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Labor market institutions, firm-specific skills, and trade patterns ☆

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ABSTRACT

This paper studies how a country's labor market institutions, by affecting workers' skill acquisition, can shape its export patterns. I develop an open-economy model in which workers undertake non-contractible activities to acquire firm-specific skills on the job. In the model, labor market protection raises workers' incentives to acquire firm-specific skills relative to general skills, turning labor laws into a source of comparative advantage. In particular, the model shows that countries with more protective labor laws export relatively more in firm-specific skill-intensive sectors at both the intensive and extensive margins. To test the theoretical predictions, I construct sector proxies for the firm-specific and industry-specific skill intensity by estimating returns to firm tenure and industry tenure for different U.S. manufacturing sectors during the 1974–1993 period. By estimating sector-level gravity equations for 84 countries using the Helpman–Melitz–Rubinstein (2008) framework, I find evidence supporting the predicted effects of labor market institutions at both margins of exports.

1. Introduction

Recent research in international trade shows that a country's contracting and legal institutions can shape its comparative advantage.[1] Labor market institutions, which vary widely across countries, receive relatively less attention in the literature on international trade patterns. Although there is an extensive strand of research examining how labor market regulations are linked to labor market outcomes, little work has been done to examine their effects on workers' investment decisions. Even less has been written about how such effects can determine a country's comparative advantage.[2]

This paper fills this void by studying how cross-country differences in labor market institutions are related to trade patterns. In particular, I focus on the channel through which labor market institutions affect workers' on-the-job skill acquisition. The idea is that when labor laws are more protective, workers expect a more stable relationship with their employers and obtain higher de facto bargaining power vis-a-vis their employers. Thus, they have more incentives to acquire firm-specific skills relative to general skills on the job. As such, countries with more protective labor laws have a comparative advantage in sectors for which firm-specific skills are more important. I test this hypothesis by estimating the gravity equation at the sector level, and find evidence that countries with more protective labor laws export relatively more in both firm-specific and industry-specific skill-intensive sectors.

A simple model is constructed to highlight how protective labor laws affect workers' on-the-job investment incentives. In the model, each worker is endowed with an exogenous level of general skills, but she needs to undertake non-contractible activities to acquire firm-specific skills on the job. The combination of the non-contractibility and relationship-specificity of investments results in ex-post bargaining over the division of the joint surplus between employers and workers. Workers acquire firm-specific skills in anticipation of payoffs from ex-post bargaining. Since they are not the full residual claimants of the gains from investments, the resulting hold-up would lead to under-investment in skills relative to the first-best level under complete contracting. Despite their well-known

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[1] This literature includes Levchenko (2007), Nunn (2007), and Costinot (2009a), among others. See the literature review below.

[2] This literature includes Saint-Paul (1997), Brügemann (2003), and Cuñat and Melitz (2010b, forthcoming). See the literature review below.

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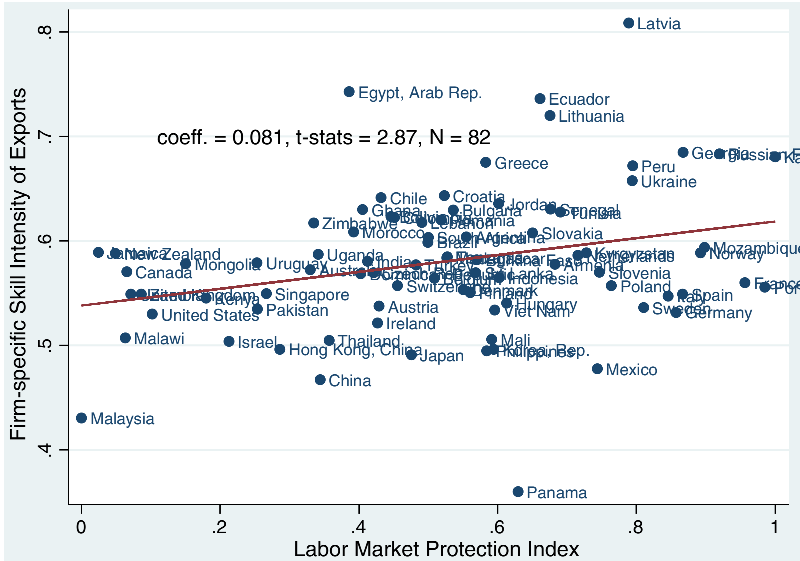

Fig. 1. Countries' firm-specific skill intensity of exports and labor protection (full sample).

inefficiencies, stringent labor laws raise workers' bargaining power and thus increase their incentives to acquire firm-specific skills. These effects are more pronounced in more specific skill-intensive sectors.

By embedding the model in an open-economy framework à la Helpman et al. (2004), I show that all else being equal, when labor laws become more protective, firms in more specific skill-intensive sectors have a relative cost advantage in production. Thus, in countries where labor laws are more protective, both the average volume of a firm's exports (the intensive margin) and the fraction of firms exporting (the extensive margin) are relatively higher in specific skill-intensive sectors.

To test these theoretical predictions, I construct sector proxies for the importance of firm-specific skills in production, following the approach adopted in studies on seniority effects on wages (Altonji and Shakotko, 1987; Topel, 1991; Altonji and Williams, 2005). Although alternative hypotheses can rationalize an upward-sloping wage–tenure profile, such as theories on incentive contracts to elicit workers' efforts (Lazear, 1981), asymmetric information about workers' abilities (Gibbons and Katz, 1991), and wage compression due to labor market frictions (Acemoglu and Pischke, 1999), I adopt the traditional approach and interpret higher returns to firm tenure as an outcome of higher intensity of firm-specific skills in production (Becker, 1964). Specifically, I estimate returns to firm tenure for different industries using the U.S. Panel Study of Income Dynamics (PSID) data for the 1974–1993 period. I use the estimated returns to tenure as sector proxies for the firm-specific skill intensity at the SIC 3-digit level. A common concern is that the estimated firm tenure effects may be industry-specific. Ideally, both industry and firm tenure effects should be estimated simultaneously for each industry. Due to data limitations, however, the industry tenure effects are estimated separately instead of simultaneously in the same wage equation.

I then adopt the Helpman et al. (2008a) two-stage procedure to estimate the gravity equation at the sector level. An interaction term between a country's index of labor protection and a sector proxy for the firm-specific skill intensity is included to identify the differential impacts of labor laws across sectors.[3] The results from the first-stage estimation confirm that countries with more protective labor laws are more likely to export in firm-specific skill-intensive sectors (the extensive margin). When the industry-specific skill interaction term is controlled for, the firm-specific skills become a less important determinant of export participation. The second-stage gravity estimation, after correcting for both the omitted variables and the selection biases in the OLS estimates, shows that firm-specific skills rather than industry-specific skills remain a significant factor shaping trade patterns at the intensive margin. These results are robust to the inclusion of controls for other sources of comparative advantage, such as cross-country differences in factor endowments, income, and contracting institutions. Moreover, an interaction term between a country's labor protection index and a sector measure of volatility is included to control for the previously studied channel through which labor market institutions affect trade patterns. In addition to checking the robustness of my results, I find evidence supporting the existing theoretical predictions. I also discuss how alternative theories about varying estimated tenure effects across sectors may explain my findings.

To preview the empirical findings, in Fig. 1 I plot countries' export specialization in specific skill-intensive sectors against their degree of labor protection.[4] A positive relationship suggests that countries with more protective labor laws have their exports more biased toward specific skill-intensive sectors. The relationship is economically significant. An increase from the 25th to the 75th percentile in the index of labor protection is associated with an increase in specialization in specific skill-intensive sectors by 0.4 standard deviation. Fig. 2 confirms the robustness of this positive association, after partialling out the effects of countries' factor abundance.

1.1. Related literature

This paper relates to several strands of literature. The first focuses on how labor market institutions affect workers' human capital investment decisions (Houseman, 1990; Estevez-Abe et al., 2001; Hassler et al., 2001; Belot et al., 2007). Among the studies on "varieties of capitalism," Estevez-Abe et al. (2001) argue that workers have more incentives to invest in firm- and industry-specific skills, instead of portable general skills, in countries that have more protective labor laws. They conjecture that in developed countries, there may be two equilibria, one characterized by high levels of job turnovers, general skills, and portable assets; and the other characterized by high levels of job tenure, specific skills, and specific assets. Consistent with this conjecture, Wasmer (2006) shows that higher firing costs increase labor market frictions

[3] This literature includes, among others, Romalis (2004), Levchenko (2007), Nunn (2007), and Manova (2008).

[4] A country's export specialization in firm-specific skill intensive sectors is a weighted average of sector measures of specific skill intensity, with weights equal to the respective sector shares in the country's total exports. See Eq. (8) for details.

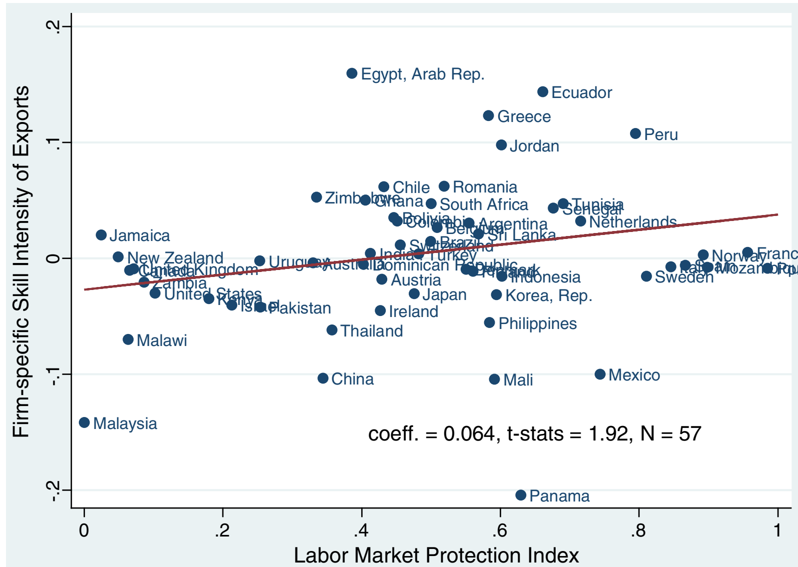

Fig. 2. Countries' firm-specific skill intensity of exports and labor protection (parsing out the effects of factor endowment differences).

and the average duration of a worker–employer relationship, raising the relative returns to specific skills in equilibrium. By emphasizing the same theoretical insight, the current paper highlights how a larger equilibrium stock of specific skills among workers shapes a country's trade patterns. Adding to the existing literature, the current study provides indirect evidence based on trade data that labor market rigidity is associated with more specific skills in a country's labor force.

