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Extensive and Intensive Margins of Exports and Labor Heterogeneity

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Abstract

This paper investigates how changes in skilled and unskilled labor supply affect different margins of exports. Using bilateral trade data in manufacturing sectors of 34 countries from 1995 to 2010, we find that most of the impact of skilled labor on exports goes through the intensive margin, whereas most of the effect of unskilled labor works through the extensive margin. These outcomes result from the impact of labor skill composition on the productivity cut-off of exporters. We also find that the impact of skilled and unskilled labor on trade margins depends on the income level of countries and on the type of products. The results indicate that the effect of skilled labor is greater for low-income countries and differentiated products, while that of unskilled labor is greater for high-income countries and homogeneous products.

1. Introduction

The recent availability of micro data has allowed economists to investigate the extensive and intensive margins of trade, which have different welfare implications for export growth. An increase in the intensive margin means that the country exports a greater volume of each product, which may worsen the terms of trade and decrease the exporter's welfare. In contrast, a rise in the extensive margin can improve welfare by increasing the market share of the exporter and diversifying exports against trade shocks. Despite the need to differentiate the two margins, the literature yields mixed results as to which margin is the more important venue for trade growth. In some studies, the extensive margin is reported to play a more important role (Hummels and Klenow, 2005); while in others, the main venue is the intensive margin (Felbermayr and Kohler, 2006; Eaton *et al*., 2008; Helpman *et al*., 2008).

The discussion of the extensive and intensive margins of trade started to receive increased attention after the arrival of the "new" new trade theories, in particular the seminal work by Melitz (2003). We provide a new mechanism that affects the two margins of trade, based on a model in Luong (2014). By including different types of labor (skilled vs unskilled labor) in the model, he shows that in addition to the within-firm effect (i.e. more managers/skilled labor implies more varieties supplied; more workers/unskilled labor produce greater quantity per product line), the change of labor composition also induces a between-firm effect that leads to firms' entry to/exit from the export market. This new effect is a result of the multiple-product feature that is now the subject of a growing literature (Bernard et al., 2010, 2011). Putting

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these results in our context, we show that more skilled labor could lower the number of varieties exported, because of severe competition leading to the exit of exporting firms. An increase in the unskilled labor could reduce production costs, inducing more firms to enter the foreign market and raising the extensive margin. Moreover, since firms have different productivity and thus different sales per product line, the entry and exit of exporting firms will also affect the intensive margin of exports. The result is different from what canonical factor–proportion models would predict.

The main contribution of this paper is to provide empirical evidence showing how an increase in different types of labor influences the two margins of trade. By merging the trade data from UN Comtrade and labor data from Economic Analysis and Statistics (EAS) Division of the Organisation for Economic Co-operation and Development (OECD), we construct a sample with 34 countries over a period of 16 years, from 1995 to 2010. The estimated results show that most of the impact of skilled labor goes to the intensive margin: a 10% increase in skilled labor raises the intensive margin by 5%, and it raises the extensive margin by only 1.4%. By contrast, the impacts of unskilled labor on the two margins are about equal: a 10% increase in unskilled labor raises the extensive margin and the intensive margin by 2.27% and 2.25%, respectively. The decomposition method applied in this paper shows that 78% of the impact of skilled labor occurs in the intensive margin, while for unskilled labor the share is 50%. These results cannot be solely explained by the within-firm effect, and they show that the new mechanism, the between-firm effect, is impressively strong.

This paper also explores the impacts of labor on trade margins across countries with different income levels and across types of products. The estimates show that the influence of unskilled labor on both the extensive and intensive margins is increasing as countries' income level rises. In contrast, the impact of skilled labor decreases with the income levels of countries. These results are intuitive: because skilled labor is more abundant in high-income countries, it has a lower marginal product in high-income countries than in low-income countries. In terms of product type, skilled labor has a greater impact on exports of differentiated products, and unskilled labor has a larger impact on that of homogeneous products. The results are in line with our expectation, since the production of differentiated products is relatively more intensive in skilled labor than in unskilled labor.

