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**Impacts of Internet use on trade:**

**New evidence for**

**developed and developing countries**

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**Abstract**

This paper investigates the impact of Internet use on bilateral trade flows using a gravity model and panel data for the period 1996–2014. First, we test the positive influence of Internet use on exports for aggregate data. Second, we test the impact of Internet use on bilateral flows separately for high-income countries and low- and middle-income countries. We find a significant and positive relationship between the Internet and bilateral exports for both groups of countries. The results also show that the impacts vary from 0.03% to 0.13% depending on the levels of income. Unlike previous studies, our findings suggest that the effect of Internet use is greater for bilateral trade flows among high-income countries. We contribute to the literature by investigating the differentiated impacts of Internet use for high-income economies and low- and middle-income countries. Our study uses panel data and covers the period of the greatest Internet diffusion.

**Keywords**: Exports, Internet, ICT, gravity model, digital divide

## 1. Introduction

The globalization process in recent decades has been characterized by both the growth of international trade and the expansion of the ICT diffusion process. This evolution has attracted significant attention from researchers interested in learning about the possible links between the two phenomena. Figure S1 (available online) shows the index numbers of export growth for the period 1996–2014. According to the World Bank, the total value of world exports in 2014 was three and a half times the export value in 1996 (index number of 355%), and the export value has multiplied threefold for rich countries and 6.2 times for low- and middle-income countries. In the same period, the percentage of total Internet users grew from 1.3% in 1996 to 39.9% in 2014 (Figure S2, available online). This rate increased from 6.7 to 78.5 Internet users per 100 inhabitants in high-income countries and from 0.1 to 32.4 in low- and middle-income ones.

From a theoretical perspective, the effects of ICT on trade have been explored based on the role of the impacts of trade costs on trade flows (Krugman 1985; Venables 2001). ICT and Internet use, in particular, facilitate access to information and the transmission of knowledge about markets, products and agents. By reducing transport costs associated with distance, information and communication costs and, in general, entry costs to new markets (Anderson and van Wincoop 2004; Fink, Mattoo, and Neagu 2005), ICT use may boost international trade. The cost reduction associated with Internet use may be influenced by several factors, such as the stage of the ICT diffusion process, trade specialization and other features associated with the level of economic development (Allen 2014; Clarke and Wallsten 2006; Demirkan et al. 2009; Vemuri and Siddiqi 2009). The academic literature has also investigated how ICT use may have different impacts on reducing the trade costs associated with the role played by geographical distance (Bojnec and Fertö 2009; Kauffman and Kumar 2008; Venables 2001).

The empirical studies, usually employing a gravity model framework, have shown that there is a positive relationship between ICT use and trade (Clarke and Wallsten 2006; Freund and Weinhold 2002, 2004; Vemuri and Siddiqi 2009). Many studies covering some years in the previous decades have employed cross-sectional data and focused on developed countries (Freund and Weinhold 2002; Yushkova 2014) or developed and developing economies (Clarke and Wallsten 2006; Marquez-Ramos and Martínez-Zarzoso 2005; Xing 2018). Other scholars using panel data have investigated either developed economies (Bojnec and Fertö 2009) or developing ones (Adjasi and Hinson 2009; Liu and Nath 2013; Ozcan 2018). However, the papers covering both developed and developing economies using panel data have no differentiated Internet use effects according to income levels (Freund and Weinhold 2004, Vemuri and Siddiqi 2009). Finally, the few studies that have investigated the impacts of Internet use on trade at the firm level (Clarke 2008; Yadav 2014) have also found a positive influence on exports.

Recent academic works have explored the impacts of technology use on trade by considering the existence of information asymmetries that can distort trade relationships, given the existence of search costs in new markets. Researchers obtain that Internet use may reduce information asymmetries by lowering matching frictions associated to search costs between producers and consumers, which are especially important for developing countries for which information frictions could be greater (Allen 2014). The impacts of information asymmetries are also higher for trade of differentiated products (Rauch 1999) and the effect of internet use might be greater in reducing information frictions, depending on trade composition (Akerman, Leuven, and Mogstad 2018). In a similar vein, the evidence also points to the role played by ICT use in reducing coordination and information costs related to the more and more complex processes of the fragmentation of production within the Global Value Chains framework (GVCs) (Baldwin 2016). The effects of ICT use on reducing information frictions in a context of increasing complexity and product differentiation and growing role of intermediate products in international trade associated to GVCs´ participation, motivate the interest to explore the differences in internet use impacts on bilateral trade flows for different groups of countries.

In this context, this study aims to analyze the impacts of the Internet on bilateral flows for both developed and developing countries. First, we test the hypothesis that Internet use positively influences trade at the aggregate level in the years of greatest expansion of Internet diffusion according to the available data. Second, we explore the existence of different impacts of Internet use on trade in bilateral flows according to income levels. In particular, we are interested in testing whether Internet use shows greater effects on bilateral flows for developing countries, as determined previously by some scholars (Clarke and Wallsten 2006; Demirkan et al. 2009; Márquez-Ramos and Martínez-Zarzoso 2005) or whether, in contrast, the higher impact corresponds to high-income countries, given their higher levels of ICT diffusion, trade composition and their role in GVCs´. We use a gravity model approach with panel data for the period 1996–2014 and for 121 countries.

The paper makes four major contributions to the literature on the effects of ICT on trade. First, it contributes to the understanding of the ICT effects on bilateral trade in the period of greatest Internet diffusion for both developed and developing countries (1996–2014). Second, we not only analyze the effects of Internet use on aggregate trade but also investigate the impacts by disaggregating the analysis by income levels. Third, by using panel data we overcome some methodological issues, such as the omitted variable bias present in cross-sectional studies (Egger 2000). In addition we tackle endogeneity and reverse causality issues by using lagged variables as instruments and the Hausman–Taylor methodology. Fourth, we study the role of trade composition to explain the effect of Internet use on trade.

The rest of the article is organized as follows. Section 2 provides the literature review on ICT impacts on bilateral trade flows. Section 3 presents the research model and variables. Section 4 focuses on methodological issues and data. Section 5 shows the main findings of our research. We finish the paper with some conclusions and discussions in Section 6.

## 2. Literature review

The effects of ICT on trade have been investigated in the academic literature from a theoretical perspective based on their impacts on trade costs. ICT may boost exports by reducing shipping costs, search and time costs and entry barriers into new markets (James 2002; Venables 2001). As general-purpose technologies (GPT) (Helpman and Trajtenberg 1998), ICT and Internet use, in particular, facilitate the search for information and its acquisition, management, processing and analysis. In this sense, ICT and the Internet, in particular, contribute to low information frictions caused by the effect of imperfect information on trade patterns (Akerman, Leuven, and Mogstad 2018; Allen 2014; Rauch 1999), so enabling access to information and the transmission of knowledge about markets, products and agents. Companies that use the Internet may expand their quality of communication while communicating faster and more cheaply, since its use improves communication between customers and suppliers, so reducing the fixed costs associated with information and communication (Fink 2005; Freund and Weinhold 2002; Harris 1995). ICT also favors the reduction of entry costs into new markets (Adjasi and Hinson 2009; Freund and Weinhold 2004) by reducing bargaining and management costs (Demirkan et al. 2009; Venables 2001) as well as the coordination costs of dispersed production processes (Baldwin 2016; Venables

2001). Internet use may also influence transport costs, since these technologies are frequently associated with organizational changes that affect shipping costs (Freund and Weinhold 2002; Venables 2001). Furthermore, ICT may enhance expansion and market diversification (Harris 1995; Petersen, Welch and Liesch 2002) and even change the geographical patterns in the internationalization process (Akerman, Leuven, and Mogstad 2018; Allen 2014; Yushkova 2014). By fostering technological diffusion, Internet use also favors the development of new products and processes, new business models and new ways of cooperating among firms that may lead to increasing international interactions (Osorio-Urzua 2008).

Researchers have usually investigated the impact of Internet use on trade flows by employing bilateral trade data using gravity models. Most of the studies found a positive effect of some technologies on trade flows. However, there are considerable differences regarding samples, time and geographical scope and methodological issues, and only a few studies explore the differences in bilateral flows between developed and developing countries. Early studies referred to a very early stage of the ICT diffusion process and investigated ICT impacts on trade using cross-sectional data. In addition, most of the researchers used Internet hosts as an ICT measure (Clarke and Wallsten 2006; Freund and Weinhold 2002, 2004). Clarke and Wallsten (2006), using quasi-bilateral trade data for 2001 and a sample of 52 developed and 46 developing countries, found that Internet hosts increase exports from developing countries, while no effect was found for bilateral trade flows from high-income countries. In subsequent studies, scholars have employed diverse variables that range from an ICT index to internet users finding positive effects on exports.

Most of the papers using panel data have investigated the effects either in OECD countries or in other areas separately (Adjasi and Hinson 2009; Bojnec and Fertö 2009; Liu and Nath 2013, 2017; Ozcan 2018; Xing 2018). In general, the academic literature has demonstrated asymmetric impacts of technological development on trade for developed and developing countries (Flam and Helpman 1987; Krugman 1985). There is also evidence that differences in ICT diffusion patterns appear to be associated with differences in development levels (Dewan, Ganley, and Kraemer 2005; Lechman 2015). In addition, the impacts of ICT vary across countries at different stages of development and ICT readiness (Demirkan et al. 2009). According to the available literature, ICT effects will depend on the relevance of different types of costs on trade flows and on how ICT influences their reduction. On the one hand, we might expect high-income countries to benefit the most from cost reduction due to the fact that these countries are more open to trade and exhibit higher levels of Internet usage (Clarke and Wallsten 2006). In addition, as mentioned earlier, their trade composition and participation in GVCs might imply that high-income economies could benefit to a higher extent than less developed economies from the reduction in information frictions and coordination costs due to ICT use. On the other hand, the literature has also highlighted that geographical distance decreases trade flows, mainly shipping and communication costs (Fink, Mattoo, and Neagu 2005; Venables 2001). The literature has also emphasized that the Internet may reduce the major role given to the influence of distance (Berthelon and Freund 2008; Demirkan et al. 2009; Kauffman and Kumar 2008). Considering that part of the impacts of ICT on cost reduction may be related to the decreased importance of distance (Kauffman and Kumar 2008), some authors have hypothesized that the impacts of Internet use might rise as the distance increases (Demirkan et al. 2009). According to these authors, the benefits in terms of cost reduction and therefore larger bilateral trade flows would be greater for those developing countries exhibiting higher levels of Internet use rather than developed ones located closer. In contrast, other researchers (Akerman, Leuven, and Mogstad 2018) obtain that the information frictions reduction due to the impacts of ICT use – in particular, broadband internet use by Norwegian firms over the period 2000–2008 – increases trade elasticity with respect to distance by 0.12.