Second, this paper is motivated by empirical studies that gauge the importance of firm-specific skills in production. Labor economists have found positive and significant firm tenure effects on wages (Kletzer, 1989; Topel, 1991; Jacobson et al., 1993; Buchinsky et al., 2010).[5] To the extent that wages are positively correlated with marginal products of labor, the estimated wage effects of firm tenure can be taken as indirect evidence of the existence of firm-specific skills.[6] Studies in organizational economics consistently find that specialized non-patentable human capital is more important than specialized physical capital in determining vertical integration between upstream and downstream firms (Monteverde and Teece, 1982; Masten et al., 1989).[7] In addition to confirming the firms' provision of incentives for specific-skill acquisition, these studies underscore the non-contractible aspect of firm-specific investments, which is a crucial assumption in my theoretical model.[8]

This paper complements a growing literature studying the interaction between labor market institutions and international trade across countries (Brecher, 1974; Matusz, 1996; Davis, 1998; Davidson et al., 1999; Davidson and Matusz, 2006). In a series of papers, Helpman and Itskhoki (2009, 2010) and Helpman et al. (2008b, 2010) examine theoretically how trade liberalization can have different effects on unemployment and wage inequality in liberalizing countries, depending on labor market rigidity. This paper also adds to the literature that examines labor market institutions as a source of comparative advantage. In that literature, Saint-Paul (1997), Brügemann (2003), and Cuñat and Melitz (forthcoming) consider a world where sectors differ in the degree of sales uncertainty, which can arise due to either demand or supply shocks. Common in these studies is the comparative advantage from the interplay between different labor reallocation costs across countries and varying needs for factor reallocation across sectors. In contrast, I focus instead on a country's endogenous comparative advantage stemming from workers' skill acquisition in response to the labor market institutions.

Finally, this paper contributes to the literature on contracting institutions as a source of comparative advantage. Levchenko (2007), Nunn (2007), and Costinot (2009a), among others, show both theoretically and empirically that countries with better contracting institutions or a better legal environment specialize in sectors in which production relies more on contract enforcement (such as sectors involving more complex production technology or relationship-specific investments by suppliers). This paper shows empirically the effects of labor market institutions on trade patterns. In addition, it highlights their effects on the extensive margin of trade. On the theoretical front, similar to Antràs (2003; 2005), Antràs and Helpman (2004), and Acemoglu et al. (2007), this paper applies the property-rights theoretical approach to study international trade.

The paper is organized as follows. Section 2 develops the theoretical framework. Section 3 discusses the econometric specifications for the regression analysis. Section 4 describes the data source, in particular, construction of the sector proxies for firm-specific skill intensity. Section 5 presents the empirical results. The last section concludes.

2. Theoretical framework

In this section, I briefly discuss a theoretical model that captures how a country's labor market institutions affect workers' skill acquisition, and therefore firm revenue, profit, and export participation. I

[5] Studies of layoffs through no fault of their own (for example, plant closings) show that laid-off employees typically earn 15 to 25% less on their next jobs. See Kletzer (1998) for a review of this literature. Although the economic significance of firm-specific skills in determining wage growth is still subject to debate, a recent paper by Buchinsky et al. (2010), by employing Markov Chain Monte Carlo methods to account for workers' mobility decisions, finds that returns to job seniority in the U.S. are higher than those to general work experience, even higher than that previously estimated by Topel (1991).

[6] Importantly, these results are not specific to the flexible U.S. labor market. For instance, Dustmann and Meghir (2005) find that the returns to sector tenure in Germany are almost zero, whereas the returns to firm tenure are substantial, especially for the unskilled. This finding is consistent with the story that workers acquire more specific skills in protective labor markets.

[7] In particular, they find that in the automobile industry, instead of vertical integration, a "quasi-integrated" organizational form with specialized tools owned by the owner and leased to the contractor is common among parts production firms.

[8] Malcomson (1997) summarizes the literature on the hold-up problem of human capital investment.

focus on the main theoretical insights and derivation of the empirical specifications, leaving most details to the Web appendix.[9]

Consider an economy with multiple sectors and labor as the only factor of production. The economy is inhabited by risk-neutral consumers/workers who supply labor inelastically. Each worker is endowed with an exogenous level of general skills.

Workers derive utility from consumption and disutility from skill acquisition. Utility from consumption takes the standard constant-elasticity of substitution (CES) aggregate over horizontally-differentiated varieties. Monopolistically competitive goods markets imply that each firm producing a variety faces a residual demand equal to $c = Dp^{-\sigma}$, where p is the variety's price; D is the demand factor for the sector, taken as given by each firm; and σ is the elasticity of substitution between varieties within a sector.

Each worker must exert effort to acquire skills. The cost of skill acquisition is measured in units of the homogeneous good, the numeraire in the model. Given the ideal price index P of consumption and income w, a worker's indirect utility is expressed as $U = \frac{w - \kappa e}{P}$, where e is the level of effort, and κ/P is the marginal disutility of effort.[10]

2.1. Production technology, incomplete contracts, and bargaining

Production requires both general and firm-specific skills. For simplicity, the model does not consider industry-specific skills. In the regression analysis below, the industry specificity of skills is controlled for separately. A firm's labor productivity is denoted by $f(a)$, which takes the following form:

$$f(a) = a^{\lambda}\bar{h}^{(1-\lambda)}, \tag{1}$$

where $\bar{h}$ is the fixed level of general skills acquired by the workers before matching up with a firm; a is the *average* level of workers' firm-specific skills acquired on the job. $\lambda \in (0,1)$ is identical for all firms within a sector, but it varies across sectors. A sector with a higher λ is considered more firm-specific skill-intensive.

In the model, workers invest in firm-specific skills on the job after receiving some up-front payments from the employer. In practice, investments in firm-specific skills are difficult if not impossible to specify in contracts. For simplicity, the model assumes that these investments are fully non-contractible.[11] Whereas the degree of contract incompleteness is assumed to be identical in all sectors, it will be carefully controlled for in the empirical analysis below.

In the Web appendix, I describe the detailed timing of events. Crucially, under incomplete contracting, the employer cannot specify the optimal level of investment by the workers. She expects to bargain with the workers over the division of the firm surplus after the workers acquire firm-specific skills. I adopt a Generalized Nash Bargaining framework between the representative worker (e.g., a union leader) and the employer, with the workers' primitive bargaining power equal to $\varphi \in (0,1)$.[12] I follow Blanchard and Giavazzi (2003) and Spector (2004) and use φ, admittedly in an abstract fashion, to represent the degree of labor protection in a country.[13] To the extent that more protective labor laws grant workers more bargaining power over the firm's surplus, φ increases in the degree of labor market protection (regulation). For examples, φ can capture the degree of extension agreements, closed-shop arrangements, or rules on the right to strike (Blanchard and Giavazzi, 2003). The bargaining power of workers is assumed to be the same across sectors and firms. Workers thus acquire firm-specific skill ex ante, anticipating a constant share of the joint surplus. When workers are the only party investing in human capital, the model predicts that their anticipation of higher payoffs from ex-post bargaining encourages more firm-specific skill acquisition ex ante.

Note that using φ to capture the degree of labor market protection is a short-cut to formalize how labor market institutions affect workers' skill acquisition and thus firm productivity. Alternatively, a higher φ can be perceived of as a higher expected return to investment due to a more stable worker–employer relationship that endogenously arises in a more protective (rigid) labor market. This in turn provides more incentives for workers to acquire relationship-specific skills and for the firm to provide training. Whereas the theoretical model focuses on workers' incentives, the empirical analysis does not identify whether the specialization pattern arises from investments by the workers or by the firm.

As the Web appendix shows, this simple model delivers a positive relation between the slope of wage growth and the degree of firm-specific skill intensity of the sector. The idea is that when the elasticity of firm revenue is increasing in λ, the ratio of the ex post payoffs to ex ante payments to workers (required to make the workers indifferent to joining any sector) is increasing in λ as well. This result provides some theoretical foundation for using estimated returns to firm tenure as proxies for the sector's firm-specific skill intensity.

Similar to Costinot (2009b), my model shows that firm labor productivity is log-supermodular in the sense that the positive effect of granting workers bargaining power is larger for firm-specific skill-intensive sectors, mitigating the potential costs of employment protection. This insight is consistent with Roberts and Van den Steen (2000), who postulate that it is optimal for an employer to grant employees a larger share of equity or more control rights when non-contractible human-capital is more important for production.

By using the solutions to the employer's and the employees' problems, a firm's labor productivity can be expressed in terms of φ and λ. Denote the endogenous productivity by $f^*(\varphi,\lambda)$, and consider two countries, i and k, which are identical in all respects, except that i has a more protective labor market, i.e., $\varphi_i > \varphi_k$. To show the differential impact of labor protection across sectors, consider the ratio of firm labor productivity between the two countries in a given sector:

$$\frac{f^*(\varphi_i,\lambda)}{f^*(\varphi_k,\lambda)} = \left(\frac{\varphi_i}{\varphi_k}\right)^{\frac{\lambda}{1-\lambda\eta}}.$$

This ratio is increasing in λ as long as $\varphi_i > \varphi_k$. Through endogenous workers' skill acquisition, the model delivers an upward-sloping technology schedule (in λ) that captures the comparative advantage between the two countries. This schedule resonates with the exogenous technology schedule in Dornbusch et al. (1977) trade model with a continuum of industries.

The model can be generalized to consider industry-specific skills, but it is abstracted away from such consideration for simplicity. The general idea is that if the outside option includes job opportunities in other industries, higher worker bargaining power or a more stable employer–employee relationship would induce workers to invest more in industry-specific skills. Because of its relatively straightforward intuition, I choose not to extend the model further.

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[9] http://www.hwtang.com/research.html.

[10] The assumption that the disutility of effort is measured in the same units as nominal wages is implicitly made in the efficiency wage model of Shapiro and Stiglitz (1984), and more recently by Davis and Harrigan (2011).

[11] Contract incompleteness of human capital investments has been used to explain firm-provided training (Balmaceda, 2005; Casas-Arce, 2006). I regard the assumption of contract incompleteness as a fact of life, and do not complicate the model by discussing its underpinnings.

[12] This assumption can be rationalized by real-world bargaining situations between the employer and union representative, who represents the common interests of the union members. Allowing decentralized bargaining between a single worker and her employer would substantially complicate the model. Along these lines, Acemoglu et al. (2007) and Helpman and Itskhoki (2010) employ the Shapley value concept to solve the workers' bargaining power in an incomplete-contract setting. They show that workers' bargaining power is higher in sectors with lower elasticities of substitution between varieties.