These findings relate our paper to a strand of literature that studies skill heterogeneity and the patterns of international trade. Grossman and Maggi (2000) show that countries with a relatively homogeneous skill distribution export the goods with supermodular technology, while countries with a more diverse skill distribution export the goods with submodular technology. Bougheas and Riezman (2007) show that the country with more human capital exports the human capital-intensive goods. While these papers focus on the impact of the skill distribution on trade patterns, we study the impact of skill composition on export performance. Another paper that is related to ours is Antras et al. (2006). They show that northern countries with relatively more skilled labor would export the knowledge services (which play a similar role as the extensive margin in our paper), while the southern countries export mostly the production services (which act as the intensive margin here).

The organization of the paper is as follows. Section 2 describes the method of decomposing exports into the extensive and intensive margins. The theoretical framework is introduced in section 3, while our data are introduced in section 4. Section 5 presents our estimated results and section 6 concludes.

2. The Extensive and Intensive Margins of Exports

In trade literature, the extensive and intensive margins can be measured at the country, industry, or firm level, depending on the issue of interest. In this paper, trade margins of manufacturing sectors are calculated with product-level data. By convention, a product variety is a particular good produced (or served) in a particular country. Based on Feenstra's (1994) framework, Hummels and Klenow (2005) propose a way to decompose exports into the extensive and intensive margins. Consider the total import value of an importer, country j, from all other countries. An exporter i's export share in country j's market in year t is[1]

$$\text{exportshare}_{ijt} = \frac{\sum_{k \in I_{ijt}} (v_{ijkt})}{\sum_{k \in I_{jt}} (\sum_i v_{ijkt})} \tag{1}$$

where k is a product category defined by HS6, and v_{ijkt} is the trade value of product k that i exports to j in year t. $\sum_i v_{ijkt}$ is the total value of product k that country j imports from all exporters. I_{jt} is the set of products that country j imports from all countries in year t. I_{ijt} is a subset of I_{jt} containing only those products that exporter i has positive exports to country j. The *export share* is the market share of exporter i in importer j's market: it equals the export value from i to j divided by the total imports value of j.

This export share is then decomposed into the extensive and intensive margins. The extensive margin is an index that measures the relative number of products that a country exports to a market. It equals the number of products that i exports to j, relative to the total number of products that j imports from all countries, with each product weighted by its total import value of country j ($\sum_i v_{ijkt}$).

$$\text{extensive}_{ijt} = \frac{\sum_{k \in I_{ijt}} (\sum_i v_{ijkt})}{\sum_{k \in I_{jt}} (\sum_i v_{ijkt})}. \tag{2}$$

The intensive margin is defined as

$$\text{intensive}_{ijt} = \frac{\sum_{k \in I_{ijt}} (v_{ijkt})}{\sum_{k \in I_{ijt}} (\sum_i v_{ijkt})}. \tag{3}$$

It equals the ratio of country i's export value relative to all countries' export value in market j, for those products that country i has positive exports in j. A high intensive margin indicates that country i's market share is large within those products that it exports to the importer's market.

From equations (1), (2) and (3), country i's export share in country j equals the product of its extensive margin and intensive margin. Note that these trade margin are calculated by importer-year: they measure the relative export performance of each exporter in an importer-year and do not represent absolute trade volumes. After taken natural logs, the export shares can be decomposed into the extensive and intensive margins additively [i.e. ln(export share) = ln(extensive) + ln(intensive)]. These trade margins are the dependent variables in the estimations.

3. Theoretical Framework

Our model, taken from Luong (2014), is similar to the conventional trade models, which is a small open economy consisting of heterogeneous firms, *à la* Melitz (2003).

