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JEL Classification: F12, F14, O33, O19

Keywords: Internet Connectivity, ICT, Submarine cables, Export behaviour

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Digital connectivity and firm participation in foreign markets: An exporter-based bilateral analysis

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1 Introduction

The fibre-optic Submarine Cable (SMC) network, the world digital connectivity cornerstone, has considerably expanded during the last two decades. This expansion has facilitated Internet communications, spurring the growth and the adoption of related digital technologies. Today, almost all coastal countries, including lower-income countries, use this infrastructure to get access to broadband Internet (Hjort and Pouslen, 2019; Cariolle, 2021; Srinivasan et al., 2021). As a result, broadband Internet has plausibly prompted the 'death of distance' between trade partners, fostering countries' and firms' participation in international trade of goods and services, by reducing information, search, and communication costs between buyers and sellers worldwide (Freund and Weinhold, 2002, 2004; Clarke and Wallsten, 2006; Lendle et al., 2016).

SMC rollout has stimulated the development of cheaper and faster telecommunications, including broadband Internet, spurring the digitisation of information and communication contents and the digitalisation of economic interactions (Tang, 2006; Weller and Woodcock, 2013; Hjort and Poulsen, 2019).[1] Ultimately, SMC rollout has permitted the rise and development of two-sided markets, in which an intermediary – Visa, Sony, Alphabet, Facebook, a real estate agency – allows sellers and buyers to interact at low cost (Tirole, 2017). Two-sided markets bring together the supply and demand for different products and services through different types of digital platforms.[2] For digital goods, the emergence of digital platforms announced the death of geographical distance while, for physical goods, they permitted significant reductions in transactions costs (Goldfarb and Tucker, 2019; Akerman et al., 2021).

One would expect that the worldwide deployment of the SMC network combined with the growing digitalization of business activities would encourage firms to participate in export markets. Using an heterogeneous firm model and a constructed panel data set, this paper shows that the evidence is more nuanced. We set up a theoretical framework, based on Melitz (2003) and Bustos (2011), showing that the arrival of a bilateral SMC is likely to allow more firms to start exporting in developed countries, as the majority of firms are able to benefit from high-speed Internet. In fact, most firms in developed countries are better poised to benefit from broadband Internet and related information technologies, owing to a greater absorptive capacity – in terms of digital skills, R&D investment, and organisational structure – and greater proximity to urban centres and hard infrastructures (Galliano and Roux, 2008; Marsh et al., 2017). At the same time, our model predicts that some exporters in developing countries may be forced to exit the international market following an improved digital connection through SMCs, since only the largest and the high-productivity firms are able to adopt digital technology and to tap into the Internet (Paunov and Rollo, 2016). The remaining firms might consist of non-exporters, and small and low-productivity exporters, which are unable to fully exploit Internet potential.

To explore empirically our expectations, we build a panel data set, merging bilateral trade data from

[1] Digitisation refers to the "representation of information in bits [...] rather than atoms" (Goldfard and Tucker, 2019, p.3). Digitalization refers to the increase use of digital technologies in the conduct of business and in daily life human interactions.

[2] With the most significant successes being Amazon in industrialized countries, Alibaba in China, or Jumia in West Africa.

the World Bank's Exporters Dynamics Database (EDD) (Fernandes et al., 2016), focusing on the number of exporting firms, with bilateral data on the maritime telecommunications infrastructure deployment from the Telegeography database. With this panel, covering 48 coastal countries during the period 1997-2014, we show that subsequent to an increase in bilateral SMC connections, the number of exporting firms increases in developed countries and declines in developing countries, especially so for countries in Middle East and North Africa (MENA), South Asia (SA) and Sub-Saharan Africa (SSA).

Our empirical strategy exploits the richness and the panel structure of the Export Dynamics Database. This panel structure allows controlling for a wide range of unobserved characteristics, including bilateral fixed effects, thereby strongly lowering the concern for omitted variable bias. An exogeneity test confirms that causality runs from bilateral SMC connection to the number of exporting firms at the bilateral level, a result consistent with the patterns of trade predicted by the heterogeneous firm model motivating our empirics.

This paper comports the view that digital connectivity is not sufficient for export success in our data-driven digital economy. In its digital economy report of 2021, UNCTAD notes that the increase in cross-border data has accelerated during the pandemic along two routes: between North America and Europe and between North America and Asia (with China and the US, the two countries having the capacity to engage and benefit from the data-driven digital economy). UNCTAD warns of a data-related divide compounding a digital divide. Unfortunately, tracking cross-border data flows is impossible so, at best, this aspect of the digital divide can only be captured in firms' trade in goods and services, preferably at the bilateral level (firms in two countries that are digitally connected would be expected to trade more intensely).

To the best of our knowledge, this is the first study that emphasizes the contribution of the SMC network – the first stage in the Internet access value chain (Schumann and Kende, 2013) – to extensive margin of exports in terms of firms, drawing on evidence at the bilateral level. The paper also contributes to the broader literature raising concerns about a growing digital divide between rich and poor nations mentioned above (World Bank, 2021; UNCTAD, 2021; Cariolle, 2021).

Most empirical evidence on the linkage between ICT and trade is on aggregate bilateral exports and country level Internet diffusion rates, showing a positive association and ignoring however the firm's export behaviour (Freund and Weinhold, 2004; Clarke and Wallsten, 2006).[3] More recent contributions analyse the internet-trade nexus using firm level panel data, but from a single country's perspective, without providing however a cross-country comparison (Kneller and Timmis, 2016; Fernandes et al., 2019; Akerman et al., 2021).[4] Kneller and Timmis (2016) follow an instrumental variable (IV) approach

[3]Some studies give evidence on positive effects of country-level Internet penetration rates on bilateral trade margins in terms of products, i.e. the number of exported products and the average exports per product (Osnago and Tan, 2016; Visser, 2019)

[4]Other studies analyse how firm's Internet use affects firm's export performance, using repeated cross-section firm-level data from small samples in selected countries, and therefore without exploiting the time variation of the internet access or use (Clarke, 2008; Hjort and Poulsen, 2019). Using data from Eastern-European and Central-Asian countries, Clarke (2008) found a positive effect of internet access on firm's probability to export but no significant effect on exports share in total sales; whereas, using firm level data from six African countries, Hjort and Poulsen (2019) showed, among other results, that

based on telephone network historical data and put in evidence a positive effect of broadband use on the firm-extensive margin of UK service exports. Fernandes et al. (2019) find that increasing the number of Internet users per-capita at the province level in China increases Chinese manufactures' likelihood to export and export intensity. They stress that this effect is stronger when firms operate in industries using Internet more intensively. Closer to our study, Akerman et al. (2021) exploit the staggered roll-out of local fiber-optic broadband access-points in Norway to estimate the causal effect of Internet adoption on Norwegian firms' bilateral exports. They find that the reduction in information friction induced by Internet access enlarges the choice set of exporters and importers, making demand for traded products more elastic to trade costs and to distance.[5]

Our study complements the previous empirical evidences on the ICT-trade nexus, by analysing this relationship from a different empirical angle, i.e. through focusing on the adjustment of bilateral number of exporting firms to the bilateral SMC connection. Moreover, unlike the former studies, we also motivate our work through a theoretical model of firm heterogeneity, by accounting for the firm's decision to adopt a digital technology and the firm's decision to export. Our model is inspired by Bustos (2011)'s framework, but we focus on the impact of the arrival of a bilateral fibre-optic submarine cable, rather than on the tariff liberalization effect, and we examine the developed economy context, in addition to the developing economy case.

The rest of the paper is organized as follows. Section 2 provides background information. Section 3 sets up a motivating theoretical framework. Section 4 reports the empirical evidence. Section 5 concludes.

2 Background and motivation

2.1 Submarine cables rollout and the digital interconnection process

Over the last few decades, digital connectivity, defined as the capacity to exchange digitised information, has been boosted by the laying of some 400 SMCs worldwide (Cariolle et al., 2019). Nowadays, more than 99% of the world's telecommunications – Internet content, phone and video calls, classified diplomatic messages – passes through SMCs (Takeshita et al., 2019).

