# Digital technology and international trade: Is it the quantity of subscriptions or the quality of data speed that matters?☆

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## ARTICLE INFO

## ABSTRACT

Information and communication technologies affect global trade patterns through transaction costs on the supply and demand sides. The relevant transaction costs are affected by both the number of telecommunication subscriptions and the speed of the available bandwidth. We test for the differential effects of telecommunication *quantity* (data subscriptions per capita) and *quality* (bandwidth data speed per subscription) of fixed and mobile telephony and internet services on countries' bilateral exports of goods. We use an augmented Gravity Model and control for multilateral resistance. Regression results for 122 countries over 1995–2008 show a significant effect on export performance of both variables. In the sub-sample analysis we find that data speed *quality* is what matters most for developing countries, while the *quantity* of subscriptions is more relevant for developed ones. We explain this by the disadvantage developing countries derive from being far from the technological communication frontier in terms of data speed, while the diffusion of additional high speed subscriptions in developed countries open up new markets there. This illustrates the importance of going beyond the traditional assessment of telecommunication infrastructure in terms of the number of subscriptions, and urges both scholars and policy-makers to start considering bandwidth quality.

## 1. Introduction

Both international trade and digital networks have increased during the past decades. Between 1995 and 2008, global trade of goods and services has grown with an annual compound growth rate of approximately 10%, while global Gross National Income (GNI) has grown less than 6%. The number of worldwide installed telecom end-user subscriptions (such as phones and Internet) has grown at 15.5% annually during the same period, and the corresponding installed telecommunication bandwidth capacity at 45%. Communication has been easier, faster and less expensive and it has changed the way we live, work and interact (Castells, 2009).

In the economic sphere, it has been shown that the increasing digitizing of economic processes has led to a general reorganization of economic activities (Acemoglu, Aghion, Lelarge, Reenen, & Zilibotti, 2007; Rosenblat & Mobius, 2004). Real-time communication among economic actors (Brynjolfsson & Hitt, 1995) and the reduction of search costs through blatant transparency (Bakos,

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2001; Borenstein & Saloner, 2001) has helped to overcome geographical distance, resulting in the much-cited "death of distance" (Cairncross, 2001). Castells (2009, p. 442–443) discusses the resulting "space of flows", in which it is not physical geography that creates space in the digital age, but "a circuit of electronic exchanges, constituted by its nodes and hubs". It can be expected that this digital network geography affects and interacts with the geography of international trade networks. Digital networks allow buyers and sellers to connect quicker (lowering search costs), trading partners and employees can be monitored more easily (less management and control costs), and communication and coordination costs can be reduced (diminished shipping costs) (Demirkan, Goul, Kauffman, & Weber, 2009; Fink, Mattoo, & Neagu, 2005). A positive relationship between digital technology and international trade can therefore be expected.

Related research has been growing, but has been lagging behind other questions in the literature of both international trade and digital technologies. Just over a decade ago, Freund & Weinhold (2002, 2004) provided the first empirical evidence on the matter, while studying the effect of the growth of Information and Communication Technologies (ICTs) on international trade growth. Several studies followed that include only cross-sectional data (Choi, 2010; Clarke & Wallsten, 2006; Demirkan, Goul, Kauffman, & Weber, 2009; Márquez-Ramos & Martínez-Zarzoso, 2010), while the ones with panel data are either of a short time span (Portugal-Perez & Wilson, 2012) or include only a limited international perspective, with few or no developing countries in the sample (Vemuri & Siddiqi, 2009; Timmis, 2012; Mattes, Meinen, & Pavel, 2012; with a notable exceptions for cross-sectional impact on service trade by Choi (2010)).