The studies that included both developed and developing countries were mostly cross-sectional studies. Márquez-Ramos and Martínez-Zarzoso (2005) found for the year 1999 that technology, measured by a technological index, shows a greater impact on trade flows in their exports for poor countries than for rich ones. These authors also determined that the impact of technology is larger than the role of geographical distance and that this variable is more important for poor than for rich countries. In the above-mentioned study, Clarke and Wallsten (2006) showed that the effect of Internet use is much stronger for exports in developing countries than those in the developed world. They found that poor countries export more to rich countries when the level of Internet penetration is higher. However, they did not establish that Internet use increases the exports of developed countries. Their possible explanation is that the use of the Internet in manufacturing firms in rich countries is so extended that it does not imply any advantage, whereas in less developed countries there is a small number of connected companies that benefit from the cost reduction associated with ICT impacts on reducing the role of distance to developed markets. Finally, Demirkan et al. (2009) found that ICT use has a greater impact on trade among smaller economies than among larger ones for the year 2005. They also ascertained that more distant trading partners experience more trade in the presence of ICT than closer countries. The estimation results suggest that Internet use among smaller economies significantly contributes to larger trade flows. Interestingly, distance seems to play the greatest role in limiting trade among the smaller economies, but the Internet helps to decrease the limitation imposed by distance.

Although Vemuri and Siddiqi (2009) used panel data to compare trade before and after the expansion of the Internet for 64 developed and developing countries and for the period 1985–2005, they did not differentiate the impacts according to development levels. These authors determined that a factor comprising telephone lines, personal computers and Internet users has a positive influence on trade.

To sum up, most of the empirical evidence indicated a positive impact of the Internet on trade. However, there are important differences regarding the time periods covered and the methodology employed, the exceptions being the study by Clarke and Wallsten (2006) for the year 2001 and that of Demirkan et al. (2009), who differentiated between larger and smaller economies, being differences in income per capita the traditional criteria to differentiate countries. The rest of the studies, despite using panel data, did not differentiate bilateral trade flows among countries, nor did they consider the recent years of greater ICT diffusion.

## 3. Research model and variables

We next state our research questions and specify the conceptual model for our empirical analysis. First, we consider the various effects of Internet use on trade costs to test whether Internet use exerts a positive impact on exports. Second, we take into account the idea that the Internet may affect trade flows differently according to income levels. In this regard we aim to test whether Internet use shows a greater impact on bilateral developing countries' exports in comparison with those of developed economies in line with the results obtained by some previous studies (Clarke and Wallsten 2006; Demirkan et al. 2009).

Following previous literature, our research model is based on the gravity equation, which, as mentioned, has been successfully employed in the academic literature to investigate bilateral trade flows. Within the standard gravity trade model it is assumed that bilateral trade is positively associated with country size and negatively associated with distance (Berthelon and Freund 2008; Pöyhonen 1963; Tinbergen 1962). In its augmented version, we also consider other additional variables that are commonly included in these types of trade models, such as population, institutional and economic factors that might improve the explanation of the variation in bilateral trade. Our model specification tries to capture most of the relevant effects explaining trade flows to avoid bias due to misspecification and omitted variables deficiencies. To this aim, the model also includes controls to capture the influence on bilateral trade of the existence of trade barriers from the rest of the trading partners, and also to avoid omitted variable bias.

$$\ln EX_{ijt} = \beta_0 + \beta_1 \ln IU_{i,t-1} + \beta_2 \ln IU_{j,t-1} + \beta_3 \ln GDP_{i,t-1} + \beta_4 \ln GDP_{j,t-1} + \beta_5 \ln POP_{i,t-1} + \beta_6 \ln POP_{j,t-1} + \beta_7 RTA_{ij,t-1} + \beta_8 \ln DIST_{ij} + \beta_9 ADJ_{ij} + \beta_{10} LANG_{ij} + \beta_{11} COL_{ij} + \varphi_i + \varphi_j + \gamma_t + \eta_{ij} + \nu_{ijt} \quad (1)$$

where subscripts $i$, $j$ and $t$ denote the exporter country, importer country and time, respectively. The dependent variable, $EX_{ijt}$, denotes the bilateral exports from country $i$ to country $j$ in year $t$. $IU_{it}$ and $IU_{jt}$ are the Internet users per 100 people in countries $i$ and $j$, respectively. This variable captures Internet use and is expected to be positively related to exports due to lower trade costs, as previously mentioned (Clarke and Wallsten 2006; Demirkan et al. 2009; Freund and Weinhold 2004; Vemuri and Siddiqi 2009).

$GDP_{it}$ and $GDP_{jt}$ are the nominal GDP of the exporting and importing countries, respectively. $POP_{it}$ and $POP_{jt}$ are the total population of the exporting and importing countries, respectively. According to Marquez (2016), population variables are usually added to gravity models to capture a different effect depending on the coefficient: an absorption effect negatively related to trade, when large countries export less, or economies of scale, positively related to trade, denoting how small countries export less than large countries.

$RTA_{ijt}$ is a dummy variable included to capture whether $i$ and $j$ are both members of a regional trade agreement in year $t$, given the wide range of literature that has highlighted the positive effect of trade agreements on exports (Baier and Bergstrand 2007). The RTA control variable has been taken from De Sousa (2012) and takes into account the existing regional trade agreements all over the world. We introduce several variables lagged by one year to deal with the potential endogeneity issues that are discussed in the next section: Internet users (IU) (Bojnec and Fertö 2009; Freund and Weinhold 2004; Liu and Nath 2013); GDP (Vemuri and Siddiqi 2009; Olivero and Yotov 2012); and regional trade agreements (RTA) (Baier and Bergstrand 2007). $DIST_{ij}$ stands for the bilateral distance. As noted, this variable is usually introduced as a proxy for transportation costs, and it is assumed that distance implies higher bilateral trade costs. The reduction in costs is assumed to have a positive impact on trade flows (Anderson and Van Wincoop 2003; Tinbergen 1962). Adjacency ($ADJ_{ij}$) is included following the assumption that transport costs are lower for neighboring countries, and thus it facilitates bilateral trade (Anderson and Van Wincoop 2003; Freund and Weinhold 2002; Kauffman and Kumar 2008). This variable takes the value 1 if the two countries share a common border and 0 otherwise. Sharing a common language ($LANG_{ij}$) favors the communication and business relationships among firms and agents, enabling information to be exchanged about suppliers and customers, firms and agents (Melitz 2008; Melitz and Toubal 2014). It takes the value 1 if the two countries share a common language and 0 otherwise. The existence of former colonial links ($COL_{ij}$) increases the current bilateral exports because both countries can benefit from the trade relations established during the colonization (Head, Mayer, and Ries 2010; Nunn and Trefler 2014). The variable takes the value 1 if the two countries shared past colonial links, and 0 otherwise.

Finally, the terms $\varphi_i$ and $\varphi_j$ represent the exporter and importer country fixed effects to control for the particular characteristics of each country. Additionally, $\gamma_t$ corresponds to time effects, which are included to control for the effects of cyclical changes on bilateral exports. $\eta_{ij}$ corresponds to the bilateral country-pair effects that control for unobserved characteristics that influence bilateral trade flows between countries. These variables are added to avoid omitted variable bias. $v_{ijt}$ is the idiosyncratic error term.

Control variables for country fixed effects are added to the gravity equation to capture third-country effects affecting the bilateral relationship, given that they are the easiest and most efficient alternative over other methodologies (Feenstra 2016). These third-country factors are defined as Multilateral Resistance Terms (MRTs) in the gravity equation proposed by Anderson and Van Wincoop (2003) and constitute a pivotal element of the gravity equation. The most recent specification of the gravity equation, the structural gravity equation defined by Head and Mayer (2014), requires the correct implementation of MRTs to be consistent with the theoretical roots of gravity. In a context of panel data incorporating the dimension of time, however, a correct specification of the gravity equation consistent with the roots of the latter structural gravity requires incorporating control variables for exporter and importer-time fixed effects, so extending the time-invariant fixed effects in cross-section data (Olivero and Yotov 2012). These time-varying fixed effects present an important feature, since they capture the effect of strategic variables like IU, our variable of interest, or GDP and POP, which are expelled from the model. This fact has been pointed to as a major shortcoming by some authors (WTO and UNCTAD. 2012; Marquez 2016). Other alternatives to capture MRTs like remoteness indices or the Bonus Vetus OLS defined by Baier and Bergstrand (2009) are criticized by Head and Mayer (2014) for not fitting accurately with the structural gravity framework. Given the aim and nature of our data, the gravity model proposed in (1) is estimated following an approach of separate exporter, importer and time effects. This approach allows us to evaluate the effects of time-varying explanatory variables when they constitute the interest of research (WTO and UNCTAD 2012). In addition, we prove in Section 5 that our results are robust to trade flow heteroskedasticity, as well as to exporter-time and importer-time fixed effects of the structural gravity equation.

