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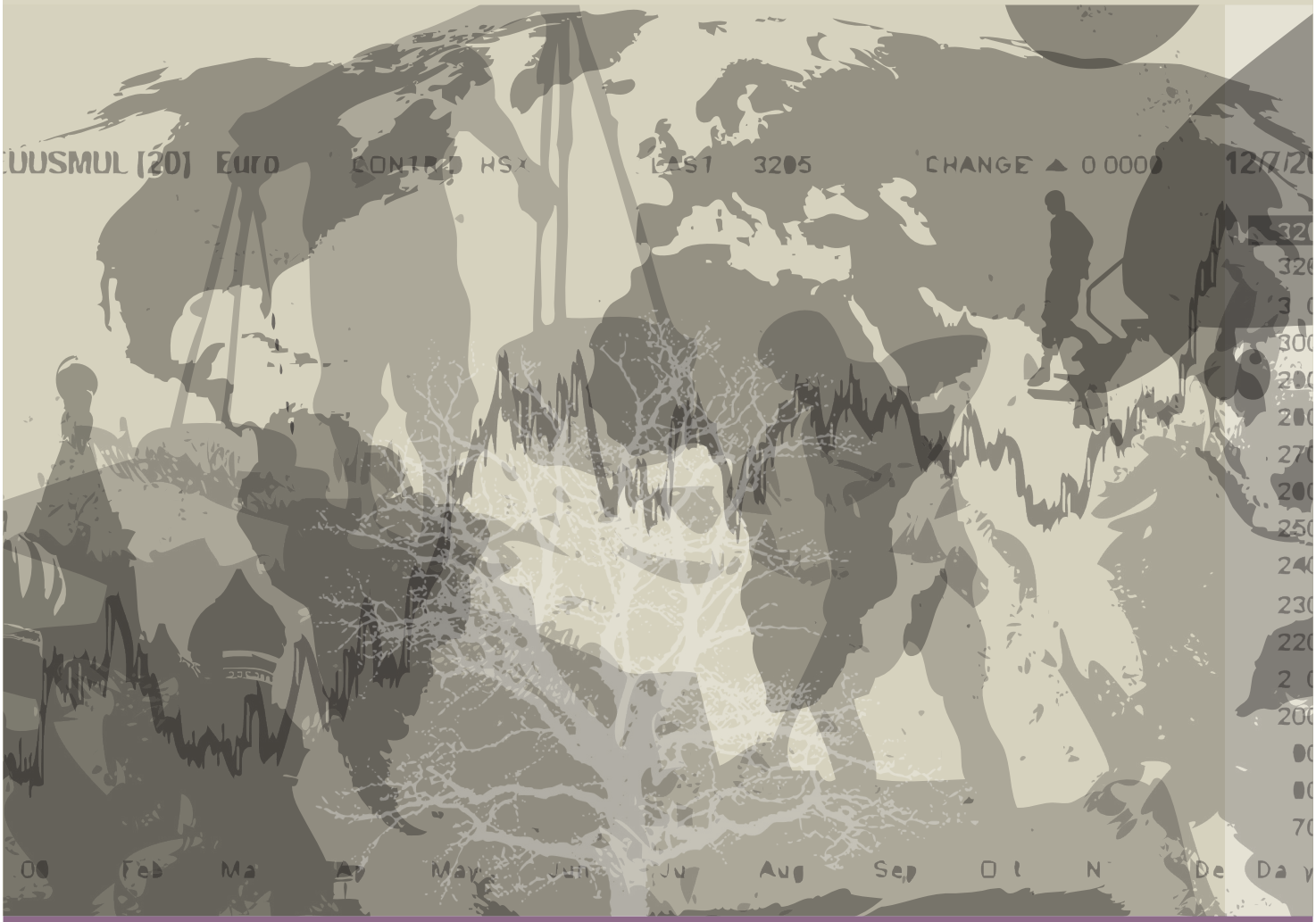
Internet use, intermediaries and international trade

Per Botolf Maurseth and Hege Medin



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Summary

This study of the relationship between internet use and international trade finds that firms in many developing countries are more likely to engage in export and/or import if they use the internet as a communication tool. An ordered probit regression indicates that internet use is positively associated with direct participation in trade, as well as with indirect participation via trade intermediaries. Data on countries' aggregate trade do not give support for the micro-findings, however: no significant association emerges between the share of internet users in a given country and that country's openness to trade.