[13] See also Griffith et al. (2007).

It is worth reiterating that the goal of the paper is to show labor market institutions as a source of comparative advantage. In other words, if stringent labor laws distort incentives and lower firm productivity, the detrimental effect is alleviated in more specific skill-intensive sectors. The paper provides no normative implications about whether labor market protection can enhance welfare.[14]

2.2. The multi-country environment

In the Web appendix, by embedding the above closed-economy model in a multi-country open-economy framework à la Helpman et al. (2004) (HMY hereafter), I can derive the main empirical specifications. Here I focus on the parts of the model that are highly relevant for deriving the empirical specifications.

Consider a world economy with multiple countries trading with each other (country i exports to country j). There are sector-specific "iceberg" transport costs (τ_{ijs}) and fixed export costs (f_{ijs}). As in HMY, firms in different sectors draw productivity ε from a common Pareto distribution over bounded support $[1, \varepsilon_H]$, with the cumulative distribution function of ε equal to $Pr(\varepsilon < \varepsilon') = G(\varepsilon) = (1-\varepsilon^{-\xi})/(1-\varepsilon_H^{-\xi})$, where ξ measures the dispersion of ε's across firms. In the presence of firm heterogeneity and fixed export costs as in Melitz (2003), only the most productive firms export. Using the firm's zero-profit condition, I can pin down the productivity threshold for exports (above which a firm would export) from country i to country j in sector s as follows:

$$\varepsilon^*_{ijs} = \frac{\Psi_{is}\tau_{ijs}}{P_{js}}\left(\frac{b_s Y_j}{f_{ijs}}\right)^{\frac{1}{1-\sigma}}, \tag{2}$$

where P_{js} is the price index of good s in the destination country j, and Y_j is j's income. b_s is a sector-specific constant. Importantly, Ψ_{is} is composed of parameters that represent country i's labor market protection and the sector's dependence on firm-specific skills.[15] Comparative statics deliver the following testable proposition.

2.2.1. Prediction 1 (extensive margin of trade)

Among a country's trade partners, those with more protective labor laws are more likely to export in firm-specific skill-intensive sectors.

Proof. See the Web appendix. □

Solving the theoretical model yields a gravity-type trade-flow equation, which depends on the degree of labor protection of the exporting country among the traditional determinants of trade flows (see the Web appendix for details). Specifically, by aggregating exports across all firms to the sector level, we obtain the volume of exports from i to j in sector s as

$$X_{ijs} = b_s N_{is} Y_j \left(\frac{\Theta_{is}\tau_{ijs}}{\eta P_{js}}\right)^{1-\sigma} W_{ijs}, \tag{3}$$

where Θ_{is} is a term composed of parameters that represent country i's labor market protection and the sector's dependence on firm-specific skills.[16] N_{is} is the number of firms (including non-exporters) in sector s and country i. As in Helpman et al. (2008a), the term capturing the extensive margin of trade is

$$W_{ijs} = max\left\{\left(\frac{\varepsilon_H}{\varepsilon^*_{ijs}}\right)^{\xi-(\sigma-1)} - 1, 0\right\}. \tag{4}$$

In sum, labor protection (a higher φ_i) affects the sectoral volume of exports at both the intensive margin and the extensive margin. Higher firm productivity due to more specific skills directly increases the volume of firm and sectoral exports (the intensive margin). For the same reason, a higher φ_i implies a larger fraction of firms exporting. Since both margins imply a greater export volume, the combined effect of labor laws on trade flows can be summarized by the following proposition.

2.2.2. Prediction 2 (intensive margin of trade)

Among a country's trade partners, those with more protective labor laws export relatively more in firm-specific skill-intensive sectors.

Proof. See the Web appendix. □

3. Econometric specifications

In the remainder of the paper, I provide empirical evidence to examine Predictions 1 and 2. To this end, I follow Manova (2011) to implement the two-stage procedure proposed by Helpman et al. (2008a) (HMR hereafter) to estimate the gravity equation at the sector level. The first stage of the estimation is a selection equation, based on the solution of ε^*_{ijs} in Eq. (2), whereas the second stage is a bilateral trade flow equation, based on the solution of X_{ijs} in Eqs. (3) and (4).

3.1. Empirical specification for the two-stage estimation

As HMR show, there are two potential biases in the OLS estimates of the gravity equation. The first is the Heckman (1979) sample selection bias. My sample shows that about half of the countries did not trade with each other in 1995.[17] At the sector level, about 88% of the potential trade relationships are zeros. This non-random selection induces a positive correlation between the unobserved and the observed trade frictions.[18] Hence, excluding the out-of-sample zeros from the regression induces a downward bias in the estimates. To correct for the selection bias, I include the inverse Mills' ratio in the second-stage equation, as proposed by Heckman (1979).

I take log of Eq. (3), assuming stochastic fixed and variable trade costs (see the Web appendix for details) and derive the main empirical specification as follows:

$$\begin{aligned}\ln X_{ijs} = {} & \alpha + \beta Labor_i \times FSpec_s + \vartheta \ln D_{ij} + \delta_n \ln N_{is} + \delta_p \ln P_{js} + \omega_{ijs} \\ & + \left(F_s + F_i + F_j\right) + u_{ijs},\end{aligned} \tag{5}$$

where the explanatory variable of interest, $Labor_i \times FSpec_s$, is an interaction between exporting country i's degree of labor protection and sector s's firm-specific skill intensity. Together with the country fixed effect, F_i, $Labor_i \times FSpec_s$ captures $\ln \Theta_{is}$. According to Prediction 2, $\beta > 0$. $\alpha = (\sigma-1)\ln\eta$ is a constant. u_{ijs} is an error term, which is assumed to be orthogonal to the regressors. Together with u_{ijs}, $\ln D_{ij}$, the (log) bilateral distance, captures

[14] For a welfare analysis of countries under different labor laws, see Nickell (1997).

[15] $\Psi_{is} = (1-\eta)^{\frac{1}{1-\sigma}}\left(\frac{1}{1-\lambda_s}\right)^{1-\lambda_s}\left(\frac{1-\varphi_i\lambda_s\eta}{1-\lambda_s\eta}\right)^{\frac{\sigma}{1-\sigma}+\lambda_s}\left(\frac{1}{\varphi_i\lambda_s}\right)^{\lambda_s}$.

[16] $\Theta_{is}(\varphi,\lambda) = \left(\frac{1}{1-\lambda_s}\frac{1-\lambda_s\eta}{1-\varphi_i\lambda_s\eta}\right)^{1-\lambda_s}\left(\frac{1}{\varphi_i\lambda_s}\right)^{\lambda_s}$.

[17] This means that country i does not export to country j, or vice versa. The number is very close to Helpman et al. (2008a).

[18] With only positive trade flows included in the sample, countries with high observed trade costs (e.g., a long distance between a pair of trading countries) are likely to have low unobserved trade frictions.

$\ln\tau_{ijs}$. $F_s=\ln b_s+\ln\tilde{\lambda}$ is a sector fixed effect. $F_j=\ln Y_j$ is an importing country fixed effect. Furthermore, according to Eq. (3), the empirical specification should include $\ln N_{is}$ and $\ln P_{js}$.

Importantly, HMR posit that in the presence of firm heterogeneity, omitting the firm self-selection term W_{ijs} as a control may lead to an overestimation of the gravity equation using OLS. To correct for this, $\omega_{ijs}=\ln W_{ijs}$ is included to capture the extensive margin of trade and the composition of the exporting firms.[19] To estimate ω_{ijs}, I use the predicted probabilities of exporting from estimating the first-stage equation, as is discussed below.

3.1.1. Firm selection into exporting (derivation of the first-stage estimation)

To empirically examine the extensive margin of trade according to Eq. (2), I derive the econometric specification for the first-stage regression as follows (see Web appendix C for details):

$$\begin{aligned}\rho_{ijs} &= Pr\left(I_{ijs}=1\middle|\text{observed variables}\right)\\ &= \Phi\left(\alpha^*+\beta^* Labor_i\times Spec_s+\vartheta^*\ln D_{ij}+\delta_p^*\ln P_{js}+\phi^*\psi_{ij}+\left(F_s^*+F_i^*+F_j^*\right)\right), \end{aligned} \quad (6)$$

where I_{ijs} is an indicator variable, which equals 1 if trade flows are observed from i to j in sector s, and 0 otherwise; $\Phi(.)$ is the c.d.f. of a unit-normal distribution; ψ_{ij} is the observed fixed trade costs that affect the likelihood of export participation, but not the volume of trade. I estimate this selection equation using a Probit model. The Probit estimation serves two purposes. It provides evidence, if any, of the extensive margin of trade. It also provides the predicted probabilities of exporting at the sector level $\hat{\rho}'_{ijs}s$, which allow me to estimate $\omega_{ijs}=\ln W_{ijs}$. See the Web appendix for a detailed discussion on the construction of ω_{ijs}.

4. Data

4.1. Sector proxies for firm-specific skill intensity

To examine the theoretical predictions, I construct sector proxies for firm-specific skill intensity, which to my knowledge have not been estimated before. To this end, I follow the labor economics literature on tenure effects on wages (Altonji and Shakotko, 1987; Topel, 1991; Altonji and Williams, 2005; Kambourov and Manovskii, 2009) and use the estimated returns to firm tenure to gauge the importance of firm-specific skills.

A number of alternative theories have been postulated to explain an upward-sloping wage-tenure profile, including theories on incentive contracts to elicit workers' effort (e.g., Lazear, 1981), asymmetric information about workers' abilities (e.g., Gibbons and Katz, 1991), and wage compression due to labor market frictions (e.g., Acemoglu and Pischke, 1999), among others. When using the estimated returns to firm tenure as proxies for firm-specific skills, I essentially adopt the traditional theory that proposes a worker's firm-specific skills can raise her labor income significantly. Below I will discuss how the results can be partially but not entirely explained by alternative theories.

To obtain sector proxies for the firm-specific skill intensity, I estimate the Mincer wage equation by including additionally a worker's job tenure with her current firm (and its squared). To allow the estimated returns to firm tenure to vary across sectors, I interact a worker's job tenure with the sector dummy in which she is currently employed. The theory on firm-specific human capital postulates a higher coefficient on the interaction for a sector in which firm-specific skills are more important to production.