## 4. Methodology and data

The analysis of time series and cross-sectional data requires the application of an appropriate methodology. The panel data technique allows us to estimate a model that takes into account the unobserved heterogeneity (i.e. the unobservable specific bilateral effects) that otherwise would bias the pooled estimates. The original specification of the linear panel data model in the framework of the gravity equation is

$$y_{ijt} = \mathbf{x}'_{ijt}\boldsymbol{\beta} + \eta_{ij} + v_{ijt} \qquad (2)$$

where $y_{ijt}$ is the log of the bilateral exports from country $i$ to country $j$, $\mathbf{x}_{ijt}$ is a vector of $k$ regressors, $\boldsymbol{\beta}$ is the parameter vector to estimate, $\eta_{ij}$ is the unobservable individual effect (the bilateral effect from the $ij$ country pair) and $v_{ijt}$ is the idiosyncratic error term. Considering the sum of $\eta_{ij} + v_{ijt}$ a compound disturbance, named $\varepsilon_{ijt}$, (2) can be written as (Arellano and Bond 1991)

$$y_{ijt} = \mathbf{x}'_{ijt}\boldsymbol{\beta} + \varepsilon_{ijt} \qquad (3)$$

Under this framework, there are two sources of endogeneity in panel data models. On the one hand, the latent component, $\eta_{ij}$, may or may not be correlated with the observable explanatory variables, $x_{ijt}$. The model specification will be assessed with the Breusch–Pagan (1980) and Hausman (1978) tests. If the bilateral effects are correlated with the regressors, the random-effects (RE) model approach does not yield consistent estimations, whereas the fixed-effects (FE) model provides unbiased estimates of the parameters while solving the endogeneity problem.

The FE model obtains consistent estimates by applying data transformation that removes the time-invariant country pair effects from the model. However, this clear advantage of the FE model raises some drawbacks, since any time-invariant variable is also expelled from the model. As a consequence, the FE model does not allow us to estimate the impact of some relevant bilateral variables in the gravity equation, such as distance, adjacency or language. The Hausman–Taylor (1981) approach (henceforth, HT) is an alternative that has been used by several authors to estimate gravity models (Egger 2002; Gallego and Llano 2014; Vemuri and Siddiqi 2009). The HT approach is a two-step estimation procedure based on the instrumental variables technique and the generalized least squares (GLS) transformation of the variables. The two-step procedure allows us to estimate both time-varying and time-invariant regressors. Another advantage of the HT method is its hybrid nature between fixed- and random-effects models, which leads to consistent estimations of regressors that are correlated and uncorrelated with the unobservable country pair effects. In our model we consider IU, GDP and RTA to be potentially related to the unobserved bilateral effects.

On the other hand, another source of endogeneity appears when the observable variables are correlated with the time-varying error term, $v_{ijt}$, which may be due to various causes. In the literature on ICT impacts on trade within the gravity model framework, some studies have taken into account the omitted variable bias (Clarke and Wallsten 2006; Freund and Weinhold 2002; Liu and Nath 2013). Additional causes of endogeneity are related to the reverse causality issue (Adjasi and Hinson 2009; Bojnec and Fertö 2009; Clarke and Wallsten 2006; Freund and Weinhold 2002, 2004). Those countries that are more open to trade also exhibit higher levels of Internet use, leading to a causal relationship in which the direction of the causation is not clear (Clarke and Wallsten 2006). Moreover, it has been demonstrated that higher levels of digitalization and therefore of

Internet use are related to high income levels (Billón, Marco, and Lera-Lopez 2010; Dewan, Ganley, and Kraemer 2005). This has led some authors to consider the GDP as endogenous (Olivero and Yotov 2012; Vemuri and Siddiqi 2009). Finally, the effect of RTAs on bilateral trade has traditionally been demonstrated to present endogeneity bias (Baier and Bergstrand 2007).

Therefore, our model specification takes into account the fact that some regressors may be endogenous in the sense that $x_{ijt}$ is correlated with $v_{ijt}$ and earlier shocks but $x_{ijt}$ is uncorrelated with $v_{ij,t+1}$ and subsequent shocks. We assume that these regressors are predetermined, meaning that $x_{ij,t-1}$ and $v_{ijt}$ are uncorrelated but $x_{ij,t-1}$ may still be correlated with $v_{ij,t-1}$ and earlier shocks. In this way, lags naturally become the instrumental variables that allow us to identify the parameters of interest. It should be noticed that incorporating lagged regressors (to avoid endogeneity with respect to the $v_{ijt}$ term) does not avoid these regressors being correlated with the time-invariant country pair effect, $\eta_{ij}$. As the model has potential doubly endogenous regressors, we propose to estimate the gravity equation by the HT approach, where IU, GDP and RTA are considered correlated with the fixed bilateral effects, as well as they are instrumented by their lags.

We use panel data for the period 1996–2014, which is large enough to capture the effects concerning ICT diffusion and yet short enough to implement the functional form (1) concerning exporter and importer fixed effects. We include a representative sample of high-income and low- and middle-income countries according to the World Bank's classification. The total number of countries is 121.

A full list of the countries considered in the analysis and their classification by income levels is shown in Table S1 (available online). The information on bilateral exports is from UN Comtrade, while countries' GDPs are from the World Bank. The data on Internet users are from the World

Bank–ITU, and the data on distance, adjacency, common language and colonial links are from the *Centre d'Études Prospectives et d'Informations Internationales* (CEPII). A description of all the variables, units and data sources is displayed in Table S2 (available online). The panel is unbalanced, and given that trade flows are aggregate and that we do not differentiate product varieties, the database does not contain zeros for the dependent variable. The total number of combinations of exporter and importer pairs is 13,961, and total observations were 199,115. Table S3 (available online) shows the main descriptive statistics for all the variables.

## 5. Empirical analysis

### *5.1. Model specification*

Table S4 (available online) reports the results for alternative estimation methods to check the specification of the research model presented in (1) as a baseline. The comparison of the HT estimates with other methods also allows us to assess the robustness of the results.

As a starting point, we consider the non-existence of unobservable heterogeneity in the model and apply a pooled ordinary least squared (POLS) estimator (column 1). The Breusch–Pagan Lagrange multiplier test on individual effects was performed. The null hypothesis is rejected ($p$-value < 1%; see column 1). This outcome indicates the existence of an unobservable component of the variance related to each individual, which implies that any approach that does not take into account the unobservable bilateral effects would provide biased estimations. The random-effects model (REM) procedure (column 2) assumes that unobservable country pair heterogeneity exists but is uncorrelated with the regressors. Compared with the POLS estimates, the main changes obtained in this second case are the higher coefficient values of Internet users and countries' GDP.

We continue by applying Hausman's test to assess whether the unobservable bilateral effects are actually orthogonal to the explanatory variables (see column 2). The null hypothesis is rejected (*p*-value < 1%), so significant differences across the FE and RE estimates exist due to latent individual effects correlated with the regressors. This implies a problem of endogeneity bias under the REM approach. The specification tests validate the endogeneity assumptions with respect to $\eta_{ij}$, which we formulated in the gravity equation.

The HT procedure using exporter and importer fixed effects is carried out and reported in column 3. We consider Internet users, the GDP in exporter and importer countries and the RTA agreements as potentially related to the country pair effects. The remaining variables included in equation (1) are considered as exogenous regressors. It should be noted that the time-invariant explanatory variables (distance, adjacency, common language and colonial) would be expelled from the model following the traditional FE procedure, but the estimates of Internet users, GDPs and RTA would be the same under HT and FE approaches since these time-variant variables are considered correlated with the fixed effects.

We use the remaining columns 4-6 to prove how the specification mentioned in (1) is consistent with heteroskedasticity problems, as well as with the postulates concerning structural gravity equation and MRTs.

We incorporate in column 4 the estimates using the Pseudo-Poisson Maximum Likelihood approach (henceforth, PPML) with exporter-time and importer-time effects in order to comply with the structural gravity equation and MRTs. Although our database does not present issues related to zero trade values, heteroskedasticity problems may arise due to the logarithmic transformation of the variables, in line with the advantages for using PPML estimator mentioned in Santos-Silva and

Tenreyro (2006). Besides, we extend this PPML specification by incorporating bilateral time-invariant pair effects in column 5.

We demonstrate in column 4 how our results are also consistent with the structural gravity framework incorporating exporter-time and importer-time fixed effects. Due to collinearity problems, we present certain time-varying variables, such as POP or GDP, in dyadic terms. Dyadic terms allow us to evaluate whether the coefficients' sign and level of significance are coherent in both the exporter and the importer country simultaneously. However, dyadic terms do not allow us to evaluate effects of time-varying variables for exporter and importer countries separately. Therefore, we interact the variable of Internet users with the distance in order to obtain separate estimates for the exporter and importer countries. We also evaluate the HT estimator in presence of a high number of dimensional time-varying fixed effects (column 6).

It should be mentioned that the estimation techniques seem to affect the magnitude but not the sign and relevance of the explanatory variables. Population is the exception since it is not significant when expressed in dyadic terms (columns 4, 5 and 6). However, this result could be expected as population elasticities show contrary signs for exporter and importer countries (columns 1, 2 and 3). As expected, Internet users in both exporter and importer countries increase bilateral flows. In addition, the Internet variables remain positive and significant in columns 4 and 5 when they are interacted with the distance under the PPML approach, complying with the structural gravity equation and MRTs. As shown, the interactive terms for exporters ($\text{lnIU}_{i,t\text{-}1} \cdot \text{lnDIST}_{ij}$) and importers ($\text{lnIU}_{j,t\text{-}1} \cdot \text{lnDIST}_{ij}$) point to internet use reducing the negative impact of distance on bilateral trade. The only exception is Internet users in the importer country, which is positive but not significant in the presence of pair effects (column 5). A similar result is observed for the country sizes. Meanwhile, distance reduces bilateral exports. Other gravity variables, such as colonial past or language, are also highly significant.

Once the model specification is assessed, the HT approach with lagged endogenous regressors incorporating exporter, importer and time effects (column 3) is the procedure selected to analyze the gravity equation segmented by income. This procedure is robust to the different challenges of the gravity equation presented in our analysis and allows us to interpret separate effects of the policy variable, IU, for the exporter and the importer country separately.

### *5.2 Gravity equation results segmented by income levels*

Table 1 displays the results for the HT estimator disaggregated by income levels for the period 1996–2014.

