Essays on International Trade and Investment

by

Heiwai Tang

B.S. Mathematics/ Economics
University of California, Los Angeles, 2001

Submitted to the Department of Economics
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2008

Signature of Author ....
Department of Economics
May 15, 2008

Certified by ....
Olivier J. Blanchard
Class of 1941 Professor, Department of Economics
Thesis Supervisor

Certified by ....
Pol Antràs
Professor, Harvard University - Department of Economics
Thesis Supervisor

Certified by ....
Roberto Rigobón
Associate Professor with Tenure, MIT Sloan School of Management
Thesis Supervisor

Accepted by ....
Peter Temin
Elisha Gray II Professor of Economics
Chairman, Department Committee on Graduate Students

Essays on International Trade and Investment

by

Heiwai Tang

Submitted to the Department of Economics
on May 15, 2008, in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Abstract

This dissertation consists of three essays on international trade and investment.

In the first essay, I study how cross-country differences in labor market institutions shape the pattern of international trade with a focus on workers' skill acquisition. I develop an open-economy model in which workers undertake non-contractible activities to acquire firm-specific skills on the job. I show that protective labor laws, by increasing workers' bargaining power, induce workers to acquire more firm-specific skills relative to general skills. When sectors differ in the dependence on firm-specific skills in production, workers' investment decisions turn a country's labor laws into a source of comparative advantage. Specifically, the model predicts that countries with more protective labor laws export relatively more in firm-specific skill-intensive sectors. To test these hypotheses, I construct sector measures of firm-specific skill intensity using estimated returns to firm tenure in the U.S. over 1985-1993. Using these measures and a cross-country, cross-sector data set of 84 countries in 1995, I find support for the theoretical predictions.

In the second essay, I use a firm-level panel data set of 90,000 Chinese manufacturing firms over the period of 1998-2001 to examine whether there exist productivity spillovers from foreign direct investment (FDI) to domestic firms in the same sector (horizontal spillovers), and in sectors supplying intermediate inputs to foreign affiliates (vertical spillovers through backward linkages). I find evidence of negative horizontal spillovers. While I find no evidence of vertical spillovers at the national level, domestic input suppliers' productivity growth decreases with the foreign presence in their downstream sectors in the same province. Second, this essay examines whether the ownership structure of foreign affiliates affects the magnitude of spillovers. I find that wholly owned and ethnic-Chinese foreign firms are associated with more negative horizontal spillovers, compared to jointly owned and non-Chinese foreign firms, respectively. I also find that negative spillovers are mostly borne by domestic firms that are state-owned, technologically-backward and located in inland provinces.

The third essay studies how government political ideology determines the pattern of trade protection across countries. I hypothesize that left-wing governments are associated with relatively higher protection in labor-intensive sectors, and relatively lower protection in capital- and human-capital intensive ones, than right-wing governments. Using a cross-country, cross-sector data set of 49 countries and 27 manufacturing sectors in the late 90s, I find evidence supporting these predictions.

Thesis Supervisor: Olivier J. Blanchard
Title: Class of 1941 Professor, Department of Economics

Thesis Supervisor: Pol Antràs
Title: Professor, Harvard University - Department of Economics

Thesis Supervisor: Roberto Rigobón
Title: Associate Professor with Tenure, MIT Sloan School of Management

Contents

Acknowledgements

It was a blessing to have Olivier Blanchard, Pol Antràs and Roberto Rigobón to be my advisors. They showed me the range of qualities that a great economist can possess.

I am deeply indebted to Olivier Blanchard, my primary adviser, for his constant guidance, support and mentoring. He always pushed me to focus on the heart of a problem rather than minor details, leading me to appreciate and understand the depth of economic research. His insistence of conducting research that "matters" made my life at MIT more challenging, but ultimately intensified my love for economics. Through him, I saw the power and beauty of a minimalist approach to research, an ideal that will have a paramount impact on my research style in the future. His devotion to education and the application of economics to real-world problems taught me what an economist should do.

I am also very grateful to Pol Antràs for his insightful comments on the sometimes incomprehensible drafts of my papers. It was his pioneering research on the intersection of the Theory of the Firm and International Trade that inspired me to write Chapter 1 of this thesis. His demand for perfection in every aspect of his work motivated me to be more demanding in my research. He showed me how to behave professionally as a young economist. He will remain my role model for the years to come.

My life as a thesis writer would have been a lot more stressful without Roberto Rigobón. In addition to all his pivotal suggestions that substantially improve my work, he cheered me up when I was down, and pointed me in the right direction when I was lost. Discussions with him on issues beyond research at his office added color to the mundane life of a thesis writer. Because of him, I will remember to bring joy to the people around me.

I am indebted to Xavier Gabaix, who amazed me with his creativity and passion for research. Special thanks also go to Marios Angeletos, Ricardo Cabellero, Fracesco Giavazzi and Guido Lorenzoni for advice, support and education, and Yashang Huang for his suggestions and provision of data for Chapter 2 of the thesis. I also want to thank Gary Hansen at UCLA for encouraging me to pursue a Ph.D. degree in economics.

I wish to thank all my friends at MIT, especially Ed Cho and George Papadakis, who shared many precious moments with me during my study. I also received a lot of care outside MIT. Special thanks go to Stanley Hok-wui Wong. Although he has been studying at UCLA during my time in Boston, his unexpected phone calls from California at midnight always lightened me up. Without him, I would not even have had the courage to apply to MIT, not to mention finishing the program. I wish to express my gratitude to Steven Chow, Thomas Kam, the Sung family, and other friends from the Boston Chinese Catholic Community who gave me the feel of home when my family was thousands of miles away.