Formally, the regression specification for constructing the sector proxies takes the following form:

$$\begin{aligned}\ln w_{kmst} &= \textstyle\sum_s Sec_s\left[\beta_{1s}Firm\_Ten_{kmt}+\beta_{2s}(Firm\_Ten_{kmt})^2\right]\\ &\quad+\textstyle\sum_s Sec_s\left[\gamma_{1s}Work\_Exp_{kt}+\gamma_{2s}(Work\_Exp_{kt})^2\right]+Cont_{kmt}+\Gamma_{kmst}+\varepsilon_{kmst}.\end{aligned} \quad (7)$$

where k, m, s, and t stand for person, employer, sector, and year, respectively; w_{kmst} denotes the real wage rate; Sec_s is a dummy for sector s; and $Firm\_Ten_{kmt}$ is the worker's self-reported tenure with the current firm. I also control for the worker's overall work experience, $Work\_Exp_{kt}$, (and its squared) to partial out the effects of general (transferable) skills on wages. Note that $Work\_Exp_{it}$ and its squared are also interacted with the sector dummy, allowing the impact of work experience to vary across sectors.

Using the estimated coefficients on $Firm\_Ten_{kmt}$ and its squared term (β_{1s},β_{2s}), I construct the sector proxies for firm-specific skill intensity as follows:

$$FSpec_s^T=\hat{\beta}_{1s}\times T+\hat{\beta}_{2s}\times T^2,$$

where $FSpec_s^T$ is the predicted return to T years of firm tenure (up to a squared term). I choose $T=5$ as the baseline to construct my sector proxies for specific-skill intensity.[20]

To account for the unexplained match-specific productivity that would affect the probability of continuing a firm–worker relationship, I include $Cont_{kmt}$, a dummy variable that equals 1 if the worker's firm tenure exceeds one year. As in most wage equations, a set of controls (Γ_{kmst}) is included in the regression: education (and its squared), a dummy for union membership, as well as sector, occupation (at the 1-digit level), state, and year fixed effects.

Data on wages, employees' tenure, and other characteristics are taken from the Panel Study of Income Dynamics (PSID) dataset for 20 waves over 1974–1993. I use the U.S. as the reference country for two reasons. First, it is the only dataset that I am aware of that is publicly available for estimating the tenure effects across a large number of sectors. Second, according to the model, the flexible labor market in the U.S. implies lower investments in firm-specific skills across sectors, compared to countries with more protective labor laws. To the extent that different tenure effects are observed across sectors in the U.S., we can expect even more pronounced differences across sectors in more protective labor markets. The bottom line is that as long as the ranking of these estimates is stable across countries, my main results remain qualitatively robust.[21]

A common concern is whether $FSpec$ captures something other than firm-specific skills. In particular, industry tenure is not included in the specification. Ideally, industry and firm tenure effects should be

[19] As shown in Eq. (2), ω_{ijs} is expressed as a function of the exporting productivity threshold ε^*_{ijs} which according to the model, is an increasing function in fixed exporting costs f_{ij}. Thus, a lower sectoral export volume can be due to a lower export volume per firm, or to fewer exporting firms, or both. Explicitly controlling for ω_{ijs} in Eq. (5) ensures that u_{ijs} comes entirely from the unobserved part of the variable trade costs. Second, ω_{ijs} summarizes the composition of exporting firms to country j, which affects the magnitude of the estimated elasticity of trade flows with respect to trade frictions and exporters' labor protection. These two features of ω_{ijs} suggest that including ω_{ijs} is essential to obtain consistent estimates of the effects of institutions on trade flows.

[20] It is worth noting that the estimated $\hat{\beta}_{2s}$'s are small, and the bilateral correlation between any two $FSpec_s^T$, $\forall\ T\in[1,10]$, is consistently higher than 95%. Importantly, the empirical results are robust to using $FSpec_s^T$ estimated over different time horizons.

[21] Using sector measures from a benchmark country (e.g., the U.S.) in cross-country regressions originates with Rajan and Zingales (1998). Subsequent empirical studies on comparative advantage, such as Romalis (2004), Levchenko (2007), Nunn (2007), and Manova (2011), adopt the same approach. Recently, Ciccone and Papaioannou (2011) show theoretically that the estimates on the interaction terms using sector measures from a benchmark country can be subject to either attenuation biases or amplification biases whenever the benchmark measures differ from the "true" measures. They show that amplification biases are more likely to dominate if a country's unobserved sector characteristics are more highly correlated with those in the benchmark country.

estimated simultaneously for each industry. However, there are not enough job switches that also involve industry switches to permit a precise estimation of both effects.[22] Instead, I tackle the potential omitted variables problem by always including an interaction term between the worker's overall work experience and the sector dummy in the wage equation. To the extent that a worker's general experience is highly correlated with industry tenure, estimates of firm-tenure premium are arguably close to the actual premium. To check the robustness of the results, I estimate the industry tenure effects for each sector by replacing firm tenure with industry tenure in Eq. (7). I then include an interaction term between the estimated industry tenure effects and the exporting country's measure of labor market protection as an additional control to estimate Eqs. (5) and (6). Admittedly, this inability to estimate both firm and industry tenure simultaneously is a drawback.

Following the literature on the effects of seniority on wages, I use a PSID sample that includes males who are heads of households, between the ages of 21 and 60 (inclusive), and who worked for at least 500 h during a year, and earned real hourly wages of at least \$2 (in 1990 dollars). Only manufacturing sectors are used so as to be consistent with the manufacturing trade data.[23] Although tenure effects can be estimated for all sectors, I discard estimates for those sectors that have fewer than 70 observations.[24] Using this cutoff, I obtain a list of 36 3-digit PSID-classified sector measures of firm-specific skill intensities (out of a total of 76 sectors).[25]

Table A1 in the appendix lists the estimates of 5-year returns to tenure in 36 sectors, as well as the corresponding t statistics: 32 of the estimates are significantly different from 0 at the 5% significance level.[26] The top three specific skill-intensive sectors are Petroleum Refining (291), Cement, Concrete, Gypsum, and Plaster Products (324, 327), and Miscellaneous Paper and Pulp Products (329). For example, a worker who stays in the same firm for five years in the "Cement, Concrete, Gypsum, and Plastic Products" sector would experience approximately an average 22% real wage growth due to her 5-year tenure with the same employer. Since petroleum companies in many countries are often state-owned, their exports are determined for strategic reasons by the government rather than comparative advantage. I will perform a battery of sensitivity analyses to ensure that the main results are robust to the exclusion of the oil sector as well as to the exclusion of the sectors for which firm tenure effects are imprecisely estimated. The bottom three specific skill-intensive sectors are Miscellaneous Plastic products (307), Glass and Glass Products (321–323), and Radio, TV, and Communication Equipment (365, 366).[27] All estimates are then normalized to range between 0 and 1 before being used in the empirical analysis. Table A1 also reports the estimated industry-tenure wage effects, which are added as a control in the gravity estimation.

There may be concerns about the validity of the findings, which are based on a dataset with about half of the sectors dropped due to data limitation. It turns out that the sectors included in the sample accounted for about 60% of global manufacturing trade flows in 1995, for both my sample (84 countries) and the sample that included all countries with trade data (184 countries). Of the top 20 sectors in global exports, five do not have sufficient observations for an estimation of the firm tenure effects.[28] These five sectors together contributed about 10% of global exports in 1995.

4.2. Other country-level and sector-level data

Industry-level data on bilateral exports in 1995 are adopted from the World Trade Flows Dataset (Feenstra, 2000). I chose this year due to its proximity to the year for which labor regulation indices and other country-level data are available. The main regression results remain significant when data from other years are used.[29] A sector is defined as an SIC87 3-digit category. Since Feenstra's trade data are classified under the SITC (rev.2) system, I first map each SITC (4-digit) code into a unique SIC code using the concordance file on Feenstra's Website.[30] The original SIC87 3-digit classification has 140 sectors. Using the concordance file on Feenstra's Website, 118 sectors suffice to cover all observations in the trade dataset. The availability of specific skill-intensity proxies further reduces the number of SIC sectors in the sample from 118 to 62. For other sector-level data under other classifications, I use publicly available concordance files to convert the industry codes into the SIC codes. The sources of the concordance files and the mapping algorithms are presented in the Web appendix.

Data on labor regulations in 84 countries are taken from Botero et al. (2004).[31] Based on the countries' legal documents from the late 1990s, the authors codify the degree of labor market regulations on employment, collective relations, and social security on a 0–1 scale. Using principal component analysis, I compute the weighted average of the two main indices from their paper — the "Employment Laws" index and the "Collective Relations" index. The "Employment Laws" index represents costs associated with firing and employment contract adjustments. Specifically, it is an unweighted average of four sub-indices: (i) alternative employment contracts, (ii) costs of increasing hours worked, (iii) cost of firing workers, and (iv) dismissal procedures. The "Collective Relations" index is an unweighted average of two subindices: (i) labor union power and (ii) collective disputes. A higher index implies more stringent labor laws. Table A2 in the appendix lists the sample countries' labor protection indices. The two countries with the most protective labor laws (according to the average of the two indices) are Kazakhstan (1.000) and Portugal (0.985), whereas the two countries with the most flexible labor regulations are Nigeria (0.023) and Malaysia (0.000). To estimate the gravity equation, I obtain the bilateral "trade cost" variables from various sources. See the Web appendix for details.

The final sample contains 84 countries and 62 SIC 3-digit sectors, which captures about 58% of global manufacturing exports in 1995, including the out-of-sample countries and sectors.

[22] Specifically, out of 5669 job switches and starters in my PSID sample, only 875 involve an industry switch.

[23] I use the variable-construction procedure proposed by Kambourov and Manovskii (2009) to improve the data quality. In particular, the procedure insures that an individual's self-reported tenure and experience are consistent across years (see the Web appendix).

[24] The results are insensitive to small adjustments to this minimum observation requirement. I decreased the requirement to 60 but the results were unchanged. However, once I decrease this requirement significantly, say below 50, the main results are dominated by a few outliers of the estimated tenure, determined by a few individuals in the occupation.

[25] Under the original census classification, the PSID dataset contains data for 81 (3-digit) census manufacturing sectors. However, five have no mapping to SIC codes, such as "Not specified electrical machinery, equipment, and supplies."

[26] Estimates that are not significantly different from 0 are very close to 0. I am aware that estimates of two consecutive sectors in the ranking may not be significantly different from each other. However, existing measures on contract dependence, for example, are estimated using the averaging approach and may have the same problem.

[27] Notice that the estimated firm tenure effects for four sectors are negative. Two possible reasons can explain these negative tenure effects. First, controlling for an individual's work experience, the partial effect of firm-specific skills could be negative in sectors where general skills account for a substantial part of the real wage growth. Second, if inflation exceeds nominal wage growth, the average real wage growth can be negative.

[28] These are industrial organic chemicals (SIC = 286, Rank = 5); plastics materials and synthetics (282; 7); general industrial machinery (356; 9); nonferrous rolling and drawing (335; 16); primary nonferrous metals (333; 19).