We depart from this set-up on two important features. First, each firm can supply one or more varieties. The multiple-product feature is important and crucial in our analysis as it enables us to decompose the firm activities into two categories: the extensive tasks and the intensive tasks. Grossman and Rossi-Hansberg (2008) categorize tasks into the the high-skilled ones and the low-skilled ones, which leads to the second important feature of our model. According to the Nelson–Phelps (1966) hypothesis, the extensive tasks are innovation and production management, which require skilled workers and can increase the scope of firms. Indeed, in order to invent new products, scientists have to be hired to work in R&D. Managing different product lines, which could have business conflicts (e.g. the cannibalization effect), is also a complex task.

There are two factors in this economy: skilled labor and unskilled labor. Using unskilled labor as our numeraire, we denote w the relative wage of skilled labor. The high-skilled activities (which are related to innovation) require only skilled labor, and the low-skilled activities (which are the simpler, repetitive production process) use only unskilled labor. In particular, to supply n product lines, the number of skilled workers required is:

$$C(n) = n^m, \quad m > 1.$$

On the intensive front, our set-up is similar to Melitz (2003). The only difference is that the firm productivity follows the exponential distribution, although all of our results still go through with the Pareto distribution:

$$g(\theta) = \gamma e^{-\gamma\theta}.$$

With this set-up, the maximization problem can be solved backwards. The monopolistic framework implies that the price equals the marginal costs multiplied by the constant markup. The firm will choose its scope to maximize its total profit

$$\Pi(n, \theta) = n\pi(\theta) - w_H F(n)$$

which yields the optimal scope (the extensive margin)

$$n(\theta) = \sqrt[m-1]{\frac{\pi(\theta)}{m w_H}}. \tag{4}$$

Under this setting, we can derive the following results that motivate our empirical analysis:[2]

Proposition 1. *(i) The relative wage of skilled labor is proportional to the relative endowment of unskilled labor. (ii) The survival production cut-off rises with the number of skilled labor but falls with the number of unskilled labor. (iii) The price index falls with the number of skilled labor and increases with the number of unskilled labor.*

This proposition points out that while more skilled labor raises the degree of competiton in a market, more unskilled labor reduces it. It is because of the multi-product feature. Indeed, an increase in the relative endowment of skilled labor results in more varieties supplied by each firm. This effect intensifies the competitiveness in the market. In this model, how changes in labor supply affect exports can be summarized by the following two effects:

(1) *The within-firm effect*
An immediate implication of Proposition 1 is that the intensive margin rises with the relative supply of unskilled labor, while the extensive margin increases with the relative supply of skilled labor. As a result, countries with more skilled labor produce more varieties and become exporters of varieties (i.e. export more types of goods), while countries abundant in unskilled labor export intensively a limited number of varieties.
(2) *The between-firm effect*
In addition to the within-firm effect as mentioned above, there is another effect that takes place between firms. On the extensive front, higher survival cut-off owing to more skilled labor or less unskilled labor means there are fewer firms and therefore fewer varieties provided in the market. Unused unskilled labor previously employed by the exiting firms then moves to the surviving firms. More unskilled labor and also less competition owing to firms' exit result in an increase in the intensive margin of the varieties supplied by the surviving firms.

This between-firm effect is the result of firm heterogeneity and the multiproduct feature, which goes in an opposite direction to that of the within-firm effect. Indeed, this effect implies that having more skilled labor will increase the output per variety and could possibly decrease the number of varieties. On the contrary, having more unskilled labor will increase the number of varieties and could decrease the output per variety. This result is crucial in our study because failing to account for the dynamic entry and exit of firms in the export market could bias the importance of the two margins (Helpman et al., 2008; Besedeš and Prusa, 2011).

The estimations in this paper enable us to evaluate the relative importance of the two effects regarding the impact of labor supply on exports. If the within-firm (between-firm) effect dominates, we expect that skilled labor increases exports mainly through the extensive (intensive) margin. For unskilled labor, the intensive (extensive) margin contributes more when the within-in (between-firm) effect plays a more important role.