Last but certainly not least, I am deeply indebted to my parents and older brothers in Hong Kong for their continuing support and love, especially my mom who has been worrying about me since the first day I arrived in the US ten years ago. I also owe an tremendous debt to my love, Joyce, who has gone through all my ups and downs during the thesis-writing process. Despite my sometimes depressive and impatient mood, she has never given up encouraging me and trying to understand my situation. I feel particularly sorry for leaving her alone on weekends when I often had to work at school. I will need to spend the rest of my life paying off the debt to her.

Many people have helped me complete this thesis. For Chapter 1, I thank Mauro Alessandro, Marios Angeletos, Suman Basu, Rodney Chan, Ed Cho, Jin Li, Devashish Mitra, George Papadakis, Steve Pischke, Carmen Taveras, Jose Tessada, Stanley Hok-wui Wong, and seminar participants at Clark, Hong Kong University, HKUST, the IMF, Iowa State, MIT, Syracuse, Tufts and Waterloo. I would like to thank Alejandro Cuñat and Marc Melitz for generously sharing their data, and Kalina Manova for advice on programming issues. For Chapter 2 and 3, I thank Yasheng Huang, Beata Javorcik, Hiau Loi Kee, and Stanley Hok-wui Wong for suggestions.

Cambridge
May 15, 2008.

To my parents, and Joyce

Chapter 1

Labor Market Institutions, Firm-specific Skills, and Trade

1.1 Introduction

In this paper, I study how cross-country differences in labor market institutions shape the pattern of international trade. In particular, I consider a country's comparative advantage arising from workers' skill acquisition. I argue that workers have more incentives to acquire firm-specific skills relative to general skills on the job when labor laws become more protective. For this reason, countries where labor laws are more protective have a comparative advantage in sectors for which firm-specific skills are more important. I test this hypothesis by examining whether countries with protective labor laws export relatively more in firm-specific skill-intensive sectors. To this end, I estimate the gravity equation at the sector level on a sample of 84 countries, and find evidence supporting the hypothesis.

The paper proceeds as follows. In section 1.2, I develop a model to show how more protective labor laws can induce workers to acquire more firm-specific skills. In the model, workers' general skills and firm-specific skills enhance firm productivity. While the level of general skills is exogenously given, that of firm-specific skills depends on workers' on-the-job skill acquisition. Specifically, the activities of skill acquisition are non-contractible, such that employers are unable to impose their preferred levels of investments on the workers. Thus, the combination of non-contractible investments and relationship-specificity leads to ex-post bargaining over the division of firm surplus between the employer and workers in a firm. In this situation, workers acquire firm-specific skills, anticipating payoffs from ex-post bargaining. Since workers are not the full residual claimants of the total gains from investments, a hold-up problem arises, resulting in under-investment in firm-specific skills relative to the first-best level.

Under these circumstances, labor laws that raise workers' bargaining power may alleviate the under-investment problem, because workers can obtain a larger share of the gains from investments. Hence, all else equal, stringent labor laws, represented by stronger workers' bargaining power, induce workers to acquire more specific skills. These effects of labor laws on firm productivity are more pronounced in more specific skill-intensive production, and therefore are a potential source of comparative advantage.

In section 1.3, I embed the model in an open-economy framework of trade in differentiated products based on Helpman, Melitz and Yeaple (2004). In the model, firms vary by productivity, sectors differ in their levels of dependence on firm-specific skills, and countries have different degrees of labor protection. Moreover, firms face both fixed and variable trade costs to export. The model predicts that labor market institutions affect trade flows on both the intensive and extensive margins of trade, where the former refers to firms' average volume of exports and the latter refers to firms' self-selection into exporting.

With the presence of fixed trade costs, only relatively more productive firms find it profitable to export. Therefore, exporters are only a subset of existing firms serving the domestic market. In particular, in a given country, there exists a productivity threshold of exporting for each sector and foreign country. Firms with productivity levels above this threshold choose to export. The model predicts that all else equal, protective labor laws reduce the productivity thresholds and therefore increase the fraction of exporting firms in all sectors (the extensive margin of trade). The reason is the following: when labor laws become more protective, firms in more specific skill-intensive sectors have a relative cost advantage in production. For the same reason, the model predicts that in countries where labor laws are more protective, the average volume of firms' exports is relatively higher in specific skill-intensive sectors (the intensive margin of trade).

In section 1.4, I extend Helpman, Melitz and Rubinstein's (2007) (HMR henceforth) empirical framework to a multi-sector setting, and test the model's predictions about the intensive and extensive margins of trade. In particular, HMR propose a two-stage estimation procedure, with the first stage being a Probit equation estimating the probability of countries' selecting into trade partners, and the second stage being a gravity equation augmented to take into account the extensive margin of trade. According to HMR, omitting the variable for the extensive margin in gravity estimation leads to an upward bias in the OLS estimates. On the other hand, owing to a predominance of zero trade flows between most countries, these OLS estimates are subject to a downward Heckman (1979) sample selection bias. To correct both types of biases, I parameterize the second-stage gravity equation to include variables imputed using the predicted probabilities of exporting across sectors from the first-stage estimation. In essence, these predicted values contain information about firms' decisions to export (the extensive margin of trade) and countries' selection into trade partners (sample selection).

In section 1.5, for the purpose of testing the theoretical predictions, I construct sector measures of the importance of firm-specific skills in production. To my knowledge, there has been no attempt by researchers to estimate them across sectors. To this end, I follow the labor economics literature on the effects of seniority on wages (Altonji and Shakotko, 1987; Topel, 1991; Altonji and Williams, 2005) in interpreting returns to firm tenure as evidence of the presence of firm-specific skills. Although there exist alternative explanations for an upward-sloping wage profile due to firm tenure, such as theories of incentive contracts to elicit workers' effort (Lazear, 1981), asymmetric information about workers' abilities (Katz and Gibbons, 1991) and wage compression due to search frictions in labor markets (Acemoglu and Pischke, 1999), I adopt the traditional view to associate returns to firm tenure with the importance of firm-specific skills (Becker, 1964). As such, I estimate returns to firm tenure in each sector on a PSID sample over 1985-1993. With the assumption that wages reflect the underlying marginal product of labor, I use the estimated returns to tenure as sector proxies for specific skill intensity for 67 SIC 3-digit sectors (out of 116 total).