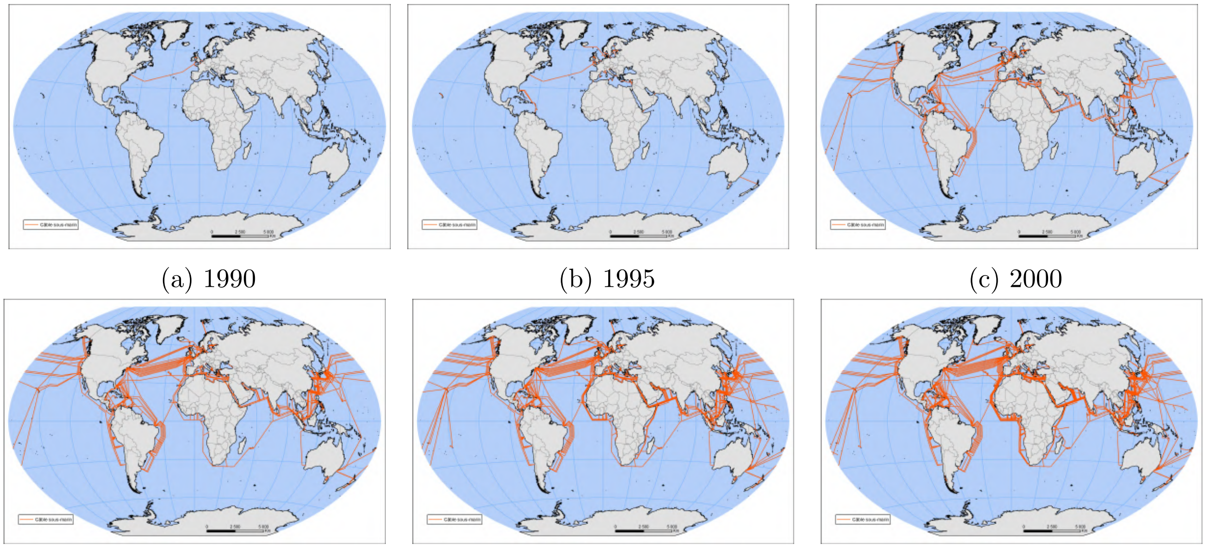
Since the first deployment of the TAT-8 transatlantic fibre-optic cable in 1988, connecting the US to Great Britain and France, the world SMC network has undergone a dramatic expansion, together with a considerable increase in the capacity and speed of transmitting information. Figure 1 shows that Northern industrialized countries have been the first recipients of these cables, followed by Latin America, the Middle-East and Asia early in the 2000s, in the wake of the Internet bubble. Africa started to benefit from the international maritime infrastructure with the arrival of higher capacity SMCs since 2005 (Weller and Woodcock, 2013; Cariolle, 2021).

The SMC network is the central infrastructure of the worldwide telecommunications network, and the first element of the Internet access value-chain. Absent an SMC connection, a country has two

the arrival of SMC positively affected firm exports at the expense of domestic sales.

[5] See the previous version of this paper (Cariolle et al., 2020) for a more detailed literature review.

Figure 1: SMC worldwide deployment over time



(a) 1990 (b) 1995 (c) 2000

(d) 2005 (e) 2010 (f) 2015

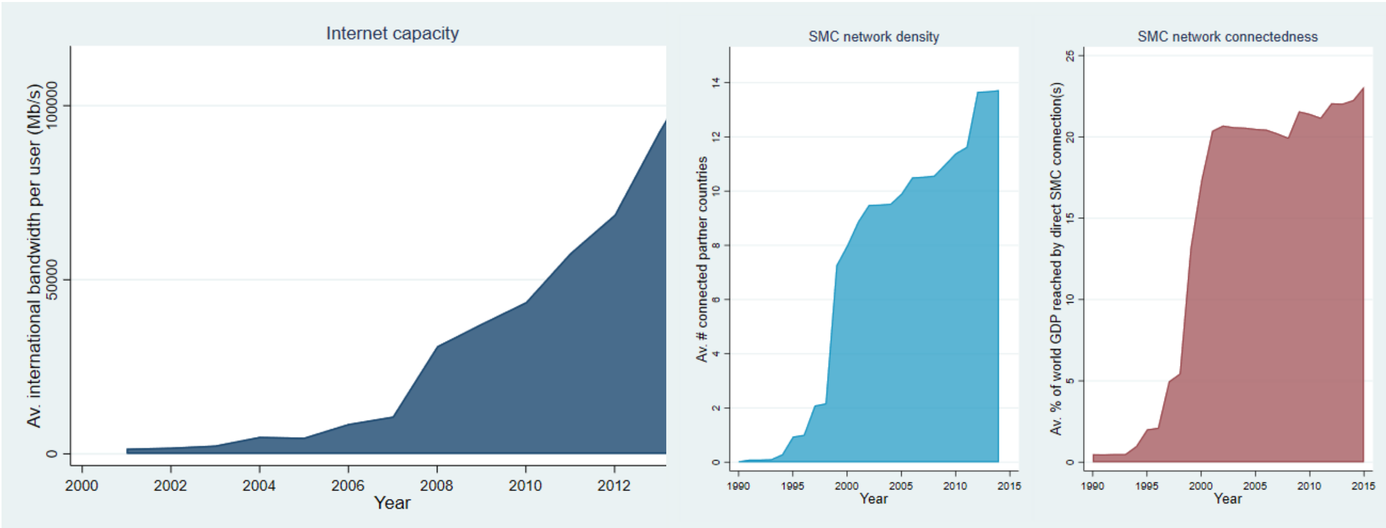
Source: Authors' elaboration using data from the Telegeography database: https://www.submarinecablemap.com/

costly and less efficient alternatives to be internationally connected: i) buying Internet bandwidth in a SMC-connected neighbouring country, or ii) resorting to expensive communication satellites. A greater number of SMCs is therefore expected to boost the digital economy by increasing Internet speed and the total bandwidth available to international communications. More bandwidth reduces the diffusion costs of internet and other ICTs, increases the quality of related services, and enhances competition in the ICT environment (but also in other sectors). In the case of cable faults, a greater number of SMCs also augments the resilience of the telecommunications network (Aceto et al., 2018; Cariolle, 2021; Cariolle et al., 2019; Carter, 2010). In sum, the deployment of SMCs has dramatically increased the worldwide telecommunications network size, capacity and redundancy.[6] From the 2010 onwards, the SMC infrastructure has brought together more than 3 billion Internet users, building digital bridges between almost all coastal countries, and irrigating a multi-trillion dollar industry (Nyirenda-Jere and Biru, 2015). As an illustration of the magnitude of this technological breakthrough induced by SMC deployment, consider that in 2013, "twenty households with average broadband usage generate as much traffic as the entire Internet carried in 1995" (Weller and Woodcock, 2013).

This exponential improvement in digital connectivity is reflected in Figure 2, plotting the evolution of three connectivity indicators: (i) the available international bandwidth per user (of which 99% is carried by SMCs) reflecting SMC network's capacity for internet communications; (ii) the average number of partner countries connected by cables, reflecting the SMC network's density and; (iii) the country average share of world GDP reached by direct SMC bilateral connections, reflecting the network's connectedness. Therefore, in 2015, a country was, on average, directly connected by cables to almost 14 countries, representing close to one quarter of the world GDP, and was benefiting from an average international

[6]Redundancy is the ability to maintain a capacity for telecommunications when a shock disrupts the infrastructure by re-rooting telecommunications traffic towards alternative paths.

Figure 2: SMCs rollout and the world connectivity.



Source: ITU database, https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx, Telegeography database: https://www.submarinecablemap.com/ and World Development Indicators https://databank.worldbank.org/source/world-development-indicators.

bandwidth of 100,000 Mbit/s per user. The sharp rise in these metrics gives a striking illustration of the dramatic increase in connectivity induced by the laying of SMCs.

2.2 Bilateral connectivity, Internet access, and firm trade

The massive worldwide deployment of broadband SMCs has been a major driver of progress for the Internet economy. SMC rollout between two countries is expected to boost bilateral trade flows through lower transaction and information costs (Freund and Weinhold, 2002, 2004; Clarke and Wallsten, 2006; Dickstein and Morales, 2018; Dasgupta and Mondria, 2018). Bilateral SMC rollout is also expected to fluidify communications between connected countries by reducing tromboning thereby limiting operators' exposure to rerouting costs charged by owners of indirect cable connections. (Dickstein & Morales, 2018).

The now-standard heterogeneous firm model of trade proposed by Melitz (2003) highlights that only the most productive firms export since they are able to cover the additional export costs, while the remaining firms only supply the domestic market. Thus, following a reduction in bilateral trade costs, more firms start supplying foreign markets, while the least productive firms exit the market due to market shares losses. In the context of Mercosur, Bustos (2011) shows that in developing countries, like Argentina, only high-productivity exporting firms are able to upgrade their technology, whereas both low-productivity exporters and non-exporters cannot, since the fixed costs of technology upgrading might be larger than the fixed costs of exporting. Therefore, a reduction in costs of Internet access may lead a greater number of exporters to adopt digital technologies, while pushing the least productive exporters to exit foreign markets and the least productive non-exporters to entirely stop their business, due to market share losses.

