

Online Exports and the Wage Gap

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Abstract

The development of the Internet is often seen as a source of demand for skilled workers and therefore a potential driver of the wage gap between skilled and unskilled workers. This paper focuses on the impact that international trade in online platforms has on the wage gap. Because online trade allows smaller firms with relatively more unskilled workers to access world markets it can be expected

a priori that an expansion of online exports reduces the wage gap. After correcting for potential endogeneity bias in a sample of 22 developing countries for which online trade and wage gap data can be matched, the study finds that a 1 percent increase in the share of online exports over GDP leads to a 0.01 percent decline in the wage gap.

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1 Introduction

We explore the impact of online international trade on the wage gap between skilled and unskilled workers. In a sample of 22 developing countries for which we have data on cross border online trade, and labor surveys to estimate the wage gap, we find that a one percent increase in the share of online exports over GDP reduces the wage gap by 0.01 percent. This can be explained by the information providing mechanisms in online platforms that reduce the fixed cost of exporting, allowing smaller firms with a more unskilled workforce to export. We provide evidence supporting this mechanism as the reduction in the wage gap associated with online exports is larger in countries with a larger share of small firms.

This result is important for at least three reasons. First, while world trade increased by 92 percent (8 percent annual growth) between 2004 and 2012, cross-border online trade grew more than 7 times faster (see Figure 1 where the left axis shows the growth in world trade, and the right axis the growth in online trade). Even if cross-border e-commerce only represents around 20 percent of online sales, it has been rapidly growing and its share is expected to double over the next 5 years (UNCTAD, 2015). For policy makers, it is important to assess early on the consequences of such a rapidly growing phenomenon. Second, the wage gap has been declining in the developing world over the last decade (Cruz and Milet, 2017). Our sample is no exception, with an average annual decline of 1 percent as can be seen from Figure 2. Understanding the forces behind the decline in the wage gap, and the role played by employment in small firms, can provide useful tools in the fight against income inequality. Third, it contributes to the debate on how technological progress affects skilled and unskilled workers, and ultimately income inequality. Does technological progress promote or reduce income inequality? While the development of the Internet has often been seen as skilled biased and contributing to income inequality (Akerman et al., 2015), this paper suggests otherwise. Online platforms that allow small firms to access world markets help unskilled workers and contribute to a reduction in income inequality.¹

We face several challenges. First, data on online cross border trade flows are not yet collected by any national or international agency, although some proposals have been put forward (UNCTAD, 2015). As a proxy we use cross-border flows on the eBay platform made available by Lendle et al.

¹As noted by Varian (2005): “*big enterprises were the first to reap the benefits of this technological progress. But the impact of information technology on small and medium-size enterprises may yet turn out to have the most impact on the economy*”. He also remarked more recently that small businesses are taking advantage of technologies which used to be the sole privilege of large companies: “[...] *even the smallest company can now afford a communications and computational infrastructure that would have been the envy of a large corporation 15 years ago*” (Varian, 2011).

(2016). One problem with using eBay flows is that the platform originally started as a peer-to-peer online market where second-hand products were auctioned, even if it rapidly became a platform mainly used by professional sellers on fixed price transactions. Because we want our proxy to reflect the access of firms to foreign consumers via an online platform rather than the general expansion of e-commerce, we decided to disregard transactions that were undertaken under the auction system. We are still left with measurement error due to the fact that cross border eBay flows are only a fraction of total online transactions between firms and foreign consumers. We will address this measurement error using an instrumental variable strategy described below.

The second challenge we face is endogeneity. Indeed, other unobserved factors such as technological progress may simultaneously determine online trade and the wage gap, thus introducing a bias in our estimates. To correct for this (and measurement error) we use an instrumental variable estimator. We use three instruments: i) the time varying geography determinants of bilateral online trade flows following Feyrer (2009); ii) the value of domestic online sales in each of the partner countries; and iii) the average import tariff in the importing countries. These three variables are likely to be valid instruments. Indeed, geography related variables and variables capturing demand shocks in importing countries are unlikely to be correlated with *other* determinants of the wage gap in the *exporting* country.

The third challenge is to provide estimates of the wage gap between skilled and unskilled workers that are consistent across countries. We do this using the methodology and data provided by Cruz and Milet (2017). The raw data are based on labor and household surveys in different countries and at different points in time harmonized by the World Bank in the International Income Distribution Database (I2D2). This makes feasible the use of the same methodology and variables to estimate the wage gap across countries and time.

We are not the first to look at the determinants of the wage gap between skilled and unskilled workers. Labor economists have emphasized the role played by changes in supply and demand to explain changes in the wage gap and ultimately in wage inequality. The workhorse framework linking supply and demand to factor prices is developed in Katz and Murphy (1992), later refined by several authors (see Card and Lemieux, 2001, for instance). The most recent version of this model features skill-biased technologies, i.e. technologies that shift outward the relative demand for skilled workers. This skill-biased technology change (SBTC hereafter) induces a permanent shift in the demand for the labor service of skilled workers.² However, technological change need not be

²The fact that wage inequalities increased at the same time when many industries were investing in computers

biased in favor of skilled workers. Luo (2017) shows that as Europe was experiencing significant technological progress during the 500 years before the First World War, the wage gap between skilled and unskilled workers declined by more than 50%. In our empirical model we will control for both demand and supply side determinants of the wage gap. Our contribution is to add as potential demand driver the growth in online international trade.

The literature has also looked at the importance of trade as a determinant of the wage gap. Some trade economists have stressed the fact that the timing of rising wage inequalities in developed and developing countries coincided with a rapid increase in international trade flows (see Feenstra and Hanson, 2001; Harrison and McMillan, 2011, for surveys). Feenstra and Hanson (1999) find that imports of intermediate inputs account for about 15 percent of the increase in the relative wage of skilled workers in the United States over the period 1979-1990. SBTC is twice as important and accounts for about a third of the increase. Evidence from developing countries is more scarce, but also suggests that wage inequalities have been driven by episodes of trade liberalization in the 1980s and 1990s (Goldberg and Pavcnik, 2007). Lower tariffs imply that many developed economies outsourced part of their production process to lower income countries, which as emphasized by the “trading tasks” models (Feenstra and Hanson, 1996; Grossman and Rossi-Hansberg, 2008) can lead to increased wage inequalities in both developed and developing countries as long as the tasks being outsourced to developing countries are considered as unskilled in the rich country and skilled in the low-income country. Autor et al. (2013) find that trade with China hurts more unskilled workers in the United States, and Autor (2014) and Autor et al. (2015) argue that the negative impact of imports from China on wage and employment of unskilled workers in the United States is much larger than the impact of technological change.

More recently, income inequality has been declining in many developing countries, especially in Latin America (De la Torre et al., 2015). Lustig et al. (2013) review some of this literature and conclude that the decline in overall inequalities in Latin American countries is to a large extent the consequence of a decline in the wage gap, income redistribution associated with government transfers, and the boom in commodity prices (Gasparini et al., 2011).

To sum up, the existing literature has concluded that both trade and skill biased technological progress play a role in explaining changes in the wage gap between skilled and unskilled workers. Importantly, these changes substantially contribute to the evolution in income inequality. However,

gave strong support to the skill-biased technology change hypothesis (Krueger, 1993; Berman et al., 1994; Autor et al., 1998; Acemoglu, 2002).

to our knowledge the impact of online cross border trade on the wage gap between skilled and unskilled workers is yet to be investigated.

The rest of the paper is organized as follows. Section 2 presents the empirical strategy and section 3 the data. Section 4 discusses the empirical results of the impact of online exports on the wage gap. Section 5 explores theoretically and empirically the role played by small firms in explaining the impact of online exports on the wage gap. Section 6 concludes.

2 Empirical strategy

We explain variations in the wage skill gap within countries and over time with the following empirical model:

$$\begin{aligned} \ln(wage\ gap)_{c,t} = & \beta_1 \ln(online\ exports_{c,t}/GDP_{c,t}) + \beta_2 \ln(exports_{c,t}/GDP_{c,t}) \\ & + \beta_3 \ln(skilled/unskilled)_{c,t} + \beta_4 \ln(Internet\ users_{c,t}/Pop_{c,t}) + \delta_c + \eta_t + \epsilon_{c,t} \end{aligned} \quad (1)$$

where β s are parameters to be estimated, $(skilled/unskilled)_{c,t}$ is the relative supply of skilled workers, δ_c and η_t are country and year fixed effects, and $\epsilon_{c,t}$ is the error term. We expect β_1 , which captures the impact of online exports on the wage gap to be negative. Indeed, the reduction in the fixed cost of entering foreign markets brought by online platforms helps smaller and less productive firms which tend to hire more unskilled workers, to enter international markets.³ This again increases the relative labor demand for unskilled workers. Total exports over GDP controls for the overall impact of trade openness on the wage gap. The expected sign is ambiguous as some of the early studies have shown that trade increased the wage gap, whereas some of the more recent studies have shown that the commodity boom has contributed to a reduction of the wage gap. The relative supply of skilled workers should reduce the wage gap and therefore β_3 is expected to be negative. The share of Internet users in the population is a proxy for skilled biased technological change (Akerman et al., 2015) and we therefore expect β_4 to be positive.