1. Introduction

Recent years have witnessed trade liberalization as well as the emergence of the internet. World trade increased from about 40 per cent of World GDP in 1990 to about 60 per cent in 2015. The share of internet users in the global population rose from zero in 1990 to more than 40 per cent in 2015. ICT is now available everywhere, for fast growing numbers of people and firms. Price indices for ICT goods (hardware and software) have been *falling* at impressive rates (see Jorgenson, 2005; Maurseth, 2017). ICT is used for a wide range of purposes and production processes. ICT has also become global, and the most rapid increase in use of ICT is now in developing countries (Maurseth, 2017). With the internet, users can search for relevant information in efficient ways. The internet has global outreach, and is complementary to other types of technology. It is also a networking technology, implying that its usefulness increases with the number of users.

Despite the obvious potentials of the internet for economic activities, empirical studies show mixed results about the economic impacts. Many microdata-based studies indicate large positive effects for the economic performance of firms, industries or regions. Studies based on macro-data, on the other hand, show more ambiguous results. While some studies find positive growth effects from the internet, others find weak or negative effects (Acemoglu et al., 2014).[1] Various possible reasons have been proposed to explain differences in results at the micro- and the macro-levels. ranging from methodological explanations (e.g., measurement errors or lack of appropriate instruments) to economic explanations. Robert Gordon (2002) argues that ICT and the internet represent far less technological progress than the case of earlier technological revolutions (e.g., the steam or combustion engines, or electricity). Drawing on Choi and Yi (2009), Meijers (2014) argues that the causal link between the share of internet users in a population and economic growth is indirect and goes via trade. Through a simultaneous equations model, he provides evidence that the internet promotes trade, and that trade promotes growth. In this paper, we study the relationship between internet use and international trade, and posit that the internet may reduce the transaction costs related to trade.

In economic models, trade costs were traditionally modelled as variable and proportional to the volumes traded. However, many studies have shown that firms face fixed costs and entry barriers when they start to export (Roberts and Tybout, 1997; Bernard and Jensen, 2004; Maurseth and Medin, 2017). One type of barrier concerns communication: firms must be able to communicate with their buyers. Access to good communication technologies is likely to facilitate domestic as well as international trade, but may be particularly important for international trade, where obstacles to communication are likely to be larger, because of greater distances; different languages; and differing rules, regulations and cultures. Having internet access may be particularly important because alternative means of communication like telephones may be

[1] This is often called the *Solow paradox*. As Robert Solow (1987) observed, 'you can see the computer everywhere but in the productivity statistics'.

relatively expensive to use for international communication. However, in many developing countries, communication infrastructure is poor, and internet access cannot be taken for granted. This may pose significant obstacles to participation in international trade, and firms with internet access are likely to have an advantage.

Trade models typically predict that trade decreases with trade costs; and since trade costs are likely to increase with distance, trade is predicted to be more intense among neighbouring countries. In recent trade models, where trade costs are modelled as consisting of both fixed and variable elements, changes in such costs are predicted to affect not only trade intensity (each firm's trade), but also trade participation: the number of firms trading (see e.g. Melitz, 2003; Medin, 2003). Freund and Weinhold (2004) construct a model where the introduction of the internet is assumed to reduce fixed costs in exporting, as trade will be enhanced by there being a higher number of exporters. Using trade data as well as data for internet hosts across countries to estimate empirically the validity of their model, they find that the internet does stimulate trade. A 10 percentage point increase in the growth of web-hosts in a country leads to a 0.2 percentage point increase in export growth. Freund and Weinhold thus argue that the internet can explain much of the increase in world trade in recent years.