Finally, in section 1.6, I estimate sector-level gravity equations to test the theoretical predictions. Following the existing empirical literature on comparative advantage,[1] I include in the gravity equation an interaction term between a country's index of labor protection and a sector proxy for specific skill intensity to capture the differential impacts of labor laws across

[1]This literature includes, among others, Romalis (2003), Levchenko (2007), Nunn (2007) and Manova (2007).

sectors. Using OLS, I find a positive and significant coefficient on the interaction term, which supports the theoretical prediction about the intensive margin of trade. Then I implement the two-stage estimation procedure. The results from the first-stage estimation confirm that countries with more protective labor laws are more likely to export in specific skill-intensive sectors, which support the prediction about the extensive margin of trade. To correct the two potential biases in the second-stage trade flow estimation, I include two variables imputed from the predicted probabilities of exporting from the first stage. Correcting for both types of biases, the second-stage gravity estimation confirms the OLS findings about the intensive margin of trade. More importantly, to confirm that my results are not driven by other country characteristics, I control for countries' factor endowments, income and contracting institutions in both selection and gravity equations. Moreover, I test the previously-examined channel through which labor market institutions affect trade patterns by including an interaction term between a country's index of labor protection and a sectoral measure of volatility. In sum, in addition to confirming the results for my hypothesis, I find evidence supporting the existing predictions on trade patterns.

To preview the empirical findings, in Figure 1-2, I plot countries' export specialization in specific skill-intensive sectors against the degree of labor protection for a sample of 84 countries.[2] A positive relationship between the two suggests that countries with more rigid labor laws have their exports biased towards specific skill-intensive sectors. The relationship is economically significant. An increase from 25th to the 75th percentile in the index of labor protection is associated with an increase in specialization in specific skill-intensive sectors of about 0.6 standard deviation. Figure 1-3 confirms this positive association among the OECD countries. For instance, Portugal, a country with more protective labor laws, derives proportionally more of its exports from specific skill-intensive sectors, than the U.S., a country with more flexible labor laws.

This paper is related to four strands of literature. First, it is motivated by empirical studies that show the importance of firm-specific human capital in production. In labor economics, empirical studies have found positive and significant effects of firm tenure on wages. (Kletzer,

[2]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 respective sector shares in a country's total exports. See equation (20) for detail.

1989; Topel, 1991; Jacobson et al., 1993; Buchinsky et al., 2004).[3] If wages reflect marginal product of labor, these findings confirm that firm-specific skills enhance firm productivity significantly.[4] In organizational economics, research (Monteverde and Teece, 1982; Masten et al., 1989) finds that the importance of specialized non-patentable human capital in production is a more significant factor compared to specialized physical capital in determining vertical integration between upstream and downstream firms in the automobile industry.[5] Besides showing that firms are often concerned of the incentives for investments in specific skills, these studies underscore the non-contractible nature of these investments.[6]

The second strand of literature studies how labor market institutions affect workers' skill acquisition (Houseman, 1990; Estevez-Abe et al.,1999; Hassler et al. 2001; Belot et al., 2007). Among them, Wasmer (2006) shows succinctly that in a search theoretical framework, labor market rigidity induces workers to acquire firm-specific skills relative to general skills, despite ambiguous welfare effects. In his model, higher firing costs increase search frictions in the external labor market and therefore the average duration of employer-employee relationships, which together result in relatively higher returns to specific skills in equilibrium. Although the current model shares a similar rationale, to my knowledge, this paper is the first attempt to incorporate this theory in an open-economy model, and test the hypotheses across countries. Importantly, the empirical findings from trade flow data offer indirect evidence to support the untested hypothesis that labor market rigidity is associated with more specific skills in a country's labor force.

The third strand of literature investigates the relationship between labor market institutions and international trade (Brecher, 1974; Matusz, 1996; Davis, 1998; Davidson et al., 1999;

[3]Among them, studies of layoffs through no fault of their own (for example, plant closings) show that laid-off employees typically earn 15 to 25 percent 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. (2004) employs Markov Chain Monte Carlo methods to account for workers' mobility decisions, and find that returns to job seniority in the U.S. are higher than those to general working experience. They claim that these "new" results are consistent with Topel (1991).

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

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

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

Davidson and Matusz, 2006; Helpman and Itskhoki, 2007). In particular, my paper is closely related to Saint-Paul (1997), Brügemann (2003) and Cuñat and Melitz (2007), who also examine labor market institutions as a source of comparative advantage. In their papers, sectors differ exogenously in uncertainty of sales, due to either demand or supply shocks. Thus, the source of comparative advantage emerges from the interplay between varying costs of labor reallocation between firms across different labor market regimes and varying needs for reallocation across sectors. Instead, I focus on a comparative advantage stemming from workers' skill acquisition in response to underlying labor laws, and different degrees of the dependence on specific skills across sectors.

Finally, my paper complements a growing strand of research on how cross-country differences in contracting institutions shape trade patterns. Among them, Costinot (2006), Levchenko (2007) and Nunn (2007) show both theoretically and empirically that countries with better contracting institutions specialize in the sectors in which production relies more on contract enforcement (such as complexity of production or the relationship specificity of investments by upstream producers). My paper contributes to this literature by showing empirically the effects of labor market institutions on trade patterns. In particular, it highlights their impact on the extensive margin of trade. On the theoretical front, this paper is similar to Antràs (2003; 2005), Antràs and Helpman (2004) and Acemoglu et al. (2007) in applying the property-rights approach in the study of international trade.