Translated to SMC arrival and digitalization of economies, following a reduction in bilateral information and communication costs permitted by the arrival of SMCs linking two countries, we expect that the number of exporting firms should increase in developed countries, where the majority of firms are more likely to absorb digital technology. By contrast, this number is expected to decline in developing countries, since only the largest and most productive exporting firms might be able to benefit from Internet access.[7] This possibility is accommodated in the model presented here below.

3 Theoretical framework

Following Melitz (2003) and Bustos (2011), we consider heterogeneous firms competing in a monopolistic competition market and two symmetric countries. Firms decide whether to supply the international market, and whether to adopt a more advanced technology, i.e. the digital technology. The "digital productivity premium" arising from the digital technology adoption is the analogue to a "high technology premium" in Bustos (2011). Differently from her study, we focus on the impact of the arrival of a bilateral fibre-optic submarine cable (SMC) that generates an increase in the digital productivity premium, rather than on the impact of a reduction in bilateral tariffs. In addition to the developing economy case, where only the most productive firms are able to adopt a more sophisticated (digital) technology, we also examine the developed economy case, where only the least productive firms are unable to use the superior technology.

3.1 Model set up

Consider two symmetric countries with L consumers in each country who provide labour at wage rate $w = 1$, and have CES preferences across varieties ω, so that the demand for a given variety is given by $q(\omega) = p(\omega)^{-\sigma} R P^{\sigma-1}$, where $p(\omega)$ is the price for each variety, σ is the elasticity of substitution between any two varieties, $P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma}\, d\omega\right]^{\frac{1}{1-\sigma}}$ is the aggregate price index of the set of all available varieties Ω, and $R = wL$ is the aggregate revenue. Firms produce within a single monopolistic competition sector, are heterogeneous in productivity φ and use labour through a linear production function to produce their varieties.

Any producer faces a fixed cost of production f and can choose to adopt the digital technology, in which case φ increases by $\gamma > 1$ ('digital productivity premium') by paying an additional fixed cost $f_h > f$. Therefore the price, revenue and profit in the domestic market for digital producer (or *high-tech* producer, $s = h$), and non-digital producer (or *low-tech* producer, $s = l$) are respectively:

$$p_s(\varphi) = \frac{\sigma}{\sigma - 1} \frac{1}{\gamma^{\theta}\varphi}$$

[7] Foster et al (2018) report results from 264 interviews in 3 export sectors (tea, tourism, business process outsourcing) in Kenya and Rwanda that comfort these findings. They document that small producers are only thinly digitally integrated in global value chains (GVCs). They conclude that improving connectivity does not benefit African firms in GVCs unless supported by complementary capacity.

$$r_s(\varphi) = p_s(\varphi)^{1-\sigma} RP^{\sigma-1}$$

$$\pi_s(\varphi) = \frac{r_s(\varphi)}{\sigma} - (f + \theta f_h)$$

where θ equals one if $s = h$, and zero otherwise. Digital producers are, on average, more efficient than non-digital producers because the former are, on average, associated with higher exogenous productivity φ and an additional productivity premium arising from digital technology adoption γ, compared to the latter.

We also assume that if a firm wants to export, it has to face an additional fixed cost $f_x > f$.[8] As a result, exporters are, on average, more productive than non-exporters because the former are, on average, associated with higher exogenous productivity φ. Firms pay the sunk fixed cost f_e to enter the market. Firms draw their productivity from a known Pareto cumulative distribution function $G(\varphi) = 1 - \varphi^{-k}$, where $k > \sigma - 1$. Then, they decide whether to stay in the market or to exit immediately.

To sort firms within a sector, we plausibly consider two cases. In developed economy case ($DC = 0$), the plentiful availability of specialized digital skills result in low fixed costs for the adoption of digital technology. In developing economy case ($DC = 1$), firms need to invest in improving the digital literacy of their workers and managers. These assumptions result in the two configurations of the fixed cost of digital technology adoption f_h and the fixed cost of exporting f_x across the two cases.

3.2 The developed economy case

In the case of a developed economy ($DC = 0$), the fixed cost of digital technology is relatively low ($f < f_h < f_x$), so that it is profitable for the majority of firms to use digital technology, including all firms that are involved in exporting. In this context, we need to consider the following profit conditions:

$$\pi_l^d(\varphi_l^d) = 0 \Longleftrightarrow \frac{r_l^d(\varphi_l^d)}{\sigma} - f = 0 \tag{1}$$

$$\pi_h^d(\varphi_h^d) = \pi_l^d(\varphi_h^d) \Longleftrightarrow \frac{r_h^d(\varphi_h^d)}{\sigma} - (f + f_h) = \frac{r_l^d(\varphi_h^d)}{\sigma} - f \tag{2}$$

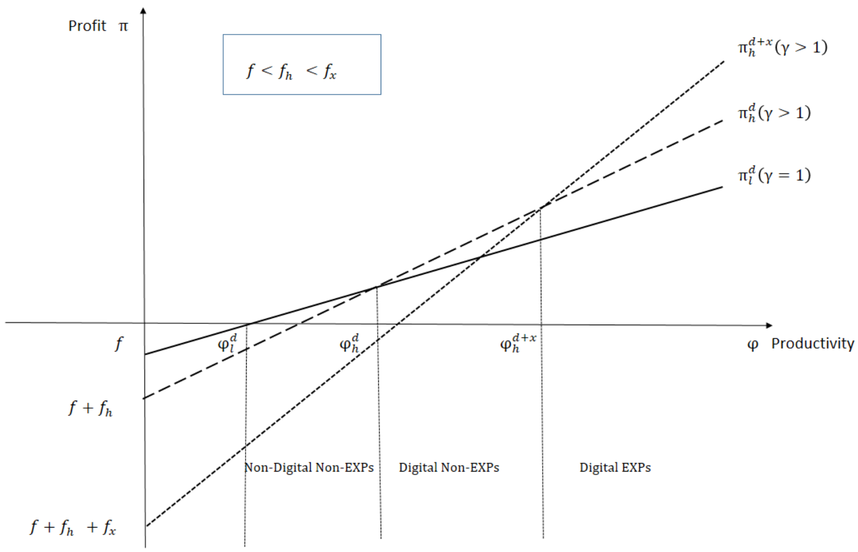
$$\pi_h^{d+x}(\varphi_h^x) = \pi_h^d(\varphi_h^x) \Longleftrightarrow \frac{r_h^{d+x}(\varphi_h^x)}{\sigma} - (f + f_h + f_x) = \frac{r_h^d(\varphi_h^x)}{\sigma} - (f + f_h) \tag{3}$$

where φ_l^d is the survival cutoff, i.e. the minimum level of productivity required to survive in the domestic market, φ_h^d is the digital technology cutoff, i.e. the minimum level of productivity required to adopt the digital technology, and is φ_h^x is the export cutoff, i.e. the minimum level of productivity required to supply the foreign market.

The equilibrium is solved by considering the free entry condition $\psi_d \frac{\tilde{\pi}}{\delta} = f_e$, where $\psi_d = 1 - G(\varphi_l^d)$ is the probability of survival, $\tilde{\pi}$ is the per-period expected profit of surviving firms, δ is a per-period exogenous

[8]Since our focus is on the impact of the arrival of new digital technology, we assume duty-free trade, i.e. we do not consider changes in trade policy. This means that firms earn a lower export profit than domestic profit, even though they have the same price and revenue in the foreign market as they do in the home market.

Figure 3: Developed Economy Case.



probability of exit. Notice that $\varphi_l^d < \varphi_h^d < \varphi_h^x$ only if the fixed cost of exporting f_x is sufficiently higher than the fixed cost of digital technology f_h,[9] which in turn is higher enough than the fixed cost of production f.[10]

From Figure 3, we can observe that there are three groups of firms: the least productive firms that focus only on the domestic market without adopting a digital technology, the most productive firms that are also involved in export activities with a digital technology, and the medium-productivity firms, which adopt digital technology without exporting. Therefore, it can be shown that an increase in digital productivity premium γ arising from the arrival of SMCs implies a reduction in the digital technology cutoff φ_h^d, so that some non-exporters start using the digital technology. At the same time, it may lead to a decrease in the export cutoff φ_h^x, which would imply the entry of new firms in the export market and, therefore, a reallocation of the export market shares from high- to low-productivity firms.