Clarke and Wallstein (2006) investigate the relationship between access to internet and export performance in developing as well as developed countries. Their data indicate that many more exporters had internet access than did non-exporters.[2] Using a gravity-like function to estimate countries' export performance as a function of the number of internet hosts per 100 people, they conclude that internet promotes exports for developing countries, but only exports to developed countries.[3] They argue that this reflects network effects: because firms in developed countries rely on the internet, access to the internet becomes more important for firms in developing countries when exporting to these countries.

Like most of the research on the impacts of ICT on trade, these two studies used aggregated trade data. In contrast, we use micro-data for a large number of individual firms to see whether access to internet-based communication tools is associated with participation in international trade. Some other articles have done this – among them Clarke (2008), Ferro (2011), Ricci and Trionfetti (2012), Timmis (2013), Yadav (2014), Manolea and Spatareanu (2015), Kotnik and Hagsten (2018). However, most of these had data for only a small or moderate selection of countries.[4] The main focus was on firms from low- and middle-income countries, and internet use was generally found to have a positive impact on the probability of exporting. As was the case in studies based on aggregated data, results concerning high-income countries were less clear. Kotnik and Hagsten (2018) found positive effects in only about half of the 11 European countries they studied. Some studies have also examined whether internet use affected export intensity – i.e. the value exported – rather than just participation in exports. The results have

[2] Note, however, that they did not use firm-level data in the analyses.

[3] The gravity function for international trade models trade between two countries as increasing with the countries' total GDP and decreasing with the distance between them.

[4] The studies that included the highest number countries were Ferro (2011), Yadav (2014), and Ricci and Trionfetti (2012), who studied 77, 52 and 32 developing countries, respectively. The other studies focused on a smaller selection of countries from specific geographical areas.

been ambiguous: whereas Clarke (2008) and Yadav (2014) found no additional effect on intensity, Ferro (2011) and Timmis (2013) found a positive effect.

Our study adds to this literature in several ways. Like most other studies, we restrict our analysis to low- and middle-income countries. This seems logical, as internet use can now be expected to be approaching saturation level in most high-income countries. However, we examine a large number of countries – 117 in total – and use recent data, with most of our observations being collected between 2013 and 2017. In contrast, the most recent observations of all the above-mentioned micro-studies were from 2010, with many observations stemming from the early 2000s. It is essential to use recent observations, because internet infrastructure is developing rapidly.

Further, we study how internet use affects not only *export* participation, but also *import participation*, as recent research indicates that fixed costs and entry barriers are likely to arise in importing as well as exporting (Kasahara and Lapham, 2013; Medin, 2017). Communication hurdles are no exception: firms must be able to communicate with foreign suppliers in order to buy from them, so internet use is likely to affect firms' probability of importing. To our knowledge, only one other study has dealt with this issue – Yadav (2014), who found a positive association between internet use and import participation among manufacturing firms.

Some firms participate in exporting or importing without being directly in contact with their buyers or suppliers. Rather than trading directly, they rely on intermediaries, like domestically located trading companies, for selling or buying their goods abroad. Trading companies like that mitigate or eliminate the need to establish contact and communicate with foreign buyers and suppliers may also act as guarantors of product quality (see e.g. Feenstra and Hanson, 2004). Access to internet-based communication tools may be less important for such indirect traders. Even so, they are still likely to be more internationally oriented than firms that sell only in the domestic market, necessitating some communication with foreign actors. Moreover, they must communicate with the trading company, which may be located far away. Consequently, internet-based communication tools may affect their trade participation, but perhaps not as much as for direct traders. Here we study trade participation of both types of traders. Using an ordered probit model, we find that internet use is positively associated with participation in both types of trade, but that the effect is larger for direct traders.[5]