Table 1. Gravity equation results disaggregated by income levels under HT estimator

| *Columns* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
|---|---|---|---|---|---|---|---|---|---|
| *Exporter´s income:* | All | *High* | *High* | *Low and middle* | *Low and middle* | *Low and middle* | *All* | *All* | *High* |
| *Importer´s income:* | All | *High* | *Low and middle* | *High* | *Low and middle* | *All* | *High* | *Low and middle* | *All* |
| ln $IU_{i,t-1}$ | 0.072*** | 0.127*** | 0.080*** | 0.038*** | 0.024* | 0.030*** | 0.054*** | 0.088*** | 0.100*** |
| | *(0.005)* | *(0.011)* | *(0.012)* | *(0.012)* | *(0.013)* | *(0.009)* | *(0.007)* | *(0.007)* | *(0.008)* |
| ln $IU_{j,t-1}$ | 0.055*** | 0.086*** | 0.079*** | 0.047*** | 0.040*** | 0.061*** | 0.065*** | 0.060*** | 0.052*** |
| | *(0.004)* | *(0.010)* | *(0.007)* | *(0.016)* | *(0.011)* | *(0.007)* | *(0.010)* | *(0.006)* | *(0.005)* |
| ln $GDP_{i,t-1}$ | 1.297*** | 1.436*** | 0.886*** | 1.513*** | 1.278*** | 1.402*** | 1.542*** | 1.075*** | 1.122*** |
| | *(0.028)* | *(0.046)* | *(0.049)* | *(0.060)* | *(0.065)* | *(0.045)* | *(0.039)* | *(0.040)* | *(0.035)* |
| ln $GDP_{j,t-1}$ | 1.075*** | 1.006*** | 1.133*** | 0.670*** | 1.072*** | 0.939*** | 0.836*** | 1.150*** | 1.199*** |
| | *(0.026)* | *(0.046)* | *(0.036)* | *(0.073)* | *(0.060)* | *(0.045)* | *(0.044)* | *(0.034)* | *(0.028)* |
| ln $POP_{i,t-1}$ | -0.206*** | 0.127** | 0.073 | 0.958*** | 0.190 | 0.391*** | 0.396*** | 0.003 | 0.101** |
| | *(0.041)* | *(0.053)* | *(0.056)* | *(0.127)* | *(0.137)* | *(0.094)* | *(0.059)* | *(0.058)* | *(0.039)* |
| ln $POP_{j,t-1}$ | 0.208*** | 0.238*** | 0.393*** | 0.609*** | 0.165 | 0.381*** | 0.423*** | 0.289*** | 0.004 |
| | *(0.037)* | *(0.044)* | *(0.084)* | *(0.072)* | *(0.136)* | *(0.063)* | *(0.043)* | *(0.077)* | *(0.041)* |
| $RTA_{ij,t-1}$ | 0.123*** | 0.110*** | 0.117*** | 0.161*** | 0.152*** | 0.145*** | 0.142*** | 0.119*** | 0.124*** |
| | *(0.016)* | *(0.021)* | *(0.024)* | *(0.034)* | *(0.052)* | *(0.029)* | *(0.020)* | *(0.024)* | *(0.016)* |
| ln $DIST_{ij}$ | -1.603*** | -1.296*** | -1.835*** | -1.777*** | -1.852*** | -1.744*** | -1.427*** | -1.835*** | -1.541*** |
| | *(0.029)* | *(0.049)* | *(0.050)* | *(0.069)* | *(0.059)* | *(0.045)* | *(0.043)* | *(0.039)* | *(0.034)* |
| $ADJ_{ij}$ | 0.704*** | 0.228 | 0.762*** | 1.264*** | 1.054*** | 1.185*** | 0.246 | 1.046*** | 0.062 |
| | *(0.117)* | *(0.159)* | *(0.254)* | *(0.345)* | *(0.203)* | *(0.174)* | *(0.170)* | *(0.152)* | *(0.137)* |
| $LANG_{ij}$ | 0.998*** | 0.468*** | 0.761*** | 1.024*** | 1.141*** | 1.134*** | 0.830*** | 0.998*** | 0.670*** |
| | *(0.061)* | *(0.120)* | *(0.091)* | *(0.127)* | *(0.118)* | *(0.089)* | *(0.093)* | *(0.077)* | *(0.074)* |
| $COL_{ij}$ | 0.706*** | 0.734*** | 0.775*** | 0.681*** | 0.053 | 0.571** | 0.854*** | 0.544*** | 0.807*** |
| | *(0.136)* | *(0.179)* | *(0.190)* | *(0.262)* | *(0.478)* | *(0.245)* | *(0.168)* | *(0.210)* | *(0.134)* |
| $\beta_0$ | -36.773*** | -37.317*** | -14.724*** | -19.047*** | -28.367*** | -34.339*** | -38.383*** | -25.673*** | -30.152*** |
| | *(1,186)* | *(1.678)* | *(2.009)* | *(3.331)* | *(4.199)* | *(2.245)* | *(1.649)* | *(1.853)* | *(1.429)* |
| Adjusted $R^2$ | 0.787 | 0.859 | 0.803 | 0.749 | 0.711 | 0.726 | 0.810 | 0.766 | 0.838 |
| Observations | 169,618 | 33,153 | 49,008 | 40,585 | 46,832 | 87,231 | 73,552 | 95,505 | 81,826 |

Source: Authors´ own elaboration. For each regression, coefficients and standard errors between parentheses are displayed. *, ** and *** denote if the variable is significant at 10%, 5% and 1%, respectively. Columns description for export scenarios: 1) All countries, 2) High-income countries, 3) High-income countries to low- and middle-income countries, 4) Low- and middle-income countries to high-income countries, 5) Low- and middle-income countries, 6) Low and middle-income countries to all countries, 7) All countries to high-income countries, 8) All countries to low- and middle-income countries and 9) High-income countries to all countries. All the cases include exporter, importer and time effects. HT specification considers ln $IU_{i,t-1}$, ln $IU_{j,t-1}$, ln $GDP_{i,t-1}$, ln $GDP_{jt-1}$and $RTA_{ij,t-1}$ as endogenous variables. The Adj-$R^2$coefficient is computed using the approach described in Carrère (2006): 1-(Sum of squared residuals/Total sum of squares).

Column 1 shows the total bilateral flows for the whole sample. The coefficients (0.072 and 0.055) indicate a positive impact of Internet use for both exporter and importer countries, in line with the previous empirical evidence, although the effect of Internet use is considerably larger for exporter countries. In addition, the impact of Internet use is significant and positive for all the scenarios for both exporter and importer countries.

The results also show that the Internet impacts vary across countries at different stages of development and different ICT diffusion levels (Demirkan et al. 2009). The first important result is that the trade elasticity respect to Internet use in the exporter country is greater for bilateral trade flows among high-income countries (column 2, 0.127). The finding is also valid for the importer country (column 2, 0.086). These results confirm the hypothesis that high-income countries benefit the most from cost reduction (Demirkan et al. 2009; Kauffman and Kumar 2008). As shown, this might be because these countries, in addition to being more open to trade, exhibit higher levels of Internet usage (Clarke and Wallsten 2006).

In contrast, the effect of the Internet on trade, for trade flows involving low- and middle-income countries (columns 3 to 6 and 8) is positive, but lower than for scenarios involving high-income countries. The smallest effects concern the bilateral trade between developing countries (column 5, 0.024 and 0.040 exporter and importer respectively), as expected, given their lower levels of internet penetration. For the whole sample, we observe that the Internet effect on trade is larger from the exporter country than from the importer country (0.072 versus 0.055, column 1) but this relationship does not hold for the scenarios: the fact is that impacts on trade are always smaller from the low- and middle-income countries, be they exporters or importers. The results might indicate that, despite the possible benefits in terms of cost reduction due to the potential decreasing importance of distance, there are other types of costs that affect trade. Among other factors, the result might be related to trade specialization of the trade flows between these countries and the differentiated impacts of ICT depending on the type of products affected by the cost reduction (Berthelon and Freund 2008; Venables 2001).

For all the scenarios our results confirm the basic theory of gravity, showing that GDP is positive and significant for both the exporter and importer country, with elasticities close to 1. The results also confirm the positive and significant sign for the variable capturing population. The positive coefficients yielded for population confirm the existence of economies of scale, where large countries tend to trade more than small countries (Marquez 2016).

The existence of a trade agreement ($RTA_{ij}$) at the country level is significant and positive for all the scenarios. The highest coefficients are found when low- and middle-income countries are the exporters (columns 4 to 6). This fact points to these country groups as the most benefited by regional trade agreements.

As expected, the results corroborate the assertion that distance (ln $DIST_{ij}$) is always significant and negative, confirming that a shorter distance between two countries increases bilateral exports. Furthermore, and in line with the previous literature, the role played by distance is the smallest in the case of trade flows among high-income economies (-1.296, column 2). On the other hand, distance plays the greatest role in limiting trade flows when the importer is a low- and middle-income country (-1.835, -1.852 and -1.835, columns 3, 5 and 8 respectively), as expected.

Sharing a common border ($ADJ_{ij}$) is a positive factor supporting trade for all the scenarios with low- and middle-income countries involved, either as importer or exporter (columns 3 to 6 and 8). In contrast, adjacency is not significant for high-income countries (columns 2, 7 and 9). The results indicate that sharing a common border is an influential factor on bilateral trade only for low- and middle-income countries, in contrast with the results obtained by Akerman, Leuven, and Mogstad (2018) using firm-level data.

The existence of a common language ($LANG_{ij}$) is always significant for all the scenarios and shows the expected positive result. Also as expected, the influence of the colonial past on trade ($COL_{ij}$) is positive and significant, with the exception of trade among low- and middle-income countries (0.053, column 5). The highest coefficients are recorded for trade between all and high-income countries (0.854 columns 7, and 0.807 column 9).