1.2 The Closed-Economy Model

In this section, I solve for the firm-level equilibrium in a closed economy, taking demand for goods as given. The ultimate goal of this section is to show how labor market institutions affect workers' skill acquisition. Specifically, I pin down a firm's optimal level of employment, and characterize its price, revenue and profit. The general-equilibrium open-economy model will be introduced in section 1.3.

1.2.1 Preferences

Consider a closed economy of $S+1$ sectors, with one sector producing homogeneous goods. and S sectors producing differentiated products. I normalize the price of the homogeneous good to 1, so that all prices are measured in units of this numéraire.

Labor is the only factor of production. The economy is inhabited by a measure L of ex-ante identical and risk-neutral consumers/workers, who supply labor inelastically. Each worker is endowed with $\widehat{h}$ units of general skills to begin with.

Preferences are composed of two parts: Utility from consumption and disutility of skill acquisition. Utility of consumption is a standard Cobb-Douglas aggregate over consumption indices of the homogeneous-good sector, C_0, and all differentiated-good sectors, C_s:

$$C = C_0^{1-\alpha}\left(\prod\nolimits_{s=1}^{S} C_s^{b_s}\right) \qquad \text{where} \sum_{s=1}^{S} b_s = \alpha.$$

Hence, in equilibrium, workers spend an exogenous fraction $1-\alpha$ of income on the homogeneous good, and a fraction b_s on the differentiated goods in sector s. Consumers exhibit love of variety. In particular, the real consumption index of sector s is a constant-elasticity of substitution (CES) aggregate over consumption of all available varieties $\omega's$ from the set Ω_s (to be determined in equilibrium):

$$C_s = \left[\int_{\omega\in\Omega_s} c_s(\omega)^{\frac{\sigma-1}{\sigma}}\, d\omega\right]^{\frac{\sigma}{\sigma-1}}$$

where $c_s(\omega)$ represents consumption of variety ω in sector s. $\sigma > 1$ is the elasticity of substitution between varieties, which implies that varieties within the same sector are better substitutes than those from other sectors. For simplicity, σ is assumed to be the same across sectors. This CES consumption function implies the following demand function of variety ω in sector s

$$c_s(\omega) = A_s p_s(\omega)^{-\sigma}$$

where $p_s(\omega)$ is its price, A_s captures the demand level for goods in sector s, which equals $P_s^{\sigma-1} b_s Y$, with Y being the aggregate spending of the economy. The specification of CES aggregates of variety consumption implies the following ideal price index of sector s :

$$P_s = \left[\int_{\omega \in \Omega_s} p_s(\omega)^{1-\sigma} \, d\omega \right]^{\frac{1}{1-\sigma}}.$$

Disutility of skill acquisition is assumed to be linear. If worker i exerts an effort level e_i to acquire skills, she incurs effort costs κe_i, measured in units of the homogeneous good. Therefore, given the ideal price index P of consumption and income w_i, her indirect utility is expressed as[7]

$$U_i = \frac{w_i - \kappa e_i}{P}.$$

1.2.2 Production Technologies and Market Structure

Production of the homogeneous goods requires only general knowledge. Technology is linear: a unit of general skills produces 1 unit of a homogeneous good. The product market for this sector is perfectly competitive, implying that the numéraire sector makes no profit and pays each worker a wage equal to her level of general skills.

The markets for differentiated products are monopolistically competitive. A potential employer chooses a sector to enter and sets up a firm with no cost. The assumption of zero fixed cost is for simplicity, and the main conclusions of the model do not depend on this assumption.

The production function of firm ω in sector s equals

$$y_s(\omega) = f_s(a(\omega), \epsilon(\omega))\, l(\omega), \tag{1.1}$$

where $l(\omega)$ is firm $\omega's$ employment. Its labor productivity f_s is

$$f_s(a, \epsilon) = \epsilon a^{\lambda(s)} \widehat{h}^{1-\lambda(s)},$$

where a represents the average level of workers' firm-specific skills; $\widehat{h}$ is the (fixed) level of their general skills; and ϵ is an exogenous productivity parameter (to be explained below). The functional form of labor productivity is sector-specific. In particular, sectors are ordered in

[7]The assumption that disutility of effort is measured in the same units of nominal wages is implicitly made in the Shapiro-Stiglitz (1984) efficiency wage model, and more recently in Davis and Harrigan (2007).

firm-specific skill intensity in ascending order, where $\lambda(s) \in (0,1)$ and $\lambda(s) > \lambda(s')$ if $s > s'$ $\forall s, s' \in \{1, .., S\}$.

After setting up the firm, the employer hires workers by posting a contractible wage, w_1. Since there is a large number of ex-ante identical workers competing for jobs, w_1 adjusts across firms and sectors, ensuring the same expected wage for all workers at the time of hiring, independent of which firms and sectors they join.

At the time of firms' hiring, workers have two choices : join one of the differentiated-good firms, or stay out in the external labor market. If they choose to stay out in the external labor market, they expect to be employed by the homogeneous-good sector later. A worker who joins a differentiated-good firm, receives w_1 and expects to exert effort to acquire specific skills. In practice, a lot of the firm-specific skills are difficult to describe in contracts, and therefore cannot be verified by a third party. For this reason, investments in firm-specific skills are assumed to be observable, but not contractible.[8] I take the assumption of contract incompleteness as a fact of life, and do not complicate the model by discussing its underpinnings. Furthermore, to focus on the main argument of the paper, I also assume the same degree of contract incompleteness across sectors. Relaxing this assumption does not alter the conclusions of the model.