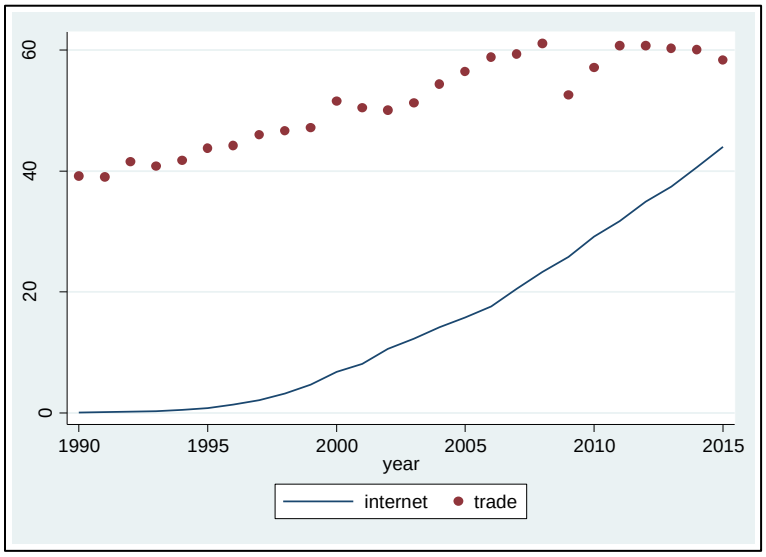
In Section 2, we present some preliminary macro-evidence. The micro-analysis is undertaken in Section 3, and Section 4 offers some concluding remarks.

[5] Timmis (2013) studied how internet use affected export intensity among direct and indirect traders and found that it only had an effect on former. However, unlike us, he did not study trade participation or importers, and examined only 18 countries. Moreover, he could not study the trade-off between indirect and direct export, as the two types of trade were analysed in in different regressions.

2. Preliminary macro evidence

As noted, both international trade and the number of internet users around the globe have increased in recent years. Figure 1 shows developments since 1990: total trade (exports plus imports) as share of world GDP, in addition to the share of the world population that uses internet. The data are from World Bank (2018) *World Development Indicators*. Trade has been on the rise for a long time, but the trend appears to have slowed down in the aftermath of the great recession. By contrast, the share of internet users has risen steadily. Technology diffusion often follows an S-shaped pattern over time (Hall, 2005). If this is the case also with internet users, their share will continue to increase in the years to come. For individual countries for which internet use has become high, the diffusion has been S-shaped (see Maurseth, 2017).

Figure 1. Growth in trade and internet use



Source: World Bank (2018)

An important issue is whether the two developments are related. As preliminary evidence we report results from a fixed-effect regression where we use panel data at the country level and regress countries' (log of) trade on (lagged) share of internet users in the population. The analysis is restricted to the sample of countries used in the micro-analysis in the next section. We estimate the following equation:

$$(1)\quad Ln(trade_{it}) = \alpha_i + \beta^{ln}(internet_{it-1}) + \boldsymbol{\beta^{Co}controls_{it-1}} + t + \varepsilon_{it}$$

where $trade_{it}$, indicates country i's total trade as share of GDP in year t. α_i is the fixed effect for country i, t is a year fixed effect and ε_{it} is the residual. Residuals were clustered at the country level. We run three versions of Eq. (1), where $trade_{it}$ refers either to total trade, to exports, or to

imports (as share of GDP). Control variables include one-year lagged values of (log of) GDP per capita, (log of) total GDP and a measure of market potential. [6]

Table 1. Regression results, macro-data

	Trade		Exports		Imports	
Independent variables	**Coef.**	**Std. error**	**Coef.**	**Std. error**	**Coef.**	**Std. error**
Internet users	-0.004 *	0.002	-0.002	0.002	-0.005 **	0.002
Ln(GDP per capita)	0.356	0.265	0.358	0.285	0.339	0.269
Ln(GDP)	-0.264	0.179	-0.121	0.228	-0.354 **	0.166
Market potential	0.000	0.000	0.000 *	0.000	0.000	0.000
# countries	117		117		117	
# observations	2605		2605		2604	
R^2	0.23		0.22		0.25	

Note: The regression covers the period 1990 to 2017. The independent variables are lagged one year. Fixed effects for countries as well as for year are included, and standard errors are clustered at the country level. * and ** denote significance at the 10% and 5% levels, respectively. No results were significant at the 1% level.

