

# ICT and Trade: Literature Review

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## Abstract

The paper reviews the literature on the effects of Information Communications Technology (ICT) on trade. Based on the literature review it argues that ICT may directly promote trade by lowering fixed and marginal trade costs. Moreover, the paper argues that ICT can also generate indirect effects on trade through enhancing labour productivity.

**Keywords:** ICT, international trade, firm heterogeneity, technological progress

**JEL codes:** F12, F14, F15, J24, O33, O47, O52

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## 1. Empirical Evidence on Effects of ICT on Trade

The literature on ICT and trade starts from the early 2000s and outlines that ICT has positive effects on trade performances by reducing trade costs. Freund and Weinhold (2002, 2004), were one of the very first scholars who examined the impact of the Internet and ICT infrastructure on trade. Authors analysed US trade in services and found that an increase in the number of web hosts by 10 percentage points is associated with the increase in exports by about 0.2 percentage points.

The positive impact of ICT infrastructure on export performances was also supported by study of Portugal-Perez and Wilson (2010). Authors outlined that together with “hard infrastructure”, ICT infrastructure enhances trade. Furthermore, while analysing impact of “soft infrastructure” on trade of Asian countries, Ismail and Mahyideen (2015) found that a 10% increase in the number of fixed and mobile phone subscribers in both exporter and importer countries increases trade by 2.6% and 2.2%, respectively. Given its importance, authors concluded that together with hard infrastructure, effects of soft infrastructure should also be examined systematically for different country groups.

Additionally, studies illustrate that the trade-enhancing effect of ICT may not depend solely on ICT infrastructure or ICT capability per se, but on its use. Namely, Liu and Nath (2013) employed panel data for forty emerging market economies from 1995 to 2010 and found that Internet subscriptions and Internet hosts have significant positive effects on both exports and imports in the emerging countries. Impact of broadband use on trade development in Middle East and North Africa is studied by Gelvanovska, Rogy and Rossotto (2014). As authors

outlined, broadband contributes in trade in this region. The study found that one percentage point increase in the number of Internet uses increases exports by 4.3 % points.

Positive impact of ICT use is furthermore outlined for trade in fruits and vegetables by Thiemann, Flemming and Mueller (2012). Authors proxy ICT use by the data on telephone main lines, Internet usage and mobile phone subscribers and found that mobile phone penetration significantly stimulates trade in vegetables and fruit. The role of ICT use for different Spanish industries is studied by Bernal-Jurado and Moral-Pajares (2010). The paper found that the largest exporting and importing industries are the ones that are more engaged in electronic commerce through different communication channels, such as EDI, Minitel or Internet.

Furthermore, there is an empirical evidence on direction of causality between Internet penetration and exports. This issue was quite controversial for the last decade, since mid 1990s and early 2000s was characterized by drastic increase in both world exports and Internet hosts. As summarized by Clarke and Wallstein (2004), world exports increased from 20% of gross world product in 1994 to 24% in 2002. At the same time the number of Internet hosts rose from 17 per 10,000 people in 1994 to 231 in 2001. Authors argued that on the one hand boom in world exports since 1990s could stimulate deployment of ICT, and on the other hand, rapid growth in ICT use could boost exports (alternatively, this could just be a coincidence). By using instrumental variable approach for macro-level analysis, the paper found that causality runs from ICT to exports.

This finding was further confirmed by Kneller and Timmis (2016) who conducted analysis on the effects of broadband use on the firm-extensive margin of UK service exports. To deal with possible endogeneity, authors built an instrument that exploited exogenous variation in access to broadband technologies owing to the historic telephone network. Empirical findings indicated that the causal effect runs from the Internet to trade in business services.

## 2. Firm-level Studies

Examining international trade based on the micro-level data was initiated already in nineties by Bernard and Jensen (1995). The paper reported that for the US manufacturing industries, firms of the same size and of the same industry differed in terms of productivity depending whether they were engaged in exporting activities or not. This research was followed by the number of papers employing firm-level data that finally gave birth to “the new new trade theory” where firm-level heterogeneity is placed at the centre of analysis.