Because no enforceable contract can be written ex ante, the employer cannot impose her preferred level of investments on her employees. For the same reason, the employer and the workers bargain over the division of surplus after workers' investments are sunk. I adopt the concept of generalized Nash bargaining between the representative worker (e.g. a union leader) and the employer within the "right-to-manage" framework, with $\phi \in (0,1)$ being the bargaining power of the workers. In the "right-to-manage" framework, the two parties in the firm bargain over wages, with the level of employment being chosen unilaterally by the employer before bargaining.[9]

Moreover, to abstract from issues related to coordination and incentive problems among workers, I assume that investments are chosen by a single representative worker of the firm.

[8]For instance, contract incompleteness of human capital investment has been used as an explanation for firm-provided training in studies by Balmaceda (2005) and Casas-Arce (2006).

[9]As discussed in Stole and Zwiebel (1996a and 1996b), firms have a strategic incentive to overemploy workers if the technology has decreasing returns to scale. However, as noted in their papers, unions internalize this effect with a single representative bargaining on other workers' positions. Thus, no incentive for overemployment arises. This statement is valid even if I relax the "right-to-manage" assumption.

The incentive and coordination problems can be studied in a richer setting with multilateral bargaining between each worker in the firm and the employer, such as those in Stole and Zwiebel (1996a and 1996b) and Acemoglu et al. (2007). Since the focus of the paper is on investment in firm-specific skills, I opt for a simpler set-up with bilateral bargaining. One way to interpret this is that bargaining happens between the union representative and the employer of a firm.[10] This representative worker chooses the optimal level of investment for each worker in the firm, anticipating a share of ex-post gains from investments for each of them. A worker who exerts effort level a to acquire skills incurs disutility κa.

After investments are sunk, the employer and the employees of a firm bargain over the division of expected surplus. At the time of bargaining, the employer's outside option is normalized to 0. One way to interpret this is that workers have spent time learning but did not produce yet at the time of bargaining. Concurrently, the homogeneous-good sector hires workers who are still in the external labor market.[11] In this situation, a worker endowed with $\widehat{h}$ units of general skills in the differentiated-good firm can quit the firm, join the competitive homogeneous-good sector, and produce $\widehat{h}$ units of homogeneous goods. Thus, a worker's outside option at the time of bargaining equals $\widehat{h}$. Production itself is normalized to require no effort.

1.2.3 Labor Regulations and Implied Workers' Bargaining Power

Following Blanchard and Giavazzi (2003) and Spector (2004),[12] I use the parameter ϕ, admittedly in an abstract fashion, to represent the degree of a country's labor protection in the model. A higher ϕ is associated with more protective (regulated) labor laws. Intuitively, when labor laws become more protective, workers are able to bargain for a larger share of surplus with their employers. To mention a few real-world examples, ϕ represents any labor regulations that increase workers' bargaining power, ranging from the existence and the nature of extension

[10]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 (2007) employ the Shapley value concept to solve for 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.

[11]The assumption that the homogeneous-good sector hires workers later than the differentiated-goods firms is not crucial for the main conclusions of the paper. Having this assumption allows me to highlight the ex-post relative returns to both types of skills. If I assume instead that the homogeneous-good sector employs workers at exactly the same time as the differentiated-goods firms, the solutions of w_1 will be different. Nevertheless, since ex-ante transfers do not affect workers' incentives to invest, the main insights of the model are unchanged.

[12]See also Griffith et al. (2007) for a discussion.

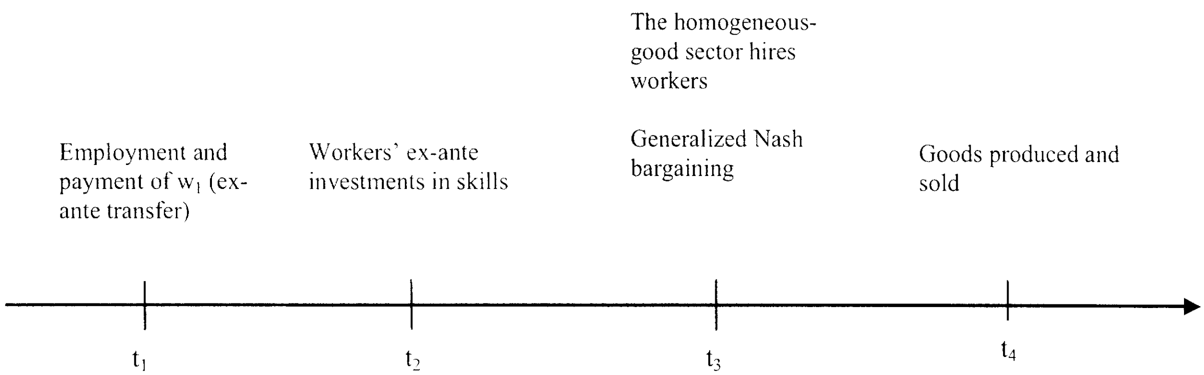


Figure 1-1: Timing of Events

agreements, to closed shop arrangements, to the rules on the right to strike (Blanchard and Giavazzi, 2003). For simplicity, I assume the same bargaining power of workers across all firms in the differentiated-good sectors in an economy.

1.2.4 Timing of Events

I summarize the timing of events as follows (see also Figure 1-1).

At t_1, the firm posts a contractible wage w_1 to hire workers. Workers have two choices: join a firm, or stay out in the external labor market. Those who stay out expect to be employed later.

At t_2, workers in a differentiated-product firm exert optimal effort to acquire specific skills, anticipating a share ϕ of ex-post surplus from sales, together with the outside options that depend only on their general skills. They incur disutility κa from skill acquisition.

At t_3, after workers' investments, agents in a differentiated-good firm bargain over the division of expected surplus. The homogeneous-good sector hires workers, and pays each of them $\widehat{h}$. The labor market clears.