3.3 The developing economy case

In the case of a developing economy ($DC = 1$), the fixed cost of digital technology is relatively high ($f < f_x < f_h$) so that few firms can adopt a digital technology, i.e. only the most productive exporters. The corresponding profit conditions are:

$$\pi_l^d(\varphi_l^d) = 0 \Longleftrightarrow \frac{r_l^d(\varphi_l^d)}{\sigma} - f = 0 \tag{4}$$

$$\pi_l^{d+x}(\varphi_l^x) = \pi_l^d(\varphi_l^x) \Longleftrightarrow \frac{r_l^{d+x}(\varphi_l^x)}{\sigma} - (f + f_x) = \frac{r_l^d(\varphi_l^x)}{\sigma} - f \tag{5}$$

[9] $f_x > \left(\frac{\gamma^{\sigma-1}}{\gamma^{\sigma-1}-1}\right) f_h$

[10] $f_h > (\gamma^{\sigma-1} - 1)f$

$$\pi_h^{d+x}(\varphi_h^x) = \pi_l^{d+x}(\varphi_h^x) \Longleftrightarrow \frac{r_h^{d+x}(\varphi_h^x)}{\sigma} - (f + f_x + f_h) = \frac{r_l^{d+x}(\varphi_h^x)}{\sigma} - (f + f_x) \tag{6}$$

where φ_l^d is the survival cutoff, φ_l^x is the export cutoff, and φ_h^x is the digital technology cutoff. As before, the free entry condition $\psi_d \frac{\tilde{\pi}}{\delta} = f_e$ determines equilibrium. Note that $\varphi_l^d < \varphi_l^x < \varphi_h^x$ only if the fixed cost of digital technology f_h is sufficiently higher than the fixed cost of exporting f_x, [11] which in turn is higher enough than the fixed cost of production f.[12]

Figure 4: Developing Economy Case.

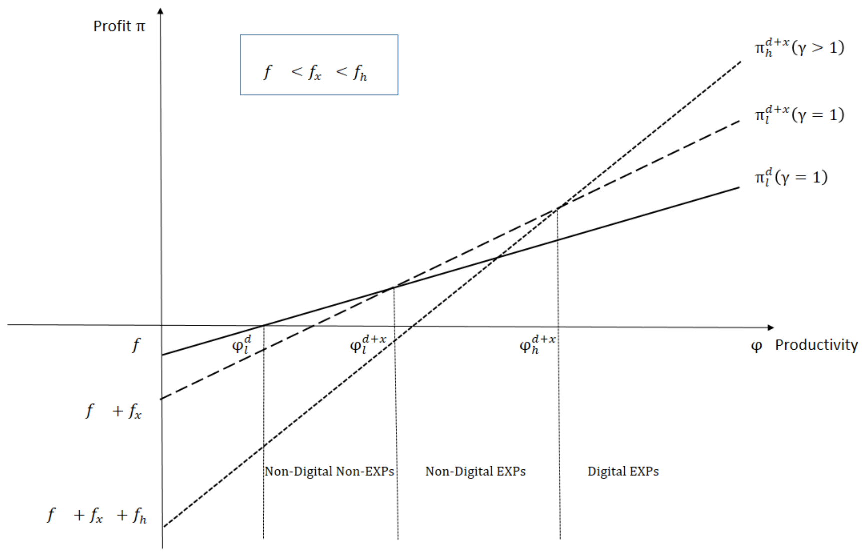


Figure 4 shows three groups of firms: the least productive firms that supply only on the domestic market without a digital technology, the most productive firms that are involved in exporting with a digital technology, and the medium-productivity firms, which export without adopting a digital technology.[13] It can be demonstrated that an increase in digital productivity premium γ resulting from the arrival of SMCs leads to some exporters to start using digital technology, due to a decrease in the digital technology cutoff φ_h^x. At the same time, it may lead to an increase in the export cutoff φ_l^x, which entails the exit of the least productive exporters from the international market, as well as export market share reallocation from low- to high-productivity firms.

3.4 How does the number of exporting firms adjust to the arrival of SMCs?

In this set-up, it can be shown that subsequent to a digital productivity gain arising from the arrival of a bilateral SMC – i.e. an increase in γ resulting from lower communication and information search costs permitted by higher internet speed and bandwidth (Dickstein and Morales, 2018) – the number of

[11] $f_h > 2(\gamma^{\sigma-1} - 1)f_x$

[12] $f_x > f$

[13] Note that this case is similar to Bustos (2011)'s study of the impact of trade liberalisation on technology upgrading of Argentinian exporters. She shows theoretically and documents empirically that a bilateral tariff cut induces more firms to adopt the new technology.

exporting firms $N_x = \psi_x N$ in developed countries ($DC = 0$) increases due to an increase in the probability of exporting $\psi_x = \left[1 - G(\varphi_h^x)\right]/\left[1 - G(\varphi_l^d)\right]$ and despite a decline in the number of surviving firms N. Conversely, the number of exporting firms $N_x = \psi_x N$ in developing countries ($DC = 1$) declines subsequent to the arrival of a bilateral SMC, through a fall in the number of surviving firms N and despite the probability of exporting $\psi_x = \left[1 - G(\varphi_l^x)\right]/\left[1 - G(\varphi_l^d)\right]$ remains unchanged.[14] Further details are reported in Appendix A.

Testable hypothesis. *Subsequent to the arrival of SMCs at the bilateral level, the number of exporting firms increases in developed countries and declines in developing countries.*

4 Empirical evidence

4.1 Data and descriptive statistics

We use bilateral trade data from the World Bank's Exporter Dynamics Database (EDD), which contains aggregated measures on export characteristics from 68 countries in different periods, ranging between 1997 and 2014 (Fernandes et al., 2016), by focusing on the number of exporting firms at the bilateral level.[15] We also use bilateral data on the maritime telecommunications infrastructure deployment across 171 countries and over 1990-2018 drawn from Telegeography database, by primarily considering the activation time of a bilateral digital connection through SMCs, and then using the number of SMCs connecting one country to another.

By merging the two datasets above, we build a final unbalanced panel of matched export and Internet data at the bilateral level for 48 coastal countries during the period 1997-2014, which saw the share of cable-connected countries passing from some 40% to more than 90%.[16] Table B.1 in Appendix shows the distribution of the observations across countries and regions. Three-quarters of our sample (shares in parenthesis) concern developing countries: Latin America and the Caribbean (LAC) (30.4%), Sub-Saharan Africa (SSA) (20.4%), Middle-East and North-Africa (MENA) (9.5%), Eastern Europe and Central Asia (ECA) (9.3%), South Asia (SA) (4.3%) and Eastern-Asia and Pacific (EAP) (3.5%). The rest of the sample (OTHERS) (22.6%) consists of high-income countries mostly located in Western Europe.[17]

By focusing on the most common year across countries, i.e. 2009, Table 1 displays a large country heterogeneity in the average number of exporting firms across destinations (from 3 in Guinea to 3,783 in Germany) and within regions (14 in Nicaragua to 500 in Brazil in LAC, and from 3 in Guinea to 348 in South Africa within SSA). Looking at the time evolution of the average number of exporting firms

[14] In other words, the number of surviving firms N and the number of exporting firms N_x decline proportionally, thanks to an increase in γ, so that the fraction of exporters ψ_x remains unchanged.

[15] This database has been build by World Bank, by using very detailed trade transactions data from all exporting firms within each country.

[16] Over a total of 172 coastal countries. Some countries from World Bank's EDD data have been dropped as they are not included in SMC data, mostly because they are landlocked countries.

[17] Kuwait, a high-income country located in the Middle-East, is the only non-European country.

Table 1: Country-level average number of exporting firms across destinations in 2009.