Our results do not indicate any trade-promoting effect due to internet use. On the contrary, the estimated coefficients for internet users are negative in the three regressions. However, they are significant only for total trade and imports (and only at the 10 % level for total trade), indicating weak or even non-existent links to trade. Also most of the other explanatory variables are not significantly associated with countries' total trade, exports or imports (as share of GDP). The exceptions are GDP, which has a significantly negative estimated coefficient for countries' imports, and market potential, which has a positive but weakly significant coefficient for exports. The lack of significance is partly due to the econometric method employed: to control for unobserved heterogeneity at the country level, we used fixed effects regressions with clustered standard errors. The regression coefficients therefore show the effect of year-by-year changes in the explanatory variables for countries' subsequent year-by-year changes in trade. In other words, instead of studying whether countries with many internet users have higher levels of trade than those with few uses, we ask whether a country increases its trade when the number of internet users increases.

In their study of bilateral trade flows (based on an extended gravity study), Rodriguez-Crespo et al. (2018) found positive effects of the internet, but results were weaker when low and middle-income countries were included. Also, Bojnec and Fertö (2009) found positive effects of the internet on exports, but their study concerned OECD countries only.

[6] We measure market potential as the weighted sum of GDP in all other countries, with the inverse of distance used as weights.

3. Evidence based on micro-data

The data used for our firm-level analyses are taken from the World Bank's Enterprise Surveys, henceforth WBES (Enterprise Surveys, 2012), which are based on standardised interview surveys among firms in the formal sector in developing countries all around the world. We use the 2017 version of the database and limit ourselves to manufacturing firms; this yields a sample of more than 20 000 firms in 117 countries. The WBES use a stratified sampling methodology. Within each country there are strata on three levels: industry, firm size, and region. The data contain information on a large number of firm-level characteristics, including participation in exporting and importing (direct, as well as indirect through trading companies); and information on whether the firm has its own website and/or uses e-mail to communicate with customers and/or suppliers.

Similar to the aggregated study, we estimate the following equation:

(2) $Trade_i = \alpha + \beta^{In} Internet_i + \boldsymbol{\beta}^{Co}\mathbf{controls} + \varepsilon_{ijs}$

where *i* indicates firm, *s* sector, and *j* country. $Trade_i$ is a categorical variable equal to 0, 1, or 2, depending on whether firm *i* operates in the domestic market only; trades indirectly, but not directly; or trades directly, respectively. Firms that trade indirectly may also operate in the domestic market; likewise, firms that trade directly may also trade indirectly and operate in the domestic market. As for the macro-study, we run three regressions: one for exporters and importers pooled together, one for exporters, and one for importers.[7] Our main explanatory variable of interest is *Internet*, which is an indicator variable equal to 1 if the firm uses the internet as a means of communication. We also include several controls reflecting company-level characteristics (such as size and productivity) that have been found to be associated with trade participation in other studies.[8] Table 2 lists all variables used in the regression analysis.

[7] When exporters and importers are pooled together, $Trade_i$= 2 if the firm either exports or imports directly (or both); and $Trade_i$= 1 if the firm exports or imports indirectly (or both), but not directly.

[8] Earlier studies have found a productivity hierarchy, where firms that operate only in the domestic market tend to score lower on several productivity indicators (like number of employees, sales per worker, total factor productivity) than those that trade internationally (see e.g. Abel-Koch, 2013; McCann, 2013; Shepherd, 2013). Among trading firms, indirect traders score lower than direct traders. Further, some evidence suggests that the most productive firms both import and export (Kasahara and Lapham, 2013). This hierarchy can be explained by fixed costs to trade, which are higher for direct than indirect trade, implying that only the most productive firms are able to profit sufficiently from foreign sales to cover their fixed costs (Ahn et al., 2011).