An important concern with the estimation of equation (1) is the endogeneity of online and total

³For evidence that small firms have a more unskilled workforce, see the classic work by Brown and Medoff (1989) or Hamermesh (1980). For evidence that online markets help small firms access otherwise unreachable international markets see Lendle et al. (2013). They show that 90 percent of US firms on the eBay platform export and that their size is much smaller than the size of traditional US exporting firms. Lendle and Olarreaga (2017) provide similar evidence for firms in developing countries.

exports flows, as well as measurement error associated with the use of eBay cross border flows as a proxy for online exports. We address this by instrumenting online and total trade flows using three exogenous sources of variation. First, we use the time-varying distance determinant of online and total exports as in Feyrer (2009). We expect the impact of distance to vary over time due to innovations in the transport sector that has shifted shipments towards air transport, as well as technological progress in the information and telecommunication sector. We expect the impact of distance to be different for online and total trade because technological improvements, which reduce information barriers and that we proxy using geographic distance, are likely to be stronger for online transactions given the information providing mechanisms in online platforms such as the top rated seller or buyer information in online markets (Lendle et al., 2016). Thus the variation in the use of these instruments comes from the differential impact of distance across time and across online and offline flows.

The second set of instruments capture foreign demand shocks for online and total exports in importing countries. In the case of online trade, domestic demand is computed as the sum of domestic online transactions and online imports. For total trade, we simply use the GDP of the importing country. We expect demand in the importing country to be positively correlated with online and total export flows of exporting countries, and uncorrelated with other determinants of the wage gap in the exporting country.

Finally, we use the average tariff imposed by the importing country. To differentiate the tariff imposed on online and total trade, we use the average import tariff on manufacturing products for online trade and the average tariff on all products (including raw materials and agricultural products) for total trade. There is no reason to believe that the average tariff imposed by the importing country is correlated with the wage gap in the exporting country other than through its impact on bilateral trade, which we expect to be negative.

We estimate the following six equations:

$$\ln(\text{online exports}_{x,m,t}/GDP_{x,t}) = \sum_t \beta_t^d \ln(\text{distance})_{x,m} + \beta_{x,m} + \beta_{x,t} + \epsilon_{x,m,t} \quad (2)$$

$$\ln(\text{online exports}_{x,m,t}/GDP_{x,t}) = \eta \ln(\text{online demand})_{m,t} + \beta'_{x,m} + \beta'_{x,t} + \epsilon'_{x,m,t} \quad (3)$$

$$\ln(\text{online exports}_{x,m,t}/GDP_{x,t}) = \lambda \ln(1 + \text{tariff}_{\text{manuf}})_{m,t} + \beta''_{x,m} + \beta''_{x,t} + \epsilon''_{x,m,t} \quad (4)$$

$$\ln(\text{exports}_{x,m,t}/GDP_{x,t}) = \sum_t \alpha_t^d \ln(\text{distance})_{x,m} + \alpha_{x,m} + \alpha_{x,t} + \mu_{x,m,t} \quad (5)$$

$$\ln(\text{exports}_{x,m,t}/GDP_{x,t}) = \theta \ln(GDP)_{m,t} + \alpha'_{x,m} + \alpha'_{x,t} + \mu'_{x,m,t} \quad (6)$$

$$\ln(\text{exports}_{x,m,t}/GDP_{x,t}) = \psi \ln(1 + \text{tariff})_{m,t} + \alpha''_{x,m} + \alpha''_{x,t} + \mu''_{x,m,t} \quad (7)$$

where $\ln(\text{online exports})_{x,m,t}$ and $\ln(\text{exports})_{x,m,t}$ are respectively the online and total exports from country x to country m in year t . $\beta_{x,m}$ and $\alpha_{x,m}$ control for time-invariant country-pair specific determinants of trade flows such as distance, colonial linkages, common language, etc. $\beta_{x,t}$ and $\alpha_{x,t}$ are year and country specific shocks in the exporting country. We use the estimate in equations (2)-(7) to predict the log of bilateral online and total exports. To estimate the impact of online trade on the wage gap, we need to aggregate the bilateral exports flows at the exporter and year level. We first take the exponential of the predicted bilateral trade flows estimated by equations (2)-(7). We then aggregate these trade flows at the exporter and year level by summing the trade flows over all importers each year. After taking logs we use these six variables to instrument the log share of online and total exports in GDP.

3 Data

The variable of interest is the wage gap between skilled and unskilled workers. We borrow the data and methodology from Cruz and Milet (2017). The data source is the International Income Distribution Database (I2D2) put together by the World Bank which compiles more than 1,000 household and labor force surveys from 164 countries over the period 1960-2014 covering more than 120 million individuals. The data have been harmonized to the extent possible ensuring that conceptual variables have similar meaning, allowing for cross-country analysis.⁴ For the purpose of this study, we selected a restricted sample of 22 countries for which sufficient data are available.⁵

⁴See Montenegro and Hirn (2009) and Montenegro and Patrinos (2014) for more information about the database.

⁵See table 1 for a list of countries and surveys.

We kept surveys for which individual information on gender, age, education achievement, and labor income (wage) was available and consistent over the period 2004-2012 for which we have cross-border trade data. We kept the working age population, and dropped individuals below 15 and above 64 years of age.⁶ Finally, we kept workers who reported being paid employees rather than self-employed. Wages are reported in various units depending on the country being surveyed. We converted them into monthly full-time equivalent.⁷ We exclude the top and bottom 1% of the wage distribution as non-response and under-reporting are typically quite severe among high-income households, and the bottom end of the distribution is likely to suffer from measurement error, misreporting, and omissions to consider financial transfers within the household (such as remittances for instance). There are five categories of educational achievement: no education or incomplete primary, complete primary, incomplete secondary, complete secondary, and post-secondary.

We define skilled workers as workers with at least a complete secondary education.⁸ The group of unskilled workers is made of individuals without education (below primary), incomplete primary and complete primary education.⁹ Following Katz and Murphy (1992) and Acemoglu and Autor (2011), wages and labor supply are defined in terms of *efficiency units* by adjusting for the composition of the workforce. We follow Acemoglu and Autor (2011) and define 50 demographic groups of individuals based on the five education categories (no education or incomplete primary education, complete primary education, incomplete secondary education, complete secondary education, and post-secondary education), five job experience groups (0-9 years, 10-19 years, 20-29 years, 30-39 years, and more than 40 years), and gender (50=5 education groups×5 experience groups×2 genders). We regress the individual log wage on the five education dummies, an experience quartic, the full interaction between the education dummies and the experience quartic, a dummy for

⁶This restriction does not affect our results. Individuals outside the [15-64] years old interval account for on average 4.7% of the population, and 4.6% of the total wage bill.

⁷Wages reported in the various surveys are either daily, weekly, bi-weekly, monthly, bi-monthly, quarterly, annually or hourly wages. In the case of hourly wages, we multiplied by the number of hours worked during the day, and by the number of weeks during the month (52 weeks divided by 12 months). In the case where wages are reported on a hourly basis and information on the number of hours is missing, we made the assumption that workers worked 8 hours per day.

⁸In unreported descriptive statistics, we show that the real wages of workers with complete secondary and post-secondary education follow similar trend over time, and so do the wages of workers with below complete secondary education. This similarity in the trends suggest that there is a higher degree of homogeneity within the skilled and unskilled workers rather than between them.

⁹In unreported descriptive statistics, we looked at the evolution of the real wage for each of these education categories. Real wages of workers with complete secondary or post-secondary education followed a similar pattern, quite different from the one for workers with at most incomplete secondary education.

whether the individual lives in an urban area, and an industry dummy¹⁰. We then predict wages at the corresponding education levels and five experience levels (at 5, 15, 25, 35, 45 years of experience, corresponding to the average experience in each experience group defined above), in each industry. We perform separate estimations for men and women. We then take the weighted average of the predicted log wage for skilled and unskilled workers. Weights are defined as the average of the labor share of each of the 50 demographic groups in each industry over time.¹¹

Figure 3 describes the evolution of the wage gap and online exports in some selected countries.¹² The countries were selected so that the variables have similar dimension for illustration purposes. Nevertheless, figure 3 suggests that if the wage gap declined in most countries in our sample, this is not the case in the Philippines, for instance.

