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Openness and Technological Innovation in East Asia

Have They Increased the Demand for Skills?

Rita K. Almeida

The World Bank
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Social Protection Team
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Abstract

This paper examines whether the increased openness and technological innovation in East Asia have contributed to an increased demand for skills in the region. The author explores a unique firm level data set across eight countries in Asia and the Pacific region. The results strongly support the idea that greater openness and technological innovation have increased the demand for skills, especially in middle-income countries. In particular, while the presence in international markets has been skill enhancing for most middle-income countries, this is not the case for manufacturing firms operating in China and in low-income countries. The author interprets this to support the premise that if international integration in the region continues to intensify and technology continues to be skilled biased, policies aimed at mitigating the skills shortages should produce continual and persistent increase in skills.

This paper—a product of the Social Protection Team,Human Development Network—is part of a larger effort in the department to analyze skills miss-matches in developing countries with micro data. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at ralmeida@worldbank.org.

Openness and Technological Innovation in East Asia: Have They Increased the Demand for Skills?

Rita K. Almeida [1]

The World Bank

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1. Motivation

East Asia is undergoing a deep structural change with employment in the region rapidly changing from agricultural activities into manufacturing and services, and from resource-based products to labor-intensive low technology products. Moreover, over the last decade, the share of skilled workers has also been increasing significantly, even within narrowly defined sectors. In some rapidly-growing economies, emerging skill shortages threaten to undermine the competitiveness of export-oriented firms with rising skills premiums. This paper investigates the extent to which the increasing openness (captured by exports and foreign direct investment) and technological innovation have increased the demand for skills. We explore a large cross-sectional micro data set for firms in the East Asia region.

Our results are consistent with greater openness and technological innovation increasing the demand for skills especially in middle-income countries. However, this is not the case for firms operating in China and in other low-income countries. There, a stronger integration of firms into the international markets is still associated with a greater specialization in low skilled intensive goods. These findings strongly suggest that international integration and the technology transferred to middle-income countries tends to be more skilled biased than for low-income countries. This is also consistent with middle-income countries having a higher absorptive capacity and, thus, being recipients of more advanced technological innovations than low-income countries.

The recent decades have been characterized in many developing countries by an increased income inequality favoring the most skilled workers. In particular, income inequality between skilled and unskilled workers increased in several countries after trade liberalization (e.g., Harrison and Hanson 1995, 1999, 1999a; Revenga, 1997; Robbins 1996). This has become a particularly severe problem in developing countries because of the potential negative social consequences associated with high poverty levels and income inequality. Moreover, a large chunk of worker reallocation has occurred within industries (between low and high skilled workers), rather than across industries (e.g., Harrison and Hanson 1995; Robbins 1996). This evidence suggests that there has been a simultaneous increase in the share of skilled labor (in total employment) and an increase in the returns to skills (e.g., Harrison and Hanson 1995; Robbins 1996) following

episodes of trade liberalization. This increase in prices and quantities cannot be solely explained by the increased (product-level) import competition from developed countries.

Most of the empirical work looking at the determinants of skill upgrading in developing countries has traditionally focused on aggregate sector data and/or on the role of foreign direct investment. For example, Harrison and Hanson (1999) find evidence for Mexico consistent with FDI acting as a channel for the spread of technology across countries. This literature is based on the assumption that foreign firms bring to their overseas subsidiaries a variety of managerial, organizational and technical innovations that otherwise would not have available to the host country. Skilled labor is needed to adapt and diffuse these innovations further in the host economy. Increased firm openness could also lead to a larger technology diffusion, which in turn could affect the demand for skills. In particular, firms importing state of the art intermediate inputs would be naturally exposed to greater technology diffusion. Similarly, firms present in international markets are also more pressured to innovate by international competition. Therefore, both activities may require higher ratios of skilled labor. Alternatively, greater openness could lead to a greater specialization in the production of goods intensive in unskilled labor (factor relatively abundant in developing countries). Therefore, a lack of skill upgrading, or even skill "downgrading" could be suggestive of openness leading to a relative specialization in low skill intensity products.

The evidence for developing countries on these links is quite scarce. For Latin America, Fajnzylber and Fernandes (2004) explore cross-sectional firm level data for Brazil. They find that increased levels of international integration (including foreign ownership) were associated with an increased demand for skilled labor. However, they find the opposite for China where integration was negatively associated with the use of skilled labor. Consistent with this positive association between skilled labor and firm openness, Almeida (2008) shows that in East Asia more globally integrated firms and those adopting newer technology are more likely to take longer to fill out external job vacancies, especially for the skilled positions in middle-income countries. This is interpreted as evidence that technology, especially that transferred from abroad, has been biased towards more skilled labor and that the supply of skills has not been adjusting fast enough. As micro data sets become available with longitudinal information, economists

started exploring changes in the degree of firm openness and technological innovation and relating it with changes in the firm's demand for skills. In general, these studies have found strong evidence of self-selection into the international activities so that the causal effect, when positive, is smaller than the cross-sectional estimates. For example, Doms and others (1997) and Pavcnik (2003) find no evidence of changes in technology adoption and global integration increasing the use of skilled labor. For Indonesia, Fernandes and Sundaram (2008) find opposite effects for export and import activities. In their sample, firms increasing their export intensity also increase the use of less skilled labor while firms increasing the imports of inputs tend to hire more skilled labor.

The increasing shares of educated workers in the workforce in the region and the rising industry skills premiums have been well documented in the literature by Di Gropello and Sakellariou (2008). Exploring household level data, they find robust evidence of increasing shares of skilled/educated workers in the long run across the region and of increasing skills wage premium. This simultaneous movement along quantities and prices is likely to be a consequence of an increase in the demand for skilled labor. In fact, if only the supply of skills had expanded, one would observe higher shares of skills but most likely a lower relative price. However, household level data have severe limitations to determine whether the demand for skilled workers has occurred within narrowly defined industries and whether it can be explained by openness and skill-biased technological change. This happens because household level data rarely contain information pertaining to openness, technology adoption or detailed sector of activity. Firm level data, in contrast, rarely contain information on the education of the workforce, except the more subjective occupational classification (skilled/unskilled indicators). Our paper relates closely to this recent international industrial organization literature exploring micro firm level data and emphasizing the importance of plant heterogeneity (e.g., Roberts and Tybout 1996). We explore a large cross-country firm level data set covering eight countries in East Asia to investigate whether the increased integration into global economic activities (captured by exports and FDI) on the one hand, and technological innovation on the other, has contributed to the increasing demand for skilled workers. The data set we explore is particularly suitable to study this topic. On the one hand, it collects information on the educational composition of the workforce

(share of the workforce with more than the secondary education). This is arguably a more meaningful indicator of skills than the usual occupational classification based on the share of skilled labor in the total workforce (proxied by the share of managers, professionals and unskilled workers). [2] On the other hand, it collects information on whether firms export, have foreign owned capital or have recently adopted new technology. The data also collect other firm characteristics usually not observed (such as, the manager's education, investment in research and development or geographical location within the country).[3]

The empirical approach we adopted in the paper is very simple. We compare the use of skilled labor for similar firms located within the same country, sector of activity (3-digits) and size category but having different degrees of openness (captured by exports or FDI) or technological innovation. In our baseline specification we control for several firm characteristics that could arguably be simultaneously correlated with greater use of skilled labor and with a greater openness/technological innovation (as age of the firm, public ownership, managerial education and firm sales per employee). Our main assumption is that the degree of firm openness and the adoption of new technology could lead to an increased demand for skilled labor. This could happen if technology is skill-biased or if firms, following the increased openness, make greater investments in skill-biased technology.