We see two major shortcoming in the past literature, one of methodological and another one of empirical nature. The methodological shortfall is the lack of consideration of the multilateral resistance terms, which "capture the fact that bilateral trade flows do not only depend on bilateral trade barriers but also on trade barriers across all trading partners" (Behrens, Ertur, & Koch, 2012, p. 773). The main shortcoming in terms of empirical evidence is that the independent variable used to represent the digital capacity does not directly represent the digital communicational capacity (Zwart, Xue, Whitt, Ryan, Hussain, Croak, Abraham-Igwe, 2015). It is standard in the literature to consider the number of ICT subscriptions as a representation of the digital communication capacity (mainly drawing from the administrative registers of the International Telecommunication Union (ITU, 2014)), including the number of personal computers, phone lines and Internet users (Ahmad, Ismail, & Hook, 2011; Clarke & Wallsten, 2006; Vemuri & Siddiqi, 2009); the number of broadband subscriptions (e.g. Demirkan, Goul, Kauffman, & Weber, 2009), or some (un)weighted index including these variables (Francois & Manchin, 2013; Márquez-Ramos & Martínez-Zarzoso, 2010; Mattes, Meinen, & Pavel, 2012; Minges, 2005; Portugal-Perez & Wilson, 2012).

The problem with using the number of ICT subscriptions as a proxy for communication capacity arises from the fact that the number of subscriptions is not necessarily representative of communication capacity, since bandwidth speed is highly diverse across subscriptions (Hilbert, 2014b, 2016; Hilbert, López, & Vásquez, 2010). This problem has become increasingly severe over past decades, as telecom access became ever more diversified. In the analog age of the late 1980's, the vast majority of telecom subscriptions were fixed-line phones, and all of them had the same performance (see Fig. 1). Given the linear relationship, there was no methodological problem in equating subscriptions with capacity. Twenty years later, there is a myriad of different telecom subscriptions with the most diverse range of performances (see Fig. 1). While some countries have reached a certain level of saturation in terms of subscriptions (at about 2–3 telecommunication subscriptions per capita), bandwidth speed capacity in kbps (kilobits per second) continues to thrive (ITU, 2012). Using the number of subscriptions as an independent variable (solely or within some kind of index) does not consider the fact that countries like Saudi Arabia count with an average installed bandwidth speed of less than 1 optimally compressed Mbps per capita in 2010, while countries like South Korea counted with almost 12 Mbps per subscription (see Fig. 1b).

A recent OECD-WTO survey (2013) reported that least developing countries suppliers "consider poor physical infrastructure, including inadequate power (59%), unreliable internet access or low bandwidth (35%) and inadequate national telecommunications
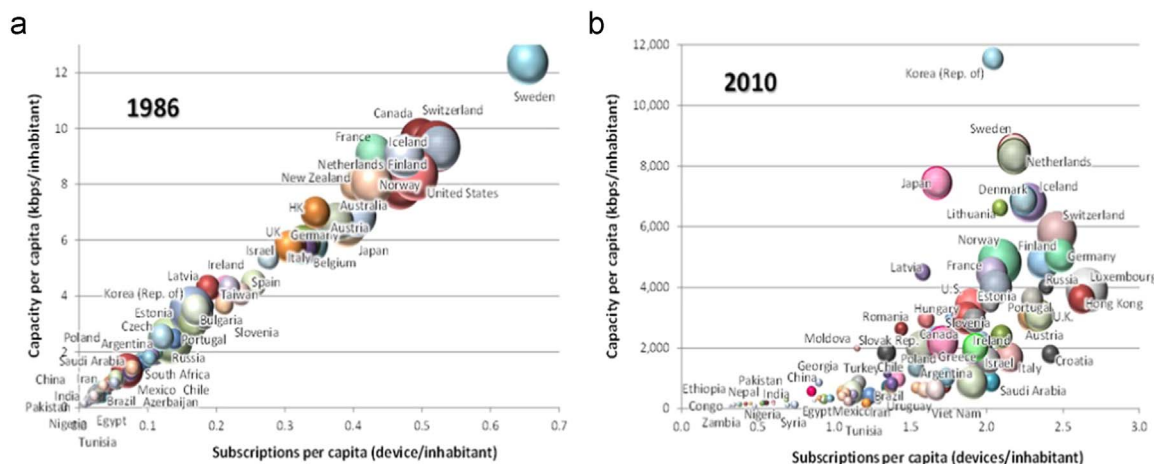


**Fig. 1.** Subscriptions per capita (fixed and mobile telecom) vs. capacity per capita (in optimally compressed kbps of installed capacity) for (a) 1986 and (b) 2010. Size of bubbles represents Gross National Income (GNI) per capita (N=100).