The online trade data are borrowed from Lendle et al. (2016), where we only consider fixed price transactions, as the mechanism we have in mind does not go through the auctioning of second-hand goods.¹³ It contains bilateral cross-border flows on the eBay platform over the period 2004-2012. Cross border flows represented on average 20 percent of the total value of transactions on the eBay platform during this period. As shown in figure 1 online trade was growing faster than overall trade over the period 2004-2012.

Table 2 provides summary statistics for all the variables used in the estimations of equations (1)-(7). The data source for GDP, average tariffs, and the share of Internet users is the World Bank's World Development Indicators. Information on distance comes from the CEPII distance database (Mayer and Zignago, 2011).

4 Online exports and the wage gap

Table 3 presents the ordinary least square estimates. All regressions include country and year fixed effects, and standard errors are clustered at the country-level to account for intertemporal correlation in the error term for each country. In all columns online exports has a negative sign and is statistically significant at the 1 percent level. Using the estimates of column (4) which corresponds to equation (1) we find that a 1 percent increase in the share of online exports over GDP decreases

¹⁰There are ten broad industries in the I2D2: agriculture, mining, manufacturing, public utilities, construction, retail and wholesale, transport, finance, public administration, and others.

¹¹See Cruz and Milet (2017) for further details on the construction of the wage gap.

¹²We selected countries based on the comparable magnitudes in terms of changes in the wage gap and online trade. Graphs for other countries show similar patterns.

¹³We also used as a robustness check all online trade flows on eBay which include auction transactions. Results are similar and often larger in magnitude.

the wage gap by 0.01 percent. The log of total exports over GDP is never statistically significant. The coefficient on the relative supply of skilled workers is as expected negative and statistically significant.¹⁴ The share of Internet users, which we use as a proxy for technological change, has a negative and statistically significant sign, suggesting that as the number of Internet users increases the wage gap between skill and unskilled workers declines.

As discussed earlier an important problem with the estimates in table 3 is measurement error as online exports are only captured by cross-border transactions that occurred over the eBay platform. Other platforms like Amazon, or Alibaba are excluded. Moreover, many electronic transactions do not occur over the platforms but directly on firms' web pages.¹⁵ There may also be omitted variable bias if the role of the Internet, which is imperfectly captured by the share of Internet users, is correlated with both online exports and the wage gap. In order to correct for these two problems we instrument online and total exports using equations (2)-(7). Results of the estimation of equations (2)-(7) are shown in table 4. The log of online exports over GDP is the dependent variable in columns (1)–(3), and the log of total exports over GDP in columns (4)–(6). Time-varying distance and trade costs have the expected negative signs but with very different point estimates. The marginal impact of distance on total export flows tends to declining over time for both online and total trade. As can be seen from column (4) in 2004 the impact of distance on total trade is 12 percent smaller than in 2012 (the reference year). For online trade the impact is more than 30 percent smaller in 2005 (we do not use 2004 as it is imprecisely estimated). Columns (2) and (5) report the estimates of equations (3) and (6) where we use the domestic demand for online products (column 2) and GDP (column 5) in partner countries as instruments for online exports and total exports respectively. In both columns the coefficients on the demand variables are positive and statistically significant, as expected. Finally, columns (3) and (6) report the estimates of equations (4) and (7) where the instruments are respectively the average tariff on manufacturing products and the average tariff on all products in the importing country. As expected, import tariffs are negatively correlated with export flows. The correlation matrix of total and online trade flows with their predicted values is given in table 5. All trade flows are highly correlated, but it is important to note that the correlation between the predicted trade flows and the actual flows

¹⁴Its magnitude, -0.10 can be interpreted in terms of the elasticity of substitution between skilled and unskilled workers. Following a simple supply and demand framework *à la* Katz and Murphy (1992), assuming that technological change is exogenous to the supply of skilled workers, the coefficient we estimate is (minus) the inverse of the elasticity of substitution between skilled and unskilled workers. Our estimate in column (4) therefore implies an elasticity around 10.

¹⁵Note that the latter may be less likely for exporters from developing countries which need independent feedback mechanisms provided by these platforms to create a reputation as a reliable business partner.

is always above 0.84, suggesting that our instrumental variables are doing a reasonable job in explaining observed trade flows. This is not surprising given that we use the gravity framework.

Table 6 provides the instrumental variable estimates of equation (1). In the first three columns we report the estimates using one of the three types of instruments for each export flow (online and total). In columns (4) to (6) we use two instruments for each trade flow, which allows us to test for the validity of our instruments. IV (2) + (3) corresponds to the first two instruments for each trade flow (i.e. obtained from equations (2) and (3) for online exports, and from equations (5) and (6) for total exports. The same logic applies to IV (2)+(4) and IV (3)+(4). In column (7) we use all instruments.

All the estimated coefficients on the share of online exports are negative as expected and statistically significant at the 1 percent level. The estimates in column (4) suggest that a 1 percent increase in online exports would lead to a 0.01 percent decline in the wage gap, which is very close to the OLS estimate. The estimated coefficient on total exports is also always negative and statistically significant with a point estimate around -0.05. The coefficient on the relative supply of skilled workers remains negative across the four specifications, but is always statistically insignificant. The share of Internet users is negative and statistically significant at the 10 percent level. At the bottom of the table we report various statistics attesting the overall validity of our instruments. The p-value of the F-test for the first stage is strongly below the admitted threshold of 5% in all specifications, and the Hansen J test shows that the overidentification restriction are valid (except perhaps in column (6) when we only use demand and tariff shocks as instruments). The Cragg-Donald F-test also attests of the strength of our instruments.

5 The role of small firms

As discussed earlier a potential explanation for the negative impact of online exports on the wage gap is that the reduction in the fixed cost of exporting benefits small firms which tend to be less skill-intensive. While small firms are under-represented in the population of regular exporters, anecdotal evidence suggest that they account for a significant share of the firms engaged in cross-border e-commerce. The company “Ecommerce Europe” which describes itself as “the voice of the e-commerce sector in Europe” represents over 25,000 online shops across Europe. Its 2016 e-commerce report surveyed 585 European firms engaged in e-commerce and shows that 334 of the

surveyed firms are what they call “pure-players” (i.e. not retailers or wholesalers).¹⁶ Most of these independent firms (72%) have fewer than 10 employees and 84% have fewer than 20 employees, and two-thirds engage in cross-border e-commerce. In developing countries, anecdotal evidence taken from UNCTAD (2015) shows that when facing substantial challenges while engaging in e-commerce, many micro and small enterprises rely on existing online platforms. Such platforms propose a variety of service that micro and small firms would not be able to provide on their own such as advertising, product management, shipping, and most importantly payments via credit cards, PayPal, or bank accounts.¹⁷

We first develop a simple analytical model to analyze the role of small firms in explaining the impact of online exports on the wage gap. We then empirically assess whether the impact of online exports on the wage gap is stronger in countries with a larger share of employment in small firms.

5.1 A conceptual framework

Building on Ekholm and Midelfart (2005) and Yeaple (2005) it can be shown that a reduction in the fixed cost of exporting faced by small firms leads to a reduction in the wage gap between skilled and unskilled workers, and that this reduction is larger in the presence of a relatively larger share of small firms.¹⁸

On the demand side we have a representative consumer with CES preferences over two imperfectly substitutable composite goods X_h and X_l who maximizes her utility with respect to her budget constraint E . Each composite good is also a CES aggregate of individual varieties produced by monopolistically competitive firms. The aggregate production and corresponding price index in each sector is given by:

¹⁶Reports are available at <https://www.ecommerce-europe.eu/>.

¹⁷In developing countries it is also important to recognize the role played by mobile phones in facilitating the access by micro and small business to e-commerce. According to WTO (2013), “*The most popular ICT in developing countries and one which is progressing very rapidly in Africa and Asia, in particular India, is the mobile phone. Mobile phones are increasingly playing a larger role in the expansion of e-commerce in developing countries, especially among users without terminal connections. [...] In many developing countries, [...] they are increasingly being used for data application such as m-commerce and m-banking. In a number of African countries, notably Kenya, South Africa, Tanzania and Zambia, mobile telephones are being used to do personal banking services*”.

¹⁸We develop a simple closed economy model, but it can be easily reinterpreted as an open economy model by either having consumers and producers being located in different countries, or by adding a second set of consumers in a different country in which a fixed cost needs to be paid in order to reach them.

$$U = \left(X_h^{\frac{\epsilon-1}{\epsilon}} + X_l^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}$$

$$E = w_h H + w_l L \tag{8}$$

$$X_k = \left(\int_0^{N_k} q_k(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \quad k \in \{h, l\} \tag{9}$$

$$P_k = \left(\int_0^{N_k} p_k(i)^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}, \quad k \in \{h, l\}. \tag{10}$$

We assume that $\sigma > \epsilon > 1$ meaning there is a greater substitutability between varieties within each composite good than in final consumption.