Our findings show a robust positive correlation between FDI, technological innovation and share of educated workers at the firm level. Therefore, openness and the adoption of new technology have contributed to skills upgrading in the region, especially for middle-income countries. The latter suggests that openness and technology adoption have been more skilled biased in middle-income countries than in low-income countries, which again is consistent with firms there having a higher absorptive capacity. In China

[2] Average years of education and share of skilled workers (captured by the occupational classification) are two measures closely related in our data for most of the countries in the region. However, they are not perfectly correlated. In the appendix we test the robustness of our main findings to this alternative definition of skills. Reassuringly, the qualitative results are similar.

[3] A related question is whether increased openness has better-benefited the more skilled workers. In the short run, assuming that the labor supply is constant, increases in the demand for skilled labor will translate into higher skill *premia*. The main problem of looking at wage premiums to access this trend is that they are also likely to capture other factors, especially if labor markets are not competitive (e.g., in the presence of labor market frictions). Moreover, we choose not to tackle this question due to several missing data on labor earnings.

and in other low-income countries, the effect of greater openness is not associated with heightened skills but rather with a greater specialization in low skilled intensive goods. The latter is explained by these countries having a comparative advantage in low skilled intensive goods (due to a relative abundance of unskilled labor) and with higher international integration leading to a higher specialization in the products intensive in this factor. In sum, the findings in the paper support the idea that international integration and technological innovation in the middle-income countries has been a key determinant of the increasing demand for skills in East Asia. These results have clear implications for policy. If international integration continues to intensify and technology continues to be skilled biased, the design of policies aimed at mitigating the persistent skills shortages in the region will only be successful if they continuously foster skills rather than producing temporary increases in skills.

The paper is structured as follows. Section 2 presents the data set used and reports within- and cross-country descriptive statistics for the main variables. Section 3 proposes an empirical methodology. Section 4 presents the main empirical findings and section 5 discusses several robustness checks and the heterogeneity of the results by income group. Section 6 concludes the paper

2. Data

The main data set we use is a large firm level data collected by the World Bank, *Enterprise Surveys*, covering eight developing countries in East Asia namely, Cambodia, China, Indonesia, Malaysia, the Philippines, Republic of Korea and Vietnam. The surveys used in this paper were conducted between 2002 and 2005, and the samples were designed to be representative of the population of firms according to their industry and location within each country.[4] We will explore one cross-section of data for each country,

[4] *Enterprise Surveys* have been used extensively to study the link between technology adoption and firm openness (Almeida, 2008, and Almeida and Fernandes, 2007), the investment in job training (Pierre and Scarpetta 2004; Almeida and Aterido 2008) as well as other topics as informality (Svensson 2003, Gatti and Honorati, 2008), effect of labor regulations (Almeida and Carneiro 2009) and business environment and firm size (Aterido and others, 2007). The main disadvantage of using the *Enterprise Surveys* is that, for most countries, there is only one cross section available. For the sake of comparability, we only include one wave of data for each country (the most recent wave). The surveys in Thailand, Malaysia and Mongolia include a worker module which could provide some additional measures of skills (e.g., type of education, core skills used in the workplace) at the worker level.

namely Cambodia (2003), China (2002, 2003), Indonesia (2003), Malaysia (2002), Philippines (2003), Republic of Korea (2005), Thailand (2004), and Vietnam (2005).

The information available in the *Enterprise Surveys* has several advantages for analyzing this topic. First, the data are based on a common questionnaire across a large set of countries, yielding comparable information on several firm level characteristics. In particular, the survey collects information on age, size, geographical location, 3-digit International Standard Industrial Classification (ISIC) sector of activity, and foreign and public ownership. Most importantly, it collects information on whether the firm participates in international trade (captured by the import and export shares). Second, the surveys collect detailed and comparable information on the current skills of the workforce, both with the share of workers with secondary and upper education as well as with the share of skilled workers (proxied by managers, professionals and non-production workers). Finally, the surveys also collect detailed balance sheet information at the firm level including total sales and value added. Table 1 reports the summary statistics and table A.1. in the appendix defines the main variables used in the paper.

The original data cover 9,776 firms distributed across a wide range of sectors (Manufacturing 77.54 percent, Construction 1.37 percent, Services 20.09 percent and Agro-Industry 1 percent). Within the manufacturing sector numerous industries are covered: auto and auto components, beverages, chemicals, electronics, food, garments, leather, metals and machinery, non-metallic and plastic materials, paper, textiles, wood and furniture.

A major caveat in these surveys is the reduced representativeness of the non-manufacturing sample in most countries. Services are only a significant part of the sample for Cambodia, China, Republic of Korea and, to a lesser extent, Vietnam. For all the other countries, non-manufacturing sectors are either not included or have a reduced sample. This naturally compromises the comparison of the main findings separately for manufacturing and services. We thus choose to report the main empirical findings of the paper only for the sample of manufacturing. This is a severe limitation of the paper since the shares of skilled labor have increased more in services than in manufacturing across most of the countries in the region (see Di Gropello and Sakellariou, 2008).

The two main measures of skills we explore in the paper are the share of workforce that is high educated (i.e., share of the workforce with more than secondary education) and the share of skilled occupations (i.e., the share of the workforce that are managers, professionals and non-production workers). The *Enterprise Surveys* collect detailed information on the occupational composition of the workforce using the following categories: management, professionals, skilled production workers, unskilled production workers and other non-production workers.[5] In particular, we consider the group of skilled workers as being the sum of management, professionals and non-production workers while the unskilled workers are the sum of skilled and unskilled production workers. In most of the earlier work on this topic (for example, Pavcnik 2003), this has been the most commonly used measure since it is frequently available. [6]

Table A2 in the appendix presents the summary statistics for the share of skilled workers in the workforce. Panel A reports the share of high educated workers (i.e., share of the workforce with more than secondary education) while Panel B reports the share of skilled occupations (i.e., the share of the workforce that are managers, professionals and non-production workers). The countries with the highest share of skilled labor are Indonesia and Republic of Korea, with China and Thailand following behind.[7] For all countries, there is robust evidence that the share of skilled labor in total employment is higher for services than for manufacturing (e.g., Di Gropello and Sakellariou, 2008). In fact, among all the countries with information, the services share is more than double. Within manufacturing, the countries with the smallest shares of skilled labor are Vietnam and Cambodia, where only approximately 10-11 percent of the workforce has more than secondary education.

3. Empirical Methodology

[5] We have also proxied the use of skilled labor by its share in the total firm compensation (wages and salaries plus bonuses and other benefits). Reassuringly, the findings (not reported) are in line with the ones reported in our main specification. We chose not to report these findings due to the reduced sample size, and the low reliability of the estimates.

[6] Yet, some of the non-production workers might themselves be engaged in low skilled tasks. Therefore, we will test the robustness of our main findings to an alternative measure of skills that is defined by excluding this group of workers (and considers only manager and professionals).

[7] Cambodia has a high share of skilled labor in the sample (both in Panel A and B). However, this is explained solely by the larger share of services in the sample for this country.

We follow the rest of the empirical literature on this topic and estimate a reduced form equation where the dependent variable is a measure of the firm's use of skilled labor with a specification of the following type:

$$Share\_Skills_{jsc} = \alpha O_{jsc} + \beta T_{jsc} + \gamma Z_{jsc} + \ln Y_{jsc} + \mu_s + \mu_c + \varepsilon_{jsc}. \qquad (1)$$

where $Share\_Skills_{jsc}$ is a proxy for the skill composition in firm j in sector s and country c (e.g., share of high educated workers or share of skilled occupations), O_{jsc} is a measure of firm openness (captured by foreign direct investment and/or export intensity)[8], T_{jsc} is a measure of recent technological innovation within the firm, Z_{jsc} are firm level characteristics (e.g., age of the firm, size, public ownership, managerial education), and Y_{jsc} captures sales per employee. μ_s and μ_c are sector- and country-specific fixed effects. Finally, ε_{jsc} is an (unobserved) firm-specific error term.