Country	Region	Av. # firms	Country	Region	Av. # firms	Country	Region	Av. # firms
DEU	OTHERS	3783	EGY	MENA	110	URY	LAC	30
ESP	OTHERS	1780	IRN	MENA	105	MUS	SSA	29
TUR	ECA	922	PER	LAC	103	CIV	SSA	22
BEL	OTHERS	723	LBN	MENA	83	TZA	SSA	19
BRA	LAC	500	MAR	MENA	75	KHM	EAP	17
DNK	OTHERS	467	EST	OTHERS	72	MDG	SSA	17
MEX	LAC	404	ECU	LAC	66	NIC	LAC	14
ZAF	SSA	348	HRV	ECA	58	CMR	SSA	14
PRT	OTHERS	343	GTM	LAC	54	ALB	ECA	13
NOR	OTHERS	323	CRI	LAC	52	SEN	SSA	13
PAK	SA	279	KEN	SSA	52	GEO	ECA	10
BGD	SA	155	JOR	MENA	37	YEM	MENA	8
COL	LAC	149	KWT	OTHERS	37	GIN	SSA	3
CHL	LAC	135	DOM	LAC	33			

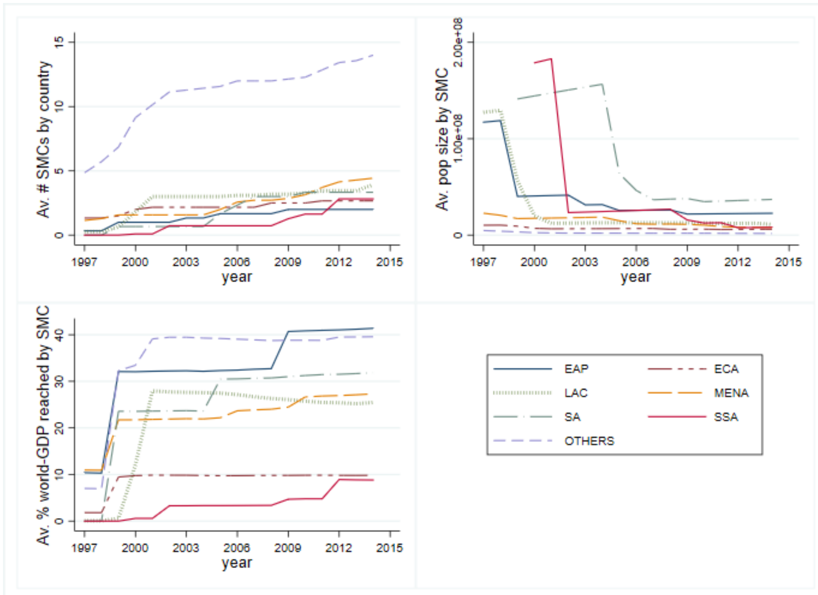
Notes: Seven countries are out because the available period is prior to 2009 (SWE, BGR and GAB) or subsequent to 2009 (MMR, LKA, THA and STP).

across destinations for each country in figures in Appendix B, we observe that this number is increasing within ECA and SA, slightly increasing or stable within OTHERS, and decreasing in EAP (except for Cambodia, where the trend is increasing after an initial decline). It is fluctuating along a constant trend in SSA (except for Kenya and Senegal, where the trend is increasing), and more heterogeneous within MENA: increasing in Egypt, Jordan, and Morocco, decreasing in Iran, fluctuating along constant trend in Lebanon, and inverted U-shaping in Yemen.

Moreover, Figure 5 displays statistics documenting at the regional level the changing patterns of the SMC network across time. Looking at proxies of the SMC network capacity (top graphs), high-income countries (OTHERS) display a markedly higher SMC network's absolute capacity — measured by the regional average number of SMCs by country (top-left graph) — and relative capacity — measured by the ratio of the regional population average over the regional average number of SMCs (top-right graph, the lower the ratio the greater the relative capacity) – than other regions. However, Sub-Saharan Africa has demonstrated a rapid growth in absolute SMC network capacity, superseding some Asian countries, and has caught up the rest of the world in terms of relative capacity, by the end of the sample period. South-Asian countries, somewhat under-represented in our sample,[18] display lower SMC capacity than the rest of the world. Looking at the SMC network's outreach (bottom graph), measured by the average cumulative share of world GDP reached by direct cable connections, SSA as well as ECA countries remain poorly connected to the world economy, by reaching in average 10% of world GDP, compared to 30-40% in high-income countries and other Asian regions.

[18]Consisting of 3 countries: Pakistan, Bangladesh, and Sri Lanka.

Figure 5: SMC network and regional connectivity through time, 1997-2014.



Source: Authors' computation, based on the baseline estimation sample. Raw data from Telegeography and World Development Indicators.

4.2 Empirical model

The trade benefits derived from Internet connectivity increase with the telecommunications' network size and the quality of interconnections (Katz and Shapiro, 1985; Crémer et al., 2000). Our empirical analysis builds on this feature to quantify the impact of direct SMC connections on firm's export participation at the bilateral level. We estimate the following baseline econometric specification, which can be derived from the structural gravity equation through the log-linearization (Anderson and Van Wincoop, 2003; Helpman et al., 2008):

$$\ln N\_exporters_{cdt} = \beta_1 \cdot SMC_{cdt} + \beta_2 \cdot SMC_{cdt} \times DC_c + \alpha_{cd} + \alpha_{ct} + \alpha_{dt} + \varepsilon_{cdt} \quad (7)$$

Where $N\_exporters_{cdt}$ is the number of firms in country c exporting to destination d in year t; and SMC_{cdt} is our main variable of interest, i.e. a dummy variable taking value one if country c is connected through SMCs to a given destination d in year t, and zero otherwise, while DC_c is a dummy variable taking value one if country c is a developing economy and zero otherwise. Considering our discussion in subsection 3.4, we expect that $\beta_1 > 0$ and $\beta_2 < 0$, i.e. following the arrival of SMCs, firm participation in export markets, on average, increases in developed countries and decreases in developing countries. Appendix Table B.2 shows the summary statistics of the main variables.

Finally, we also include country-destination pair fixed effects (α_{cd}) to account for time-invariant characteristics at the bilateral level (e.g. distance), as well as country-year and destination-year fixed effects (α_{ct},α_{dt}) to control for time-varying characteristics at either country or destination level (e.g. GDP and multilateral resistance in both trading partners). Standard errors have been corrected for clustering at the bilateral level. Since the estimation of equation (7) using a linear regression technique might be inconsistent in the presence of heteroscedasticity, and does not consider the zero trade values adequately (Silva and Tenreyro, 2006), we also adopt a Poisson pseudo-maximum likelihood (PPML) model, considering the same high dimension of fixed-effects coherently with most recent studies (Larch et al., 2019):

$$N\_exporters_{cdt} = exp(\beta_1 \cdot SMC_{cdt} + \beta_2 \cdot SMC_{cdt} \times DC_c + \alpha_{cd} + \alpha_{ct} + \alpha_{dt}) + \nu_{cdt} \quad (8)$$

Considering that trade flows involving small and poor countries turn out to be more heteroscedastic than those involving other countries (Larch et al., 2019) and that our data mainly concern developing countries, we expect differences between PPML and OLS estimates. Since standard errors should allow for simultaneous correlations across all the three dimensions of the panel (c, d, t) we also correct standard errors for the multi-way clustering, which nests the typical practice of assuming that standard errors are only clustered within country-destination pair across time (Larch et al., 2019).

4.3 Empirical results

4.3.1 The impact of bilateral SMC arrival on the extensive margin of exports

Table 2 reports estimates of equations (7) and (8) in columns (1) and (2), respectively. Column (1) highlights that subsequent to a bilateral direct connection through SMCs, the number of exporting firms increases in developed economies and declines in developing ones, in line with our expectations. More specifically, the arrival of bilateral SMC leads to an increase in the number of exporting firms by about 11% in developed countries, as well as a decrease by about 7% in developing countries. These findings are confirmed in column (2), although with a slight different magnitude: when a bilateral SMC connection is created, the number of exporting firms increases by about 9.6% in advanced countries and declines by about 2.3% in poorer economies. We consider the empirical approach of (8) for the rest of the paper since it addresses several econometric issues, as highlighted above.

We also explore the possibility of heterogeneous effects of SMC bilateral deployment among developing countries, by decomposing the group of developing economies by several geographic areas: Eastern Europe and Central Asia (ECA), Latin America and Caribbean (LAC), Middle East and North Africa (MENA), South Asia (SA) and Sub-Saharan Africa (SSA). Exploring this geographic heterogeneity in column (3) stresses differences across developing areas: while the number of exporting firms in ECA and LAC increases by 9.4% and 1.7% following a bilateral SMC connection, this number decreases by 6.5% in MENA and SA countries, and by 5.4% in SSA countries. These results suggest that areas concentrating countries from the lower-middle and low-income groups, that is, MENA, SA, and SSA, are those where exporting firms lose from the bilateral connection process.

Moreover, we investigate whether our results also depend on destination heterogeneity in development stage, by interacting our main explanatory variables in equation (8) with a dummy that takes value one if the destination is a developing country and zero otherwise (DC_d). Results in column (4) suggest that the effects of improved connectivity on the number of exporting firms does not depend on whether the trading partners are similar or dissimilar in the development stage.

Table 2: Bilateral-level linkage between number of exporting firms and SMC arrival.