Namely, the most popular framework modelling firm heterogeneity is Melitz model (see Melitz, 2003). This model predicts that more productive firms are able to face entry barriers to the foreign markets by covering all fixed costs related to exporting. In other words, there is a self-selection of more productive firms on the foreign markets. This hypothesis is broadly supported by number of studies done for different countries, including advanced, transition or least developed economies (see the survey of the literature by Wagner, 2007, 2012).

However, Melitz (2003) model explains export activities mainly by a firm-level productivity

and does not endogenize trade costs. Unlike to Melitz (2003) model, Schmitt and Yu (2001) and Jørgensen and Schröder (2008) introduce heterogenous export costs. These models imply that export activities of firms vary not only due to differences in their efficiencies, but also due to differences in their trade costs.

### **3. Channels of ICT Effects on Firm-level exports**

#### **a. Direct effects of ICT on exports**

The ICT shall affect export performances via lowering fixed and marginal export costs. Fixed export costs here imply costs related to firms' abilities to collect information about foreign markets and consumer tastes. While marginal export costs refer to costs related to keep up export activities, for instance, cost of communication with trade partners and costumers abroad.

Importance of fixed and marginal export costs in determining export activities is highlighted by several empirical studies. For instance, Bugamelli and Infante (2003) found that there are substantial differences among Italian manufacturing firms' abilities to collect information about foreign markets and consumer tastes. Moreover, Das et al. (2001) estimated an empirical model with fixed and marginal cost heterogeneity based on panel data for Colombian chemical producers and concluded that sunk export costs vary considerably across plants.

As for marginal export costs, even though they are more homogenous than fixed export costs, empirical evidence suggests that their impact on exports is still significant. For example, Fink et al. (2005) outlined that the high cost of making telephone call significantly decreased bilateral trade flows. Moreover, the paper showed that ICT by allowing communication abroad with minimal costs, importantly lowers trade costs. Furthermore, impact of ICT turned out to be greater for trade in differentiated products compared to the homogenous ones.

Given its benefits, ICT should affect both, fixed as well as marginal export costs. First, ICT should enable firms to study preferences and demand of customers abroad in a simpler, cheaper and faster way. And second, ICT should decrease the monetary and time costs of communication with trade partners and foreign customers. While the former may present fixed cost of penetrating foreign markets, the latter could rather relate to variable costs needed to keep and extend export activities. Consequently, a drop in fixed costs of exports should positively affect decision of a firm to start exporting (extensive margins of exports) and a drop in marginal costs of exports should contribute in increasing export shares (intensive margins of exports).

#### **b. Indirect effects of ICT**

According to the "New New Trade Theory" export activities are determined by the efficiency of firms. Namely, as Melitz (2003) model outlines, export-oriented firms are the ones which are the most efficient. Here the main focus comes on labour productivity since according to the model it defines the level of efficiency of a given firm. Given benefits of ICT use in improving

performance of workers, ICT could indirectly contribute in export activities through enhancing labour productivity. More precisely, first ICT could contribute in raising labour productivity, then improved labour productivity could lead to decrease in marginal cost of production and eventually decreased production costs could enable a firm to sink fixed cost of exporting and enter a foreign market. Thus, together with direct effects via decreasing trade costs, ICT can also generate indirect effects on trade via enhancing labour productivity.

Although, it is considerable that when it comes to ICT effects on productivity, the literature shows that effects of ICT are difficult to identify and more difficult to quantify. Paradoxically by late 80s there was found zero or the negative impact of ICT and by the recent century surprisingly lower contribution than expected. As Robert Solow stated, computers were visible everywhere but in the productivity statistics (Solow, 1987).

Ambiguous results could be caused by measurement errors, or simply by the fact that ICT enhances multifactor productivity, raises capital deepening and therefore it becomes very difficult to separate ICT effects from the contribution of factors of production. Alternatively, ICT could be reflected in total factor productivity (TFP), which is in fact a residual in Solow (1956) model.<sup>1</sup> As Abramovitz (1956) would put it, TFP by the construction is a “Solow residual” or a “measure of our ignorance”.