The main coefficients of interest in the reduced form (1) are α and β. α captures the differences in the skill composition of the workforce for firms with different degrees of international integration but located in the same country and 2-digit ISIC sector of activity (and holding all the other Z_{jsc} variables constant). A positive estimated $\hat{\alpha}$ suggests a greater openness at the firm level being associated with an increased demand for skills. Similarly, a positive $\hat{\beta}$ suggests that firms having recently adopted new technology having increased demand for skills. We will discuss in detail below that, with our reduced form equation, it is very difficult to disentangle correlation from causality.

It can be shown that the reduced form equation we estimate is close to the one derived from a minimization problem where each firm chooses their variable inputs (skilled and unskilled labor) by minimizing a cost function, subject to an output constraint. For example, Berman and others (1994) and Pavcnik (2003) estimate an equation similar to (1) and interpret that it has a "relative demand for skilled labor" (see also, Fajnzylber and Fernandes (2004) for an application in developing countries). The main difference between the reduced form (1) and this minimization problem is that the

[8] We have also tried to control for the degree of firm imports. Since this information was available only for a smaller group of firms we choose not to include it.

share of skilled labor is also a function of the firm's capital-labor ratio and the skill wage premium.[9]

We faced two major obstacles when trying to control for these firm characteristics in our reduced form. First, the number of observations for which there is information on mean wages and capital stock is significantly smaller (less than half). Moreover, we find robust evidence that, within countries, firms not reporting information on inputs or capital stock are not a random sample. Second, in the reduced form we explore, these variables are likely to be endogenous and simultaneously determined with the dependent variable (share of skilled labor) at the firm level. Unfortunately, we do not have a good instrument for any of these variables in our data. Even though we choose not to include them directly the detailed set of country and sector dummy variables included (covering a total of 14 sector categories) will likely mitigate this problem. Moreover, this problem is most likely mitigated further in our preferred specification where we control for a country-sector-size time invariant effects.

Controlling for country-sector-size time invariant effects also helps address the concern of the estimates capturing any spurious correlations. In particular, a visual investigation of the data pointed out that the share of skilled labor varied significantly by firm size due to reasons not necessarily directly related with the effect of openness. In particular, the share of skilled workers within a firm is likely to be a decreasing function of firm size simply because of a scale factor. Thus, in our preferred specification we control for country-sector-size time invariant effects instead of controlling independently for each of these. In other words, identification of the effect of openness will come from comparing the skill composition of the workforce in firms as similar as possible in

[9] Assuming a trans-logarithmic production function and logarithmic variable costs, it can be shown that the firm's demand for skills is of the form:

$Share\_Skills_{jsc} = \alpha O_{jsc} + \gamma Z_{jsc} + \beta T_{jsc} + \phi SW_{jsc} + \lambda \frac{\ln K_{jsc}}{\ln Y_{jsc}} + \ln Y_{jsc} + \mu_s + \mu_c$, where *SW jsc* is the relative wage of skilled workers in firm j sector s in country c, *Yjsc* is the firm's value added and *Kjsc* is the firm's capital stock. Equation (1) is very similar but assumes that the term $\phi SW_{jsc} + \lambda \frac{\ln K_{jsc}}{\ln Y_{jsc}}$ is captured either by the country or sector fixed effects, or alternatively by the error term ε_{jsc}. In the estimation of equation (1) we proxy the firm value added by firm's sales in order to maximize the number of observations.

observable characteristics and operating in the same country, 3-digit manufacturing sector and in the same size category.

Finally, in our robustness we will also test the robustness of our main findings to the comparison of firms located in the same geographical region (captured either by size dummies or by country-sector-city dummies). This is important since one of the reasons why some firms might use more skilled labor is its relative price. Assuming that labor markets are competitive at the local level, and that firms take prices as given in their localities, the relative price of skilled labor would be well captured by the country-sector-city dummy.[10]

Needless to say, there will still be several problems associated with interpreting α or β in a causal way. In particular, endogeneity, reverse causality and omitted variable problems are all likely to be sources of concern. We do not have a valid exogenous instrument for firm openness or technological innovation and thus will be severely limited in the extent to which we will be able to disentangle simple correlation from causality in our exercise. Reassuringly, however, our main findings will be robust to several specifications and subsamples. First, following Pavcnik (2003), we control for unobserved characteristics common to a geographic location or industry, which could affect both the demand for skills and firm openness. We test this by adding to our reduced form city and country-industry-city fixed effects. Second, we try to minimize omitted variable problems by exploring the detailed information available in the *Enterprise Surveys*. In particular, it is possible that the more educated managers are simultaneously more likely to engage in international activities and also better in identifying more able/skilled workers. Controlling for the manager's human capital (captured by its educational level) could mitigate this problem. Third, there is robust evidence that firms self-select into international activities, with the more productive and those with a more educated workforce being more likely to be more open (see e.g., Tybout 2000). In particular there is robust evidence of self-selection into exports and into foreign direct investment (e.g., Tybout 2000; Fernandes and Isgut 2005; Almeida 2007). One way to overcome this would be to assume that this positive correlation can be

[10] Pavcnik (2003) and Fajnzylber and Fernandes (2004), and most of the literature, also omit the relative wages in the reduced form equation they estimate.

captured by a firm time invariant effect and control for firm heterogeneity. Unfortunately, our data do not have a longitudinal dimension for most of the countries and we are thus unable to account for this heterogeneity.[11] Alternatively, we propose to proxy the degree of firm openness with sector and regional aggregates for foreign direct investment and exports (which are arguably more exogenous to firm outcomes). In particular, we have computed regional and sector averages for foreign presence and export intensity.[12] Finally, we will test the robustness of our findings to different samples. We specifically will consider the following diverse samples: country level, low income versus middle income (high income), manufacturing versus services, high tech versus low tech, and capital city versus other cities. We will also test the robustness of the main results by exploring alternative measures of technological innovation in the firm.

4. Main Empirical Findings

Before discussing the main findings, we summarize briefly the evidence on the two main channels of the demand for skilled labor discussed in the paper: firm openness and firm technological innovation. Tables 2 through 4 report the share of firms that export, share of firms with FDI and the share of firms adopting new technology , by country and manufacturing sector of activity, respectively.

The last row in table 2 reports the mean share of exporting firms for all countries in each manufacturing sector. We measure export intensity using a dummy variable equal to one when firms export and foreign ownership with a dummy variable equal to one for firms with more than 10 per cent of foreign capital.[13] Cambodia and Malaysia are the countries with the greatest share of exporting firms. In Malaysia exports are also present across a significant share of all the manufacturing sectors. On average, 82 per cent of the firms in Malaysia export, and this share is never below 74 per cent in each manufacturing sector. Cambodia is also a country with a high export intensity in our

[11] The only exception is the *Enterprise Survey* in Cambodia where there surveys were conducted in two different years and some firms can be traced over time. However, we only two waves, there is little time variation on the share of exports or foreign direct investment at the firm level to precisely identify the effect of openness.

[12] In these specifications, we do not control for regional sector-fixed effects because of perfect colinearity. The results (not reported but available on request) are similar to the ones presented in our base specification except that they tend to be statistically weaker for all the variables of interest.

[13] In table A1 in the appendix, we report definitions for all the variables used throughout the paper.

sample but, as discussed above, this is simply driven by the fact that 60 of the 62 firms in manufacturing operate in the Garment and Leather sector, which is the sector with the highest propensity to export in the region. In fact, among all sectors, Garments represent the largest share of exports in Cambodia but also in Malaysia, Philippines and Vietnam. In China and Republic of Korea, the highest propensity to export is in Textiles, in Indonesia it is Wood and Paper Products, while in Thailand it is in Food Products and Agro-Industry.