On the supply side, firms in each sector behave monopolistically. Firms in sector h incur a fixed cost paid in skilled labor, and a unit skilled labor requirement to produce one unit of output. Firms in sector l use a different technology. They incur a lower fixed cost paid in skilled labor, and a unit unskilled labor requirement to produce one unit of output.¹⁹ The cost functions of a typical firm in each sector are given by:

$$\begin{aligned} TC_h(q_h) &= Fw_h + q_h w_h \\ TC_l(q_l) &= \delta Fw_h + q_l w_l, \quad \delta < 1. \end{aligned}$$

where $\delta < 1$ is the discount on the fixed cost faced by firms in sector l . Our objective is to see what is the impact of a reduction in δ (the fraction of fixed cost paid by firms in sector l) on the wage gap, and how this changes with the share of firms in sector l . Firms maximize their profit, and we get the standard pricing rule, where firms charge a constant markup over their marginal cost.

$$p_h = \frac{\sigma}{\sigma-1} w_h \tag{11}$$

$$p_l = \frac{\sigma}{\sigma-1} w_l. \tag{12}$$

Free-entry in each sector drives profits to zero and gives us the equilibrium quantities produced by a typical firm in each sector:

¹⁹In the appendix we develop the more general case where both sectors use unskilled and skilled labor, but with different intensity.

$$q_h = F(\sigma - 1) \quad (13)$$

$$q_l = \delta F(\sigma - 1)\omega, \quad (14)$$

where ω is the wage gap ($\omega = w_h/w_l$). The revenues of a typical h -type firms are given by: $R_h = p_h q_h = F\sigma w_h$ and the revenues of a typical L -type firms are: $R_l = p_l q_l = \delta F\sigma w_h$. With δ smaller than one, it follows that $R_h/R_l = 1/\delta$ is greater than one, meaning that h -type firms have greater revenues than l -type firms.

Within each sector we can express the aggregate quantities consumed X_h and X_l , as well as the corresponding price indices P_h and P_l , as a function of the number of firms in each sector, N_h and N_l :

$$X_k = q_k N_k^{\frac{\sigma}{1-\sigma}}, \quad k \in \{h, l\} \quad (15)$$

$$P_k = p_k N_k^{\frac{1}{1-\sigma}}, \quad k \in \{h, l\}. \quad (16)$$

Relative demand for the two composite goods is given by:

$$\frac{X_h}{X_l} = \left(\frac{P_h}{P_l} \right)^{-\epsilon} \quad (17)$$

Substituting equations (15) and (16) into equation (17), and then using equations (11) to (14), we can express the wage gap as a function of δ , and the relative number of firms:

$$\begin{aligned} \frac{q_h}{q_l} \left(\frac{N_h}{N_l} \right)^{\frac{\sigma}{\sigma-1}} &= \left[\frac{p_h}{p_l} \left(\frac{N_h}{N_l} \right)^{1/(1-\sigma)} \right]^{-\epsilon} \\ \delta^{\frac{1}{\epsilon-1}} \left(\frac{N_l}{N_h} \right)^{\frac{\sigma-\epsilon}{(\sigma-1)(\epsilon-1)}} &= \omega \end{aligned} \quad (18)$$

It is straightforward to see that the derivative of ω with respect to δ is positive and that the second derivative with respect to δ and N_l/N_h is also positive. Thus, a lower fixed cost faced by smaller and less skill-intensive firms (due to online platforms) leads to a reduction in the wage-gap and the effect is stronger the larger is the share of smaller firms.²⁰

²⁰Note that the number of firms is endogenous in this monopolistic competitive model. In the appendix we

5.2 Empirical evidence

To empirically investigate the role of small firms in cross-border e-commerce, we go back to the harmonized I2D2 and extract information on firm size. We compute, for each country and year the share of workers employed in firms with fewer than 10 employees.²¹ It is on average 45 percent, and it oscillates between 15 percent in Russia and 74 percent in Costa Rica. This suggests that for many countries in our sample the share of employment in small firms is sufficiently large as to have an economically significant impact on the wage gap.

We also compute the share of skilled workers in small and large firms to check whether small firms are less skilled-intensive. Columns (2) and (3) of table 7 show that on average only 25 percent of workers in small firms (firms with fewer than 10 employees) are considered skilled. In large firms (firms with more than 50 employees) 49 percent of workers are skilled. Comparing each row in columns (2) and (3) of table 7 we observe in all countries a larger share of skilled workers in large firms.

The variation across countries in the share of employment in small firms suggests that if the mechanism at work is the one described above, then the impact of online exports on the wage gap is likely to be heterogeneous across countries. In order to test this heterogeneity and provide evidence for our mechanism, we re-estimate equation (1) with an interaction between online exports and two dummies indicating whether the country is above or below the median share of employment in small firms in our sample. The median is at 44 percent in our sample. We use a dummy for two reasons. First, the size of the firm is not systematically reported by all individuals in the I2D2 surveys and the resulting information may be quite noisy. In addition, the I2D2 does not provide the exact number of employees, but an interval with a lower and upper bound for firm size. Second, the relationship between the impact of online exports on the wage gap and the share of workers in small firms may not be linear. The solution to these two problems is to use a dummy variable instead of the actual continuous variable. We expect the coefficient on the interaction of online exports with the dummy indicating a share of employment in small firms above the median to be negative and larger than the coefficient on the interaction of online exports with the dummy indicating a share of employment in small firms below the median. Because we are ultimately

endogenize the number of firms and solve for a full model with more general assumptions on the production side to show that the wage gap increases with the fixed costs faced by firms in the less skill-intensive sector, and that this effect is larger the larger is the endowment of unskilled to skilled workers.

²¹Information on firm size is unfortunately not available for Colombia, the Dominican Republic, Sri Lanka, and the Philippines.

interested in the interaction between the role of small firms and online exports, we also interact the total exports with the same dummies to ensure that the mechanism we describe is not also present in the case of total exports. If the channel through which exports affect the wage gap works through the ability of small firms to export via online platforms, the interaction terms between total exports and the dummies should not be statistically different from one another.

The instrumental variable estimates are reported in table 8. The interaction between online exports and the dummy indicating a share of employment in small firms above the median is negative and statistically significant in all specifications. It is almost identical to the baseline results. Note that the coefficient is very stable across specifications and precisely estimated (p-value below 1%). On the other hand, the interaction with the dummy indicating a share of employment in small firms below the median is not statistically different from zero. Thus, the negative impact of online exports on the wage gap is observed in countries with a larger share of small firms. The impact of total exports on the wage gap remains negative and statistically significant.²²

6 Concluding remarks

We examine the impact of online exports in reducing the wage gap between skilled and unskilled workers. Our econometric results suggest that as the share of online exports increases the wage gap declines. The economic significance of the impact is small as the elasticity of the wage gap with respect to the share of online exports is 0.01, reflecting the fact that online cross-border trade is still a relatively small phenomenon. However, with online cross border trade growing at a pace seven times faster than world trade, its contribution to reductions in wage inequality is bound to increase.

We also find that the impact is stronger in countries where the share of the labor force in small firms is larger. Small firms are more likely to benefit from the reduction in the fixed cost of exporting provided by online markets. They also tend to hire relatively more unskilled workers. Thus, as the share of online exports increases, this leads to a relative increase in the demand faced by small firms, which will in turn increase the relative demand for unskilled workers, and reduces the wage gap. In fact we find that the negative impact is only observed in countries with a large share of the labor force in small firms. In countries where the share of the labor force in small firms

²²We also interact total exports with the same dummies as for online exports. The coefficients on the two interactions are not statistically different from each other. Thus, the impact of total exports on the wage gap does not depend on the relative importance of small firms in the economy.

is below the median, an increase in online exports has no impact on the wage gap.

These results suggest that reducing barriers to online trade may be desirable for reasons that go beyond economic efficiency, as it may help reduce labor income inequality. Anyone who has tried to purchase goods online across borders knows that there are still important administrative barriers to international trade online. These include unclear taxationm customs requirements, and long customs delays. Solutions to these problems need to be considered. Examples include the introduction of higher de minimis thresholds under which no customs duties or other taxes (such as VAT) apply, the introduction of streamlined procedures for payment of customs duties and other taxes, such as e-Customs or e-taxation, or a coordination effort by exporting and importing countries to allow for the payment of customs duties online.