### *5.3 Internet impacts on trade: Evidence for high-income countries*

In this section, we are interested in further exploring the results obtained for high income economies. On the one hand, the fragmentation of production at internationl level has increased trade of intermediate goods for both developed and developing economies. Because of the nature of their trade composition, trade flows between developed nations have traditionally been associated to intra-industry trade, usually related to intermediate goods. A large percentage of those bilateral flows takes place in regional GVCs, with Europe having the highest level of intra-regional trade of intermediate goods (70% in 2015; World Bank 2017). We may expect that considering the potential effects of internet use on coordination and information cost reduction, high-income economies would benefit from higher positive impacts on trade through this channel. On the other hand, information and search costs are greater for heterogeneous than for homogeneous products (Rauch 1999). The trade composition of developed economies, characterized by a higher complexity level and a higher weight of knowledge intensive goods, leads us to expect that bilateral flows for these type of countries would benefit more from the positive impacts of internet use on the reduction of information frictions (Akerman, Leuven, and Mogstad 2018; Allen 2014; Rauch 1999) for differentiated products. In other words, we aim to explore whether high-income countries benefit relatively more from internet use because they are involved in production chains that are more sensitive to information and communications costs, or, whether, in contrast, the results are driven by the composition of trade, since developed economies export heterogeneous goods that might be subject to information frictions. To this aim, we replicate the HT estimate strategy (Table 1) but including an interacting term between the Internet variables and a variable capturing the trade composition. Three variables are collected to represent the composition of trade: the lagged share of intermediate goods for the exporter and the importer country ($SHI_{i,t-1}$ and $SHI_{j,t-1}$, respectively) in Table S5 (available online), and the lagged value of the Economic Complexity Index (Hausmann and Hidalgo 2011) for the exporter and the importer country ($ECI_{i,t-1}$ and $ECI_{j,t-1}$, respectively) in Table S6 (available online). As a robustness check, we also use the 1-year lagged share of manufactured goods as a measure of trade composition ($SHM_{i,t-1}$ and $SHM_{j,t-1}$, results in Table S7, available online). These additional analyses allow us to assess whether the impacts of Internet on trade are conditioned by the composition of trade.

The results in Table S5 allow us to assess whether the trade elasticity with respect to Internet is conditioned by the export share of intermediate goods, which would be confirmed by significant interaction terms. For the exporters ($\beta_5$, $\ln IU_{i,t-1} \cdot \ln SHI_{i,t-1}$), the sign of the interaction is positive and significant in most of the scenarios, implying that a rise in the share of intermediate goods in the exporter country will additionally increase the impact of Internet on trade. For instance, referring to the whole sample, one additional percentage point in the share of intermediate goods in the exporter country would raise the impact of Internet on trade by 0.160 (column 1). Table S5 shows that high-income countries benefit most from the positive synergy between Internet and the share of intermediate products (0.678, column 2).

Conversely, the interaction between Internet use and the share of intermediate goods of the importer country ($\beta_6$, $\ln IU_{j,t-1} \cdot \ln SHI_{j,t-1}$) is negative and significant for the whole sample (-0.072, column 1) and in most scenarios (columns 4 to 8). This means that a larger share of intermediate goods in the importer country will diminish the effect that Internet has on trade. As an exception, the negative interaction between the share of intermediate goods and IU does not occur when the exporter is a high-income country (columns 2, 3 and 9).

Therefore, the global effect of Internet on trade in a model accounting interactions will depend on the level of the share of intermediate products. The bottom panel in Table S5 shows the final impacts on trade evaluated for a country with a share equal to the mean share. The largest global impact takes place among high-income countries for both exporters and importers (0.110 and 0.079 respectively, column 2). It is worth noting that the results throughout the scenarios are in line with the estimates of the Internet effects in Table 1. These similarities support the idea that the Internet effects on trade are affected by trade composition.

Table S6 (available online) shows the trade elasticity to internet use when we take into account the interaction between Internet and the product complexity of exporters and importers. The country product differentiation is measured by the corresponding value of the economic complexity index ($ECI_{i,t-1}$ for exporters and $ECI_{j,t-1}$ for importers). The interaction effects between IU and ECI for both exporter and importer ($\beta_5$ and $\beta_6$, respectively) are mostly significant and positive, pointing to a positive synergy between internet use and product complexity that contributes to enlarge the final impact of Internet on trade. The exporter countries in the intra high trade (0.057, column 2) and the importer countries in the intra low- and middle-income trade (0.043, column 5) benefit the most from the positive synergy between Internet and product complexity. Finally, global impact of internet use on trade is evaluated for a country with an average complexity level, for both exporter and importer in each scenario. The global impact of Internet on trade is the largest for trade between high-income countries, (0.306 exporter and 0.158 importer, respectively; column 2), and for those scenarios with all and high-income countries involved (columns 7 and 9). To sum up, trade composition and product complexity affect trade elasticity with respect to Internet use and also explain the larger impact of Internet use on the bilateral trade of high-income countries.

As an additional robustness check, we also interact Internet users with the share of exports of manufactured products (results in Table S7). Regarding the significance of the interactions, results are in line with the findings of the share of intermediate goods (Table S5), since interaction terms show opposite signs for exporters ($\beta_{5,}$ positive) and importers ($\beta_{6,}$ negative). In most of the scenarios, the exporter benefits from a positive synergy between Internet use and the share of manufactured products (SHM). However, an increase in the SHM in the importer country will reduce the Internet impact on trade flows. Considering the global effects (evaluated for a country with a mean SHM value in each scenario), larger values are always found –either exporter or importer– for high-income countries. Specifically, the largest final impacts are 0.159 and 0.128 for the exporter country for scenarios high-high (column 2) and high-all (column 9), respectively.

The additional results in Section 5.3 point to the importance of considering how trade composition impacts on the relationship between internet use and trade. In line with other authors (Akerman, Leuven, and Mogstad 2018; Rauch 1999), we find that manufactured goods are more sensitive to information flows and, hence, the effect of internet users on trade is greater for these types of products. We also find that this greater effect of internet use on trade is asymmetric when we distinguish income levels by country: the largest coefficients are found for bilateral flows between high-income countries.

## 6. Conclusion and discussion

This study aimed to analyze the impacts of the Internet on bilateral flows considering not only aggregate trade flows but also developed and developing bilateral flows separately. First, we tested the hypothesis that Internet use positively influences trade at the aggregate level in the years of greatest expansion of Internet diffusion, according to the available data. Second, we explored the existence of different impacts of Internet use on bilateral flows according to development levels. Considering the previous findings in the academic literature, we were interested in testing the hypothesis that Internet use shows greater effects on bilateral flows for developing countries. We followed a gravity model approach with panel data for the period 1996–2014. This paper also tackled some of the common methodological issues frequently associated with trade gravity models. The flexibility of the Hausman–Taylor panel data procedure allowed us to deal with endogeneity issues as well as to obtain estimates for the time-invariant variables that are traditional in gravity models.

The results indicate that the use of the Internet generates a positive effect on aggregate exports. They also show that the impacts vary depending on development levels. Our findings suggest that the effect of using the Internet is greater for developed countries, a conclusion that differs from those reached in prior studies, probably due to methodological issues and above all to the time period covered in the present analysis. The previous studies referred to shorter periods of Internet diffusion. The results confirm the hypothesis that high-income countries benefit the most from the cost reduction associated with ICT use. In particular, for this group an increase of 1% in the number of Internet users in the export country increases exports to low-and middle-income countries by 0.08% and to other high-income countries by 0.13%. The findings obtained for developing countries might indicate that, despite the possible benefits in terms of cost reduction other factors affect the impacts of Internet use. In this sense, the greater elasticity of Internet use in high-income countries might be due to the differences in their ICT diffusion stages. Given their more mature level of technological development, achieving 1 additional percentage point of increase in Internet users may be more difficult for developed economies than for developing ones. Our results also indicate that the composition of trade and, in particular, the role played by the share of intermediate goods and the level of product differentiation also explain the highest effects found for bilateral flows involving high-income countries. In particular, our findings suggest that an increase of 1% in Internet use at the exporter country increases trade 0.31% when we consider a country with an average economic complexity.

From a public policy perspective, the results highlight the importance of promoting Internet use in foreign trade activities. The globalization process forces companies to develop new strategies for going global. In this context efforts to enhance the technological capabilities of enterprises that favor and promote ICT investments and use emerge as a key issue. Internationalization policies should take into account the role played by ICT use in reducing transaction costs. In developing countries efforts should be oriented towards improving connectivity, in particular for high-speed Internet, since it plays a major role in changing the way in which companies conduct their business. In addition to institutional reforms to encourage competition and private sector participation to develop the telecommunication infrastructure, public measures should focus on increasing SMEs' capacity to assess the returns and costs of using ICT, attracting and retaining ICT-skilled labor and promoting training and skills development programs (Khalil, Dongier, and Qiang 2009).

Future research should address the various impacts of the Internet on different sectors as well as on different types of technologies. In particular, it would be interesting to study ICT impacts when disaggregating by the degree of product differentiation using the Rauch´s (1999) sectoral classification. It would also be interesting to explore how these impacts may vary when some countries reach to their saturation levels. Additionally, the impacts of other information and communication technologies should be analyzed to compare their effects according to economic development levels and diffusion trajectories. In particular, in the near future it will be necessary to tackle the effects on trade of new emerging ICT, such as the Internet of things, cloud computing or Big Data.

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**Appendix: Supplementary material**

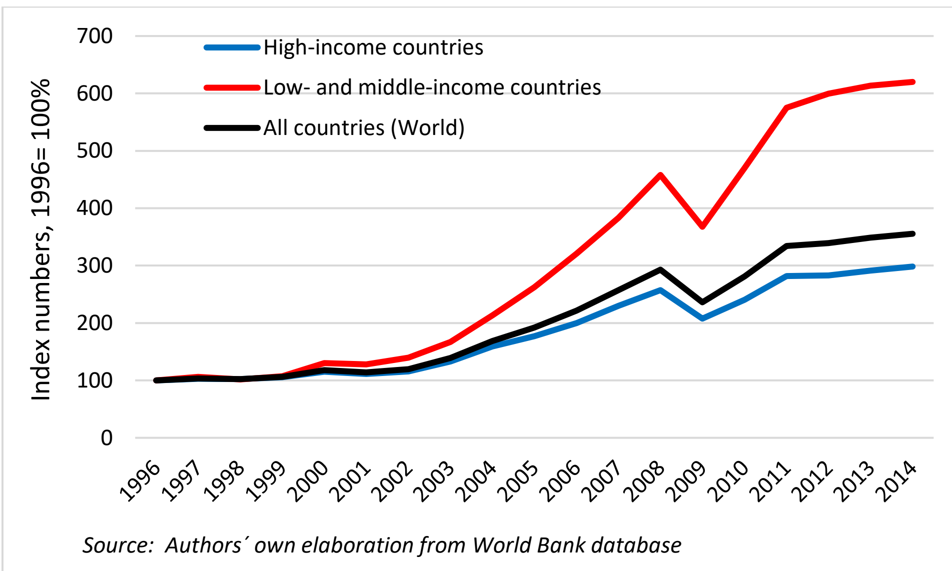


Figure S1. Export value index (1996 = 100%) during the period 1996–2014 for all countries, high-income countries and low- and middle-income countries. The export values are the current value of exports (FOB) converted into U.S. dollars and expressed as a percentage of the average for the base period (1996)