[29] Results are available upon request.

[30] Concordance file: http://cid.econ.ucdavis.edu/usixd/wp5515d.html. Since there are more SITC categories than SIC categories, I allow multiple mapping from SITC to SIC, but not vice versa. For SIC codes that have multiple SITC codes, I aggregate the export values across the SITC codes within the same SIC category.

[31] The Botero et al. (2004) dataset contains 85 countries. Here, I do not include Taiwan because trade cost data for Taiwan are unavailable.

5. Results

5.1. Cross-country correlation between labor protection and specialization patterns

Before examining the effects of labor laws on export patterns based on the framework developed in Section 3, I present reduced-form cross-country evidence to verify whether exports of countries with protective labor laws are biased toward more specific skill-intensive sectors. To this end, I construct country i's proxy for the firm-specific skill intensity of exports, $XSpec_i$, as follows:

$$XSpec_i = \sum_s \left(\frac{X_{is}}{X_i}\right) FSpec_s, \tag{8}$$

where i and s stand for the exporting country and sector, respectively, X_{is} is the value of i's exports (in U.S. 2000 dollars) to the rest of the world in s, X_i is i's total exports, and $Spec_s$ is the measure of firm-specific skill intensity for sector s, an estimate from estimating Eq. (7).

The model predicts a positive relation between $XSpec_i$ and the workers' bargaining power in country i. Fig. 1 suggests a strongly positive correlation between $XSpec_i$ and the countries' degree of labor market protection for the sample countries in 1995. Note that both developed and developing countries are well represented at both ends of the distribution of the labor protection indices. The strong positive correlation is robust to controlling for the exporting country's factor abundance (capital, human capital, and natural resources) (see Fig. 2).

These plots mask important cross-country heterogeneity. To provide more systematic evidence, I estimate the following equation:

$$\ln X_{is} = F_i + F_s + \beta Labor_i \times FSpec_s + \mathbf{Z}_i \mathbf{h}_s \gamma + e_{is}, \tag{9}$$

where i and s stand for country and sector, respectively; $\ln X_{is}$ is (log) country i's exports in sector s to the rest of the world; $Labor_i \times FSpec_s$ is an interaction between i's index of labor protection and s's firm-specific skill intensity; $\mathbf{Z}_i$ is a vector of country characteristics, such as physical and human capital endowments; and $\mathbf{h}_s$ is a vector of sector characteristics, such as physical and human capital intensities. The interaction terms $\mathbf{Z}_i\mathbf{h}$ are included to control for country characteristics other than labor market institutions that affect their comparative advantages; e_{is} is the error term; F_i and F_s are country and sector fixed effects. The functional form of the specification is identical to the baseline specification in Nunn (2007).

Table 1 presents the results from estimating Eq. (9). Standardized beta coefficients are reported. Without controlling for other sources of comparative advantage, column (1) shows that countries with more protective labor laws export relatively more (to the rest of the world) in specific skill-intensive sectors. The coefficient on $Labor_i \times FSpec_s$ is positive and significant at the 1% level. Specifically, one standard deviation increase in $Labor_i \times FSpec_s$ is associated with a 0.09 standard-deviation increase in $\ln X_{is}$. In columns (2) to (3), I control for the Heckscher–Ohlin determinants of comparative advantage by including the interaction terms between a country's factor endowment and a sector's factor intensity. The magnitude of the coefficient on $Labor_i \times FSpec$ drops to 0.06; its statistical significance declines to about 5%. Note that

Table 1
Exports to the rest of the world. This table examines the effects of labor protection on exports to the rest of the world across sectors, using regression specification (9).

Dependent variable: (ln) exports from i to the rest of the world by sector: $\ln(X_{is})$						
	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All				Exclude oil exporters	Exclude oil sector (SIC = 291)
Panel A: OLS estimation						
Labor × Firm spec.	0.086**	0.057†	0.058†	0.107**	0.112**	0.084*
	(2.70)	(1.68)	(1.68)	(2.76)	(2.89)	(2.01)
ln(K/L) × Capital intensity		−0.043	−0.013	0.161	0.190	0.241
		(−0.30)	(−0.09)	(1.10)	(1.28)	(1.63)
ln(H/L) × Skill intensity		0.392**	0.314**	0.320**	0.324**	0.361**
		(7.77)	(5.52)	(5.66)	(5.64)	(6.21)
ln(Resource/L) × Mat. intensity		0.575**	0.630**	0.541**	0.443**	0.650**
		(4.24)	(4.42)	(3.84)	(3.16)	(4.27)
Ln(RGDP) × Value added			−0.049	−0.113	−0.165	−0.238
			(−0.32)	(−0.75)	(−1.07)	(−1.56)
Judicial × Contract dep.			0.415**	0.339**	0.365**	0.353**
			(3.82)	(3.10)	(3.25)	(3.23)
ln(K/L) × Firm-spec.				−1.136**	−1.255**	−0.987*
				(−2.74)	(−2.97)	(−2.32)
ln(H/L) × Firm-spec.				−0.012	−0.010	−0.011
				(−0.14)	(−0.11)	(−0.11)
ln(Resource/L) × Firm-spec.				0.336**	0.327**	0.345**
				(2.99)	(2.72)	(3.12)
Ln(RGDP) × Firm-spec.				0.655	0.796†	0.524
				(1.47)	(1.70)	(1.15)
Judicial × Firm-spec.				−0.092	−0.080	−0.045
				(−1.03)	(−0.83)	(−0.49)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sector fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Num. of observations	4153	3009	2966	2966	2895	2917
Num. of countries	84	60	56	56	54	56
Num. of SIC sectors	62	62	62	62	62	61
R2	0.759	0.773	0.779	0.782	0.783	0.783
Panel B: 2SLS estimation						
Labor × Spec.	0.162**	0.118*	0.108*	0.130*	0.141*	0.110+
	(3.50)	(2.35)	(2.18)	(2.29)	(2.50)	(1.82)

Standardized beta coefficients are reported. t-statistics based on robust standard errors are reported in parentheses.
**, * and † denote 1%, 5% and 10% significance levels. The instruments for *Labor × Firm Spec.* in the 2SLS estimation are the four legal origin dummies (British, French, German and Socialist), each interacted with *Spec*. The results for the first stage and other interaction terms are suppressed to save space. Oil exporters (share of oil exports > 0.5) — Nigeria and Venezuela are excluded in column (5). Oil sector (SIC = 291) is excluded in column (6). See Appendix C for detailed description of the variables.

the sample size decreases from 84 to 56 countries when the factor endowment controls are included. Following Nunn (2007), in column (3) I add an interaction term between the country's (log) per capita GDP and the sector's value-added share, as well as an interaction term between the quality of the country's contracting institutions and the sector's dependence on contract enforcement, a measure proposed by Nunn (2007). Importantly, the coefficient on the labor market interaction term remains significant and similar in magnitude.

In column (4), I interact all the measures of country characteristics explored in column (3) with the measure of firm-specific skill intensity. The estimated coefficient on $Labor_i \times FSpec_s$ is now more significant economically and statistically. Recall that in my model, investments in specific skills are assumed to be completely non-contractible. To the extent that firm-specific investments are partially contractible, these investments can be better specified in contracts in countries where contracting institutions are more developed. The insignificant coefficient on $Judicial \times FSpec$ fails to support that conjecture. Finally, in column (5), I exclude the two large oil-exporting countries, Nigeria and Venezuela where petroleum accounts for over half of the country's total exports; and in column (6), I exclude the petroleum sector (SIC = 291). The main results remain robust.

Recent research argues that industrial specialization due to international trade may affect domestic institutions (Acemoglu et al., 2005; Do and Levchenko, 2007). To address the concern of reverse causality, I use legal origins (British, French, German, and Scandinavian) as instruments for labor protection and estimate Eq. (9) using 2SLS. The estimates in the second stage of the 2SLS estimation, as shown in Panel B, support the claim that the impact of labor laws on the proposed comparative advantage is causal.[32] One caveat is that a country's legal origins may affect specialization through other channels, such as the development of contracting institutions. Therefore, one should interpret the 2SLS results with caution, as the instruments may not satisfy the criteria of exclusion restrictions.

5.2. The impact of labor laws on export volume

In this section, I test whether labor protection affects countries' intensive and extensive margins of trade. I first estimate the gravity equation at the sector level using OLS and then I implement the two-stage estimation procedure as specified in Section 3.1.

Each observation in my sample represents a bilateral trade relationship in a sector. As such, my sample includes 958,272 potential bilateral relationships (84 exporting countries × 184 importing countries × 62 sectors). Table 2 reports estimates of Eq. (5) based on OLS. In column (1), controlling for exporter, importer, and sector fixed effects, I regress (log) export volume from i to j in sector s ($\ln X_{ijs}$) on the interaction term between i's labor protection and s's firm-specific skill intensity, $Labor_i \times FSpec_s$. I find a positive point estimate on the interaction term ($\hat{\beta} = 0.694$, $t\text{-}stat = 6.17$). As specified in Eq. (5), included in the regression are exporter, importer, and sector fixed effects. The export volume in the sector depends on the competitiveness of the sector in the importing country, which according to Eq. (5) is captured by $\ln(P_{js})$. Without measures of sectoral prices for a large number of countries, I include in the specification an interaction term between the (log) consumption price level (relative to the U.S.) of the importing country and the dummy for sector s.[33] Standard errors are clustered by importer–exporter pairs to account for the correlation between unobserved trade barriers.

To control for observable trade costs and distances that may affect the revealed trade patterns, I include in the regression nine "trade cost" variables between the two trading partners. Consistent with the traditional gravity estimates, the estimated coefficients on these "trade cost" variables show that there is relatively more trade if the countries (i) are closer to each other, (ii) have ever been in a colonial relationship, (iii) have majority of the populations speaking a common language, (iv) share a common border, (v) share the same legal origin and (vi) are signatories of the same free trade agreements. The estimates on the dummy for the same currency union, the dummy for whether one of the countries is landlocked, and the dummy for whether one of the countries is an island are either statistically insignificant or contradict the conventional wisdom. Unless specified otherwise, this entire set of "trade cost" will be controlled for in all estimations below.

In addition to all the regressors included in column (1), column (2) takes into account the Heckscher–Ohlin determinants of comparative advantage by including the interactions between the countries' factor (capital and human capital) endowments and the sectors' factor intensities. Additionally, column (3) controls for the effects of natural resource endowments on trade flows. Controlling for per capita factor endowments, labor market institutions remain a significant determinant of comparative advantage.