4. Data

The section describes the measures and data source of the dependent and explanatory variables in the estimation. The merged sample contains 34 countries over the period 1995–2010.

Skilled and Unskilled Labor

As described in section 3, labor is divided into two categories: skilled labor and unskilled labor. Production workers are defined as unskilled labor, while employees who engage in technological improvement, supervision and administrative work are characterized as skilled labor. In the literature, the white–blue collar distinction is widely used as measures of skilled and unskilled labor. Indeed, Berman et al. (1994) report that from 1973 to 1987, the fraction of non-production workers closely mirror that of white collar workers in the USA. To be consistent with our discussion in section 3, we need to find a measure of skilled labor such that it has no effect on the production process within a firm. For this purpose, we use the number of researchers as a measure of skilled labor, and all the other employment is defined as unskilled labor. This measure of skilled labor is obviously a narrower definition, compared with

the conventional measures in the literature. This narrow definition, nevertheless, fits our set-up in the theoretical framework, in which skilled labor only expands the number of products but plays no role in production activities.

The researcher/employment variables are obtained from the OECD Main Science and Technology Indicators, which is a biannual report. The report is prepared by the Economic Analysis and Statistics (EAS) Division of the OECD Secretariat in collaboration with the Working Party of National Experts on Science and Technology Indicators (NESTI). The total number of researchers is expressed on a full-time equivalent basis.

International Trade

We use the UN Comtrade data to construct the extensive and intensive margins of exports. The dataset contains the quantity and value of bilateral trade. Trade flows are recorded at the six-digit Harmonized System (HS6), and each HS6 is considered a product k in the decomposition process in equations (1)–(3).

We merge the trade data with that of labor supply, keeping countries that appear in both data sets. For every importer, we then calculate the total export share, extensive margin, and intensive margin in manufacturing sectors of each exporter that have positive exports to the importer.

Gravity-model Variables

The gross domestic product (GDP) data are obtained from the OECD. To capture transportation cost, we include the geographical distance (in kilometers) between the two countries in the model. The common language, colony and border are binary variables equal to one if the two trading partners share a common language, had a colonial history and share a common border. These variables are taken from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) database. We also include a binary variable, FTA, which equals one if the two trading countries are in the same regional trade agreement. The information is obtained from Regional Trade Agreements Information System (RTA-IS) of the World Trade Organization (WTO).

5. Model of Estimation and Results

In this section, we construct the empirical model and present the estimated results. In addition to the benchmark case, we also estimate models that allow the effect of labor on trade to differ by a country's GDP per worker and by product type.

Benchmark Estimation

The main point of the estimation, which is motivated by the model in section 3, is to analyze how skilled and unskilled labor affect the different margins of exports. It is likely that both the within-firm and between-firm effects take place in the real world. Therefore the objective of the estimation is not to test any one of the two effects and to reject the other one. Instead, we try to estimate the relative importance of the two effects in the influence of labor supply on exports.

We expand the gravity model by decomposing the size of exporters, which is measured by GDP, into total employment and GDP per worker. We then separate the total employment into skilled and unskilled labor. The empirical model specification is:

$$\begin{aligned}\ln \text{trade}_{ijt} = {} & \beta_0 + \beta_1 \ln \text{Skill}_{it} + \beta_2 \ln \text{Unskill}_{it} + \beta_3 \ln \text{GDPPW}_{it} \\ & + \beta_4 \ln \text{GDP}_{jt} + \beta_5 \text{Language}_{ij} + \beta_6 \text{Colony}_{ij} \\ & + \beta_7 \ln \text{Distance}_{ij} + \beta_8 \text{Border}_{ij} + \beta_9 \text{FTA}_{ijt} + \mu_t + u_{ijt}. \end{aligned} \quad (5)$$