Table 2. Summary statistics and description of variables in the sample

Variable	Mean	Description
Internet	0.824	=1 if the firm has its own webpage or uses email to interact with buyers or suppliers, 0 otherwise
# employees	88.9	the firm's number of employees (permanent and temporary)
TFP	1.82	the firm's total factor productivity, calculated using the YKL method (Cusolito et al., 2017)
Age	17.5	age of the firm
Foreign owner	0.069	= 1 if the firm has foreign owners, 0 otherwise
Foreign tech.	0.139	= 1 if firm uses technology licensed from a foreign-owned company, 0 otherwise
Credit	0.341	= 1 if the firm has a line of credit or loan from a financial institution, 0 otherwise
Indirect export	0.106	= 1 if the firm exports indirectly (but not directly), 0 otherwise
Direct export	0.179	= 1 if the firm exports directly, 0 otherwise
Indirect import	0.228	= 1 if the firm imports indirectly (but not directly), 0 otherwise
Direct import	0.133	= 1 if the firm imports directly, 0 otherwise
# countries	117	
# sectors (2-digit isic)	22	

Note: countries are sampled in various years 2006–2017, with approx. 70% of observations sampled after 2012. Source: World Bank Enterprise Surveys (Enterprise Surveys, 2012), 2017 version. Indirect export/import refers to firms that trade in foreign markets exclusively through domestically located trading companies.

Due to the categorical nature of the dependent variable, we estimate Eq. (2) using an ordered probit model. Results, shown in Table 3, indicate that internet use is positively associated with trade participation, exports as well as imports. Of course, these results do not prove a causal relationship from internet use to trade participation. Instead of internet use leading to trade, there may be reversed causality, where firms that already participate in trade find it wise to invest in ICT. The results are still interesting, however: in both cases, internet use helps firms to participate in trade. Another possibility is that the correlation between internet use and trade participation is spurious due to omitted variable bias, where unobserved factors affect both variables positively. While there is no guarantee against this type of bias, we believe that we have corrected for the most important sources by including industry- and country dummies (controlling for unobserved factors at those levels) as well characteristics that reflect the technological level of firms (like productivity and use of foreign technology).

Results for the control variables indicate that larger firms and firms with foreign owners are more likely to trade. Firms that import are more likely to export, and firms that export are also more likely to import. For exporters, access to credit is also positively associated with trade participation. These results are in line with findings from other studies (see footnote 7).

Table 3. Ordered probit estimates of firms' trade participation status

	Exporters and importers			Exporters			Importers		
Independent variables	**Coef.**		**Std. error**	**Coef.**		**Std. error**	**Coef.**		**Std. error**
Internet	0.349	***	0.067	0.376	***	0.097	0.420	***	0.069
# employees	0.351	***	0.021	0.351	***	0.022	0.086	***	0.022
TFP	0.048		0.030	0.042		0.033	-0.044		0.028
Age	-0.018		0.035	0.038		0.040	-0.119	***	0.033
Foreign owner	0.759	***	0.110	0.566	***	0.096	0.566	***	0.104
Foreign tech.	0.170	**	0.081	0.128		0.083	0.020		0.069
Credit	0.283	***	0.048	0.269	***	0.052	0.064		0.049
Direct trade	.		.	0.903	***	0.071	0.827	***	0.071
Cut 1	1.133		0.501	3.263		0.674	0.537		0.606
Cut 2	2.024		0.500	3.752		0.673	1.591		0.606
# obs	21 018			21 018			21 018		
# strata	5 555			5 555			5 555		
Estimated # population obs	790 048			790 048			790 048		
APP dependent variable = 0	0.512			0.715			0.643		
APP dependent variable = 1	0.250			0.106			0.223		
APP dependent variable = 2	0.238			0.179			0.134		