Similarly, table 3 reports the share of firms with at least 10 percent of foreign capital across countries and sectors. As expected, there is a higher share of firms that export than ones reporting having some foreign capital. The findings in table 3 are similar to the ones reported for exports in table 2. Cambodia and Malaysia lead the penetration of FDI with 82 percent and 32 percent of the firms in the sample reporting at least 10 percent of foreign capital, respectively. Unlike the case for exports, Electronics is the sector in the region with the highest FDI penetration (39 per cent of the firms). More than 60 percent of the firms in this sector in Indonesia, Malaysia, Philippines and Thailand report at least 10 percent of FDI penetration. A closer examination also shows that this is the sector where the share of foreign capital is highest in the region reaching 30.8 percent of total capital. This contrasts with the Food and Agro Industry sector where foreign penetration is the lowest in the region reaching 6 percent of total capital (these shares are not reported in table 3 but available on request).

Finally, table 4 reports the mean share of firms adopting new technology across countries and manufacturing sectors. We define that a firm has adopted new technology when it reports having "introduced a new technology that substantially changed the way the main product was produced in the three years prior to the survey" (*Enterprise Surveys*). On average, 52 percent of the firms in the sample report having adopted a new technology that has significantly changed the way the main product is produced. Technological innovation was greater for Cambodia and Thailand but again the findings for Cambodia are driven by the selected set of industries included in our sample. Electronics and Metals and Machinery are the sectors with the greatest technological innovation according to this definition.

Figures 1 to 3 report each country's share of skilled workers (proxied by the share of the workforce with more than secondary education), by the degree of global integration (measured by exports and FDI penetration) and technological innovation, respectively. At the aggregate level, we find some evidence that countries with a larger share of firms engaged in exports, with FDI or adopting new technology also report a greater share of more educated workers. Nonetheless, exceptions exist like, China or Vietnam for exports and Cambodia for FDI. In non-exporting Chinese manufacturing firms, for example, on average 22 percent of the workforce has more than 12 years of education. This number is 7 percentage points smaller for exporting Chinese firms.

Table 5 reports the least squares estimates of equation (1). The dependent variable is the share of workers with at least secondary education (i.e., with 12 or more years of schooling). We argue that this is a better measure to proxy human capital in the workforce than the commonly used skilled/unskilled classification, where it is more difficult to guarantee within and across country consistency in the worker's classification. Columns (1) to (5) differ in the firm controls included in Z_{jsc} and on the set of time invariant effects considered. In column (1) we start by including age of the firm and public ownership after controlling for 3-digit industry fixed effects (total 14 categories) and for country fixed effects separately. Column (2) considers country-sector fixed effects, column (3) adds country-sector-size fixed effects, column (4) adds managerial education and column (5) adds (log) sales per employee. The specification in column (5) will be the baseline specification throughout the paper. The control variables in the baseline specification, in addition to the country-sector-size dummies, include export intensity, foreign ownership, and degree of technological innovation, age of the firm, public ownership, managerial education and (log) sales per employee.

Two interesting facts come up in the table. First, for most specifications, there is no robust correlation between being an exporter and the use of a more educated workforce; second, technological innovation and foreign ownership are both associated with greater demand for more educated workers. The former lack of correlation is likely to be driven by two forces which could have offsetting effects in developing countries. On the one hand, in developing countries globalization is likely to lead to specialization in the goods intensive in the abundant factor (or unskilled labor-intensive goods). This is

likely to lead to an increase in the relative demand for unskilled workers (and also to a reduction in the skilled-unskilled wage differential). On the other hand, if technological change has been skill-biased, and if openness is associated with greater technological innovation, exports and FDI could act as channels for the international diffusion of skill-biased technologies developed in industrialized countries. This force is thus likely to increase the demand for more skilled labor.[14]

It is worth stressing that in our baseline specification (reported in column (5)), we compare the demand for skills in firms with different degrees of openness and technological innovation but located in the same country, 3-digits sector and size category, and with similar profile regarding age, public ownership, managerial education and sales per employee. In column (5) the positive correlation between FDI and technological innovation is positive and statistically strong.

The results in column (5) of table 5 also highlight other interesting correlations for the control variables. First, older firms, located in the same country, 3-digit sector and size category, have a smaller share of high educated workers. Second, public owned firms are also more likely to use more educated workers. It is worth stressing though that this *premia* holds even after conditioning on sector of activity and on firm size. This positive correlation is in line with the empirical evidence found by others in developing countries (e.g., Earle, and Telegdy, 2008). Third, firms with more educated managers (measured by whether managers have post-secondary education) are also prone to use a more educated workforce. This finding is capturing either the complementarities across skills in the different jobs, or the better capacity of high educated managers to screen and select more educated workers. Finally, we also find robust evidence that firms with larger (log) sales per employee tend to use more educated workers (after conditioning on sector and size). As mentioned above, under some assumptions on the functional form for the production and cost function, the relative demand for skilled labor would imply that the demand for skills is a function of value added. Since in our data set this information is available for a smaller number of firms, we choose to control for sales per employee, instead.[15] A

[14] So could imports but again this variable is available for a smaller set of countries. However, we will test our findings to control for this activity.

[15] Controlling for log value added per employee would lead also to a positive correlation between scale of production and demand for skilled labor.

positive coefficient signals the presence of increasing returns to scale (e.g., see also Pavcnik, 2003).

5. Robustness and Heterogeneity of Results

In tables 6 and 7 we do some robustness checks over the baseline specification (reported in column 5 of table 5).

Table 6 controls for additional firm characteristics like city location (in columns 1 and 2) and access to finance (in column 3). As discussed above, controlling for geographical location is important because one of the reasons why some firms might use more skilled labor is its relative price. Assuming that labor markets are competitive at the local level, and that firms take prices as given in their localities, the relative price of skilled labor would be well captured by the country-sector-city dummy. Moreover, by controlling in column (2) for country-sector-city fixed effects, we can also assume that firms face a similar supply of skilled workers. Reassuringly, the findings in column (1) and (2) for the main variables of interest remain similar to the ones reported in our main specification. Moreover, firms located further away from the capital city tend to use less educated workers than firms located in the capital city (omitted category). This finding is likely to capture the scarcity of more educated workers in localities further away from the capital city. In column (3) we further test whether our main findings are driven by the more open firms having a greater access to external finance (omitted variable up to now). In particular, it is plausible that firms differ in their ability to finance new technological investments and presence in international markets and that their financial situation might also affect their ability to attract more skilled workers. The results show that, after controlling for access to finance, the correlation between exports and use of more educated workers becomes positive and strong. However, a closer investigation shows that this fact is fully explained by the exclusion of China from the sample. Firms in China do no report information on access to finance and we will show ahead that export oriented Chinese firms tend to use less skilled labor.

Table 7 reports the robustness of our main results after controlling for alternative proxies of the technological sophistication in the firm. Even though in our preferred specification we already control for country-sector-size fixed effects, we worry that

heterogeneity in the firm's technology could be explaining the main findings in table 5. This could happen if firms with a more advanced technology were more likely to be open and adopt more frequently new technology and also use more skilled labor. Column (1) controls for whether the firm has an ISO certification, column (2) for whether the firm conducts any R&D activities, column (3) for the share of R&D in total sales, in column (4) for the computer use and in column (5) for the email/internet use in daily activities. Even though the findings show that the effect on exports is not robust, the effect of FDI and technological innovation remains positive and strong after controlling for most of these variables. The major exception relates to the findings in column (4) of table 7, where the correlation between skills and FDI becomes statistically insignificant. This suggests that the presence of FDI and the use of computers is closely correlated and that it is difficult to disentangle the two effects. It is also interesting to note that all these variables capturing technological advancement are also positively correlated with the use of more educated workers. This strongly suggests that more advanced technology is complementary to the degree of human capital in the firm (e.g., Berman and others, 1994). In sum, the results in these tables show that the negative correlation between exports and use of skills is not systematically strong while the one for FDI and technological innovation tends to be so.