The dependent variables are the export share, the extensive margin and the intensive margin of the exporting country i in the importing country j's market at time t. Each trade margin is regressed on the same set of explanatory variables as in equation (5). Note that skilled labor (Skill_{it}), unskilled labor (Unskill_{it}), and GDP per worker (GDPPW_{it}) are variables of the exporters, while GDP_{jt} is a variable of the importers. These variables and distance are in log terms. The dummy variables $Language_{ij}$, $Colony_{ij}$ and $Border_{ij}$ take the value 1 when the trading countries share a same language, a colonial history and a common border. The dummy FTA_{ijt} takes the value 1 if countries i and j have a trade agreement effective at time t. Year fixed effects are included in the model.

A discussion about the measures of labor supply is in order. In the estimation, we include log of skilled and unskilled labor as two explanatory variables, instead of including the relative labor supply (i.e. skilled labor/unskilled labor) as in models based on factor proportions theories. According to the theoretical model in section 3, the relative importance of the within-firm and between-firm effects can be different for the two types of labor. Including both skilled and unskilled labor enables us to identify which effect is more important for each type of labor. Estimating the effect of relative labor supply, nevertheless, imposes a restriction that the dominating effect is the same for both types of labor (since in that case, only the relative labor supply matters). As a result, we include the two types of labor supply in the benchmark estimation, and use the relative labor supply in a robustness check later in this section.

The benchmark model is estimated by ordinary least squares (OLS). Estimated coefficients and standard errors are reported in Table 1. The regressors of interest here are the skilled and unskilled labor. An increase in either skilled or unskilled labor improves the exporter's overall export share. Column (1) shows that a 10% increase in skilled labor will raise an exporter's manufacturing export share in a market by 6.4%. The increase can be decomposed into a 1.4% increase in the extensive margin (column 2) and a 5% increase in the intensive margin (column 3). The intensive margin accounts for 78% of skilled labor's influence, while the extensive margins account for 22%. A 10% increase in unskilled labor will increase export share by 4.5%, which can be decomposed into a 2.3% increase in the extensive margin and a 2.2% increase in the intensive margin. In terms of the influence of unskilled labor on exports, the extensive margin accounts for a slightly larger share than does the intensive margin.

The results show that skilled and unskilled labor have significantly positive effects on both margins. From the theoretical model, it is evident that both the within-firm and between-firm effects take place in the sample. We can infer the relative importance of the two effects by examining the contribution of each margin. The results show that the intensive margin dominates in the effect of skilled labor on exports, while the extensive margin contributes slightly more than half of unskilled labor's impact. The estimates show that the between-firm effect indeed plays a very

Table 1. Results of the Benchmark Estimation

Variables	*(1) Export share*	*(2) Ext. margin*	*(3) Int. margin*
ln(exporter skilled labor)	0.642***	0.141***	0.501***
	(0.0690)	(0.0392)	(0.0493)
ln(exporter unskilled labor)	0.452***	0.227***	0.225***
	(0.0720)	(0.0454)	(0.0498)
ln(exporter GDPPW)	1.102***	0.551***	0.551***
	(0.0973)	(0.0523)	(0.0593)
ln(importer GDP)	0.124***	0.202***	–0.0784***
	(0.0121)	(0.00866)	(0.00841)
ln(distance)	–0.738***	–0.367***	–0.371***
	(0.0284)	(0.0185)	(0.0205)
Common border	0.443***	–0.227***	0.670***
	(0.0514)	(0.0324)	(0.0326)
Common language	0.652***	0.292***	0.360***
	(0.0830)	(0.0350)	(0.0601)
Colony	0.307***	0.152***	0.155***
	(0.0508)	(0.0245)	(0.0363)
FTA	0.366***	0.0245	0.341***
	(0.0627)	(0.0308)	(0.0482)
Constant	–10.99***	–3.978***	–7.010***
	(0.479)	(0.321)	(0.347)
Time FE	Yes	Yes	Yes
Observations	14,448	14,448	14,448
R^2	0.717	0.547	0.646

Notes: Standard errors in parentheses are clustered by exporter-year. All the variables, except the dummies, are in log terms. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively.

important role. The results provide evidence that the factor proportions theory alone cannot fully explain the impact of labor supply on exports. The between-firm effect is at least equally, if not more, important as the within-firm effect.