Note: Survey ordinal probit estimation (using the svy: oprobit command in Stata 15.1). Trade participation status: 0 indicates domestic trade only; 1 indicates indirect international trade (trade exclusively through a domestic trading company operating in foreign markets) and possibly also domestic trade); and 2 indicates direct international trade and possibly also domestic trade and indirect international trade. *Trade* refers to either export + import, export, or import. Cross-sectional data is used, where all observations for each country are from one year only, but firms from different countries may be sampled in different years. Dummies for country and 2-digit isic industry are included. For *# employees* and *Age,* the natural logarithm of the original variable + 1 is used. *Direct trade* is an indicator variable for direct imports in the exporter regression, and direct exports in the importer regression. *APP* refers to average predicted probability.

To assess the magnitude of the effects, we also calculate average partial effects (APEs), displayed in Table 4. They indicate that using the internet as a means of communication is associated with ca. 6–7 percentage points higher probability of direct international trade, as compared to trading indirectly in foreign markets or in the domestic market only. This absolute effect is largest when importers and exporters are pooled together, and smallest when importers are studied separately. However, evaluated relative to the average predicted probability of direct international trade participation (see Table 3), the effect is largest for importers – a 42 per cent increase in the probability of importing directly. When exporters and importers are pooled together or exporters are studied alone, the relative effect is 32–35 per cent. For indirect trade in foreign markets, on the other hand, the corresponding relative increases amount to less – only 13 per cent when both types of traders are pooled together, and 23 per cent for either exporters or importers separately. Thus, internet use seems to be more important for direct than for indirect international trade. That is in line with what we would expect if communication barriers are greater for the first type of trade

Table 4. Average partial effects (APEs)

	Exporters and importers				Exporters				Importers			
	Indirect trade		Direct trade		Indirect trade		Direct trade		Indirect trade		Direct trade	
Variable	**APE**	**Std. error**	**APE**	**Std. error**	**APE**	**Std. error**	**APE**	**Std. error**	**APE**	**Std. error**	**APE**	**Std. error**
Internet	0.033 ***	0.007	0.076 ***	0.014	0.025 ***	0.007	0.063 ***	0.015	0.053 ***	0.009	0.057 ***	0.008
# employees	0.027 ***	0.002	0.082 ***	0.005	0.021 ***	0.002	0.065 ***	0.004	0.010 ***	0.003	0.013 ***	0.003
TFP	0.004	0.002	0.011	0.007	0.003	0.002	0.008	0.006	-0.005	0.003	-0.007	0.004
Age	-0.001	0.003	-0.004	0.008	0.002	0.002	0.007	0.007	-0.014 ***	0.004	-0.018 ***	0.005
Foreign owner	0.021 ***	0.004	0.210 ***	0.034	0.030 ***	0.004	0.126 ***	0.025	0.059 ***	0.009	0.103 ***	0.022
Foreign tech.	0.012 **	0.005	0.041 **	0.020	0.008	0.005	0.025	0.017	0.002	0.008	0.003	0.010
Credit	0.021 ***	0.004	0.069 ***	0.012	0.017 ***	0.004	0.052 ***	0.010	0.008	0.006	0.010	0.008
Direct trade	.	.	.	.	0.046 ***	0.003	0.218 ***	0.021	0.088 ***	0.007	0.157 ***	0.017

4. Conclusions

This study has examined the relationship between the internet and international trade, using firm level data. We find a positive and significant association between the use of internet as a mean of communication and participation in international trade – whether exports, imports or both. The effects are positive not only for firms that are directly in touch with their foreign buyers or suppliers. As compared to firms that operate solely in the domestic market, firms that use the internet are also more likely to trade through a domestically located trading company. They are even more likely to participate directly in trade, however.

These findings are not supported by macro-data, where we find no indications of any association between a country's share of internet users in the population and its openness to trade. In that respect, the findings presented here are in line with the literature on the productivity effects of ICT and the internet, which often reports contradictory results from macro- as opposed to micro-data.

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