The effect of labor regulations is economically significant. For example, if the U.S., the country at the 10th percentile of the distribution of labor protection, adopts the labor laws of Germany, the country at the 90th percentile, the gap between the average unilateral export volume of Sawmills and Planing Mills (90th percentile in firm-specific skills) and that of Fabricated Structural Metal Products (10th percentile in firm-specific skills) would increase by about 20 percentage points.[34]

However, my measure of firm-specific skills may contain a significant amount of skills that are industry-specific. Ideally, I would estimate Eq. (7) including both the firm and industry tenure measures. Due to the issue of collinearity, I estimate the firm tenure and industry tenure effects separately, carefully controlling for a worker's overall work experience. The correlation of the estimates of the firm tenure effects and the industry tenure effects is about 60%, which is quite high but still permits the inclusion of both measures when estimating the gravity equation (see Figure A1 in the appendix).

As is shown in column (4), I add the interaction term between the exporting country's labor protection and the sectoral measure of the industry-specific skill intensity. The estimated coefficient on $Labor_i \times FSpec_s$ declines to 0.53, but remains statistically significant at the 1% level. The estimate for the interaction between labor protection and industry-specific skill intensity is positive and statistically significant (at the 5% level), suggesting that countries with more protective labor laws also specialize in sectors that are industry-specific skill-intensive. Although my theoretical model does not explicitly spell out such a relationship, it would predict that higher worker bargaining power or a more stable relationship with the employer encourages investment in both industry-specific and firm-specific skills.

According to Eq. (5), the sector-level export volume is also positively correlated with the number of producers in the exporting country. In light of this, I include the (log) number of firms in the same sector of the exporting country as a control (column (5)).[35] The estimates on the variables of interest remain statistically significant. In column (6), standardized beta coefficients are reported for the same regression as in column (5). One standard-deviation increase in $Labor_i \times FSpec_s$ is associated with a 0.04 standard-deviation increase in the sectoral export volume. The impact on industry-specific skill-intensive exports is

[32] In unreported results, I find that legal origins strongly predict labor law protection in the first stage of the 2SLS estimation, with an R^2 equal to 0.43.

[33] This approach was also used by Manova (2011).

[34] This comparative statics exercise is based on the estimates in column (4). Formally, this "diff-in-diff" result is derived from the following formula $\exp\left[\ln X^{i'}_{ijs} - \ln X^{i'}_{ijs'}\right] = \exp\left[\hat{\beta} Labor^{i'}_{i} \times Spec_s\right] \simeq 1.202$, where $\hat{\beta} \simeq 0.897$. The difference in the indices of labor protection between Germany and the U.S. is $Labor^{i'}_{i} = 0.858 - 0.102$, and the difference in specificity between the two industries is $Spec_s \simeq 0.678 - 0.407$. Notice that this "diff-in-diff" exercise does not predict the direction of the change in exports of either sector.

[35] The measure for the number of firms per sector in 1995 is from United Nations Industrial Development Organization (2006) dataset, which is only disaggregated only at the ISIC 3-digit industry level (28 industries).

Table 2
Labor protection and bilateral export volumes (OLS). This table examines the effects of labor protection on bilateral exports volumes, based on regression specification (5).

Dependent variable: (ln) bilateral exports from i to j by sector: $\ln(X_{ijs})$	(1) Baseline	(2) +K/L and H/L endowment	(3) +Natural resources	(4) +Labor × Industry-spec.	(5) +Num. of exporting firms	(6) Beta coeff. − (5)	(7) +Importer-sector FEs (beta coeff.)
Labor × Firm-spec.	0.694**	0.897**	0.850**	0.530**	0.435*	0.039*	0.035*
	(6.17)	(7.89)	(7.23)	(2.73)	(2.26)	(2.26)	(2.21)
Labor × Industry-spec.				0.413*	0.504**	0.040**	0.038**
				(2.19)	(2.67)	(2.67)	(2.81)
ln(distance)	−0.629**	−0.634**	−0.647**	−0.647**	−0.663**	−0.312**	−0.317**
	(−26.69)	(−26.39)	(−26.76)	(−26.76)	(−27.03)	(−27.03)	(−26.53)
Ever colony	0.506**	0.508**	0.523**	0.523**	0.525**	0.064**	0.070**
	(7.79)	(7.72)	(7.86)	(7.86)	(7.80)	(7.80)	(8.47)
Common language	0.0590	0.0549	0.0475	0.0474	0.0707†	0.016†	0.024*
	(1.49)	(1.37)	(1.16)	(1.16)	(1.67)	(1.67)	(2.41)
Common border	0.721**	0.703**	0.704**	0.704**	0.700**	0.077**	0.077**
	(8.89)	(8.04)	(7.90)	(7.91)	(7.56)	(7.56)	(8.02)
Common legal origin	0.181**	0.184**	0.188**	0.189**	0.185**	0.045**	0.049**
	(6.23)	(6.18)	(6.07)	(6.08)	(5.82)	(5.82)	(6.17)
Currency union	−0.0252	−0.0446	−0.0304	−0.0296	−0.177	−0.005	0.017
	(−0.08)	(−0.14)	(−0.09)	(−0.09)	(−0.47)	(−0.47)	(0.97)
RTA members	0.207**	0.208**	0.198**	0.198**	0.195**	0.044**	0.052**
	(5.27)	(5.10)	(4.64)	(4.64)	(4.45)	(4.45)	(5.14)
Any landlocked	0.504*	0.465*	0.470*	0.470*	0.915**	0.024**	0.024**
	(1.99)	(2.16)	(2.15)	(2.16)	(3.07)	(3.07)	(2.88)
Any island	−0.119	−0.144	−0.223*	−0.223*	−0.225*	−0.017*	−0.012
	(−1.30)	(−1.55)	(−2.00)	(−2.00)	(−2.00)	(−2.00)	(−1.21)
ln(K/L) × Capital intensity		−0.029*	−0.056**	−0.057**	−0.013	−0.054	0.030
		(−2.57)	(−4.98)	(−5.00)	(−1.08)	(−1.08)	(0.60)
ln(H/L) × Skill intensity		2.213**	2.267**	2.274**	1.851**	0.415**	0.449**
		(25.12)	(25.42)	(25.45)	(20.27)	(20.27)	(22.55)
ln(M/L) × Mat. intensity			0.138**	0.139**	0.127**	0.413**	0.375**
			(9.18)	(9.23)	(8.53)	(8.53)	(7.89)
ln(Num. of est.)					0.204**	0.196**	0.209**
					(21.81)	(21.81)	(23.85)
R^2	.475	.471	.479	.479	.485	.485	.573
Num. of exporters	84	60	57	57	53	53	53
Num. of clusters	4363	3987	3701	3595	3496	3496	3858
Num. of observations	95,107	87,009	82,734	82,734	78,731	78,731	84,823

All regressions include exporter, importer, and sector fixed effects, besides the last column where importer-sector and exporter fixed effects are included.
t-statistics based on standard errors clustered by importer–exporter pair are in parentheses.
**, * and † denote 1%, 5% and 10% significance levels respectively.
See Web appendix A for detailed description of the variables.

similar in magnitude. Taken at face value, the combined effect of firm- and industry-specific skills is about one-sixth of the comparative advantage effect due to the overall human capital endowment (0.45).

Finally, I estimate a saturated specification including importer-sector and exporter fixed effects. The main coefficients remain quantitatively and statistically robust (column (7)).

5.3. Brief discussion of alternative theories

Note that my interpretation of the findings relies on the assumption that returns to firm tenure are valid proxies for firm-specific skills. Since several alternative theories can explain an upward-sloping wage-tenure profile (see Section 4), how do we know that it is through the specific-skill channel proposed in this paper, rather than through other channels suggested in the existing literature that labor market institutions shape a country's comparative advantage? This section briefly discusses the determinants of an upward-sloping wage-tenure profile according to different theories and show how these determinants can turn a country's labor market institutions into a source of comparative advantage.

The incentive-contract theory by Lazear (1981) and others postulates an optimal wage structure that postpones compensation to the later part of an employee's career, providing most incentives to both junior and senior employees in a firm. Despite the relevance to this paper, it is not clear why employers would be more inclined to delay compensation in a more protective labor market. Rather, it is reasonable to believe that employers need to use a steeper wage-tenure profile to provide incentives to or retain experienced workers in a more flexible labor market. As such, in contrast to my findings, the incentive-contract theory would predict that countries with flexible labor markets specialize in high tenure-premium sectors.

The theory of asymmetric information (e.g. Gibbons and Katz, 1991), which argues that employers may prefer to postpone compensation until uncertainty about their employees is cleared up, is also related to the current study. However, it is unclear how the employers' knowledge about their workers' ability is related to the degree of labor market protection. To the extent that more flexible labor markets are associated with more job turnovers and potentially more information revealed about the employees, we would expect countries with more protective labor laws to specialize in high tenure-premium sectors. However, if a stable employer–worker relationship gives the employer more time to observe the worker's performance, there may be less of a need to delay payment (i.e., a flatter wage-tenure profile).

The most challenging theory to my interpretation is the wage-compression theory proposed by Acemoglu and Pischke (1999), among others. Acemoglu and Pischke (1999) argue that when labor market frictions increase, outside options for workers would decrease relative to their current wages (wage compression). If tenure effects are estimated based on the differences in payments between the stayers and the switchers, the wage-tenure profiles would be steeper in more protective labor markets. Furthermore, if switching costs are increasing with the worker's firm-specific skills, an intuitive assumption and also

Table 3
Labor protection and firm selection into exporting (first-stage Probit estimation). This table examines the effects of labor protection on the extensive margin of trade, using the Probit model specified in Eq. (6). The columns in this table correspond to those in Table 2. Two additional trade barrier variables — (i) Procedures to Start Businesses and (ii) Days to Start Businesses, are included in the first stage, but will be excluded in all second-stage estimations in the next table.