Interactions with GDP per Worker

The effect of an increase in skilled and unskilled labor on exports can differ by countries' levels of development. The literature on product diversification/sophistication (Imbs and Warcziarg, 2003; Hausmann et al., 2007; Cadot et al., 2011) shows that product diversification has a bell-shaped relationship with GDP per capita. For low-income countries, the growth of trade is shown as an expansion of product sets, which increases the extensive margin. High-income countries will concentrate on improving the quality of specific products, which is captured by an increase in the intensive margin. Additionally, when a new product is created (usually by a developed country), the product classification system may not change immediately to incorporate the creation of the new product. Trade in this product will increase the intensive margin until a new product classification is built into the system. For developing countries with zero trade in more existing product lines, an increase in skilled labor will expand the range of products they can export in the classification, thus increasing the extensive margin directly.

The implication of the product diversification literature is that an improvement in labor composition should have a relatively greater impact on the extensive margins for developing countries than for developed countries. To explore this issue, we include interaction terms between country's demeaned GDP per worker and labor.[3] The estimated coefficients on labor and its interaction with demeaned GDP per worker are presented in the first panel of Table 2. The influence of skilled and unskilled labor are similar to that of the benchmark case. For a country whose log GDP per worker equals the sample average (i.e. demeaned log GDPPW equals 0), an increase in both skilled and unskilled labor will improve the overall export performance, along with both the extensive and intensive margins. For each margin, the interaction term of skilled labor has a negative coefficient, while that of unskilled labor has a positive coefficient. The results indicate that the effect of skilled labor is greater for low-income countries, and that of unskilled labor is stronger for high-income countries. The finding is consistent with factor endowment proportion theories. Since rich countries are more abundant in skilled labor, the marginal product of skilled labor is lower, and its impact on exports is weaker. In contrast, poor countries have relatively more unskilled labor than skilled labor, and thus an increase in skilled labor will improve their export performance more.

To compare the effect of skilled/unskilled on exports in countries with different GDP per worker, we calculate the elasticity of three countries in the sample: South Africa, Spain and Belgium, whose GDPPW percentiles are 10%, 50% and 90% in the year 2000, respectively. The results are reported in the second panel of Table 2. Column (1) shows that the estimated influence of skilled labor on overall exports is

Table 2. Interactions with GDP per Worker

	(1) *Export share*	*(2)* *Ext. margin*	*(3)* *Int. margin*
I. *Estimated coefficients of labor*			
ln(exporter skilled labor)	0.461***	0.0608*	0.400***
	(0.0604)	(0.0324)	(0.0480)
ln(exporter unskilled labor)	0.604***	0.293***	0.310***
	(0.0660)	(0.0381)	(0.0477)
demean ln(exp gdppw) × ln(exp skill)	–0.573***	–0.229***	–0.344***
	(0.107)	(0.0706)	(0.0761)
demean ln(exp gdppw) × ln(exp unskill)	0.207**	0.0726	0.135**
II. *Elasticity of exports in different countries*			
Skilled labor			
South Africa	0.765	0.182 (24%)	0.582 (76%)
Spain	0.323	0.006 (2%)	0.317 (98%)
Belgium	0.163	–0.058 (–36%)	0.221 (136%)
Unskilled labor			
South Africa	0.494	0.255 (52%)	0.239 (48%)
Spain	0.654	0.311 (48%)	0.343 (52%)
Belgium	0.712	0.331 (46%)	0.381 (54%)

Notes: Panel I reports the estimated coefficients of labor and its interaction with demeaned GDPPW. Coefficients of other regressors are skipped to save space. Standard errors in parentheses are are clustered by exporter-year. Panel II presents the elasticities of exports of three countries with different GDPPW. The % shows the relative contribution of each margin. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively.

much greater in low-income than in high-income countries, while that of unskilled labor is larger in high-income countries than in low-income countries.