At t_4, if both parties in the firm agreed to continue the relationship at t_3, workers produce goods using their acquired skills effortlessly. Ex-post surplus S from sales (revenue minus the outside options of both parties) is divided between the employer and the employees, according to labor laws, with ϕS and $(1-\phi)\,S$ going to the workers and the employer, respectively. The homogeneous sector produces and sells an amount $\widehat{h}l_0$ of goods. All goods markets clear. There is no discounting between t_1 and t_4.

1.2.5 Firm-level Equilibrium

Preliminaries

I solve the model backward in time from t_4. First, I solve for the workers' optimal effort of investments. Then I go back in time to pin down a firm's optimal level of employment, and the implied price, output, revenue and profit. Given ϵ, with the assumption of symmetric equilibrium, the solutions to all firms' problems are identical. Thus, in this section, I focus on a single firm and suppress the firm subscript ω. Sector subscript s is also suppressed when there is no ambiguity.

Given downward-sloping demand for each variety, the price of a variety and firm revenue (as a function of y) are expressed as follows:

$$p = A_s^{1-\eta} y^{\eta-1}; \qquad R = A_s^{1-\eta} y^{\eta}, \tag{1.2}$$

where $\eta = 1-1/\sigma$ and A_s is the demand level for goods in sector s (to be solved in equilibrium).[13] Since each firm is infinitesimal, A_s is taken as given by agents in each firm. Because $\eta < 1$, firm revenue is concave in its output, ensuring unique solutions for the optimal levels of employment and workers' investments (see below).

With the value of a worker's outside option equal to $\widehat{h}$, and that of the employer normalized to 0, the ex-post surplus of a firm with a measure l of workers equals $S = R - \widehat{h}l$.

Workers' Investment in Firm-specific Skills (at t_2)

Since workers' investments in specific skills are non-contractible, employers have no way to impose their preferred levels of investments. Workers invest optimally at t_2, anticipating payoffs from ex-post bargaining at t_3. Throughout the paper, I assume that firms do not directly invest in workers' human capital.[14]

[13] $A_s = P_s^{\sigma-1} b_s Y$

[14] They do, however, indirectly pay for them in equilibrium through ex-ante transfers.

To simplify algebra, I assume that the marginal cost of skill acquisition κ equals 1. Since a worker in a firm with a measure l of workers expects to get $\phi S(a)/l + \widehat{h}$, the representative employee of the firm maximizes her expected ex-post payoffs by choosing the level of investment in specific skills, a, subject to the linear effort cost as:

$$\max_a \phi R(a)/l + (1-\phi)\widehat{h} - a$$

where from (1.2), $R(a) = A^{1-\eta}\left(\epsilon a^{\lambda}\widehat{h}^{1-\lambda}l\right)^{\eta}$.

With l pre-determined, the first order condition delivers the optimal investment level of specific skills a^* as:

$$a^*(\lambda,\phi) = \left[\phi\lambda\eta B\left(\epsilon\widehat{h}^{1-\lambda}\right)^{\eta}\right]^{\frac{1}{1-\lambda\eta}}, \tag{1.3}$$

where $B = (A/l)^{1-\eta}$ is a function of sector-level demand, A, and firm-level employment, l, both taken as given by workers in the maximization problem.

Stronger workers' bargaining power ϕ increases a^*, *ceteris paribus*, for the following reason. When workers anticipate a larger share of firm revenue due to higher bargaining power, they are more willing to invest in the interest of the firm. This is a standard second-best result in a world with incomplete contracting. To illustrate this, consider the situation when human capital investments are contractible for the moment. The employer can therefore impose her preferred levels of investments on the workers to maximize joint surplus. Denote the first-best investment level under complete contracting as $a^c = \arg\max_a R(a)/l - a$. The corresponding first-order conditions show that $a^c = \left[\lambda\eta B\left(\epsilon\widehat{h}^{1-\lambda}\right)^{\eta}\right]^{\frac{1}{1-\lambda\eta}} > \left[\phi\lambda\eta B\left(\epsilon\widehat{h}^{1-\lambda}\right)^{\eta}\right]^{\frac{1}{1-\lambda\eta}} = a^*$. This inequality implies that workers always underinvest in firm-specific skills compared to the first-best level. This is an outcome of a one-sided hold-up problem, of which workers are not the full residual claimants of the gains derived from their investments (i.e. when $\phi < 1$).[15] In other words, as ϕ approaches 1, workers choose an investment level closer to what the employer prefers.[16]

[15]In reality, ϕ is never close to 1. Also, this simple model does not include capital as a factor of production. With capital as a factor of production, an employer will always require some surplus to cover her sunk investment costs.

[16]The focus of this paper is on comparative advantage arising from labor regulations. The current discussion about ϕ has no normative implications for optimal labor laws. For welfare analysis for countries with different labor laws, readers are referred to a review by Nickell (1997).

Using $a^*(\lambda,\phi)$ from (1.3), I can derive firm labor productivity in terms of parameters and aggregate variables as:

$$f^*(\lambda,\phi) = \left[\epsilon \widehat{h}^{1-\lambda} (\phi\lambda\eta B)^{\lambda}\right]^{\frac{1}{1-\lambda\eta}}. \tag{1.4}$$

The effect of employer-specific exogenous productivity ϵ on $f^*(\lambda,\phi)$ is magnified with $\frac{1}{1-\lambda\eta} > 1$. In addition to the direct effect, there is an indirect effect stemming from workers' increased incentives in human capital investment in a more productive firm. More importantly, the effect of labor regulations on firm productivity, which underlies the proposed institutional comparative advantage in this paper, is summarized by the following lemma.[17]

Lemma 1 Let $\varsigma_{\phi}(\lambda,\phi) \equiv \partial \ln f^*(\lambda,\phi)/\partial \ln \phi$ be the elasticity of $f^*(\lambda,\phi)$ with respect to ϕ, and $\varsigma_{\lambda} \equiv \partial \ln f^*(\lambda,\phi)/\partial \ln \lambda$ be the elasticity of $f^*(\lambda,\phi)$ with respect to λ. I have that:

i) $\varsigma_{\phi}(\lambda,\phi) > 0$;

ii) $\partial\varsigma_{\phi}(\lambda,\phi)/\partial\lambda > 0$ and $\partial\varsigma_{\lambda}(\lambda,\phi)/\partial\phi > 0$.