In tables 8 and 9 we test the robustness of our main findings to restricting the sample to different groups. Table 8 replicates our preferred specification in column (1) while columns (2) and (3) present the results when restricting the sample to high and low technology manufacturing sectors.[16] While there is strong positive correlation between technology and FDI, and the use of educated workers for low and high technology sectors, the negative correlation between exports and the use of educated workers is strong only for the set high tech sectors. This negative correlation is fully driven by the inclusion of the Chinese firms in the sample. In fact, if we were to exclude China from the sample in the regressions reported in table 8, exports and skills would be positively correlated within countries for the low and high technology sectors, though not strong in

[16] We consider high technology manufacturing sectors the following 3-digit ISIC sectors: Auto or Auto-component, Chemical and Pharmaceutical, Electronics or Metals and Machinery industries. The low technology manufacturing sectors are the Beverages, Food, Garment and Leather, Non-metallic/Plastic Materials, Wood and Paper, Textiles. These definitions follow Parisi and others (2006).

the latter case (these results are not reported but available on request). As discussed above, we cannot rule out that this finding is driven by either the self-selection of firms into the exporting activity nor by an increase in the exporting intensity in the demand for skills. However, this is not the case in China, and especially among the high technology sectors, where the workforce in exporting firms tends to have fewer years of schooling.[17] The latter is likely to reflect the fact that the comparative advantage in this sector is based mostly on low wages (low skills) and not so much on high quality products.

The importance of China in driving the results previously discussed is clearly documented in Table 9. There, we investigate whether our findings are very sensitive to the inclusion/exclusion of each country in the sample. Table 9 reports the sensitivity of our preferred specification when excluding one country at a time. The findings show that the positive correlation between technological change and FDI and the use of more educated labor are positive and significant across all the specifications. As discussed above, the negative and strong correlation between the exporting intensity and the use of more educated workers is driven solely by China. There, the effect of specialization dominates the potential increase in the demand for skilled labor associated with technological change, leading to a strong negative correlation between export intensity and the use of more educated workers.

Finally, table 10 estimates our preferred specification (in column 5 of table 5) separately for different income groups in our sample. Column (1) restricts the sample to low-income countries (Cambodia and Vietnam), column (2) to middle-low income (China, Indonesia, Philippines and Thailand) and column (3) to middle-upper income (Malaysia).[18] The findings show that for the low-income countries, there is a strong correlation between FDI and the use of more educated workforce, which is not robust to the middle-income or even low-middle-income countries. This finding is suggestive that the technology transferred by foreigners to low-income countries is more advanced than the one operated by similar domestic firms (which then translate into higher skill use). Rather in low-middle-income and in middle-income countries, there is a strong positive correlation between technological innovation and the demand for educated workers,

[17] High technological sectors include Auto and Auto Components, Chemicals and Pharmaceuticals, Electronics, and Metals and Machinery.
[18] South Korea is not included in table 10 as it is a high income OECD country.

which does not hold in low-income countries. The link between exports and demand for skills is also different across low and middle-income countries. Among low-income countries there is no systematic correlation while among low-middle and middle-income countries the correlation is negative and strong. A closer investigation shows that this finding in the low-middle-income countries is driven only by China, where the specialization effect of exports dominates (see also Fajnzylber and Fernandes, 2004).

Finally, we investigate the robustness of our main findings to the skills measure used in the paper (captured by share of workers with more than secondary education). Alternatively, we measure skills using the share of managers, professionals and non-production workers in the total workforce. The results in table 11 show that qualitatively the results are similar to the ones reported in table 8 although the effect of FDI on skills is not statistically strong. This suggests that although the occupational classification is similar, firms with foreign capital have a more educated workforce. These findings reinforce the fact that the two skills measures do not capture the same dimension of the human capital in the firm.

6. Conclusion

East Asia is undergoing a deep structural change with the demand for skills increasing significantly in the region, even within narrowly defined sectors. Job creation in the region is also increasingly biased towards the use of more skills. This paper investigates the extent to which the increased openness (captured by exports and foreign direct investment) and recent technological innovation in the region have contributed to a greater demand for skills and, thus, for the observed skill upgrading. We explore a large cross-sectional micro data across eight countries in East Asia.

Our results are consistent with greater openness and technological innovation at the firm level being associated with an increasing demand for skills, especially for middle-income countries. In particular, we show that the presence in international markets through exports has been skill enhancing for most middle-income countries, although this is not the case for firms operating in China and in low-income countries. There, a stronger integration in international markets is associated with a greater specialization in relatively low skilled intensive goods. These findings strongly suggest

that international integration and technology transferred to middle-income countries tend to be more skilled biased than for low-income countries. This evidence is fully consistent with middle-income countries having a higher absorptive capacity and, thus, being recipients of more advanced technological innovations than low-income countries. Rather, in China and other low-middle-income countries, where the absorptive capacity is smaller, the effect of greater openness is associated with a stronger specialization in low skilled intensive goods.

In sum, the findings in the paper support the idea that international integration and technological innovation in the middle-income countries has been a key determinant of the increasing demand for skills in East Asia. These results have clear implications for policy. If international integration continues to intensify and technology continues to be skilled biased, the design of policies aimed at mitigating the persistent skills shortages in the region will only be successful if they continuously foster skills rather than producing temporary increases in skills.

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Table 1. Summary Statistics Main Variables

	Obs.	Mean	S.D.	Min	Max
Share High Educated Workers	8,396	26.75	30.76	0	100
Share of Skilled Occupations	9,623	34.31	29.63	0	100
Total Employment	9,776	369.04	1665	1	67,598
Exporter	9,418	0.34	0.47	0	1
Foreign Ownership	9,662	0.19	0.40	0	1
Technological Innovation	9,650	0.48	0.50	0	1
Age Firm	9,693	14.94	13.27	0	215
Public Ownership	9,546	0.14	0.35	0	1
Managerial Education	9,776	0.96	0.19	0	1
Sales per employee	9,374	6.40	3.11	-4.6	19.9
City > 1mln individuals	9,059	0.37	0.48	0	1
City 250k-1mln individuals	9,059	0.17	0.38	0	1
City 50k-250k individuals	9,059	0.17	0.37	0	1
City > 50k individuals	9,059	0.13	0.34	0	1
Access to External Finance	7,540	0.60	0.49	0	1
ISO certification	9,085	0.30	0.46	0	1
R&D Activities	5,970	0.33	0.47	0	1
R&D/Sales	5,970	1.82	9.32	0	100
Computer Use	5,181	0.59	0.49	0	1
Email/Internet Use	6,334	0.58	0.49	0	1
High-Tech Manufacturing Sectors	7,580	0.42	0.49	0	1
Low Income Countries	9,776	0.22	0.41	0	1
Low-Middle Income Countries	9,776	0.63	0.48	0	1
Upper-Middle Income Countries	9,776	0.09	0.29	0	1

Source: *Enterprise Suveys* (World Bank).
Note: All variables defined in table A1 in the appendix.