Columns (2) and (3) display that the contribution of the two margins also differs by countries' GDP per worker. For skilled labor, the relative importance of the extensive margin is greater in low-income countries than in high-income countries (24% vs—36%). This result matches findings in the literature on product diversification. Developed countries are more focused on quality improvement in specific product lines, and thus the range of products exported decreases with the growth of skilled labor. For unskilled labor, the contribution of the intensive margin is greater for high-income countries than low-income countries (54% vs 48%), although the difference across countries is not significant.

In summary, the estimated results in this section indicate that: (1) Skilled labor is more important than unskilled labor in improving developing countries' export performance; and (2) An increase in labor supply will improve export performance of developed countries mainly through the intensive margin. These findings are in line with predictions of factor proportion theories and product diversification literature.

Estimation by Product Type

Skilled and unskilled labor may have an asymmetric impact on different types of products. Based on the Rauch (1999) classification, we categorize products into two types: homogeneous (including reference priced) and differentiated. We then calculate the trade margins and estimate the model in equation (5) of each product type separately.

The estimates are reported in Table 3. Columns (1)–(3) show the estimated coefficients of homogeneous products, while columns (4)–(6) show that of differentiated products. For both types of products, the coefficients on skilled and unskilled labor are positive in each margin, which is consistent with the benchmark estimation. However, the relative importance of skilled and unskilled labor differs greatly across product type. A 10% increase in skilled labor will increase export share of homo-

Table 3. Estimations by Product Type

	(1) *Export Share*	*(2)* *Ext. Margin*		*(3)* *Int. Margin*	
I. *Homogeneous*					
ln(exporter skilled labor)	0.293***	0.0921**	18%	0.201***	82%
	(0.0840)	(0.0444)		(0.0635)	
ln(exporter unskilled labor)	0.616***	0.403***	65%	0.212***	34%
	(0.0781)	(0.0502)		(0.0616)	
II. *Differentiated*					
ln(exporter skilled labor)	0.775***	0.117***	15%	0.658***	85%
	(0.0693)	(0.0389)		(0.0451)	
ln(exporter unskilled labor)	0.358***	0.249***	69%	0.109**	31%
	(0.0692)	(0.0454)		(0.0463)	

Notes: This table reports the estimated coefficients on labor by product type. The % shows the relative contribution of each margin. Standard errors in parentheses are clustered by exporter-year. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively.

geneous products by 3%, while it will increase that of differentiated products by 7.8%. A 10% increase in unskilled labor, in contrast, will raise the export share of homogeneous and differentiated products by 6.2% and 3.6%, respectively. The estimates confirm our expectation, that skilled labor is used more intensively in the production of differentiated products, while unskilled labor plays a greater role in that of homogeneous products.

In terms of the relative contribution of the extensive and intensive margins, there is no large difference between the two types of products: the extensive margin contributes 60%–70% of the positive effect of unskilled labor, and the intensive margin contributes more than 80% of the effect of skilled labor. The relative importance of the two margins is similar in both types of products, which is consistent with the outcomes of our benchmark estimation.