Dependent variable: (ln) bilateral exports from i to j by sector: $\ln(X_{ijs})$					
	(1)	(2)	(3)	(4)	(5)
	Baseline	+K/L and H/L endowment	+Natural resources	+Labor industry-spec.	+Num. of exporting firms
Labor × Firm-spec.	0.691**	0.707**	0.637**	0.004	−0.004
	(9.20)	(8.98)	(7.87)	(0.03)	(−0.03)
Labor × Industry-spec.				0.826**	0.758**
				(6.00)	(5.49)
ln(distance)	−0.713**	−0.738**	−0.742**	−0.743**	−0.756**
	(−41.88)	(−40.76)	(−39.12)	(−39.12)	(−38.39)
Ever colony	0.589**	0.617**	0.620**	0.620**	0.614**
	(9.27)	(8.97)	(8.88)	(8.87)	(8.62)
Common language	0.193**	0.185**	0.199**	0.199**	0.232**
	(7.42)	(6.82)	(7.13)	(7.13)	(7.87)
Common border	0.241*	0.247*	0.253*	0.254*	0.200
	(2.21)	(2.09)	(2.13)	(2.13)	(1.64)
Common legal origin	0.138**	0.139**	0.139**	0.139**	0.135**
	(6.67)	(6.45)	(6.15)	(6.16)	(5.80)
Currency union	0.286	0.282	0.286	0.286	0.164
	(0.89)	(0.84)	(0.84)	(0.84)	(0.36)
RTA members	0.0413†	0.0335	0.0221	0.0221	0.0134
	(1.75)	(1.33)	(0.85)	(0.85)	(0.50)
Any landlocked	0.0529	−0.0205	−0.0391	−0.0387	0.132
	(0.59)	(−0.23)	(−0.43)	(−0.43)	(1.17)
Any island	0.137†	0.131	0.0588	0.0585	0.0474
	(1.75)	(1.59)	(0.66)	(0.65)	(0.52)
Procedures to start businesses	−0.638**	−0.697**	−0.660**	−0.660**	−0.651**
	(−4.88)	(−5.18)	(−4.80)	(−4.80)	(−4.62)
Days to start businesses	−0.0783**	−0.0943**	−0.119**	−0.119**	−0.126**
	(−3.38)	(−3.94)	(−4.67)	(−4.66)	(−4.87)
ln(K/L) × Capital intensity		0.0266**	0.00757	0.00727	0.0318**
		(4.30)	(1.16)	(1.11)	(4.61)
ln(H/L) × Skill intensity		1.826**	1.857**	1.868**	1.633**
		(36.03)	(35.91)	(36.00)	(31.82)
ln(Resource/L) × Mat. intensity			0.112**	0.112**	0.109**
			(14.03)	(14.08)	(13.25)
ln(Number of establishments)					0.155***
					(27.23)
Log-likelihood	−98,377	−89,830	−84,804	−84,782	−79,942
Num. of exporters	71	60	57	57	53
Num. of clusters	7526	6360	6042	6042	5618
Num. of observations	466,612	394,320	374,604	374,604	338,038

All regressions include exporter, importer, and sector fixed effects.
z-statistics based on standard errors clustered by importer–exporter pair are in parentheses.
**, * and † denote 1%, 5% and 10% significance levels respectively.
See Web appendix A for detailed description of the variables.

what Acemoglu and Pischke's (1999) model implies, we would obtain the same ranking of estimated returns to firm tenure, despite our different theoretical explanations. In short, the positive correlation between labor market protection, job switching costs, and the degree of wage compression proposed by Acemoglu and Pischke (1999) is entirely consistent with, though not necessarily independent of, my interpretation of the observed specialization patterns. Common to both our theories, labor market frictions are conducive to on-the-job training or skill acquisition (general skills in their case; firm-specific skills in this case).

In sum, my results are unlikely to be explained by the incentive-contract theory, but can possibly be explained by the asymmetric-information theory if labor market protection impedes information flows, and can be rationalized by the wage-compression theory.

5.4. First-stage estimation of the extensive margin of trade

In this section, I present the empirical results of the two-stage estimation outlined in Section 3.

Prediction 2 posits that countries with more protective labor laws are more likely to export in specific skill-intensive sectors. I test this proposition by estimating the Probit Eq. in (6). The dependent variable is an indicator that equals 1 if positive trade flows are observed from i to j in s, and 0 otherwise. Exporter, importer, sector fixed effects, and proxies for sectoral prices in the importing country are always included. In addition to testing the extensive margin, I use the predicted probability based on this estimation to construct measures for correcting the two biases discussed in Helpman et al. (2008a).

Variables that satisfy the exclusion restriction criteria, which are required to correct for the standard Heckman selection bias, are needed. Thus, in addition to the nine "trade cost" variables included in the gravity estimation above, I include two additional trade barrier variables in the regressions — the number of procedures and the number of days required to legally start a business, in both the importing and exporting countries. These two measures are from Djankov et al. (2002) for a subset of the exporting countries in my sample. Serving as proxies for legal barriers that deter cross-border transactions, they are included as regressors in the first-stage equation but not in the second-stage gravity estimation, in the belief that these barriers mostly affect participation in exports, but not the export volume conditional on exporting. In other words, lower entry costs in either the importing or exporting country would increase the chance of a firm's selecting into exporting, and thus the likelihood of trade between the two countries. But once a trade relationship is established, these start-up costs do not impair trade flows. The averages of these two variables between the importing and exporting countries are used, under the assumption that firm entry costs affect domestic and foreign exporting firms symmetrically.[36]

Table 3 presents the results of the first-stage Probit estimation. The specifications are parallel to those in Table 2 in terms of the set of regressors included. Most of the estimated coefficients on "trade cost" variables have the same signs as those reported in Table 2 (although not always significant). Importantly, the estimates reported in columns (1) through (3) show that countries with more protective labor laws are more likely to export to another country in specific skill-intensive sectors. These findings support Prediction 2, and are robust to the inclusion of variables for the traditional sources of comparative advantage.

When the proxy for industry-specific skill intensity is included, the estimate on the firm-specific skill interaction term becomes insignificant, whereas that for industry-specific skills is significant. This implies that industry-specific skills, but not firm-specific skills, affect export participation through the proposed channel of trade. Note that the estimated firm–tenure premium and the estimated industry–tenure premium are highly correlated, and thus collinearity may be an issue in interpreting these results (see Figure A1 in the appendix). In sum, these empirical results continue to support the general idea that job stability encourages investment in both industry- and firm-specific skills, with the latter playing a significantly more important role in affecting the intensive margin of trade.

5.5. Second-stage estimation of the trade flow equation

Using the predicted probabilities obtained from the Probit estimation, I correct both types of biases in the OLS estimation, as discussed in Section 3, and examine whether labor regulations continue to affect trade patterns. I estimate the second-stage trade flow Eq. (5) controlling for the effects of firm self-selection into exporting. In brief, to correct for the bias due to this unobserved firm heterogeneity, I include an estimate of ω_{ijs} as a regressor. As discussed in the Web appendix, a consistent estimate of ω_{ijs} in Eq. (5) can be constructed by using the predicted probabilities of exporting (by sector) from estimating the first-stage equation. Additionally, to correct for the Heckman selection bias, I include the inverse Mills' ratio as a stand-alone regressor. Because the variable for the extensive margin is a non-linear function of the first-stage estimates, I estimate the second-stage specification (5) using the maximum likelihood estimation (MLE) model.

Table 4 presents the results of the second-stage MLE estimation. With all regressors from the first-stage except the two "entry cost" variables included, the interaction term for labor protection remains positive and significant for all specifications. This result is robust to the inclusion of the interactions for the Heckscher–Ohlin sources of comparative advantage. Notice that the coefficients should not be compared directly with their OLS counterparts in Table 2, as only a subset of the countries have data on entry costs from Djankov et al. (2002). In column (6), I report the OLS estimates for the results that correspond to column (5), using the same sample.

To check the robustness of the MLE results, I relax the Pareto distribution assumption of firm productivity, as well as the joint normality assumption of the unobserved fixed and variable trade costs. To correct for the two sources of biases, I first assign the predicted probabilities of exporting ($\hat{\rho}_{ij}s$) into 50 bins, each having the same number of observations. Then I replace $\hat{\overline{\omega}}_{ijs}$ and the inverse Mills' ratio by these 50 dummies and again estimate the second-stage gravity equation again. The results estimated using OLS are presented in Panel B of Table 4, which confirm the MLE results in Panel A.

[36] Helpman et al. (2008a) use dummy variables, which are set equal to one if both the importing and the exporting countries have business start-up costs (e.g., days to start a business) that are higher than the median in the sample. Manova (2011) also uses the averages between the importing and exporting countries.

5.6. Robustness

5.6.1. Sensitivity analysis

To check the robustness of the estimation results, I re-run the regression of column (4) of Table 4 using various sub-samples of the exporting countries.[37] The results of the sensitivity analysis are reported in Table A7. First, I separate the sample into OECD (column (1)) and non-OECD (column (2)) exporters. The coefficient on $Labor_i \times FSpec_s$ is significant for both samples, but it is significantly larger for the non-OECD sample.

Next, to deal with the concern that my results may be driven by the large oil-exporting countries, for which comparative advantage may not be the main driving force for trade, I exclude the exporting countries where over half of total exports come from the "Petroleum Refining" sector (column (3)). In column (4), I simply exclude the "Petroleum Refining" sector. Both of these exclusions only slightly affect the magnitude and the significance of the results. Next, to ensure that my results are not driven by a few outlying industries, I drop the top two and the bottom two firm-specific skill-intensive sectors from the regression (column (5)). I also exclude industries for which estimates of tenure effects are insignificantly different from 0 (column (6)). The economic significance of the results decreases for the former but increases for the latter.

Another concern is that the importance of firm-specific skills may differ between production and non-production workers within the same industry. It is possible that firm-specific skills are important for non-production workers but not for production workers. An opposite argument can be made for certain industries. To this end, I try using only production workers to estimate firm tenure, and then I interact the resulting estimates with the labor protection index of the exporting country. The results, as reported in column (7), reveal that the strength of the proposed comparative advantage declines. An explanation is that all else being equal, firm-specific skills are more crucial for non-production (skilled) workers than for production workers, who more readily can be replaced. Finally, column (8) shows that the results reported so far also hold for year 2000. Notice that across all specifications, the industry-specific skill intensity does not appear to be a significant determinant of the intensive margin of trade.

5.6.2. Alternative sources of comparative advantage

In Table 5, I check whether the baseline results are driven by the alternative sources of institutional comparative advantage that are proposed in recent literature. Since uncertainty of firm performance would weaken workers' ex-ante incentives to acquire firm-specific skills, the sector measure of firm-specific skill intensity may be highly correlated with sales volatility. If that is the case, the results reported so far simply support the findings in Cuñat and Melitz (forthcoming), who show both theoretically and empirically that countries with flexible (rigid) labor markets specialize in volatile (stable) sectors. First, note that the bilateral correlation between sales volatility and specific skill intensity in my sample is only −0.06 (see Table A4 in the appendix).

But to address this concern formally, I estimate the specification for column (4) in Table 4 by adding an interaction between a country's labor protection and the sales volatility of an industry. The results in column (1) support the prediction of Cuñat and Melitz (forthcoming). In column (2), I use gross job flow rates in the U.S. sectors from Davis et al. (1996) as another measure of sectoral volatility.