Table 2: Share of Exporting Firms, by Country and Manufacturing Sector

	Food & Agroindustry	Textiles	Garments & Leather	Metal & Machinery	Electronics	Chemicals and Plastics	Wood & Paper	All Manufacturing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cambodia	-	0.50	0.93	-	-	-	-	0.92
China	0.04	0.63	0.39	0.16	0.30	0.05	-	0.25
Indonesia	0.17	0.42	0.43	0.45	0.85	0.24	0.49	0.39
Malaysia	0.74	0.88	0.92	0.79	0.93	0.81	0.87	0.83
Philippines	0.11	0.40	0.47	-	0.71	-	-	0.37
SouthKorea	0.13	0.65	0.41	0.37	0.50	0.36	0.26	0.38
Thailand	0.91	0.43	0.74	0.43	0.66	0.42	0.50	0.56
Vietnam	0.47	0.79	0.88	0.23	0.45	0.28	0.43	0.42
All Countries	0.38	0.51	0.56	0.26	0.44	0.40	0.48	0.42

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: Table reports the share of exporting firms in the sample, by country and manufacturing sector. Exporting firms are defined as those exporting at least 10% of their sales. The last row reports the mean share of exporting firms for all the countries. The latter is a weighted average of the mean share of exporting firms in each country weighted by each country's sample size in the total sample. The last column reports the mean share of exporting firms for all manufacturing sectors. Again, this is the weighted average of the mean shares in each sector, weighted by sector's size in the total country sample.

Table 3: Share of Firms with Foreign Direct Investment, by Country and Manufacturing Sector

	Food & Agroindustry	Textiles	Garments & Leather	Metal & Machinery	Electronics	Chemicals and Plastics	Wood & Paper	All Manufacturing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cambodia	-	1.00	0.82	-	-	-	-	0.82
China	0.12	0.32	0.20	0.22	0.29	0.08	-	0.23
Indonesia	0.04	0.15	0.13	0.39	0.65	0.24	0.08	0.17
Malaysia	0.19	0.31	0.24	0.27	0.61	0.41	0.22	0.32
Philippines	0.07	0.14	0.28	-	0.67	-	-	0.25
SouthKorea	0.19	0.00	0.06	0.18	0.08	0.32	0.10	0.15
Thailand	0.21	0.20	0.18	0.33	0.61	0.14	0.11	0.26
Vietnam	0.12	0.22	0.18	0.12	0.32	0.10	0.06	0.12
All Countries	0.13	0.20	0.24	0.22	0.39	0.21	0.10	0.22

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: Table reports the share of firms in the sample with at least 10% of foreign capital , by country and manufacturing sector. The last row reports the mean share of firms with FDI for all the countries. The latter is the weighted average of the mean share for each country, weighted by each country's sample size in the total sample. The last column reports the mean share of firms with FDI for all manufacturing sectors. Again, this is the weighted average of the mean shares in each sector, weighted by sector's size in the total country sample.

Table 4: Share of Firms Adopting New Technology, by Country and Manufacturing Sector

	Food & Agroindustry	Textiles	Garments & Leather	Metal & Machinery	Electronics	Chemicals and Plastics	Wood & Paper	All Manufacturing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cambodia	-	1.00	0.85	-	-	-	-	0.85
China	0.49	0.30	0.33	0.44	0.51	0.48	-	0.44
Indonesia	0.37	0.44	0.44	0.49	0.79	0.51	0.47	0.46
Malaysia	0.32	0.30	0.30	0.50	0.61	0.39	0.36	0.39
Philippines	0.67	0.61	0.46	-	0.76	-	-	0.60
SouthKorea	0.63	0.61	0.24	0.51	0.92	0.76	0.48	0.55
Thailand	0.65	0.57	0.63	0.79	0.81	0.53	0.50	0.66
Vietnam	0.58	0.58	0.65	0.62	0.75	0.64	0.55	0.61
All Countries	0.54	0.50	0.47	0.55	0.60	0.51	0.50	0.53

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: Table reports the share of firms in the sample recently adopting new technology, by country and manufacturing sector. A firm reports having adopted new technology when it significantly changed the way its main product is produced. The last row reports the mean share of firms adopting new technology for all the countries. The latter is a weighted average of the mean shares in each country weighted by each country's sample size in the total sample. The last column reports the mean share of firms with adopting new technology for all manufacturing sectors. Again, this is the weighted average of the mean shares in each sector, weighted by sector's size in the total country sample.

Table 5. Openness, Technological Innovation and the Demand for Skills.

	(1)	(2)	(3)	(4)	(5)
Exporter	-0.003	0.003	-0.041	-0.050	-0.0653*
	[0.0350]	[0.0360]	[0.0386]	[0.0386]	[0.0388]
Foreign Ownership	0.219***	0.249***	0.230***	0.216***	0.209***
	[0.0393]	[0.0399]	[0.0411]	[0.0410]	[0.0414]
Technological Innnovation	0.318***	0.315***	0.282***	0.268***	0.265***
	[0.0331]	[0.0333]	[0.0341]	[0.0342]	[0.0342]
Age Firm	-0.00350***	-0.00345***	-0.00555***	-0.00566***	-0.00555***
	[0.00126]	[0.00127]	[0.00132]	[0.00131]	[0.00130]
Public Ownership	0.315***	0.320***	0.335***	0.327***	0.333***
	[0.0487]	[0.0493]	[0.0534]	[0.0532]	[0.0534]
Managerial Education	-	-	-	0.709***	0.696***
				[0.109]	[0.109]
Sales per employee	-	-	-	-	0.0223***
					[0.00829]
Industry Fixed Effects?	Yes	No	No	No	No
Country Fixed Effects?	Yes	No	No	No	No
Country-Industry Fixed Effects?	No	Yes	No	No	No
Country-Industry-Size Fixed Effects?	No	No	Yes	Yes	Yes
Observations	6,072	6,072	6,072	6,072	5,976
Rsquared	0.19	0.20	0.27	0.27	0.28

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is the logarithm of the share of workforce with more than the secondary education. Columns (1) through (5) report different specifications. In addition to the firm characteristics reported in each column , column (1) controls for 3-digit industry fixed effects (total 27 categories) and for country fixed effects separately, column (2) controls for country-industry fixed effects and column (3) through (5) control for country-industry-size fixed effects. All the variables are defined in table A1 in the appendix. The specification in column (5) will be the baseline specification throughout the paper. The control variables in the baseline specification, in addition to the country-industry-size dummies, include exporter, foreign ownership, technology adoption, age of the firm, public ownership, managerial education and (log) sales per employee.

Table 6: Openness, Technological Innovation and the Demand for Skills: Robustness

	(1)	(2)	(3)
Exporter	-0.0923**	-0.120***	0.0773*
	[0.0395]	[0.0369]	[0.0408]
Foreign Ownership	0.259***	0.276***	0.187***
	[0.0423]	[0.0413]	[0.0432]
Technological Innnovation	0.264***	0.285***	0.220***
	[0.0350]	[0.0344]	[0.0368]
City>1mln individuals	0.165***	-	-
	[0.0621]		
City 250k-1mln individuals	-0.127**	-	-
	[0.0626]		
City 50k-250k individuals	-0.127**	-	-
	[0.0567]		
City > 50k individuals	-0.253***	-	-
	[0.0618]		
Access to External Finance	-	-	-0.050
			[0.0403]
Baseline Firm Characteristics?	Yes	Yes	Yes
Country-Industry-Size Fixed Effects?	Yes	No	Yes
Country-Industry-City Fixed Effects?	No	Yes	No
Observations	5,592	5,592	4,937
Rsquared	0.26	0.23	0.30

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is the logarithm of the share of workforce with more than the secondary education. Columns (1) assumes the baseline specification (column 5 of table 5) controlling in addition to the location of the firm (city level). Column (2) controls for the firm characteristics in the baseline specification controlling for country-industry-city fixed effects (instead of the country-industry-size fixed effects in the baseline). Column (3) reports the baseline specification controlling in addition to the firm's access to external finance. All the variables are defined in table A1 in the appendix.