	(1)	(2)	(3)	(4)
Dep. Var:	$\ln N\_exporters_{cdt}$	$N\_exporters_{cdt}$		
SMC_{cdt}	0.110***	0.0965***	0.0945***	0.0930***
	(0.0419)	(0.0221)	(0.0214)	(0.0293)
$SMC_{cdt} \times DC_c$	-0.180***	-0.119***		-0.105**
	(0.0529)	(0.0410)		(0.0411)
Regions of origin				
$SMC_{cdt} \times ECA_c$			0.0127	
			(0.139)	
$SMC_{cdt} \times LAC_c$			-0.0777*	
			(0.0434)	
$SMC_{cdt} \times MENA_c$			-0.159***	
			(0.0448)	
$SMC_{cdt} \times SA_c$			-0.159**	
			(0.0717)	
$SMC_{cdt} \times SSA_c$			-0.148**	
			(0.0712)	
Destination's development stage				
$SMC_{cdt} \times DC_d$				0.0123
				(0.0565)
$SMC_{cdt} \times DC_c * DC_d$				-0.0298
				(0.0676)
Country-Destination FE	YES	YES	YES	YES
Country-Year FE	YES	YES	YES	YES
Destination-Year FE	YES	YES	YES	YES
Observations	53,963	65,429	65,429	65,429
R-squared	0.978	0.998	0.998	0.998

Note: Unbalanced panel of country-destination pairs. Column (1) is based on OLS model, where standard errors are corrected for clustering at the bilateral level. Columns (2)-(4) are based on PPML model, where standard errors are corrected for multi-way clustering.

Overall, this first bunch of results supports that bilateral SMC deployment contributes to increase the number of exporting firms in developed countries but to reduce it in developing countries. Among developing economies, this adverse effect is more striking in countries from SA, SSA, and MENA regions, but does not seem to be related to export destination's development stage. This evidence therefore suggests that the SMC bilateral deployment can be beneficial for firms in developed countries, being able to adopt ICT technologies, and detrimental for firms in developing economies, due to their lower capacity to absorb Internet-related technologies.

4.3.2 SMC effects on intensive margin of exports and total export value

In Table 3, we look at the effect of SMCs on average exports per firm (intensive margin) and total export value, in addition to the number of exporting firms (extensive margin). While data on extensive margin may have missing values when there are zero trade flows, data on intensive margin and total export value in the EDD database have missing values also when there is only one exporting firm at the bilateral level because of confidential issues. Consequently, we focus now only on the sub-sample of country-destination pairs that have a positive value of average export value per firm. For this reason, we replicate the regression on extensive margin ($N\_exporters_{cdt}$) along with the intensive margin (ave_exp_{cdt}) and total export value (exp_{cdt}). While the results on extensive margin are strongly confirmed (column (1)), we found no statistically significant effect of SMCs on intensive margin (column (2)), which implies weak effects on total export value (column (3)).

Table 3: SMC impact on Export value, extensive and intensive margins.

	(1)	(2)	(3)
	Extensive margin	Intensive margin	Export value
Dep. Var:	$N\_exporters_{cdt}$	ave_exp_{cdt}	exp_{cdt}
SMC_{cdt}	0.0866***	-0.0578	-0.0188
	(0.0195)	(0.0895)	(0.0360)
$SMC_{cdt} \times DC_c$	-0.112***	0.172	-0.142*
	(0.0400)	(0.170)	(0.0817)
Country-Destination FE	YES	YES	YES
Country-Year FE	YES	YES	YES
Destination-Year FE	YES	YES	YES
Observations	48,939	48,939	48,939
R-squared	0.998	0.888	0.999

Note: Unbalanced panel of country-destination pairs. PPML model, where standard errors are corrected for multi-way clustering.

4.3.3 Endogeneity test

Through the inclusion of fixed effects at different levels, the omitted variable bias problem is drastically reduced. Previous studies highlighted that the arrival of SMCs is unlikely to be endogenous from the firm's perspective (Hjort and Poulsen, 2019), but the laying of SMCs could be affected by aggregate conditions, such as a country's outward orientation, which would be a source of reverse causality bias. To check this possibility, we run a simple test by including both lagged and lead values in our specification in addition to the current values of our main explanatory variables. While we expect insignificant coefficients for lead variables to exclude reverse causality, we could have significant coefficients for lagged variables since the effect of SMC can take some time. In line with our expectations, Table 4 shows that when including lagged, current and lead values in our specification, only the coefficients related to the lagged values are statistically significant, confirming that the causality runs from SMC arrival to firm participation into export market, rather than the opposite.

Table 4: Endogeneity test.

	(1)
Dep. Var:	$N\_exporters_{cdt}$
SMC_{cdt-1}	0.0759***
	(0.0176)
$SMC_{cdt-1} \times DC_c$	-0.0952**
	(0.0394)
SMC_{cdt}	0.0202
	(0.0129)
$SMC_{cdt} \times DC_c$	-0.0289
	(0.0199)
SMC_{cdt+1}	0.0469
	(0.0429)
$SMC_{cdt+1} \times DC_c$	-0.0598
	(0.0414)
Country-Destination FE	YES
Country-Year FE	YES
Destination-Year FE	YES
Observations	51,566
R-squared	0.998

Note: Unbalanced panel of country-destination pairs. PPML model, where standard errors are corrected for multi-way clustering.

4.3.4 Does the size or quality of bilateral connections matter?

Here, we explore the channels through which bilateral Internet connection may affect firm participation in the export markets. We expect that the effects are increasing in both size and quality of the bilateral SMC connection. We use the number of SMCs between any two countries, (N_SMC_{cdt}), to address the size channel, and the risk of SMC faults induced by their exposure to seismic shocks, ($Seaquake\_Freq_{cdt}$), to investigate the quality channel. It is indeed documented that such natural hazards represent an exogenous source of lower capacity for and stability of international telecommunications (Carter, 2010; Carter et al., 2014; Pope et al., 2017; Aceto et al., 2018; Cariolle et al., 2019).[19] The reduced benefits and increased costs of Internet access resulting from SMC's exposure to seaquake shocks should hence deteriorate lower-productivity exporters' capacity to supply foreign markets, and eventually, to provoke their exit.

Therefore, to study the effects of the quality of bilateral SMC connections on firms' export participation, we compute a variable reflecting the bilateral SMC connection's exposure to seismic events, following the approach of Cariolle et al. (2019). This variable consists in firstly calculating the annual frequency of maritime seismic events occurring in the vicinity of SMC landing stations in the origin and destination countries, separately. Two distinct measures of bilateral SMC's exposure to seaquakes are then computed as follow:

$$Seaquake\_Freq1_{cdt} = SMC_{cdt} \times (Seaquake\_Freq_{ct} + Seaquake\_Freq_{dt})$$
$$Seaquake\_Freq2_{cdt} = SMC_{cdt} \times (\frac{Seaquake\_Freq_{ct} + Seaquake\_Freq_{dt}}{2})$$

where SMC_{cdt} is the bilateral SMC connection dummy. SMC's bilateral exposure to seaquakes is either approximated by the annual number of seaquakes that occurred in the vicinity of SMCs in both origin and destination countries ($Seaquake\_Freq1_{cdt}$), or by the average SMC exposure to seaquakes in origin and destination countries ($Seaquake\_Freq2_{cdt}$).

We therefore estimate the following specification:

$$\begin{aligned} N\_exporters_{cdt} = exp(&\beta_1 \cdot N\_SMC_{cdt} + \beta_2 \cdot N\_SMC_{cdt} \times DC_c + \beta_3 \cdot Seaquake\_Freq_{cdt} \\ &+ \beta_3 \cdot Seaquake\_Freq_{cdt} \times DC_c + \alpha_{cd} + \alpha_{ct} + \alpha_{dt}) + \nu_{cdt} \end{aligned} \tag{9}$$

Results are reported in Table 5. We focus on the size channel only in column (1), on the quality channel only in columns (2) and (4), and on both channels simultaneously in columns (3) and (5). First, in line with previous results, we find that an increase in the number of SMCs at the bilateral level leads a greater number of exporters from developed countries and a smaller number of exporters from developing ones. Second, we also find evidence that a decrease in quality of connections arising from a higher SMC exposure to seaquakes significantly reduces the number of exporting firms from developing countries.

These results suggest that a reduction in SMC quality as captured by an increase exposure of the SMC network to maritime seismic events, provokes additional exits of less performing firms from export markets by increasing the costs of Internet access and reducing the benefits of international telecommunications.

