71	84
2	Australia	High	East Asia & Pacific	22	0.25	75	95
3	Austria	High	Europe & Central Asia	20	0.21		93
4	Belgium	High	Europe & Central Asia	13	0.19		96
5	Brazil	Upper Middle	Latin America & Caribbean	30	0.15	64	73
6	Brunei Darussalam	High	East Asia & Pacific	59	0.38		28
7	Bulgaria	Upper Middle	Europe & Central Asia	47	0.14		79
8	Canada	High	North America	15	0.25	87	98

(continued on next page)

Table A1 (*continued*)

S. No.	Country	Income Level (World Bank, 2022)	Region (World Bank, 2022)	ICT Services Export Rank (World Bank, 2021)	DTRI Index (Ferracane et al., 2018) (low: less restrictive; high: highly restrictive)	Internet Freedom Score (0: least free; 100: most free) (Freedom House, 2022)	Global Freedom Score (low: not free; high: free) (Freedom House, 2022)
9	Chile	High	Latin America & Caribbean	44	0.04		94
10	China	Upper Middle	East Asia & Pacific	6	0.82	10	9
11	Colombia	Upper Middle	Latin America & Caribbean	54	0.23	65	64
12	Costa Rica	Upper Middle	Latin America & Caribbean	53	0.04	87	91
13	Croatia	High	Europe & Central Asia	41	0.11		85
14	Cyprus	High	Europe & Central Asia	46	0.14		93
15	Czech Republic	High	Europe & Central Asia	33	0.16		91
16	Denmark	High	Europe & Central Asia	19	0.35		97
17	Estonia	High	Europe & Central Asia	50	0.20	94	94
18	Finland	High	Europe & Central Asia	37	0.33		100
19	France	High	Europe & Central Asia	4	0.45	78	89
20	Germany	High	Europe & Central Asia	3	0.41	79	94
21	Greece	High	Europe & Central Asia	23	0.23		87
22	Hong Kong SAR, China	High	East Asia & Pacific	17	0.16		43
23	Hungary	High	Europe & Central Asia	34	0.30	70	69
24	Iceland	High	Europe & Central Asia	57	0.19	96	94
25	India	Lower Middle	South Asia	10	0.31	49	66
26	Indonesia	Lower Middle	East Asia & Pacific	40	0.44	48	59
27	Ireland	High	Europe & Central Asia	12	0.20		97
28	Israel	High	Middle East & North Africa	32	0.18		76
29	Italy	High	Europe & Central Asia	9	0.31	76	90
30	Japan	High	East Asia & Pacific	7	0.04	76	96
31	Korea, Rep.	High	East Asia & Pacific	16	0.39		83
32	Latvia	High	Europe & Central Asia	51	0.20		88
33	Lithuania	High	Europe & Central Asia	52	0.34		89
34	Luxembourg	High	Europe & Central Asia	18	0.20		97
35	Malaysia	Upper Middle	East Asia & Pacific	39	0.35	58	50
36	Malta	High	Middle East & North Africa	48	0.22		89
37	Mexico	Upper Middle	Latin America & Caribbean	35	0.26		60
38	Netherlands	High	Europe & Central Asia	5	0.13		97
39	New Zealand	High		42	0.22		99

(*continued on next page*)

Table A1 (*continued*)

S. No.	Country	Income Level (World Bank, 2022)	Region (World Bank, 2022)	ICT Services Export Rank (World Bank, 2021)	DTRI Index (Ferracane et al., 2018) (low: less restrictive; high: highly restrictive)	Internet Freedom Score (0: least free; 100: most free) (Freedom House, 2022)	Global Freedom Score (low: not free; high: free) (Freedom House, 2022)
			East Asia & Pacific				
40	Nigeria	Lower Middle	Sub-Saharan Africa	58	0.23	59	43
41	Norway	High	Europe & Central Asia	25	0.13		100
42	Pakistan	Lower Middle	South Asia	55	0.30	25	37
43	Paraguay	Upper Middle	Latin America & Caribbean	60	0.16		65
44	Peru	Upper Middle	Latin America & Caribbean	56	0.22		72
45	Philippines	Lower Middle	East Asia & Pacific	39	0.11	65	55
46	Poland	High	Europe & Central Asia	26	0.27		81
47	Portugal	High	Europe & Central Asia	31	0.22		81
48	Romania	High	Europe & Central Asia	38	0.27		83
49	Russian Federation	Upper Middle	Europe & Central Asia	24	0.63	30	19
50	Singapore	High	East Asia & Pacific	14	0.25	54	47
51	Slovak Republic	High	Europe & Central Asia	45	0.19		90
52	Slovenia	High	Europe & Central Asia	49	0.18		90
53	South Africa	Upper Middle	Sub-Saharan Africa	36	0.20	73	79
54	Spain	High	Europe & Central Asia	8	0.30		90
55	Sweden	High	Europe & Central Asia	21	0.26		100
56	Switzerland	High	Europe & Central Asia	11	0.25		96
57	Thailand	Upper Middle	East Asia & Pacific	27	0.29	36	29
58	Turkey	Upper Middle	Europe & Central Asia	38	0.60	34	32
59	United Kingdom	High	Europe & Central Asia	2	0.31	78	93
60	United States	High	North America	1	0.15	75	83

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