Table 7. Openness, Technological Innovation and the Demand for Skills: Robustness Technological Variables

	(1)	(2)	(3)	(4)	(5)
Exporter	-0.0658	-0.144***	-0.147***	-0.276***	0.0323
	[0.0416]	[0.0468]	[0.0470]	[0.0679]	[0.0419]
Foreign Ownership	0.199***	0.241***	0.223***	0.068	0.110**
	[0.0435]	[0.0496]	[0.0497]	[0.0682]	[0.0446]
Technological Innnovation	0.244***	0.235***	0.281***	0.324***	0.113***
	[0.0372]	[0.0426]	[0.0420]	[0.0551]	[0.0385]
ISO Certification	0.283***	-	-	-	-
	[0.0403]				
R&D Activities	-	0.316***	-	-	-
		[0.0439]			
R&D/Sales	-	-	0.00889***	-	-
			[0.00212]		
Computer Use	-	-	-	0.517***	-
				[0.0581]	
Email/Internet Use	-	-	-	-	0.438***
					[0.0425]
Baseline Firm Characteristics?	Yes	Yes	Yes	Yes	Yes
Country-Industry-Size Fixed Effects?	Yes	Yes	Yes	Yes	Yes
Observations	5,492	4,127	4,127	2,824	4,111
Rsquared	0.29	0.27	0.26	0.30	0.33

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is the logarithm of the share of workforce with more than the secondary education. Columns (1) through (5) take the baseline specification (column 5 of table 5) adding additional firm level variables. Column (1) controls for whether the firm has an ISO certification, column (2) for whether the firm conducts any R&D activities, column (3) for the share of R&D in total sales, in column (4) for the computer use and in column (5) for the email/internet use in daily activities. All the variables are defined in table A1 in the appendix.

Table 8: Openness, Technological Innovation and the Demand for Skills: Robustness Manufacturing Sample

	Manufacturing	Low Tech Manufacturing	High Tech Manufacturing
	(1)	(2)	(3)
Exporter	-0.0653*	0.0471	-0.229***
	[0.0388]	[0.0505]	[0.0599]
Foreign Ownership	0.209***	0.107*	0.276***
	[0.0414]	[0.0550]	[0.0628]
Technological Innnovation	0.265***	0.215***	0.329***
	[0.0342]	[0.0431]	[0.0551]
Baseline Firm Characteristics?	Yes	Yes	Yes
Country-Industry-Size Fixed Effects?	Yes	Yes	Yes
Observations	5,976	3,391	2,585
Rsquared	0.277	0.284	0.238

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is the logarithm of the share of workforce with more than the secondary education. Columns (1) through (3) take the baseline specification (in column 5 of table 5) and run it again for all the firms in the manufacturing sectors (column 1), manufacturing low technology sectors (column 2) and for the manufacturing high technology sectors (column 3). All the variables are defined in table A1 in the appendix.

Table 9. Openness, Technological Innovation and the Demand for Skills: Robustness Alternative Samples

	Cambodia	China	Indonesia	Malaysia	Philippines	South Korea	Thailand	Vietnam
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exporter	-0.0664*	0.121***	-0.0992**	-0.0814**	-0.064	-0.0698*	-0.151***	-0.102**
	[0.0388]	[0.0417]	[0.0397]	[0.0394]	[0.0395]	[0.0394]	[0.0482]	[0.0464]
Foreign Ownership	0.213***	0.139***	0.236***	0.213***	0.229***	0.207***	0.258***	0.0965**
	[0.0415]	[0.0450]	[0.0426]	[0.0434]	[0.0423]	[0.0418]	[0.0513]	[0.0466]
Technological Innnovation	0.266***	0.167***	0.270***	0.277***	0.243***	0.268***	0.308***	0.285***
	[0.0342]	[0.0387]	[0.0351]	[0.0353]	[0.0349]	[0.0345]	[0.0402]	[0.0402]
Baseline Firm Characteristics?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Industry-Size Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,949	4,114	5,515	5,657	5,485	5,791	4,681	4,640
Rsquared	0.28	0.31	0.26	0.28	0.29	0.27	0.27	0.28

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is the logarithm of the share of workforce with more than the secondary education. Table reports the results for the baseline specification (column 5 in table 5) but restricting the sample to exclude one country at the time (excluded country reported at the top of each column). All the variables are defined in table A1 in the appendix.

Table 10. Openness, Technological Innovation and the Demand for Skills: Robustness across Income Groups

	Low Income	Low-Middle Income	Middle Income
	(1)	(2)	(3)
Exporter	0.00159	-0.115**	-0.0958**
	[0.0746]	[0.0489]	[0.0474]
Foreign Ownership	0.459***	0.0721	0.0785
	[0.0933]	[0.0512]	[0.0486]
Technological Innnovation	0.015	0.297***	0.280***
	[0.0589]	[0.0395]	[0.0380]
Baseline Firm Characteristics?	Yes	Yes	Yes
Country-Sector-Size Effects?	Yes	Yes	Yes
Observations	1,865	5,077	5,396

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is the logarithm of the share of workforce with more than the secondary education. Columns (1) through (3) take the baseline specification (in column 5 of table 5) but run it separately for low income countries (column 1), low-middle income countries (column 2) and middle income countries (column 3). All the variables are defined in table A1 in the appendix.

Table 11. Openness, Technological Innovation and the Demand for Skills: Alternative Skills Definition

	Manufacturing	Low Tech Manufacturing	High Tech Manufacturing
	(1)	(2)	(3)
Exporter	-0.106***	-0.0206	-0.230***
	[0.0228]	[0.0312]	[0.0325]
Foreign Ownership	0.0148	0.00603	0.0465
	[0.0243]	[0.0348]	[0.0342]
Technological Innnovation	0.0810***	0.105***	0.0523*
	[0.0195]	[0.0271]	[0.0276]
Baseline Firm Characteristics?	Yes	Yes	Yes
Country-Industry-Size Fixed Effects?	Yes	Yes	Yes
Observations	6,865	3,916	2,949
Rsquared	0.26	0.22	0.18

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is logarithm of the share of skilled occupations (captured by managers, professionals and non-production workers). Columns (1) through (3) take the baseline specification (in column 5 of table 5) but run it separately for manufacturing sectors (column 1), manufacturing low technology sectors (column 2) and for the manufacturing high technology sectors (column 3). All the variables are defined in table A1 in the appendix.