[37] I use this specification instead of the one in column (5) because of concerns about potential collinearity between institutions and the number of firms in a given exporting country. For example, better contracting institutions are often associated with lower business costs, which encourage entrepreneurship, and therefore increase the number of firms in a given country. Moreover, this effect is probably different across sectors with different degrees of contract dependence, fixed costs of entry, and so on. In unreported results, when the (log) number of firms by sector is added as a regressor, the estimated coefficient on $Labor \times Spec$ becomes even more robust.

Table 4
Labor protection and bilateral export volumes (second-stage estimation). This table reports the second-stage gravity estimation results parallel to the first-stage results in Table 3. δ (from *wijs*) is the variable controlling for the extensive margin of trade. *eijs* is the inverse Mills' ratio correcting the Heckman selection bias. See Section 3.1 for details. Panel A reports the second-stage estimation results using maximum likelihood, while Panel B reports the corresponding results using OLS with 50 dummy variables denoting the percentiles of the predict probability of exporting. The columns in this table correspond to those in Table 3.

Dependent variable: (ln) bilateral exports from *i* to *j* by sector: $\ln(X_{ijs})$	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	+*K*/*L* and *H*/*L* endowment	+Natural resources	+Labor industry-spec.	+Num. of exporting firms	OLS coeffs. for Eq. (5)
Panel A: Maximum likelihood estimation						
Labor × Firm-spec.	0.980**	0.859**	0.805**	0.666**	0.555**	0.435*
	(5.70)	(4.81)	(4.82)	(3.42)	(2.89)	(2.26)
Labor × Industry-spec.				0.173	0.297	0.504**
				(0.74)	(1.34)	(2.67)
ln(*K*/*L*) × Capital intensity		−0.011	−0.038**	−0.039**	0.007	−0.0125
		(−0.94)	(−3.38)	(−3.40)	(0.56)	(−1.08)
ln(*H*/*L*) × Skill intensity		2.231**	2.222**	2.227**	1.824**	1.851**
		(6.23)	(6.41)	(6.37)	(6.10)	(20.27)
ln(Resource/L) × Mat. intensity			0.121**	0.122**	0.111**	0.127**
			(4.80)	(4.80)	(4.52)	(8.53)
eijs	1.510**	1.427**	1.386**	1.383**	1.407**	
	(7.87)	(6.97)	(7.15)	(7.11)	(7.54)	
δ(from *wijs*)	0.697**	0.751**	0.765**	0.765**	0.738**	
	(2.82)	(2.93)	(3.15)	(3.14)	(3.12)	
Panel B: Flexible specification: OLS using 50 bins for predicted probability						
Labor × Firm-spec.	1.160**	1.047**	0.992**	0.653**	0.559**	0.435*
	(9.96)	(9.05)	(8.37)	(3.34)	(2.90)	(2.26)
Labor × Industry-spec.				0.438*	0.487*	0.504**
				(2.22)	(2.51)	(2.67)
ln(*K*/*L*) × Capital intensity		−0.00477	−0.0365**	−0.0369**	0.0157	−0.0125
		(−0.42)	(−3.21)	(−3.24)	(1.35)	(−1.08)
ln(*H*/*L*) × Skill intensity		2.731**	2.777**	2.800**	2.229**	1.851**
		(22.00)	(21.25)	(21.55)	(17.94)	(20.27)
ln(Resource/*L*) × Mat. intensity			0.152**	0.153**	0.135**	0.127**
			(9.09)	(9.18)	(8.18)	(8.53)
R^2	.51	.525	.533	.533	.54	.485
Num. of exporters	71	60	57	57	53	53
Num. of clusters	3047	2927	2852	2852	2777	2777
Num. of observations	83,448	79,994	75,969	75,969	72,208	72,208

All regressions include exporter, importer, and sector fixed effects, as well as the 9 trade frictions variables listed in Table 2.
Standard errors are clustered by importer–exporter pair. z-statistics (besides column (6)) are reported in parentheses in Panel A, t-statistics in panel B.
**, * and † denote 1%, 5% and 10% significance levels respectively.
See Web appendix A for detailed description of the variables

The measure captures the degree of instability in employer–employee relationships across sectors. Once again, I find a negative and significant estimate on the interaction term, supporting Cuñat and Melitz (forthcoming). Importantly, sectoral differences in specific-skill intensities remain an independent and important channel through which labor laws shape trade patterns.

Table 5
Labor protection and other sources of comparative advantage. This table repeats the analysis for column (4) in Table 4, including interaction terms for other channels through which labor market or contracting institutions can affect trade patterns. Only the second-stage regression results, estimated using the maximum likelihood estimation method, are reported.

Dependent variable: (ln) bilateral exports from *i* to *j* by sector: $\ln(X_{ijs})$	(1)	(2)	(3)	(4)	(5)	(6)
	Labor law × Volatility	Labor law × Volatility	Legal inst. × Contract	Contract and vol.	Contract and vol.	Beta coeff. for (5)
Measure of volatility	Sales volatility	Gross job flows	–	Sales volatility	Gross job flows	Gross job flows
Labor × Firm-spec.	0.613**	0.366†	0.669**	0.563**	0.379**	0.034**
	(3.18)	(1.87)	(3.44)	(2.96)	(1.94)	(1.94)
Labor × Industry-spec.	0.203	0.298	0.135	0.238	0.256	0.020
	(0.87)	(1.21)	(0.59)	(1.04)	(1.05)	(1.05)
Labor × Volatility	−0.754†	−0.029**		−0.263	−0.030**	−0.083**
	(−1.79)	(−4.02)		(−0.63)	(−3.90)	(−3.90)
Judicial × Contract dep.			2.456**	1.277*	2.437**	0.227**
			(4.14)	(2.12)	(4.15)	(4.15)
# exporters	57	57	56	56	56	56
# clusters	2852	2852	2840	2777	2840	2840
# observations	75,969	75,969	75,851	72,208	75,851	75,851

Controls include exporter, importer, and sector fixed effects; Interactions between 1) capital endowment and capital intensity; 2) human capital endowment and human capital intensity; 3) resource endowment and material intensity; 4) importers' CPI and sector dummies; and 9 trade frictions variables listed in Table 2.
z-statistics, based on standard errors are clustered by importer–exporter pair, are reported in parentheses.
**, * and † denote 1%, 5% and 10% significance levels respectively.
See Web appendix A for detailed description of the variables.

Next, I examine whether cross-country differences in contracting institutions affect the main results. As discussed in the model, another important source of comparative advantage regarding firm-specific investments is the quality of domestic contract-enforcement institutions. In the present context, the underinvestment problem becomes less severe if contracts are more complete, potentially due to better contract enforcement. Furthermore, recent literature on institutional comparative advantage shows that countries with better contracting institutions specialize in sectors that rely more on effective contract enforcement (Levchenko, 2007; Nunn, 2007). I control for this type of comparative advantage, like Nunn (2007), by including an interaction between the quality of judicial system and the sector's dependence on contract enforcement.[38] I find supporting evidence for the literature on contract enforcement and trade.

In the last column of Table 5, I report standardized beta coefficients to compare the economic significance of different institutional channels of comparative advantage. A one standard-deviation increase in the labor law interaction is associated with a 0.034 standard-deviation increase in the (log) export volume. In comparison, the beta coefficient on the labor-law job-flow interaction is −0.083, whereas that on the legal-contract interaction is 0.23 (column (6)).[39]

5.6.3. Isolating the effects of other country and industry characteristics

After examining the effects of other channels of comparative advantage, I further verify the robustness of the main results by sequentially isolating the effects of other country characteristics. In Table A8 in the appendix, I interact the specific-skill intensity with different exporting country characteristics, and include the interaction terms as controls. The country characteristics include: (1) log GDP per capita; (2) human capital endowment; (3) physical capital endowment, and; (4) quality of the judicial system. Moreover, all regressions in Table A8 already control for the interactions for the Heckscher–Ohlin sources of comparative advantage. Importantly, the coefficient on the labor protection interaction remains positive and significant.

Finally, to confirm that firm-specific skill intensity is a crucial sectoral channel through which labor market institutions shape trade patterns and that it is independent from the effects of other sectoral characteristics, I interact the labor protection index with the measures of various sectoral characteristics, which include the sector's: (1) share of total manufacturing value added; (2) skill intensity; (3) capital intensity; (4) dependence on contract enforcement; (5) dependence on external finance, and (6) total factor productivity growth rate. All these measures are constructed using U.S. manufacturing firms in the 1990s. Details about these sector measures can be found in Web appendix A. As Table A9 in the appendix shows, controlling for the standard determinants of trade patterns, the type of comparative advantage proposed in this paper remains robust.

6. Conclusion

This paper identifies a new source of comparative advantage arising from the interaction between workers' on-the-job skill acquisition and a country's labor regulations. I develop a simple model to show that workers have more incentives to acquire firm-specific skills relative to general skills in more protective labor markets. Embedding this model in a multi-sector open-economy framework shows that countries with a more protective labor market are more likely to export and export relatively more in industries for which firm-specific skills are more important. Importantly, I show that this endogenous channel of comparative advantage is independent of the previously examined channel through which labor market institutions affect trade patterns.

By estimating sector-level gravity equations for a sample of 84 countries, I find that countries with protective labor markets specialize in both firm-specific and industry-specific skill-intensive sectors on the intensive margin, with the industry-specific skills playing a more significant role in shaping the pattern of export participation. These results support the general idea that a stable employer–employee relationship encourages relationship-specific investments. The empirical results are robust to the correction of the biases arising from the countries' selection into trade partners, as well as firm self-selection into exporting. They are also independent of other sources of comparative advantage, including factor endowments, income, and contracting institutions.

It should be noted that this paper aims to show labor market institutions as a source of comparative advantage. It provides no normative implications about whether labor market protection can enhance welfare. A way to interpret the results is that if stringent labor laws indeed distort incentives and lower firm efficiency, this detrimental effect is more mitigated in more specific skill-intensive sectors.

Future research should construct sector measures for specific-skill intensities using data from other countries and extend the model in a dynamic framework. A dynamic model would shed light on the effects of labor laws on workers' on-the-job and off-the-job investment decisions, which in turn affect trade patterns. One promising research direction is to examine how trade openness, by affecting workers' skill acquisition, may reinforce persistent differences in labor market institutions across countries.

Appendix A. Supplementary data

Supplementary data to this article can be found online at doi:10.1016/j.jinteco.2012.01.001.

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[38] Specifically, a sector's dependence on contract enforcement is proxied by the inverse of the market thickness of the upstream supplier industries.

[39] Chor (2010) finds the same order of magnitude of the beta coefficients on these institutional comparative advantage interactions.

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