References

- Acemoglu, D. (2002). Directed Technical Change. *Review of Economic Studies* 69(4), 781–809.
- Acemoglu, D. and D. Autor (2011). *Skills, Tasks and Technologies: Implications for Employment and Earnings*, Volume 4 of *Handbook of Labor Economics*, Chapter 12, pp. 1043–1171. Elsevier.
- Akerman, A., I. Gaarder, and M. Mogstad (2015). The Skill Complementarity of Broadband Internet. *The Quarterly Journal of Economics* 130(4), 1781–1824.
- Autor, D. (2014). Polanyi’s Paradox and the Shape of Employment Growth. NBER Working Papers 20485.
- Autor, D. H., D. Dorn, and G. H. Hanson (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *American Economic Review* 103(6), 2121–68.
- Autor, D. H., D. Dorn, and G. H. Hanson (2015). Untangling Trade and Technology: Evidence from Local Labour Markets. *The Economic Journal* 125(584), 621–646.
- Autor, D. H., L. F. Katz, and A. B. Krueger (1998). Computing Inequality: Have Computers Changed The Labor Market? *The Quarterly Journal of Economics* 113(4), 1169–1213.
- Berman, E., J. Bound, and Z. Griliches (1994). Changes in the Demand for Skilled Labor within U.S. Manufacturing: Evidence from the Annual Survey of Manufactures. *The Quarterly Journal of Economics* 109(2), 367–97.
- Brown, C. and J. Medoff (1989). The Employer Size-Wage Effect. *Journal of Political Economy* 97(5), 1027–59.
- Card, D. and T. Lemieux (2001). Can Falling Supply Explain The Rising Return To College For Younger Men? A Cohort-Based Analysis. *The Quarterly Journal of Economics* 116(2), 705–746.
- Cruz, M. and E. Milet (2017). Skill Premium in Developing Countries. mimeo, World Bank.
- De la Torre, A., A. Ize, G. Beylis, and D. Lederman (2015). Jobs, Wages and the Latin American Slowdown. World Bank Other Operational Studies 22709, The World Bank.
- Ekholm, K. and K. H. Midelfart (2005). Relative wages and trade-induced changes in technology. *European Economic Review* 49(6), 1637–1663.

- Feenstra, R. and G. Hanson (2001). Global Production Sharing and Rising Inequality: A Survey of Trade and Wages. NBER Working Papers 8372.
- Feenstra, R. C. and G. H. Hanson (1996). Globalization, Outsourcing, and Wage Inequality. *American Economic Review* 86(2), 240–45.
- Feenstra, R. C. and G. H. Hanson (1999). The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990. *The Quarterly Journal of Economics* 114(3), 907–940.
- Feyrer, J. (2009). Trade and Income – Exploiting Time Series in Geography. NBER Working Papers 14910.
- Gasparini, L., S. Galiani, G. Cruces, and P. Acosta (2011). Educational Upgrading and Returns to Skills in Latin America: Evidence from a Supply-Demand Framework, 1990-2010. IZA Discussion Paper 6244.
- Goldberg, P. K. and N. Pavcnik (2007). Distributional Effects of Globalization in Developing Countries. *Journal of Economic Literature* 45(1), 39–82.
- Grossman, G. M. and E. Rossi-Hansberg (2008). Trading Tasks: A Simple Theory of Offshoring. *American Economic Review* 98(5), 1978–97.
- Hamermesh, D. S. (1980). Commentary. In J. J. Siegfried (Ed.), *The Economics of Firm Size, Market Structure and Social Performance*. Washington: FE. Trade Comm.
- Harrison, A. and M. McMillan (2011). Offshoring Jobs? Multinationals and US Manufacturing Employment. *The Review of Economics and Statistics* 93(3), 857–875.
- Katz, L. F. and K. M. Murphy (1992). Changes in Relative Wages, 1963-1987: Supply and Demand Factors. *The Quarterly Journal of Economics* 107(1), 35–78.
- Krueger, A. B. (1993). How Computers Have Changed the Wage Structure: Evidence from Microdata, 1984-1989. *The Quarterly Journal of Economics* 108(1), 33–60.
- Lendle, A. and M. Olarreaga (2017). Can Online Market Make Trade More Inclusive? ADBI Working Papers 742.

- Lendle, A., M. Olarreaga, S. Schropp, and P.-L. Vézina (2013). eBay’s anatomy. *Economics Letters* 121(1), 115–120.
- Lendle, A., M. Olarreaga, S. Schropp, and P.-L. Vézina (2016). There Goes Gravity: eBay and the Death of Distance. *Economic Journal* 126(591), 406–441.
- Luo, R. (2017). Skill Premium and Technological Change in the very Long Run: 1300-1914. Discussion Papers in Economics 17/09, University of Leicester.
- Lustig, N., L. F. Lopez-Calva, and E. Ortiz-Juarez (2013). Declining Inequality in Latin America in the 2000s: The Cases of Argentina, Brazil, and Mexico. *World Development* 44(0), 129 – 141.
- Mayer, T. and S. Zignago (2011). Notes on CEPII’s Distances Measures: The GeoDist Database. CEPII Working Papers 2011-25.
- Montenegro, C. E. and M. Hirn (2009). A new disaggregated set of labor market indicators using standardized household surveys from around the world. *Background paper prepared for World Development Report*.
- Montenegro, C. E. and H. A. Patrinos (2014). Comparable estimates of returns to schooling around the world. *World Bank Policy Research Working Paper* (7020).
- UNCTAD (2015). Information Economy Report 2015: Unlocking the potential of E-Commerce for developing countries. UNCTAD/IER/2015.
- Varian, H. (2005). Technology Levels the Business Playing Field. *The New York Times*, August 25.
- Varian, H. (2011). Micromultinationals Will Run the World. *Foreign Policy*, August 15.
- WTO (2013). e-Commerce in Developing Countries: Opportunities and challenges for small and medium-sized enterprises. ISBN 978-92-870-3864-7.
- Yeaple, S. R. (2005). A Simple Model of Firm Heterogeneity, International Trade, and Wages. *Journal of International Economics* 65(1), 1–20.

Appendix

In this appendix we generalize the model we presented in section 5.1 to allow for more general assumptions on the production side. We also fully close the model and instead of looking at whether the impact of a reduction in the fixed cost faced by small and unskilled-intensive firms is affected by the number of small and unskilled-intensive firms relative to large firms (which is an endogenous variable) we explore the results in terms of endowments of unskilled to skilled workers in the economy, which are assumed exogenous and are a determinant of the number of small and large firms.

Aggregate Demand

The model draws on Ekholm and Midelfart (2005) and Yeaple (2005). As in section 5.1 a representative consumer has CES preferences over two imperfectly substitutable composite goods X_h and X_l and maximize their utility with respect to their budget constraint E . Each composite good is a CES aggregate of individual varieties produced by monopolistically competitive firms in different sectors. It is useful to think as sector h as populated by firms more skill-intensive than those in sector l . The aggregate consumption and corresponding price index in each sector are given by:

$$U = \left(X_h^{\frac{\epsilon-1}{\epsilon}} + X_l^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}$$

$$E = w_h H + w_l L \tag{19}$$

$$X_k = \left(\int_0^{N_k} q_k(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \quad k \in \{h, l\} \tag{20}$$

$$P_k = \left(\int_0^{N_k} p_k(i)^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}, \quad k \in \{h, l\}. \tag{21}$$

We assume that $\sigma > \epsilon > 1$ meaning there is a greater substitutability between varieties within each composite good than in final consumption.

Firm production

In each sector, firms behave monopolistically and incur a fixed cost to be paid in skilled labor, and a variable using a mix of skilled and unskilled labor. In sector h firms incur a fixed cost F and require α_h skilled-labor and $1 - \alpha_h$ unskilled labor to produce one unit of output. In sector l firms incur a fixed cost δF ($\delta \leq 1$) and require α_l skilled labor and $1 - \alpha_l$ unskilled workers. We assume

that firms in sector h are more skill-intensive in production than firms in sector l , i.e. $\alpha_h > \alpha_l$. The cost functions of a typical firm in each sector are given by:

$$\begin{aligned} TC_h(q_h) &= Fw_h + q_h w_h^{\alpha_h} w_l^{1-\alpha_h} \\ TC_l(q_l) &= \delta Fw_h + q_l w_h^{\alpha_l} w_l^{1-\alpha_l}, \quad \delta < 1. \end{aligned}$$

Firms maximize their profit, and we get the standard pricing rule, where firms charge a constant markup over their marginal cost.

$$p_k = \frac{\sigma}{\sigma-1} w_h^{\alpha_k} w_l^{1-\alpha_k} \quad (22)$$

$$p_k = \frac{\sigma}{\sigma-1} w_h^{\alpha_l} w_l^{1-\alpha_l} \quad (23)$$

Free-entry in each sector drives profits to zero and gives us the equilibrium quantities produced by a typical firm in each sector:

$$q_h = F(\sigma - 1)\omega^{1-\alpha_h} \quad (24)$$

$$q_l = \delta F(\sigma - 1)\omega^{1-\alpha_l}, \quad (25)$$

where ω is the wage gap between skilled and unskilled worker (i.e. the wage gap $\omega = w_h/w_l$). Note that as long as delta is strictly lower than one, firms in sector h has greater revenues than firms in sector l : $R_h/R_l = 1/\delta$.