Table A.1. Definitions Main Variables

Variable	Definition
Share High Educated Workers	Share of the workforce with more than the secondary education
Share of Skilled Occupations	Share of the workforce that are managers, professionals and non-production workers
Exporter	Dummy variable equal to 1 if the firm exports directly or indirectly
Foreign Ownership	Dummy variable equal to 1 if the firm has more than 10% of foreign capital
Technological Innovation	Dummy variable equal to 1 if the firm introduced a new technology that substantially changed the way the main product was produced in the three years prior to the survey
Age Firm	Years since the firm started operations
Public Ownership	Dummy variable equal to 1 if the government ownes a positive amount of the firm's capital
Managerial Education	Dummy variable equal to 1 if the manager completed at least the secondary education
Sales per employee	Firm total sales divided by the number of total employees
City > 1mln individuals	Dummy variable equal to 1 if the firm is located in a city with population greater than 1 million individuals other than capital city
City 250k-1mln individuals	Dummy variable equal to 1 if the firm is located in a city with population between 250 thousand and 1 million individuals
City 50k-250k individuals	Dummy variable equal to 1 if the firm is located in a city with population between 50 thousand and 250 thousand individuals
City > 50k individuals	Dummy variable equal to 1 if the firm is located in a city with population between smaller than 50 thousand individuals
Access to External Finance	Dummy variable equal to 1 if a firm finances its investments through commercial banks or leasing arrangements.
ISO certification	Dummy if the firm has an ISO certification.
R&D Activities	Dummy variable equal to 1 if the firm reports having design and R&D expenditures (e.g., labor costs with R&D personnel, materials or subcontracting costs).
R&D/Sales	Share of R&D expenditure divided by the firm's total sales
Computer Use	Dummy equal to 1 if the firm uses computers on their daily activities
Email/Internet Use	Dummy equal to 1 if the firm uses internet or email in their daily activities
High-Tech Manufacturing Sectors	Dummy equal to 1 if the firm operates in the auto or auto-component, chemical and pharmaceutical, electronic or metals and machinery industries.
Low-Tech Manufacturing Sectors	Dummy equal to 1 if the firm operates in the beverage, food, garment, leather, non-metallic/plastic materials, paper, other manufacturing, textiles, or in the wood and furniture industries. These definitions follow Parisi et al. (2006).
Low Income Countries	Dummy variable equal to 1 if firm is located in Cambodia or Vietnam
Low-Middle Income Countries	Dummy variable equal to 1 if the firm is located in China, Indonesia, Philippines or Thailand.
Upper-Middle Income Countries	Dummy variable equal to 1 if the firm is located in Malaysia.
Country-Industry Fixed Effects	Dummy variable equal to 1 for each combination of country and 3-digit sector of activity.
Country-Industry-Size Fixed Effects	Dummy variable equal to 1 for each combination of country, 3-digit sector of activity and size category. We consider 5 size categories: micro (1-10 workers), small (10-50 workers), medium (50-100 workers), large (100-250 workers) and very large (>250 workers).

Source: *Enterprise Surveys* (World Bank).

Table A2: Share of High Educated and Skilled Workers, by Country and Sector of Activity

	Manufacturing	Services	Agroindustry	Construction	Other	Total
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Share of High Educated Workers						
Cambodia	10.76	22.64	0.94	4.79	-	16.28
China	20.31	53.20	-	-	-	31.50
Indonesia	47.40	-	64.33	-	-	47.89
Malaysia	17.53	-	-	-	-	17.53
Philippines	27.24	-	-	-	-	27.24
SouthKorea	37.64	45.88	-	62.14	18.89	43.88
Thailand	24.06	-	-	-	-	24.06
Vietnam	11.41	32.00	-	28.33	80.00	14.43
Panel B: Share of Skilled Occupations						
Cambodia	0.166	0.713	0.458	0.353	-	0.572
China	0.342	0.766	-	-	-	0.480
Indonesia	0.201	-	0.115	-	-	0.199
Malaysia	0.239	-	-	-	-	0.239
Philippines	0.258	-	-	-	-	0.258
SouthKorea	0.328	0.378	0.521	-	0.333	0.372
Thailand	0.182	-	-	-	-	0.182
Vietnam	0.217	0.634	0.358	-	1.000	0.274

Source: Author's calculations are based on the *Enterprise Suveys* (World Bank)

Note: Panel A reports the mean of the share of high educated workers (more than the secondary education), by country and sector of activity. Panel B reports the mean share of skilled occupations (management, professionals and nonproduction workers), by country and sector of activity.

Fig 1: Share of High Educated Workers:
Cross-country Correlation by Export Status

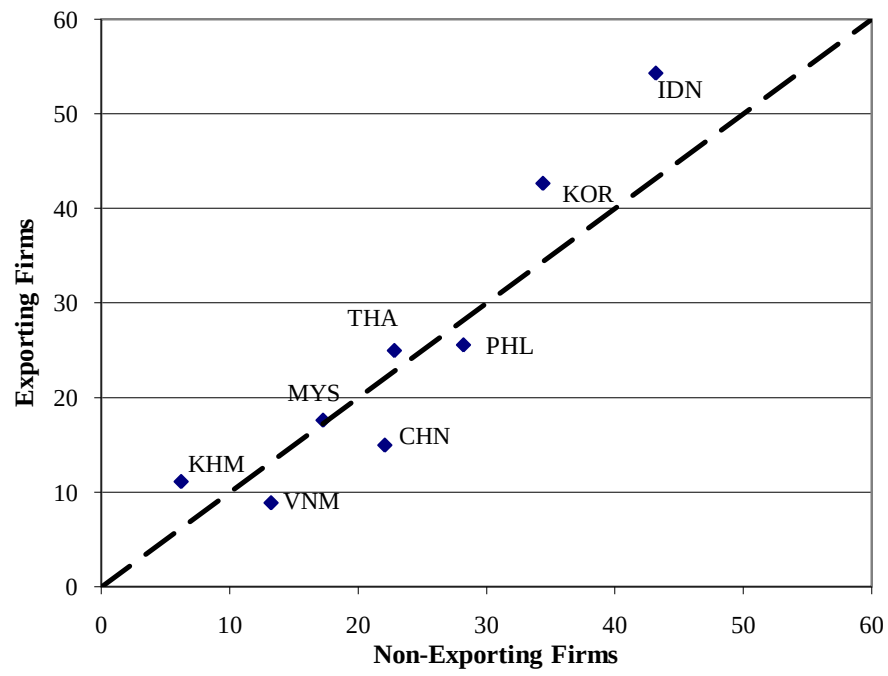

Fig 2: Share of High Educated Workers:
Cross-country Correlation by Foreign Ownership

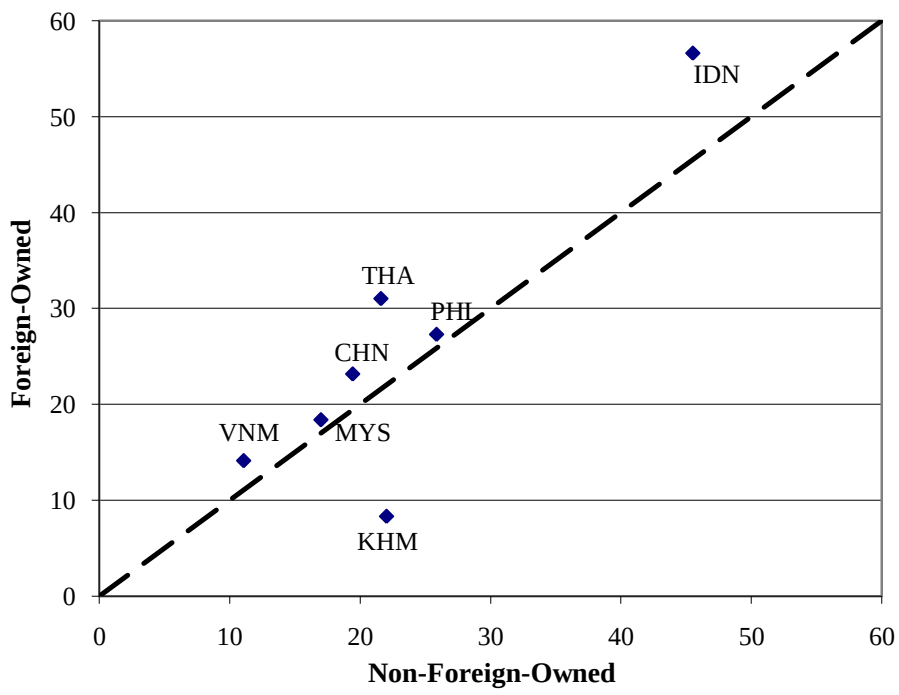

Fig 3: Share of High Educated Workers:
Cross-country Correlation by
Technological Innovation