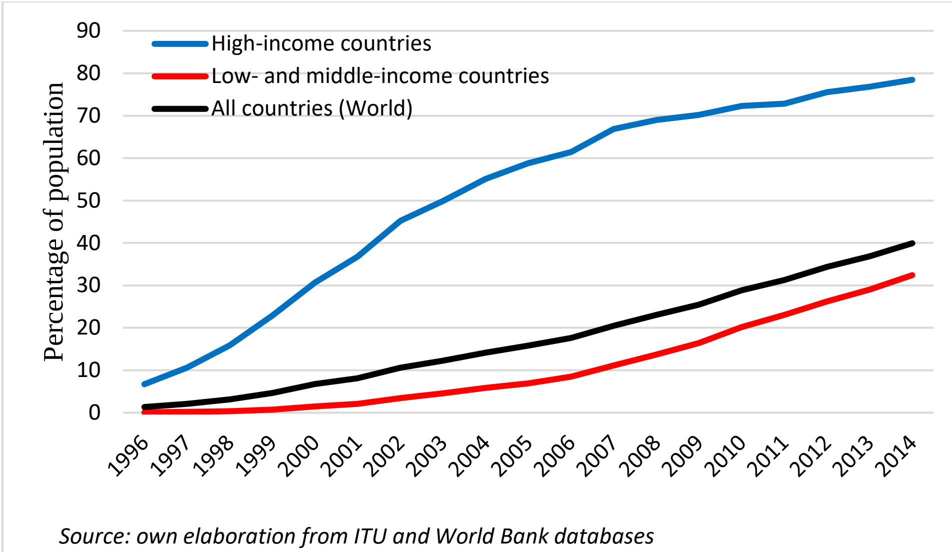


Figure S2. Individuals using the Internet, percentage of population, years 1996–2014. All countries, high-income countries and low- and middle-income countries

Table S1 List of countries

| | | | |
|---|---|---|---|
| Albania | Egypt | **Lithuania** | **Singapore** |
| Algeria | El Salvador | Madagascar | **Slovakia** |
| **Argentina** | **Estonia** | Malawi | **Slovenia** |
| **Australia** | Ethiopia | Malaysia | South Africa |
| **Austria** | **Finland** | Mauritania | **Spain** |
| Azerbaijan | Fmr Sudan | Mauritius | Sri Lanka |
| Bangladesh | **France** | Mexico | Sudan |
| Belarus | Gabon | Mongolia | **Sweden** |
| **Belgium** | Georgia | Morocco | **Switzerland** |
| **Belgium-Luxembourg** | **Germany** | Mozambique | Syria |
| Bolivia (Plurinational State of) | Ghana | Namibia | TFYR of Macedonia |
| Bosnia Herzegovina | **Greece** | **Netherlands** | Thailand |
| Botswana | Guatemala | **New Zealand** | **Trinidad and Tobago** |
| Brazil | Guinea | Nicaragua | Tunisia |
| Bulgaria | Honduras | Nigeria | Turkey |
| Cambodia | **Hungary** | **Norway** | Turkmenistan |
| Cameroon | India | **Oman** | **USA** |
| **Canada** | Indonesia | Pakistan | Uganda |
| **Chile** | Iran | Panama | Ukraine |
| China | **Ireland** | Papua New Guinea | **United Arab Emirates** |
| **China, Hong Kong SAR** | **Israel** | Paraguay | **United Kingdom** |
| Colombia | **Italy** | Peru | United Rep. of Tanzania |
| Congo | Jamaica | Philippines | **Uruguay** |
| Costa Rica | **Japan** | **Poland** | **Venezuela** |
| **Croatia** | Jordan | **Portugal** | Viet Nam |
| Cuba | Kazakhstan | **Qatar** | Yemen |
| **Czech Rep.** | Kenya | **Rep. of Korea** | Zambia |
| Cote d'Ivoire | **Kuwait** | Rep. of Moldova | Zimbabwe |
| **Denmark** | **Latvia** | **Russian Federation** | |
| Dominican Rep. | Lebanon | **Saudi Arabia** | |
| Ecuador | Libya | Senegal | |

Note: We classify countries according to the World Bank Analytical Classification in 2014. Those countries exceeding the threshold USD12,735 are high-income countries and appear in bold (46). The rest of the countries are low- and middle-income countries (75)

Table S2 Variables description and sources

| Variable | Description | Units | Source |
|---|---|---|---|
| $EX_{ijt}$ | Aggregate bilateral exports from *i* to *j* during year *t*. | USD | UN Comtrade |
| $IU_{i,t-1}, IU_{j,t-1}$ | Internet users for *i* and *j* during year *t*, 1-year lagged. | Users per 100 inhabitants | World Bank- WDI and ITU |
| $GDP_{i,t-1}, GDP_{j,t-1}$ | GDP for *i* and *j* during year *t*, PPP adjusted, 1-year lagged. | USD | IMF-WEO |
| $POP_{i,t-1}, POP_{j,t-1}$ | Total population for *i* and *j* during year *t*, 1-year lagged. | Inhabitants | World Bank- WDI |
| $RTA_{ij,t-1}$ | Variable that takes value 1 for a regional trade agreement in force and 0 otherwise, 1-year lagged. | | De Sousa (2012) |
| $DIST_{ij}$ | Distance between *i* and *j* weighted by the population and Constant Elasticity of Substitution | Kilometers | CEPII |
| $ADJ_{ij}$ | Variable that takes value 1 if the country pair shares a common border and 0 otherwise | | CEPII |
| $LANG_{ij}$ | Variable that takes value 1 if at least 10% of the exporter and importer country inhabitants speak the same language and 0 otherwise | | CEPII |
| $COL_{ij}$ | Variable that takes value 1 if both countries share past colonial linkages and 0 otherwise | | CEPII |
| $ECI_{i,t-1}, ECI_{j,t-1}$ | Economic Complexity Index for *i* and *j* during year *t*, 1-year lagged | | TOEC |
| $SHI_{i,t-1}, SHI_{j,t-1}$ | Export share of intermediate products for *i* and *j* during year *t*, 1-year lagged | Percentage | World Bank-WITS |
| $SHM_{i,t-1}, SHM_{j,t-1}$ | Export share of manufactured products for *i* and *j* during year *t*, 1-year lagged | Percentage | World Bank-WITS |

Source: Authors' own elaboration. CEPII corresponds to "Centre d´Études Prospectives et d'Informations Internationelles", ITU "International Telecommunications Union", TOEC "The Observatory of Economic Complexity", WDI "World Development Indicators", WEO "World Economic Outlook" and WITS "World Integrated Trade Solution"

Table S3 Descriptive statistics

| *Variables* | *Observations* | *Mean* | *Std. Dev.* |
|---|---|---|---|
| $EX_{ijt}$ | 199 115 | 9.29e+08 | 7.04e+09 |
| $\ln EX_{ijt}$ | 199 115 | 1.618 | 3.731 |
| $\ln IU_{i,t-1}$ | 198 930 | 2.343 | 2.002 |
| $\ln IU_{j,t-1}$ | 198 872 | 2.139 | 2.171 |
| $\ln GDP_{i,t-1}$ | 195 994 | 2.590 | 1.636 |
| $\ln GDP_{j,t-1}$ | 195 125 | 2.579 | 1.661 |
| $\ln POP_{i,t-1}$ | 199 115 | 1.661 | 1.466 |
| $\ln POP_{j,t-1}$ | 199 115 | 1.657 | 1.450 |
| $RTA_{ij,t-1}$ | 199 115 | 0.165 | |
| $\ln DIST_{ij}$ | 199 115 | 8.608 | 0.862 |
| $ADJ_{ij}$ | 199 115 | 0.029 | |
| $LANG_{ij}$ | 199 115 | 0.131 | |
| $COL_{ij}$ | 199 115 | 0.020 | |
| $ECI_{i,t-1}$ | 175 960 | 1.710 | 1.034 |
| $ECI_{j,t-1}$ | 175 960 | 1.471 | 1.074 |
| $\ln SHI_{i,t-1}$ | 125 719 | 3.074 | 0.298 |
| $\ln SHI_{j,t-1}$ | 125 719 | 3.059 | 0.310 |
| $\ln SHM_{i,t-1}$ | 125 247 | 3.680 | 1.051 |
| $\ln SHM_{j,t-1}$ | 118 439 | 3.537 | 1.259 |