Labor market clearing conditions

To close the model we need to determine the number of firms active in each sector, which we get from the labor market clearing conditions. Skilled labor is used to pay the fixed cost of firms in both sector, and used with intensity α_h in sector h , and with intensity α_l in the l sector. Unskilled labor is only used in the production of each firm with the complementary intensities $1 - \alpha_h$ in sector h and $1 - \alpha_l$ in sector l . Using the total cost functions and Shephard's lemma, we obtain the following demand for skilled and unskilled labor:

$$H = N_h F(1 + \alpha_h(\sigma - 1)) + N_l \delta F(1 + \alpha_l(\sigma - 1)) \quad (26)$$

$$L = N_h F \omega(\sigma - 1)(1 - \alpha_h) + N_l \delta F \omega(\sigma - 1)(1 - \alpha_l) \quad (27)$$

The equilibrium is given by the 11 equations (20)-(27) and the 11 unknowns $E, X_h, X_l, P_h, P_l, p_h, p_l, q_h, q_l, N_h, N_l$.

Solving for the wage gap

Our aim is to express the wage gap (ω) as a function of the relative factor endowment ($\frac{H}{L}$) and the parameter δ . The labor market clearing conditions allow us to pin down the number of firms in each sector. Using equations (26) and (27) we get:

$$N_h = \frac{H\omega(\sigma - 1)(1 - \alpha_l) - L(1 + \alpha_l(\sigma - 1))}{F\omega\sigma(\sigma - 1)(\alpha_h - \alpha_l)} \quad (28)$$

$$N_l = \frac{H\omega(\sigma - 1)(\alpha_h - 1) + L(1 + \alpha_h(\sigma - 1))}{F\omega\delta\sigma(\sigma - 1)(\alpha_h - \alpha_l)} \quad (29)$$

For convenience, let us define the ratio of the number of firms as a function of the wage gap ω and relative factor endowment $\frac{H}{L}$. We define the function g such that: $\frac{N_h}{N_l} = \delta g(\omega, \frac{H}{L})$ where $g(\omega, \frac{H}{L}) = \frac{\frac{H}{L}\omega(\sigma - 1)(1 - \alpha_l) - (1 + \alpha_l(\sigma - 1))}{\frac{H}{L}\omega(\sigma - 1)(\alpha_h - 1) + (1 + \alpha_h(\sigma - 1))}$. Note that the function g is strictly positive and different from zero as it is defined as the ratio of the number of firms in each sector.²³ Using CES preferences in the consumption of the aggregate goods gives the usual relationship between relative aggregate consumption and relative price indices:

$$\frac{X_h}{X_l} = \left(\frac{P_h}{P_l} \right)^{-\epsilon}. \quad (30)$$

Within each sector, the CES structure of consumption of varieties allows us to express the aggregate quantities consumed X_h and X_l as well as the corresponding price indices as a function of the number of firms in each sector:

²³CES preferences over the varieties in each sector ensures that there is at least one firm producing in each sector.

$$X_k = q_k N_k^{\frac{\sigma}{1-\sigma}}, \quad k \in \{h, l\} \quad (31)$$

$$P_k = p_k N_k^{\frac{1}{1-\sigma}}, \quad k \in \{h, l\}. \quad (32)$$

Substituting for the equilibrium prices and quantities into equations (31) and (32) and plugging into equation (30), we can express the wage gap as a function of relative factor endowment, δ , and the relative number of firms:

$$\begin{aligned} \frac{X_h}{X_l} &= \left(\frac{P_h}{P_l} \right)^{-\epsilon} \\ \frac{q_h}{q_l} \left(\frac{N_h}{N_l} \right)^{\frac{\sigma}{\sigma-1}} &= \left[\frac{p_h}{p_l} \left(\frac{N_h}{N_l} \right)^{1/(1-\sigma)} \right]^{-\epsilon} \\ g(\omega, \frac{H}{L})^{\frac{\sigma-\epsilon}{\epsilon-1}} \omega^{(\alpha_h - \alpha_l)(\sigma-1)} &= \delta \end{aligned} \quad (33)$$

This last expression links the wage gap ω to factor endowment $\frac{H}{L}$ and to the difference in fixed cost requirement between firms in sectors h and l . We now use the implicit function theorem and totally differentiate this expression. Using hat-algebra (i.e. $\hat{x} = \frac{dx}{x}$) we obtain:

$$\hat{\omega} = \frac{1}{(\sigma-1)(\alpha_h - \alpha_l) + \frac{\sigma-\epsilon}{\epsilon-1} \varepsilon_{g,\omega}} \hat{\delta} - \frac{\frac{\sigma-\epsilon}{\epsilon-1} \varepsilon_{g,H/L}}{(\sigma-1) + \frac{\sigma-\epsilon}{\epsilon-1} \varepsilon_{g,\omega}} \frac{\widehat{H}}{L}, \quad (34)$$

where $\varepsilon_{g,\omega}$ and $\varepsilon_{g,H/L}$ are the elasticities of the g function with respect to ω and $\frac{H}{L}$ respectively. It is straightforward to check that these two elasticities are identical: $\varepsilon_{g,\omega} = \varepsilon_{g,H/L}$ are equal to:

$$\begin{aligned} \varepsilon_{g,\omega} = \varepsilon_{g,H/L} &= \frac{\omega \frac{H}{L} \sigma (\sigma-1) (\alpha_h - \alpha_l)}{\left[\frac{H}{L} \omega (\sigma-1) (\alpha_h - 1) + (1 + \alpha_h (\sigma-1)) \right]^2} \frac{1}{g(\omega, H/L)} \\ &= \frac{\frac{H}{L} \omega \sigma (\sigma-1) (\alpha_h - \alpha_l)}{\left(\frac{H}{L} \omega (\sigma-1) (\alpha_h - 1) + 1 + \alpha_h (\sigma-1) \right) \left(\frac{H}{L} \omega (\sigma-1) (\alpha_l - 1) - 1 - \alpha_l (\sigma-1) \right)} \end{aligned}$$

These two elasticities are strictly positive since we imposed $\alpha_h > \alpha_l > 0$ and $\sigma > 1$. It follows that in expression (34), the terms in front of $\hat{\delta}$ and $\frac{\widehat{H}}{L}$ are positive. Therefore, a reduction in the fixed cost of exporting for firms in sector l reduces the wage gap between skilled and unskilled workers.

Similarly, an increase in the relative supply of skilled workers also reduces the wage gap. Finally, we want to investigate whether the marginal effect of a reduction in the fixed cost of exporting for firms in sector l varies with factor endowment. We simply take the second order derivative of the wage gap with respect to δ and to the relative factor endowment:

$$\begin{aligned}\frac{\partial \omega}{\partial \delta} &= \frac{\omega^{1-(\alpha_h-\alpha_l)(\sigma-1)}g(\omega, H/L)^{-\frac{\sigma-\epsilon}{\epsilon-1}}}{(\sigma-1)(\alpha_h-\alpha_l) + \frac{\sigma-\epsilon}{\epsilon-1}\varepsilon_{g,\omega}} \\ \frac{\partial^2 \omega}{\partial \delta \partial H/L} &= -\frac{(\frac{\sigma-\epsilon}{\epsilon-1})\omega^{1-(\alpha_h-\alpha_l)(\sigma-1)}g(\omega, H/L)^{-\frac{\sigma-\epsilon}{\epsilon-1}}}{\left[(\sigma-1)(\alpha_h-\alpha_l) + \frac{\sigma-\epsilon}{\epsilon-1}\varepsilon_{g,\omega}\right]^2} \left[\frac{L}{H}\varepsilon_{g,H/L} \left((\sigma-1)(\alpha_h-\alpha_l) + \frac{\sigma-\epsilon}{\epsilon-1}\varepsilon_{g,\omega} \right) + \frac{\partial \varepsilon_{g,\omega}}{\partial H/L} \right].\end{aligned}$$

A sufficient condition for this equation to be negative is for the partial derivative $\frac{\partial \varepsilon_{g,\omega}}{\partial H/L}$ to be positive since the other terms between brackets are positive. Deriving the elasticity gives us the following expression, which is positive given the restriction imposed on factor-intensity ($\alpha_h > \alpha_l > 0$).

$$\frac{\partial \varepsilon_{g,\omega}}{\partial H/L} = \frac{(\sigma-1)(\alpha_h-\alpha_l)(1-\alpha_h)\omega}{\alpha_l \left[\frac{H}{L}\omega(\sigma-1)(\alpha_h-1) + 1 + \alpha_h(\sigma-1) \right]^2}.$$