Proof: See Appendix.

Part (i) of this lemma highlights that all else equal, higher bargaining power of workers enhances labor productivity. In the current model in which workers are the only party investing in human capital, workers' anticipation of higher ex-post payoffs induces acquisition of specific skills, which in turn enhances firm productivity.

More importantly, part (ii) of this lemma captures the key determinant of institutional comparative advantage in the paper. The positive effect of granting workers bargaining power is larger for firm-specific skill-intensive firms. Specifically, when there is a greater need for firm-specific skills in production, the proportional increase in $f^*(\lambda,\phi)$ due to labor protection is larger. In other words, the more important workers' specific investments are in production, the more beneficial it is (in the sense of enhancing productivity) to grant the workers more residual claims, so as to lessen the hold-up. This insight is consistent with Roberts and Van den Steen (2000), who argue that it is optimal for an employer to grant her employees a larger share of equity ownership, or essentially a bigger role in governance, when non-contractible

[17] $f^*(\lambda,\phi)$ is increasing in $B = (A/l)^{1-\eta}$. However, since both A and l are taken as given at this stage, and will be determined in equilibrium, no general-equilibrium comparative statics on f^* can be done for either A or l here.

human-capital investments become more important.

While Lemma 2 shows comparative statics of ϕ and λ based on elasticities, its implication is more general. To illustrate this, consider a world with two countries: i and k, which are identical on all aspects besides that labor laws are more protective in i than k, i.e. $\phi_i > \phi_k$. To show that the impact of labor protection on different sectors varies, consider the ratio of firm labor productivity between two countries:

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

This ratio is increasing in λ as long as $\phi_i > \phi_k$. Intuitively, through endogenous workers' skill acquisition, the model delivers an upward-sloping technology schedule (in λ) summarizing comparative advantage of the two countries. In spirit, this schedule is similar to the exogenous technology schedule in Dornbusch, Fischer and Samuelson's (1977) two-country Ricardian trade model with a continuum of industries.

At t_3, because of ex-post efficiency of Nash bargaining, both parties always agree to continue the relationship. Workers produce goods effortlessly with the acquired skills at t_4.

Firm Employment Decision (t_1)

Now go back in time to t_1. Anticipating a payoff of $(1-\phi)\, S(a^*)$, the employer hires workers by offering a contractible wage, w_1. She chooses the level of employment l to maximize the expected net surplus as follows:

$$\widetilde{\pi}(a^*) \equiv \max_l (1-\phi)\left[R(a^*) - \widehat{h}l\right] - w_1 l.$$

At t_1, the outside options for workers are determined by the (expected) employment opportunities in the homogeneous-good sector. Since the wage of each unit of general skills equals 1, a worker endowed with $\widehat{h}$ units of general skills has an outside option equal to $\widehat{h}$. On the other hand, if a worker joins a firm with ϵ, she gets $w_1(\epsilon)$, expecting to undertake optimal investments $a^*(\epsilon)$ to obtain payoffs $\phi R + (1-\phi)\widehat{h}$ after production. Hence, the ex-ante participation constraint for a worker joining the firm at t_1 is

$$w_1(\epsilon) + \phi R(a^*, \epsilon) + (1-\phi)\widehat{h} - a^* \geq \widehat{h}.$$

Inelastic supply of ex-ante identical workers implies that $w_1(\epsilon)$ will adjust in a way until the participation constraint binds. Therefore, $w_1(\epsilon)$ is pinned down as follows:

$$w_1(\epsilon) = -[\phi R(a^*, \epsilon)/l - a^*] + \phi\widehat{h}. \tag{1.5}$$

Notice that $w_1'(\epsilon) < 0$. Since a higher ϵ implies higher ex-post payoffs for the workers, all else being equal, a higher ϵ reduces the "required" ex-ante transfer $w_1(\epsilon)$ to employ workers. Furthermore, with the concavity of $R(a^*, \epsilon)$, optimal efforts chosen by workers ensure that the term inside the square brackets in (1.5) is always positive. Therefore, w_1 is less than $\phi\widehat{h}$, and can even be negative.[18] For simplicity, I assume that workers are not borrowing-constrained, so that a negative w_1 is feasible. Substituting w_1 into the firm's objective function yields

$$\widetilde{\pi}(a^*, \epsilon) \equiv \max_l R(a^*, \epsilon) - a^* l - \widehat{h}l.$$

With $a^*(\lambda, \phi)$ solved in (1.3), I can derive $R(a^*(\lambda, \phi), \epsilon)$ in terms of λ, ϕ and ϵ, and rewrite the employer's problem as (see derivation in appendix):

$$\widetilde{\pi}^*(\phi, \lambda, \epsilon) = \max_l \left(A^{1-\eta}\epsilon^{\eta}\right)^{\frac{1}{1-\lambda\eta}} \psi(\phi, \lambda) \left(\widehat{h}l\right)^{\delta(\lambda)} - \widehat{h}l, \tag{1.6}$$

where $\psi(\phi, \lambda) = (\phi\lambda\eta)^{\frac{\lambda\eta}{1-\lambda\eta}}(1-\phi\lambda\eta)$. Since $0 < \delta(\lambda) = \frac{(1-\lambda)\eta}{1-\lambda\eta} < 1$, the problem is convex. Together with $\psi(\phi, \lambda) > 0$, the first order condition of this problem yields a unique optimal level of employment. Substituting the optimal choice of employment into (1.2) delivers the following functions of firm price, output, revenue and the employer's net surplus as (see derivation in