Robustness Checks

The discussion so far shows that the main findings in the benchmark estimation are robust to different countries and products types. In this section, we carry out additional estimations to verify that our results are robust to different model specifications and variable measures: (1) We replace logs of skilled and unskilled labor with total employment and a relative supply of skilled to unskilled labor (i.e. a skilled–unskilled labor ratio), to control for both the composition and scale of labor skills; (2) We include the importer fixed effects in the model; (3) We use the number of R&D personnel as an alternative measure of skilled labor; (4) We calculate the trade margins of all sectors, instead of only that of the manufactures as in the benchmark; (5) we estimate the model with two alternative estimators to account for possible bias owing to excluding observations of zero trade: the Poisson pseudo-maximum-likelihood (PPML) estimator (Santos Silva and Tenreyro, 2006) and the two-stage estimation procedure in Helpman et al. (2008);[4] (6) We construct a cross-sectional sample for every year and estimate the model year by year. The estimated coefficients on relevant explanatory variables are reported in Table 4.[5] The results are consistent with the benchmark estimation, in which skilled and unskilled labor have a relatively greater effect on the intensive and extensive margin, respectively.

6. Conclusion

Trade liberalization has been promoted as an effective way to enhance welfare, yet the gains depend on which component of trade flows flourishes. If export booms because of the extensive margin, more goods will be available for consumption and more types of inputs will be available for production. If the intensive margin increases, buyers can experience cheaper or/and higher quality goods, but it may also worsen the exporter's terms of trade. The literature investigating the source of export growth has been growing, but there is still no consensus on which margin plays a greater role. Our paper contributes to the literature on trade growth by studying how supply of skilled and unskilled labor affects the different margins of exports. Using trade data from 34 countries over 1995–2010, we find that skilled labor plays a more important role in explaining the rise in the intensive margin while unskilled labor plays a greater role in explaining the rise in the extensive margin. The results could be explained by the effect of labor skill composition on the productivity cut-off of exporting firms. We also find that the impact of skilled and unskilled labor on trade margins depends on the income level of the exporting country and on the type of products.

Table 4. Robustness Checks

Variables	*(1) Export share*	*(2) Ext. margin*	*(3) Int. margin*
I. *Skill–unskill ratio*			
ln(exporter skilled–unskilled ratio)	0.636***	0.139***	0.497***
ln(exporter employment)	1.094***	0.368***	0.725***
II. *All sectors*			
ln(exporter skilled labor)	0.629***	0.142***	0.486***
ln(exporter unskilled labor)	0.499***	0.237***	0.262***
III.			
ln(exporter skilled labor)	0.629***	0.142***	0.486***
ln(exporter unskilled labor)	0.499***	0.237***	0.262***
IV. *Alternative labor measure*			
ln(exporter skilled labor)	0.713***	0.193***	0.520***
ln(exporter unskilled labor)	0.425***	0.204***	0.222***
V. *PPML*			
ln(exporter skilled labor)	0.560***	0.104***	0.510***
ln(exporter unskilled labor)	0.209***	0.117***	0.119***
VI. *Two-stage*		1st stage	2nd stage
ln(exporter skilled labor)		0.0403***	0.238***
ln(exporter unskilled labor)		0.0585***	0.328***

Notes: Control variables such as country size and distance are included in the estimations as in the benchmark. In this table, we only report estimated coefficients and their significance levels of labor related explanatory variables to save space. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively.

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Notes

1. The method of decomposition is similar to Bao and Chen (2013).
2. Proofs of these results are provided by the authors upon request.
3. Demeaned log GDPPW equals each exporter's log GDPPW minus the mean of all exporters' log GDPPW in year *t*.
4. In the two-stage estimation, export variables are measured at the industry level (HS2). As in Helpman et al. (2008), we calculate $\hat{\bar{\eta}}^*$ (the inverse Mills ratio) and $\hat{\bar{z}}^* = \Phi^{-1}(\hat{\rho})$ from the first stage, where $\hat{\rho}$ is the predicted value in the probit. $\hat{\bar{\eta}}^*$ and polynomials of $\hat{\bar{z}}^*$ are included in the second stage estimation to account for firm heterogeneity and sample selection bias. We select common language and colonial history as excluded variables in the second stage (see Bao and Qiu, 2012).
5. The estimated coefficients of (6) are not reported here to save space, but results similar to the benchmark case are found in estimations of almost all years.