Table 1: List of the countries and survey years

Country	(1) # Surveys	(2) Years available
ARG	7	2005, 2006, 2007, 2008, 2009, 2010, 2012
BOL	4	2005, 2007, 2008, 2009
BRA	8	2004, 2005, 2006, 2007, 2008, 2009, 2011, 2012
CHL	3	2006, 2009, 2011
COL	7	2004, 2005, 2006, 2007, 2008, 2009, 2010
CRI	6	2004, 2005, 2006, 2007, 2008, 2009
DOM	9	2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012
ECU	8	2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012
ETH	6	2005, 2006, 2009, 2010, 2011, 2012
GTM	3	2004, 2006, 2011
HND	7	2004, 2005, 2006, 2007, 2009, 2010, 2011
KHM	2	2006, 2008
LKA	2	2004, 2008
MEX	3	2008, 2010, 2012
NIC	2	2005, 2009
PAN	8	2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012
PER	9	2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012
PHL	8	2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011
PRY	8	2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012
RUS	6	2004, 2005, 2006, 2007, 2008, 2009
SLV	4	2004, 2005, 2006, 2007
URY	9	2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012

Table 2: Summary statistics

Variable	#Obs.	Mean	Std. Dev.
Ln online exports/GDP	131	-13.67	3.68
Ln online exports/GDP (IV: distance)	131	-14.03	4.19
Ln online exports/GDP (IV: importer online domestic sales)	131	-14.03	4.18
Ln online exports/GDP (IV: importer tariff on manuf. products)	131	-14.04	4.19
Ln total exports/GDP	131	-1.84	0.70
Ln total exports/GDP (IV: distance)	131	-2.08	0.86
Ln total exports/GDP (IV: importer GDP)	131	-2.08	0.86
Ln total exports/GDP (IV: importer tariff on all products)	131	-2.09	0.86
Ln relative supply	131	0.21	0.63
Internet user/Pop.	131	0.21	0.14
Ln distance	60038	8.56	0.92
Ln demand (online)	60038	12.53	4.92
Ln GDP	60038	25.84	1.90
Ln(1+ average tariff on manuf. products)	60038	1.51	0.72
Ln(1+ average tariff)	60038	1.54	0.70

Source: Online trade data comes from Lendle et al. (2016). Data on the wage gap and relative supply of skilled workers is from Cruz and Milet (2017). Data on bilateral distance comes from Mayer and Zignago (2011). Predicted trade flows are estimated by the authors. All other variables come from the World Bank's World Development Indicators 2016.

Table 3: Impact of online exports on the wage gap (OLS)

	(1)	(2)	(3)	(4)
Ln online exports/GDP	-0.010*** (0.002)	-0.009*** (0.002)	-0.009*** (0.002)	-0.012*** (0.003)
Ln total exports/GDP		-0.020 (0.013)	-0.018 (0.012)	-0.019 (0.014)
Ln relative supply			-0.102** (0.046)	-0.100*** (0.033)
Internet user/Pop.				-0.303** (0.145)
Observations	131	131	131	131
R^2	0.34	0.35	0.40	0.43

All regressions include country and year fixed effects. Robust standard errors clustered at the country level in parenthesis. Significance levels: *: 10%, **: 5% ***: 1%.

Table 4: Instrumenting online and total bilateral flows using equations (2)-(7)

<i>dep. var:</i>	Ln (online exports/GDP)			Ln (total exports/GDP)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln distance – 2004	-0.080 (0.094)			-0.122*** (0.017)		
Ln distance – 2005	-0.350*** (0.076)			-0.122*** (0.015)		
Ln distance – 2006	-0.301*** (0.056)			-0.126*** (0.014)		
Ln distance – 2007	-0.317*** (0.053)			-0.125*** (0.016)		
Ln distance – 2008	-0.297*** (0.055)			-0.109*** (0.014)		
Ln distance – 2009	-0.160*** (0.044)			-0.104*** (0.017)		
Ln distance – 2010	-0.078** (0.039)			-0.045*** (0.014)		
Ln distance – 2011	-0.014 (0.043)			-0.033*** (0.012)		
Ln demand (online)		0.204*** (0.019)				
Ln(1+ average manuf. tariff)			-0.406*** (0.093)			
Ln GDP					0.755*** (0.026)	
Ln(1+ average tariff)						-0.083*** (0.025)
Observations	60,038	60,038	60,038	60,038	60,038	60,038
R^2	0.712	0.713	0.711	0.950	0.951	0.950

All columns include bilateral and exporter times year fixed effects. Bootstrapped (50 replications) standard errors in parenthesis. Significance levels: *: 10%, **: 5% ***: 1%. The dependent variable in columns (1)-(3) is the log of bilateral online exports over GDP. The dependent variable in columns (4)-(6) is the log of bilateral total exports. Ln Online demand is domestic online sales on eBay. Data on average tariffs are taken from the World Development Indicator.

Table 5: Correlation between observed and predicted trade flows using equations (2)-(7)

	$\text{Ln } X_{online}$	$\text{Ln } \widehat{X}_{online}$	$\text{Ln } \widehat{X}_{online}'$	$\text{Ln } \widehat{X}_{online}''$	X	$\text{Ln } \widehat{X}$	$\text{Ln } \widehat{X}'$	$\text{Ln } \widehat{X}''$
$\text{Ln } X_{online}$	1							
$\text{Ln } \widehat{X}_{online}$	0.8436	1.0000						
$\text{Ln } \widehat{X}_{online}'$	0.8442	0.9986	1.0000					
$\text{Ln } \widehat{X}_{online}''$	0.8433	0.9996	0.9989	1.0000				
$\text{Ln } X$	0.3365	0.3944	0.3939	0.3943	1.0000			
$\text{Ln } \widehat{X}$	0.3414	0.4047	0.4041	0.4046	0.9745	1.0000		
$\text{Ln } \widehat{X}'$	0.3437	0.4044	0.4040	0.4044	0.9750	0.9995	1	
$\text{Ln } \widehat{X}''$	0.3412	0.4045	0.4042	0.4046	0.9745	0.9999	0.9994	1

X stands for total exports, and eBay for online exports. \widehat{X}_{online} , \widehat{X}_{online}' , and \widehat{X}_{online}'' are predicted online trade flows over GDP using equations (2), (3) and (4) respectively. \widehat{X} , \widehat{X}' , and \widehat{X}'' are predicted total trade flows over GDP using equations (5), (6), and (7) respectively.

Table 6: Impact of online exports on the wage gap (instrumental variables)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln online exports/GDP	-0.012*** (0.002)	-0.012*** (0.003)	-0.012*** (0.003)	-0.012*** (0.002)	-0.011*** (0.003)	-0.012*** (0.003)	-0.012*** (0.003)
Ln total exports/GDP	-0.047*** (0.018)	-0.050*** (0.018)	-0.047*** (0.018)	-0.047*** (0.018)	-0.049*** (0.018)	-0.046*** (0.017)	-0.049*** (0.018)
Ln relative supply	-0.095 (0.077)	-0.094 (0.077)	-0.095 (0.077)	-0.095 (0.077)	-0.095 (0.077)	-0.095 (0.077)	-0.094 (0.077)
Internet user/Pop.	-0.339* (0.175)	-0.342* (0.176)	-0.337* (0.175)	-0.343** (0.173)	-0.338* (0.175)	-0.348** (0.174)	-0.349** (0.175)
Observations	131	131	131	131	131	131	131
R^2	0.40	0.39	0.40	0.40	0.39	0.40	0.39
F-test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen (p-value)				0.386	0.549	0.066	0.179
Cragg-Donald (F-test)	64.851	65.112	64.111	33.682	33.442	32.451	22.142
IV-online trade	(2)	(3)	(4)	(2)+(3)	(2)+(4)	(3)+(4)	(2)-(4)
IV-total trade	(5)	(6)	(7)	(5)+(6)	(5)+(7)	(6)+(7)	(5)-(7)

All regressions include country and year fixed effects. Robust standard errors in parenthesis. Significance levels: *: 10%, **: 5% ***: 1%. We report the p-values of the F-test of the first stage, the Hansen overidentification J test on the validity of the instruments and the F-test on the Cragg-Donald identification test for weak instruments. The critical value at 10% for test of relative size bias is 7.03 in columns (1)-(3), 16.87 in columns (4)-(6), and 21.68 in column (7). The critical value at 5% for the test of relative bias in columns (4)-(6) is 11.04, and 15.72 in column (7)