Source: Authors' own elaboration

Table S4 Estimates of panel gravity equation

| *Column* | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *Dependent variable in* | Log | Log | Log | Level | Level | Log |
| *Specification* | **POLS** | **REM** | **HT**(i) | **PPML** | **PPML** | **HT**(i) |
| ln $IU_{i,t-1}$ | 0.014* | 0.071*** | 0.072*** | | | 0.113*** |
| | *(0.007)* | *(0.005)* | *(0.005)* | | | (0.007) |
| ln $IU_{j,t-1}$ | 0.040*** | 0.054*** | 0.055*** | | | 0.062*** |
| | *(0.007)* | *(0.004)* | *(0.004)* | | | (0.006) |
| ln $IU_{i,t-1}$ · ln $DIST_{ij}$ | | | | 0.015** | 0.036*** | |
| | | | | *(0.007)* | *(0.012)* | |
| ln $IU_{j,t-1}$ · ln $DIST_{ij}$ | | | | 0.145*** | 0.012 | |
| | | | | *(0.007)* | *(0.009)* | |
| ln $GDP_{i,t-1}$ | 1.147*** | 1.287*** | 1.297*** | | | |
| | *(0.043)* | *(0.028)* | *(0.028)* | | | |
| ln $GDP_{j,t-1}$ | 0.926*** | 1.067*** | 1.075*** | | | |
| | *(0.040)* | *(0.027)* | *(0.026)* | | | |
| ln $GDP_{i,t-1}$ · ln $GDP_{j,t-1}$ | | | | 0.008* | -0.007 | 0.032*** |
| | | | | *(0.004)* | *(0.018)* | *(0.001)* |
| ln $POP_{i,t-1}$ | -0.351*** | -0.212*** | -0.206*** | | | |
| | *(0.063)* | *(0.041)* | *(0.041)* | | | |
| ln $POP_{j,t-1}$ | 0.165*** | 0.206*** | 0.208*** | | | |
| | *(0.057)* | *(0.038)* | *(0.037)* | | | |
| ln $POP_{i,t-1}$ · ln $POP_{j,t-1}$ | | | | -0.004 | 0.012 | 0.002 |
| | | | | *(0.004)* | *(0.032)* | *(0.002)* |
| $RTA_{ij,t-1}$ | 0.409*** | 0.159*** | 0.123*** | 0.612*** | 0.044* | 0.105*** |
| | *(0.015)* | *(0.015)* | *(0.016)* | *(0.019)* | *(0.024)* | *(0.019)* |
| ln $DIST_{ij}$ | -1.460*** | -1.559*** | -1.603*** | -1.250*** | | -1.599*** |
| | *(0.008)* | *(0.024)* | *(0.029)* | *(0.027)* | | *(0.040)* |
| $ADJ_{ij}$ | 0.690*** | 0.782*** | 0.704*** | 0.498*** | | 0.704*** |
| | *(0.028)* | *(0.096)* | *(0.117)* | *(0.022)* | | *(0.163)* |
| $LANG_{ij}$ | 0.827*** | 0.984*** | 0.998*** | 0.098*** | | 1.051*** |
| | *(0.015)* | *(0.049)* | *(0.061)* | *(0.023)* | | *(0.085)* |
| $COL_{ij}$ | 0.743*** | 0.765*** | 0.706*** | 0.261*** | | 0.676*** |
| | *(0.032)* | *(0.112)* | *(0.136)* | *(0.024)* | | *(0.189)* |
| $\beta_0$ | -27.022*** | -35.990*** | -36.773*** | | | 5.677*** |
| | *(1.733)* | *(1.176)* | *(1.186)* | | | *(0.812)* |
| Breusch-Pagan LM test | 3.2e+05[0.000] | | | | | |
| Hausman test FE – RE | | 4440.04[0.000] | | | | |
| Adj-$R^2$ (ii) | 0.767 | 0.765 | 0.787 | 0.898 | 0.995 | 0.788 |
| Observations | 169,618 | 169,618 | 169,618 | 147,296 | 147,296 | 138,988 |
| Exporter effects | Yes | Yes | Yes | No | No | No |
| Importer effects | Yes | Yes | Yes | No | No | No |
| Time effects | Yes | Yes | Yes | No | No | No |
| Exporter-time effects | No | No | No | Yes | Yes | Yes(iii) |
| Importer-time effects | No | No | No | Yes | Yes | Yes(iii) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Pair effect | No | No | No | No | Yes | No |

*Notes*: Standard robust errors in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively. POLS (Pooled Ordinary Least Squares), REM (Random Effects Model) and HT (Hausman-Taylor). (i) HT specification considers $\ln IU_{i,t-1}$, $\ln IU_{j,t-1}$, $\ln GDP_{i,t-1}$, $\ln GDP_{j,t-1}$ and $RTA_{ij,t-1}$ as endogenous variables. Breusch-Pagan Lagrange multiplier test for random effects. Hausman test between FE and RE estimates. *p*-values of the tests are showed in brackets. (ii) The $R^2$ coefficient in HT specification is computed using the approach described in Carrère (2006): 1-(sum of square residuals/total sum of squares). PPML regressions in Columns 4 and 5 are estimated using the command *panel_ppml_sg* (Zylkin, 2016). (iii) Regression in column 6 implements exporter-time and importer-time controls for each five year period (2000, 2005, 2010 and 2014) following Foster (2012).To guarantee the convergence of the command *panel_ppml_sg*, the baseline period for columns 4, 5 and 6 is 2000–2014 to show comparable results.

Table S5 Gravity equation results disaggregated by income levels including the interaction term of Internet users with the share of intermediate goods. Hausman-Taylor estimates.

| *Columns:* | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** |
|---|---|---|---|---|---|---|---|---|---|
| *Exporter´s income:* | All | *High* | High | *Low and middle* | *Low and middle* | *Low and middle* | *All* | *All* | *High* |
| *Importer´s income:* | All | *High* | *Low and middle* | High | *Low and middle* | *All* | *High* | *Low and middle* | *All* |
| $\beta_1$:ln$IU_{i,t-1}$ | 0.059** | 0.399*** | 0.216*** | 0.138*** | -0.146*** | -0.002 | 0.166*** | -0.046 | 0.303*** |
| | *(0.024)* | *(0.062)* | *(0.069)* | *(0.045)* | *(0.049)* | *(0.033)* | *(0.033)* | *(0.036)* | *(0.048)* |
| $\beta_2$:ln$IU_{j,t-1}$ | 0.055** | 0.174*** | 0.131*** | -0.344*** | 0.023 | -0.044 | -0.071 | 0.086*** | 0.132*** |
| | *(0.022)* | *(0.056)* | *(0.029)* | *(0.094)* | *(0.046)* | *(0.038)* | *(0.055)* | *(0.026)* | *(0.023)* |
| $\beta_3$:ln$SHI_{i,t-1}$ | 0.001 | -0.096*** | -0.047** | -0.028** | 0.053*** | 0.012 | -0.035*** | 0.037*** | -0.070*** |
| | *(0.007)* | *(0.019)* | *(0.021)* | *(0.013)* | *(0.014)* | *(0.009)* | *(0.010)* | *(0.010)* | *(0.014)* |
| $\beta_4$: ln$SHI_{j,t-1}$ | -0.003 | -0.031* | -0.025*** | 0.130*** | -0.011 | 0.027** | 0.044** | -0.019*** | -0.025*** |
| | *(0.006)* | *(0.018)* | *(0.008)* | *(0.030)* | *(0.013)* | *(0.011)* | *(0.017)* | *(0.007)* | *(0.007)* |
| $\beta_5$:ln$IU_{i,t-1}$ · ln$SHI_{i,t-1}$ | 0.160*** | 0.678*** | 0.132 | 0.157*** | 0.103* | 0.136*** | 0.235*** | 0.075 | 0.379*** |
| | *(0.032)* | *(0.080)* | *(0.089)* | *(0.057)* | *(0.062)* | *(0.042)* | *(0.043)* | *(0.046)* | *(0.061)* |
| $\beta_6$:ln$IU_{j,t-1}$ · ln$SHI_{j,t-1}$ | -0.072** | 0.027 | -0.049 | -0.437*** | -0.187*** | -0.148*** | -0.184** | -0.105*** | -0.021 |
| | *(0.030)* | *(0.075)* | *(0.04)* | *(0.125)* | *(0.062)* | *(0.052)* | *(0.073)* | *(0.035)* | *(0.033)* |
| *Global effect of Internet users on trade evaluated for the mean of the logarithm of the share of intermediate products (1)* | | | | | | | | | |
| $\beta_1+\beta_5\overline{lnSHI}_{i,t-1}$ | 0.063*** | 0.110*** | 0.076*** | 0.050*** | 0.020 | 0.037*** | 0.059*** | 0.068*** | 0.092*** |
| | *(0.006)* | *(0.014)* | *(0.015)* | *(0.014)* | *(0.016)* | *(0.011)* | *(0.008)* | *(0.009)* | *(0.011)* |
| $\beta_2+\beta_6\overline{lnSHI}_{j,t-1}$ | 0.047*** | 0.079*** | 0.053*** | 0.044** | -0.011 | 0.037*** | 0.060*** | 0.026*** | 0.054*** |
| | *(0.006)* | *(0.012)* | *(0.009)* | *(0.019)* | *(0.015)* | *(0.010)* | *(0.011)* | *(0.008)* | *(0.006)* |
| Adjusted $R^2$ | 0.781 | 0.854 | 0.800 | 0.745 | 0.716 | 0.724 | 0.802 | 0.762 | 0.833 |
| Observations | 122,312 | 25,710 | 34,879 | 29,398 | 32,225 | 61,723 | 55,108 | 67,204 | 60,589 |

Gravity equations are estimated under the full specification (Table 1) but estimates of ln$GDP_{i,t-1}$, ln$GDP_{j,t-1}$, ln$POP_{i,t-1}$, ln$POP_{j,t-1}$, $RTA_{ij,t-1}$, ln$DIST_{ij}$, $ADJ_{ij}$, $LANG_{ij}$, $COL_{ij}$ are not shown for reasons of space.