[19]First, damages incurred by SMCs reduce the benefits of international broadband connectivity by increasing latency and instability of telecommunications, and thereby, firms' communication and information search costs. Second, these shocks also imply expensive repairs on damaged cables, higher insurance costs, and additional costs related to the rerouting of Internet traffic towards more expensive and less-capacity cable paths, which are reported on Internet tariffs by telecommunication operators (Carter et al., 2014)

Table 5: Channels – Size and quality of bilateral cable connections.

	(1)	(2)	(3)	(4)	(5)
Dep. Var:			$N\_exporters_{cdt}$		
N_SMC_{cdt}	0.0219**		0.0219**		0.0219**
	(0.0111)		(0.0111)		(0.0111)
$N\_SMC_{cdt} \times DC_c$	-0.0547**		-0.0532**		-0.0532**
	(0.0225)		(0.0227)		(0.0227)
$Seaquake\_Freq1_{cdt}$		-1.20e-06	1.33e-06		
		(1.47e-05)	(1.34e-05)		
$Seaquake\_Freq1_{cdt} \times DC_c$		-0.000295**	-0.000269**		
		(0.000122)	(0.000112)		
$Seaquake\_Freq2_{cdt}$				-2.40e-06	2.66e-06
				(2.93e-05)	(2.69e-05)
$Seaquake\_Freq2_{cdt} \times DC_c$				-0.000591**	-0.000538**
				(0.000244)	(0.000225)
Observations	65,429	65,429	65,429	65,429	65,429
R-squared	0.998	0.998	0.998	0.998	0.998
Country-Destination FE	YES	YES	YES	YES	YES
Country-Year FE	YES	YES	YES	YES	YES
Destination-Year FE	YES	YES	YES	YES	YES

Note: Unbalanced panel of country-destination pairs. PPML model, where standard errors are corrected for multi-way clustering.

We find no effect of SMC exposure to seaquakes in developed countries because of the collinearity with the fixed-effects explained by the low, almost null, exposure of these countries to maritime seismic events.

5 Conclusion

In this paper, we explore an undocumented feature of international trade patterns: whether and to what extent the digital network's densification at the bilateral level has contributed to trade creation in developed and developing countries. By providing digital interconnections between trade partners, the laying of SMCs has reduced communication and information search costs in a dramatic way, and thereby, could have increased trade flows between connected countries.

By combining data on the bilateral number of exporting firms in 48 countries with an original panel dataset on bilateral SMC deployment, we document that improved bilateral digital connectivity through SMC connections has a positive effect on the number of exporting firms from developed countries, and a negative effect on the number of exporters from developing countries, as predicted from our theoretical model. This negative effect of bilateral digital connectivity on firm export participation is stronger in countries from the lower-middle and low-income groups – that is, in the Middle-East and North Africa, South Asia, and Sub-Saharan Africa.

We argue that the arrival of broadband Internet through bilateral SMCs may have stimulated export participation for firms located in developed countries, by reducing information and communication costs, as they are capable of absorbing digital technology upgrading. By contrast, firms located in developing economies, which may not have the financial, human and organizational capacity to absorb the Internet technology may reduce their export participation, even leaving foreign markets.

Therefore, our findings suggest to policy-makers that making a better digital technology available to firms in developing countries is a necessary but not a sufficient condition to enable them better compete internationally. More efforts and investments to enhance digital absorptive capacity across workers and firms are required.

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Appendices

A Theoretical results and comparative statics

A.1 Developed economy case

Considering the equations (1), (2), and (3), as well as the free entry condition in section 3.2, we can determine that

the survival cutoff is $\varphi_l^d = \left[\left(\frac{\sigma-1}{k-\sigma+1}\right)\frac{1}{\delta f_e}\right]^{\frac{1}{k}}\Delta^{\frac{1}{k}}$, where $\Delta = f + \psi_h f_h + \psi_h^x f_x$

the digital technology cutoff is $\varphi_h^d = \left[\frac{f_h}{f(\gamma^{\sigma-1}-1)}\right]^{\frac{1}{\sigma-1}}\varphi_l^d$

the export cutoff is $\varphi_h^x = \left(\frac{f_x}{f\gamma^{\sigma-1}}\right)^{\frac{1}{\sigma-1}}\varphi_l^d$

the probability of survival is $\psi_d = (\varphi_l^d)^{-k}$

the probability of digital technology adoption $\psi_h = \left(\frac{\varphi_h^d}{\varphi_l^d}\right)^{-k} = \left[\frac{f_h}{f(\gamma^{\sigma-1}-1)}\right]^{\frac{-k}{\sigma-1}}$

the probability of exporting is $\psi_x = \left(\frac{\varphi_h^x}{\varphi_l^d}\right)^{-k} = \left(\frac{f_x}{f\gamma^{\sigma-1}}\right)^{\frac{-k}{\sigma-1}}$

the number of surviving firms is $N = \frac{R}{\bar{r}} = \frac{L}{\sigma(\tilde{\pi}+\Delta)} = \left(\frac{k-\sigma+1}{k}\right)\frac{L}{\sigma\Delta}$

the number of exporting firms is $N_x = \psi_x N = \left(\frac{f_x}{f\gamma^{\sigma-1}}\right)^{\frac{-k}{\sigma-1}}\left(\frac{k-\sigma+1}{k}\right)\frac{L}{\sigma\Delta}$

the price index is $P = \left(\frac{L}{\sigma f}\right)^{\frac{1}{1-\sigma}}\frac{1}{\rho\varphi_l^d}$

Therefore, the derivative of N_x w.r.t. γ is

$\frac{\partial N_x}{\partial\gamma} = \frac{\partial\psi_x}{\partial\gamma}N + \frac{\partial N}{\partial\gamma}\psi_x = k\psi_x\gamma^{-1}N\left[1-\Delta^{-1}\left(\frac{\gamma^{\sigma-1}}{\gamma^{\sigma-1}-1}\psi_h f_h + \psi_h^x f_x\right)\right] > 0$

A.2 Developing economy case

Considering the equations (4), (5), and (6), as well as the free entry condition in section 3.3, we can determine that

the survival cutoff is $\varphi_l^d = \left[\left(\frac{\sigma-1}{k-\sigma+1}\right)\frac{1}{\delta f_e}\right]^{\frac{1}{k}}\Delta^{\frac{1}{k}}$, where $\Delta = f + \psi^x f_x + \psi_h^x f_h$

the export cutoff is $\varphi_l^x = \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}}\varphi_l^d$

the digital technology cutoff is $\varphi_h^x = \left[\frac{f_h}{f2(\gamma^{\sigma-1}-1)}\right]^{\frac{1}{\sigma-1}}\varphi_l^d$

the probability of survival is $\psi_d = (\varphi_l^d)^{-k}$

the probability of exporting is $\psi_x = \left(\frac{\varphi_l^x}{\varphi_l^d}\right)^{-k} = \left(\frac{f_x}{f}\right)^{\frac{-k}{\sigma-1}}$

the probability of digital technology adoption is $\psi_h = \left(\frac{\varphi_h^x}{\varphi_l^d}\right)^{-k} = \left[\frac{f_h}{f2(\gamma^{\sigma-1}-1)}\right]^{\frac{-k}{\sigma-1}}$

the number of surviving firms is $N = \frac{R}{\bar{r}} = \frac{L}{\sigma(\tilde{\pi}+\Delta)} = \left(\frac{k-\sigma+1}{k}\right)\frac{L}{\sigma\Delta}$

the number of exporting firms is $N_x = \psi_x N = \left(\frac{f_x}{f}\right)^{\frac{-k}{\sigma-1}}\left(\frac{k-\sigma+1}{k}\right)\frac{L}{\sigma\Delta}$

the price index is $P = \left(\frac{L}{\sigma f}\right)^{\frac{1}{1-\sigma}}\frac{1}{\rho\varphi_l^d}$

Therefore, the derivative of N_x w.r.t. γ is

$\frac{\partial N_x}{\partial\gamma} = \psi_x\frac{\partial N}{\partial\gamma} = -\psi_x N\Delta^{-1}k\psi_h(\gamma^{\sigma-1}-1)^{-1}\gamma^{\sigma-1}f_h < 0$

B Additional tables and figures

B.1 Sample statistics

Table B.1. Unbalanced panel of bilateral trade (1997-2014): Sample distribution across 48 countries and 7 regions