Table 7: Share of employment in small and large firms by country

Country	(1) Employment share in small firms	(2) Skilled/total in small firms	(3) Skilled/total in large firms
ARG	29.52	48.61	78.22
BOL	52.42	44.15	71.07
BRA	60.96	39.71	.
CHL	26.13	46.98	72.47
CRI	73.96	21.06	.
ECU	49.13	8.768	19.06
ETH	59.69	20.13	38.67
GTM	53.92	16.25	34.99
HND	59.79	7.520	48.78
KHM	45.07	12.57	16.44
MEX	41.96	21.75	48.86
NIC	42.33	14.88	50.59
PAN	20.34	28.36	69.74
PER	44.00	53.58	85.46
PRY	43.38	39.10	70.39
RUS	14.61	14.33	19.94
SLV	33.73	4.96	16.10
URY	37.59	17.77	46.43
Average	45.20	25.39	49.20

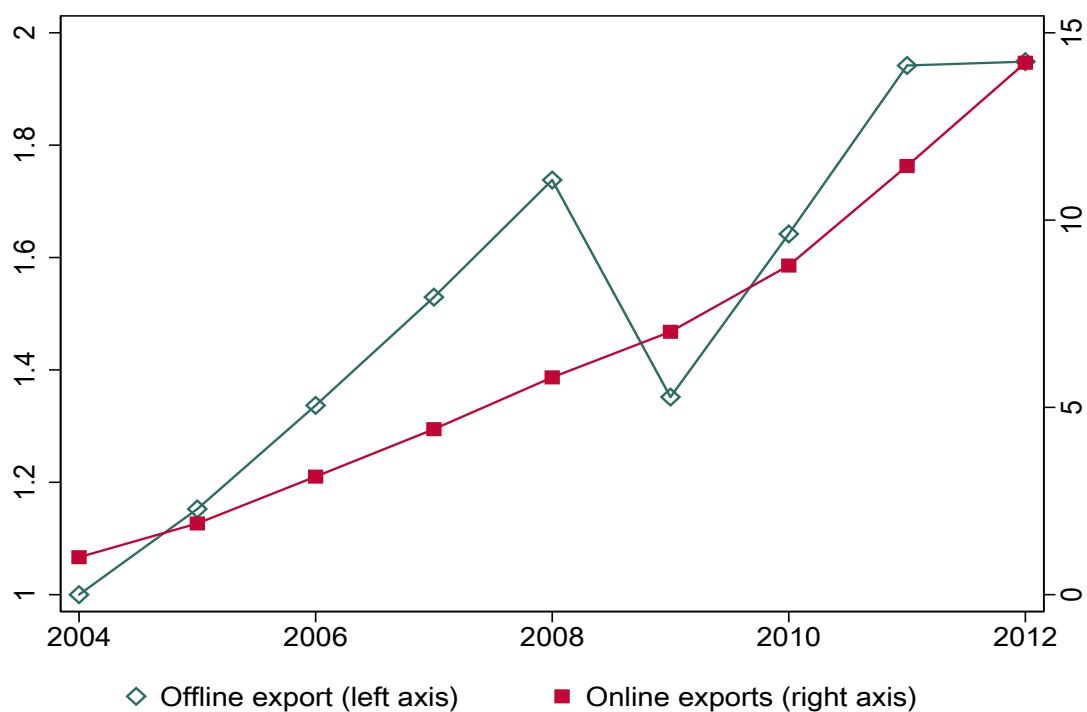
Source: World Bank's I2D2 database. Small firms are defined as those with less than 10 employees (excluding self-employment). Column (1) provides the share of workers in small firms in the total labor force. Column (2) provides the share of skilled workers in small firms' total employment, and column (3) the share of skilled workers in large firms' total employment. Skilled workers are defined as workers with at least a complete secondary education.

Table 8: Impact of online exports on the wage gap (IV): The role of small firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln online exports/GDP \times small firms above median	-0.010*** (0.002)	-0.010*** (0.002)	-0.010*** (0.002)	-0.011*** (0.002)	-0.010*** (0.002)	-0.011*** (0.003)	-0.011*** (0.002)
Ln online exports/GDP \times small firms below median	-0.012 (0.017)	-0.012 (0.018)	-0.011 (0.017)	-0.009 (0.016)	-0.015 (0.016)	0.000 (0.017)	-0.005 (0.015)
Ln total exports/GDP	-0.051** (0.022)	-0.055** (0.023)	-0.050** (0.021)	-0.049** (0.020)	-0.054** (0.022)	-0.045** (0.019)	-0.047** (0.020)
Ln relative supply	-0.095 (0.080)	-0.095 (0.079)	-0.095 (0.080)	-0.094 (0.080)	-0.096 (0.079)	-0.092 (0.080)	-0.093 (0.080)
Internet user/Pop.	-0.260 (0.206)	-0.263 (0.209)	-0.258 (0.206)	-0.268 (0.203)	-0.264 (0.206)	-0.265 (0.205)	-0.278 (0.204)
Observations	105	105	105	105	105	105	105
R^2	0.39	0.40	0.40	0.39	0.40	0.40	
F-test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen (p-value)				0.204	0.549	0.078	0.113
Cragg-Donald (F-test)				9.443	9.286	11.727	7.916
IV-online trade	(2)	(3)	(4)	(2)+(3)	(2)+(4)	(3)+(4)	(2)-(4)
IV-total trade	(5)	(6)	(7)	(5)+(6)	(5)+(7)	(6)+(7)	(5)-(7)

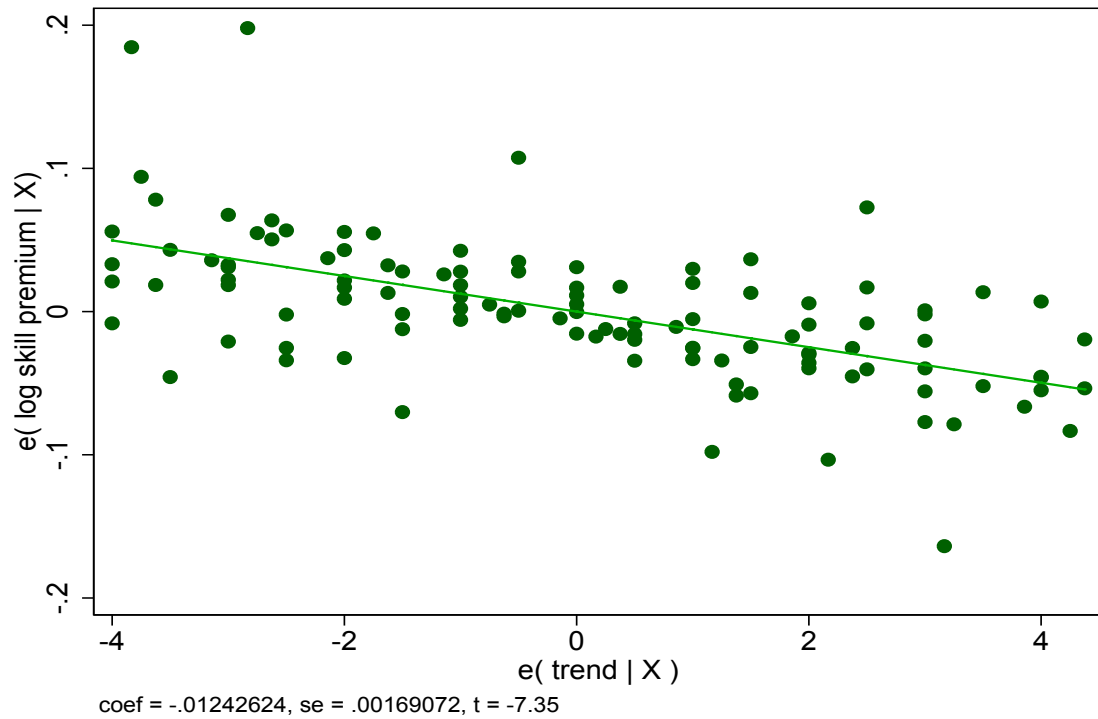
All regressions include country and year fixed effects. Robust standard errors in parenthesis. Significance levels: *, 10%, **, 5% ***, 1%. Small firms are defined as those with less than 10 employees (excluding self-employment). We report the p-values of the F-test of the first stage, and of the Hansen overidentification J test on the validity of the instruments.

Figure 1
Evolution of world and online cross-border trade, 2004-2012



Note: The evolution of world trade is from United Nations' Comtrade database. The evolution of online cross-border trade is proxied by the evolution of eBay cross-border trade from Lendle et al. (2016) (fixed price transactions only).

Figure 2
Evolution of wage skill premium, 2004-2012



Note: This is the partial plot of a regression of the log of the wage gap between skilled and unskilled workers on a time trend and country fixed effects for countries in our sample with more than 7 observations over the period 2004-2012. The estimates of wage gap are from Cruz and Milet (2017).

Figure 3: Wage gap and online trade in selected countries