As for studies particularly focused on Europe, empirical evidence shows that the contribution of ICT in productivity growth across the EU falls behind the one across the US. For instance, to explain productivity slowdown, Crafts (2008) outlines insufficient investment in intangible capital. Such intangible capital may refer to organizational changes and firms’ own experiments to adopt new technologies in practice. However, as argued in the study, processes related to “co-invention” in firms takes longer time than modernization of technologies, therefore effects of ICT could show up after some time (Crafts, 2008 cited in Akhvlediani, 2016).

This intuition is embodied in the idea of classifying ICT as a General Purpose Technology (GPT). This implies that all the advantages related to a new GPT might be fully utilized through complementary investment in both tangible and intangible assets (Bresnahan and Trajtenberg, 1995). Here investment in tangible assets refer to investments in ICT equipment and software, while organizational changes in firms represent investment in intangible assets (Brynjolfsson and Hitt, 2000, 2003; Basu et al., 2003; Lechman, 2016).

Classification of ICT as GPT underlines importance of human capital and digital literacy in ICT uptake. As underlined by the International Telecommunication Union (ITU), ICT development can be reflected in the following factors: in ICT infrastructure that provides readiness for employing ICT; in ICT use, since the contribution of ICT does not exist unless ICT is not deployed; and in skills (human capital) that enables usage of ICT (ITU, 2009).

Furthermore, importance of high-quality university system and widespread of digital skills is highlighted by Renda (2016). As the author states, in the age of digitalisation one of the scarcest

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<sup>1</sup> The model is later discussed in section 3.2.

resource in ICT ecosystem is human capital since the latter presents a fundamental driver of ICT uptake. Therefore, according to Renda (2016) development of high-quality university system and widespread of e-skills and digital literacy should be one of the main targets of policies aiming at improving economic performance, competitiveness and innovation.

As for empirical evidence at the firm-level, several studies find positive and statistically significant impact of ICT (see Baldwin and Sabourin, 2002; Baldwin et al., 2004). By employing the micro data of manufacturing firms from Brazil and India, Commander et al. (2011) find strong positive evidence between ICT and firm-level productivity. Additionally, the paper outlines the role of institutions and labour qualities in determining magnitude of ICT effects. Namely, poor institutions and poor labour policy are associated with lower contribution of ICT in productivity growth.

The role of ICT in better and more efficient decision making of firms is highlighted by Chauhan et al. (2017). Authors outline the effects of ICT via creation and employment of Big Data. In particular, they discuss the four features of Big Data: Volume, Velocity, Variety and Veracity, as the main contributing factors in design of better management policies of firms. In addition, the paper brings into discussion another “V” standing for Value which is generated with respect to socioeconomic development due to existence of Big Data. Taking into account the effects of all these features of Big Data, the paper states that ICT, by enabling creation and usage of Big Data, brings huge benefits to developed as well as to developing nations.

#### 4. Conclusions

To conclude, according to the studies reviewed above, ICT may generate positive effects on trade via ICT infrastructure and ICT use by lowering trade costs. As evidenced by the literature on the possible endogeneity between exports and Internet penetration, causality should run from ICT on exports and not the way around. As for indirect effects, there are several controversies of ICT effects on productivity at the macro-level. However, the literature outlines positive effects of ICT on the firm-level productivity. Moreover, empirical studies highlight the role of human capital in ICT uptake. This indicates that ICT may also generate indirect effects on exports through enhancing labour productivity.

More precisely:

- ICT infrastructure and ICT use should have positive and significant impact on extensive margins of trade via decreasing fixed trade costs;
- ICT infrastructure and ICT use should positively affect intensive margins of trade via decreasing marginal trade costs;
- ICT should indirectly contributes in trade performances of firms through enhancing labour productivity.

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