Country	EAP	ECA	LAC	MENA	SA	SSA	OTHERS
ALB	0	1,512	0	0	0	0	0
BEL	0	0	0	0	0	0	2,856
BGD	0	0	0	0	1,680	0	0
BGR	0	1,008	0	0	0	0	0
BRA	0	0	3,024	0	0	0	0
CHL	0	0	1,680	0	0	0	0
CIV	0	0	0	0	0	672	0
CMR	0	0	0	0	0	2,856	0
COL	0	0	1,176	0	0	0	0
CRI	0	0	2,520	0	0	0	0
DEU	0	0	0	0	0	0	672
DNK	0	0	0	0	0	0	2,016
DOM	0	0	2,184	0	0	0	0
ECU	0	0	2,184	0	0	0	0
EGY	0	0	0	1,176	0	0	0
ESP	0	0	0	0	0	0	1,680
EST	0	0	0	0	0	0	2,520
GAB	0	0	0	0	0	1,176	0
GEO	0	1,680	0	0	0	0	0
GIN	0	0	0	0	0	672	0
GTM	0	0	1,512	0	0	0	0
HRV	0	1,008	0	0	0	0	0
IRN	0	0	0	840	0	0	0
JOR	0	0	0	1,680	0	0	0
KEN	0	0	0	0	0	1,512	0
KHM	1,680	0	0	0	0	0	0
KWT	0	0	0	0	0	0	336
LBN	0	0	0	840	0	0	0
LKA	0	0	0	0	168	0	0
MAR	0	0	0	2,016	0	0	0
MDG	0	0	0	0	0	1,008	0
MEX	0	0	2,184	0	0	0	0
MMR	504	0	0	0	0	0	0
MUS	0	0	0	0	0	1,848	0
NIC	0	0	2,184	0	0	0	0
NOR	0	0	0	0	0	0	3,024
PAK	0	0	0	0	1,512	0	0
PER	0	0	2,856	0	0	0	0
PRT	0	0	0	0	0	0	2,688
SEN	0	0	0	0	0	2,184	0
STP	0	0	0	0	0	168	0
SWE	0	0	0	0	0	0	1,680
THA	504	0	0	0	0	0	0
TUR	0	2,016	0	0	0	0	0
TZA	0	0	0	0	0	1,680	0
URY	0	0	2,016	0	0	0	0
YEM	0	0	0	840	0	0	0
ZAF	0	0	0	0	0	2,016	0
TOT	**2,688**	**7,224**	**23,520**	**7,392**	**3,360**	**15,792**	**17,472**

Notes: EAP = East Asia & Pacific; ECA = Europe & Central Asia; LAC = Latin America & Caribbean; MENA = Middle East & North Africa; OTHERS = Developed Economies; SA = South Asia; SSA = Sub-Saharan Africa.

Table B.2. Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
$N\_exporters_{cdt}$	77,448	261.038	1179.869	0	32,648
SMC_{cdt}	77,448	0.086	0.281	0	1
DC_c	77,448	.774	.418	0	1

B.2 Time evolution of the number of exporting firms across destinations for each country

Figure B.1. East Asia and Pacific.

Figure B.2. Eastern Europe and Central Asia.

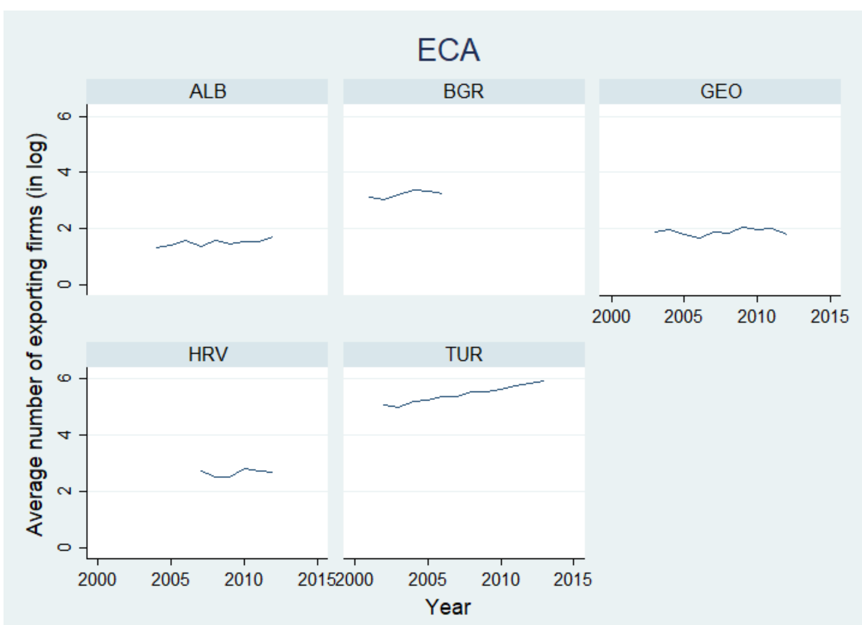


Figure B.3. Middle East and North Africa.

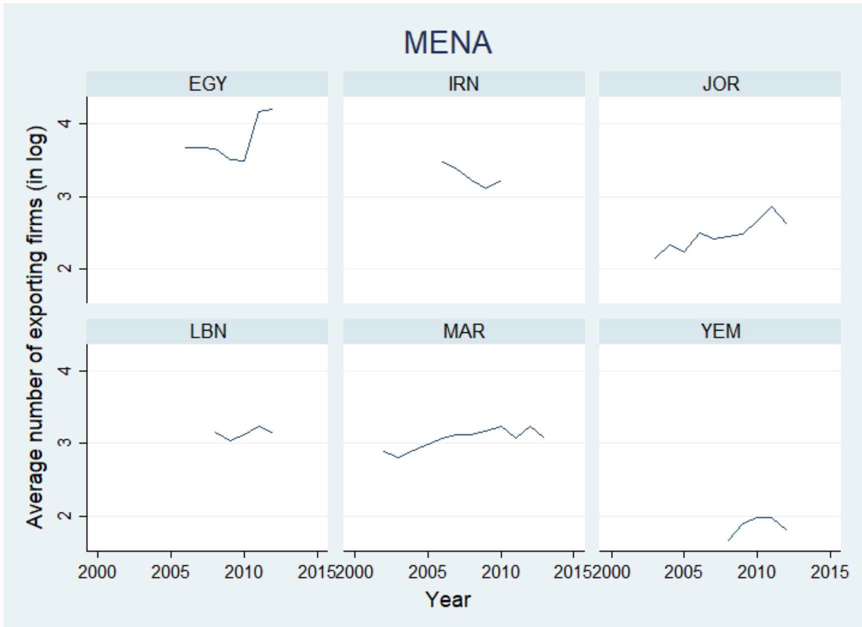


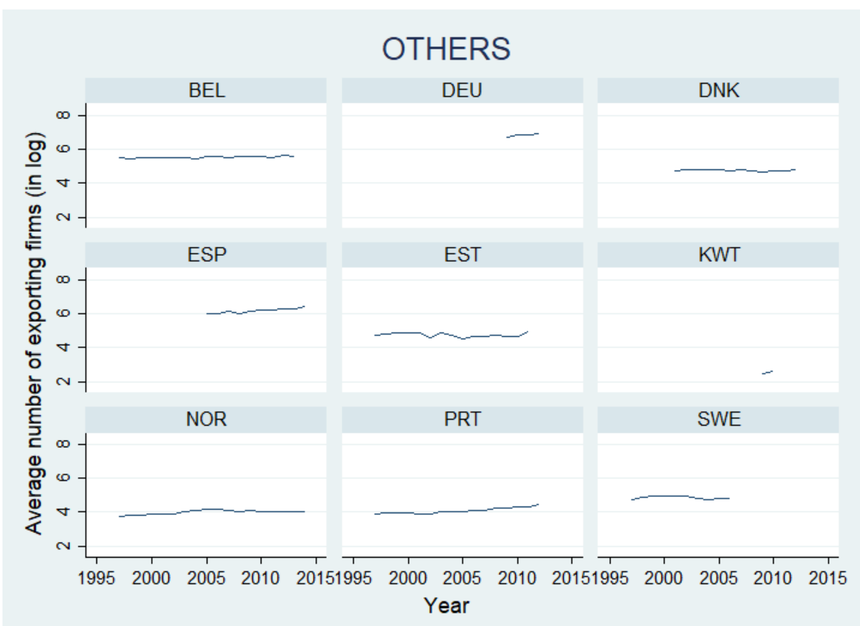
Figure B.4. South Asia.

Notes: Sri Lanka is missing because only one-year data are available

Figure B.5. Sub-Saharan Africa.

Notes: Sao Tomé is missing because only one-year data are available

Figure B.6. Others.



Notes: OTHERS includes countries from Western Europe and Koweit.