(1) Global effect of $IU_i$ and $IU_j$ on bilateral trade evaluated for the mean of the logarithm of the share of exports of intermediate goods. In the presence of interactions, the global effect of Internet users on trade is a function of the share of exports of intermediate goods, such as $\beta_1+\beta_5$ ln$SHI_{i,t-1}$, with $\beta_1$ being the individual effect of Internet users in the exporter country (ln$IU_{i,t-1}$) and $\beta_5$ is the interaction effect between Internet users and the share of exports of intermediate goods (ln$IU_{i,t-1}$ · ln$SHI_{i,t-1}$) of the exporter country. The procedure is the same to calculate the global effect of Internet users on trade from the importer country (ln$IU_{j,t-1}$): $\beta_2+\beta_6$ ln$SHI_{j,t-1}$

Table S6. Gravity equation results disaggregated by income levels including the interaction term of Internet users with the Economic Complexity Index. Hausman-Taylor estimates.

| *Columns:* | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** |
|---|---|---|---|---|---|---|---|---|---|
| *Exporter´s income:* | All | *High* | High | *Low and middle* | *Low and middle* | *Low and middle* | *All* | *All* | *High* |
| *Importer´s income:* | All | *High* | *Low and middle* | High | *Low and middle* | *All* | *High* | *Low and middle* | *All* |
| $\beta_1$:$\ln IU_{i,t-1}$ | 0.079*** | 0.101*** | 0.030** | 0.027* | 0.042*** | 0.038*** | 0.089*** | 0.069*** | 0.058*** |
| | *(0.006)* | *(0.011)* | *(0.012)* | *(0.014)* | *(0.015)* | *(0.011)* | *(0.008)* | *(0.008)* | *(0.008)* |
| $\beta_2$:$\ln IU_{j,t-1}$ | 0.088*** | 0.080*** | 0.078*** | 0.040** | 0.101*** | 0.097*** | 0.058*** | 0.089*** | 0.080*** |
| | *(0.005)* | *(0.010)* | *(0.009)* | *(0.016)* | *(0.014)* | *(0.009)* | *(0.010)* | *(0.008)* | *(0.006)* |
| $\beta_3$:$ECI_{i,t-1}$ | 0.287*** | 0.435*** | 0.622*** | 0.003 | 0.279*** | 0.132*** | 0.146*** | 0.429*** | 0.540*** |
| | *(0.015)* | *(0.026)* | *(0.028)* | *(0.033)* | *(0.036)* | *(0.024)* | *(0.021)* | *(0.022)* | *(0.020)* |
| $\beta_4$:$ECI_{j,t-1}$ | -0.010 | 0.209*** | -0.124*** | 0.207*** | -0.083*** | 0.018 | 0.203*** | -0.106*** | -0.029** |
| | *(0.014)* | *(0.024)* | *(0.020)* | *(0.039)* | *(0.031)* | *(0.023)* | *(0.023)* | *(0.018)* | *(0.015)* |
| $\beta_5$:$\ln IU_{i,t-1} \cdot ECI_{i,t-1}$ | 0.017*** | 0.057*** | 0.006 | -0.005 | 0.013* | 0.005 | 0.035*** | 0.001 | 0.027*** |
| | *(0.003)* | *(0.004)* | *(0.005)* | *(0.007)* | *(0.007)* | *(0.005)* | *(0.004)* | *(0.004)* | *(0.003)* |
| $\beta_6$:$\ln IU_{j,t-1} \cdot ECI_{j,t-1}$ | 0.026*** | 0.023*** | 0.004 | 0.013* | 0.043*** | 0.029*** | 0.019*** | 0.022*** | 0.022*** |
| | *(0.002)* | *(0.004)* | *(0.004)* | *(0.007)* | *(0.006)* | *(0.004)* | *(0.004)* | *(0.004)* | *(0.003)* |
| *Global effect of Internet users on trade evaluated for the mean value of the Economic Complexity Index (1)* | | | | | | | | | |
| $\beta_1 + \beta_5\overline{ECI}_{i,t-1}$ | 0.108*** | 0.306*** | 0.051** | 0.027* | -0.061 | 0.037*** | 0.148*** | 0.071*** | 0.156*** |
| | *(0.009)* | *(0.020)* | *(0.021)* | *(0.014)* | *(0.050)* | *(0.010)* | *(0.013)* | *(0.013)* | *(0.015)* |
| $\beta_2 + \beta_6\overline{ECI}_{j,t-1}$ | 0.127*** | 0.158*** | 0.078*** | 0.082*** | 0.100*** | 0.054*** | 0.122*** | 0.089*** | 0.112*** |
| | *(0.008)* | *(0.019)* | *(0.009)* | *(0.031)* | *(0.014)* | *(0.007)* | *(0.019)* | *(0.008)* | *(0.009)* |
| Adjusted $R^2$ | 0.788 | 0.860 | 0.804 | 0.749 | 0.711 | 0.726 | 0.811 | 0.767 | 0.839 |
| Observations | 169,618 | 33,153 | 48,795 | 40,530 | 47,140 | 87,670 | 73,683 | 95,935 | 81,948 |

Gravity equations are estimated under the full specification (Table 1) but estimates of $\ln GDP_{i,t-1}$, $\ln GDP_{j,t-1}$, $\ln POP_{i,t-1}$, $\ln POP_{j,t-1}$, $RTA_{ij,t-1}$, $\ln DIST_{ij}$, $ADJ_{ij}$, $LANG_{ij}$, $COL_{ij}$ are not shown for space reasons.

(1) Global effect of $IU_i$ and $IU_j$ on bilateral trade evaluated for the mean value of the Economic Complexity Index. In the presence of interactions, the global effect of Internet users on trade is a function of the Economic Complexity Index, such as $\beta_1 + \beta_5\, ECI_{i,t-1}$, with $\beta_1$ being the individual effect of Internet users in the exporter country ($\ln IU_{i,t-1}$) and $\beta_5$ the interaction effect between Internet users and the Economic Complexity Index ($\ln IU_{i,t-1} \cdot ECI_{i,t-1}$) of the exporter country. The procedure is the same to calculate the global effect of Internet users on trade from the importer country ($\ln IU_{j,t-1}$): $\beta_2 + \beta_6\, ECI_{j,t-1}$

Table S7 Gravity equation results disaggregated by income levels, including the interaction term of Internet users with the share of manufactured goods. Hausman-Taylor estimates.

| *Columns* | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
|---|---|---|---|---|---|---|---|---|---|
| *Exporter´s income:* | All | *High* | High | *Low and middle* | *Low and middle* | *Low and middle* | *All* | *All* | *High* |
| *Importer´s income:* | All | *High* | *Low and middle* | High | *Low and middle* | *All* | *High* | *Low and middle* | *All* |
| $\beta_1$:ln$IU_{i,t-1}$ | 0.014 | -0.152*** | -0.033 | 0.052*** | -0.009 | 0.028** | 0.014 | 0.01 | -0.091*** |
| | *(0.009)* | *(0.027)* | *(0.033)* | *(0.017)* | *(0.020)* | *(0.013)* | *(0.012)* | *(0.014)* | *(0.021)* |
| $\beta_2$:ln$IU_{j,t-1}$ | 0.040*** | 0.026 | 0.079*** | -0.05 | -0.016 | 0.014 | -0.013 | 0.038*** | 0.062*** |
| | *(0.008)* | *(0.022)* | *(0.011)* | *(0.037)* | *(0.017)* | *(0.013)* | *(0.022)* | *(0.010)* | *(0.008)* |
| $\beta_3$:ln$SHM_{i,t-1}$ | 0.019*** | 0.080*** | 0.034*** | -0.002 | 0.020*** | 0.008*** | 0.014*** | 0.026*** | 0.057*** |
| | *(0.002)* | *(0.007)* | *(0.009)* | *(0.004)* | *(0.004)* | *(0.003)* | *(0.003)* | *(0.003)* | *(0.006)* |
| $\beta_4$: ln$SHM_{j,t-1}$ | 0.009*** | 0.016** | -0.006** | 0.040*** | 0.008** | 0.019*** | 0.028*** | 0.0003 | 0.001 |
| | *(0.002)* | *(0.007)* | *(0.002)* | *(0.011)* | *(0.004)* | *(0.003)* | *(0.007)* | *(0.002)* | *(0.002)* |
| $\beta_5$:ln$IU_{i,t-1}$ · ln$SHM_{i,t-1}$ | 0.082*** | 0.079* | 0.283*** | 0.059*** | 0.037 | 0.047*** | 0.076*** | 0.090*** | 0.185*** |
| | *(0.012)* | *(0.041)* | *(0.049)* | *(0.020)* | *(0.024)* | *(0.016)* | *(0.016)* | *(0.019)* | *(0.032)* |
| $\beta_6$:ln$IU_{j,t-1}$ · ln$SHM_{j,t-1}$ | -0.063*** | -0.051 | -0.059*** | -0.121* | -0.065*** | -0.068*** | -0.088** | -0.062*** | -0.058*** |
| | *(0.010)* | *(0.037)* | *(0.013)* | *(0.062)* | *(0.020)* | *(0.018)* | *(0.036)* | *(0.012)* | *(0.011)* |
| *Global effect of Internet users on trade evaluated for the mean of the logarithm of the share of manufactured goods (1)* | | | | | | | | | |
| $\beta_1+\beta_5\overline{lnSHM}_{i,t-1}$ | 0.085*** | 0.159*** | 0.101*** | 0.046*** | 0.061*** | 0.057*** | 0.064*** | 0.107*** | 0.128*** |
| | *(0.006)* | *(0.015)* | *(0.017)* | *(0.015)* | *(0.017)* | *(0.011)* | *(0.009)* | *(0.010)* | *(0.011)* |
| $\beta_2+\beta_6\overline{lnSHM}_{j,t-1}$ | 0.073*** | 0.087*** | 0.060*** | 0.101*** | 0.010 | 0.082*** | 0.094*** | 0.039*** | 0.066*** |
| | *(0.006)* | *(0.014)* | *(0.010)* | *(0.023)* | *(0.016)* | *(0.011)* | *(0.014)* | *(0.009)* | *(0.007)* |
| Adjusted $R^2$ | 0.783 | 0.858 | 0.803 | 0.747 | 0.717 | 0.726 | 0.805 | 0.764 | 0.837 |
| Observations | 114,897 | 25,070 | 31,363 | 28,815 | 29,649 | 58,464 | 53,885 | 61,012 | 56,433 |

Gravity equations are estimated under the full specification (Table 1), but estimates of ln$GDP_{i,t-1}$, ln$GDP_{j,t-1}$, ln$POP_{i,t-1}$, ln$POP_{j,t-1}$, $RTA_{ij,t-1}$, ln$DIST_{ij}$, $ADJ_{ij}$, $LANG_{ij}$, $COL_{ij}$ are not shown for reasons of space.

(1) Global effect of $IU_i$ and $IU_j$ on bilateral trade evaluated for the mean value of the logarithm of export share of manufactured products. In the presence of interactions, the global effect of Internet users of the exporter country on trade is a function of the share of manufactured products, such as $\beta_1+\beta_5$ ln$SHM_{i,t-1}$, with $\beta_1$ being the individual effect of Internet users (ln$IU_{i,t-1}$) and $\beta_5$ the interaction effect between Internet users and the share of manufactured products (ln$IU_{i,t-1}$ ·ln$SHM_{i,t-1}$) of the exporter country. The procedure is the same to calculate the global effect of Internet users on trade from the importer country, ln$IU_{j,t-1}$: $\beta_2+\beta_6$ ln$SHM_{j,t-1}$.