[18] To show that shirking is never an equilibrium outcome, consider the situation when a worker shirks, and invest in no skills at all. The expected "life-time" income of a shirker is equal to w_1 plus her outside option at t_3, which will become $\widehat{h}$, i.e. $U_{shirk} = \left(w_1(\epsilon) + \widehat{h}\right)/P$. For a worker who exerts optimal effort to acquire skills, she will get $U_{opt.} = \left[\widehat{h} + w_1(\epsilon) + w_2(a^*, \epsilon) - a^*\right]/P$. Since $w_2(a^*, \epsilon)$ is concave in a, optimal choices a^* guarantee that $w_2(a^*, \epsilon) - a^* > 0$. Thus, $U_{opt.} \geq U_{shirk}$ and shirking is always an off-equilibrium outcome.

appendix):

$$
\begin{aligned}
p(\phi,\lambda,\epsilon) &= \frac{\Theta(\phi,\lambda)}{\epsilon\eta}; \qquad y(\phi,\lambda,\epsilon) = A\left(\frac{\Theta(\phi,\lambda)}{\epsilon\eta}\right)^{-\sigma} \\
R(\phi,\lambda,\epsilon) &= A\left(\frac{\Theta(\phi,\lambda)}{\epsilon\eta}\right)^{1-\sigma}; \qquad (1.7) \\
\widetilde{\pi}(\phi,\lambda,\epsilon) &= A\left(\frac{\Theta(\phi,\lambda)}{\epsilon\eta}\right)^{1-\sigma}\frac{(1-\phi\lambda\eta)(1-\eta)}{1-\lambda\eta} \qquad (1.8)
\end{aligned}
$$

where

$$\Theta(\phi,\lambda) = \widetilde{\lambda}\left(\frac{1-\lambda\eta}{1-\phi\lambda\eta}\right)^{1-\lambda}\left(\frac{1}{\phi}\right)^{\lambda}; \qquad \widetilde{\lambda} = (1-\lambda)^{-(1-\lambda)}\lambda^{-\lambda}.$$

These firm values take the familiar functional forms. Price is a standard mark-up over marginal cost $\Theta(\phi,\lambda)$, with a smaller markup associated with a higher elasticity of demand. A higher employer-specific exogenous productivity term, ϵ, decreases prices, and increases output, revenue and employers' net surplus. Furthermore, a higher sector-level demand A increases output, revenue and employers' net surplus linearly.

Perhaps surprisingly, all these equations are independent of the nominal wage, $\widehat{h}$. It happens that $\widehat{h}$ is multiplied to l in both the employers' surplus and labor costs, which offset each other in these equations. Importantly, the effects of labor protection on these firm values are summarized by the following proposition.

Proposition 1 (Profitability): All else being equal, higher workers' bargaining power increases firm output, revenue and the employer's net surplus. These effects of labor laws are more pronounced in sectors for which firm-specific skills are more important.

Proof: See appendix.

The intuition of Proposition 1 follows that of Lemma 1. When the workers in a firm are given more bargaining power, they expect to receive a bigger fraction of ex-post surplus derived from investments in specific skills. For this reason, they exert more effort to acquire skills, which in turn increase firm productivity. Consequently, in sectors for which specific skills are more important in production, the productivity effect due to protective labor laws is more pronounced.

One may argue that since the employer's ex-post surplus is decreasing with ϕ, all else being equal, the employer should be worse off when the workers gain more bargaining power. However, with a constant ex-ante outside option $\widehat{h}$ for the workers, ex-ante transfers to the workers $w_1(\epsilon)$ adjust in such a way so that all workers across firms and sectors receive the same "life-time" income. Hence, when a higher ϕ increases investments in specific skills and therefore joint surplus, the employer's net surplus increases one for one.[19]

In this closed-economy model, workers invest only in firm-specific skills. However, the model is flexible enough to also incorporate investment decisions for general skills. In the previous version of the paper, I develop a model in which workers undertake non-contractible activities to acquire both firm-specific and general skills on the job. The solutions of the extended model posit that higher workers' bargaining power alleviates the underinvestment problems for all human capital investments, more so for production that depends more on specific skills. The rationale is that since specific skills are not transferable across firms, the corresponding underinvestment problem is more severe. If protective labor laws have an effect in alleviating the underinvestment problems for both types of skills, the impact will be greater for specific human-capital investments, and for production that depends more on them. Although the extended model is more realistic, the main insight about comparative advantage in the paper is unchanged. I therefore choose to present a simpler model in this paper.

1.3 The Multi-Country Open-Economy Model

In this section, I embed the closed-economy model in a multi-country open-economy framework with heterogeneous firms, a là Helpman, Melitz and Yeaple (2004). The ultimate goal of this section is to derive sector-level gravity equations, which capture the impact of labor market institutions on both the intensive and extensive margins of trade. Without imposing the firm free-entry condition, general equilibrium solutions cannot be characterized without specific assumptions about the number of firms in each sector. Therefore, I first present the partial-

[19]Notice that the timing of the game is crucial for the results here. Since workers acquire specific skills after they receive the transfers, the amount of the transfers no longer matters for their investment incentives. Therefore, even though the employer's net surplus increases one for one, workers' incentives to invest does not decrease. In fact, exactly the opposite happens: anticipating a larger share of firm surplus, workers have more incentives to invest, driving up the employer's (expected) surplus by adjusting the ex-ante incentive-neutral transfers.

equilibrium version of the open-economy model by taking the measure of firms in each sector as given. This approach was first employed by Helpman, Melitz and Rubinstein (2007). and was extended by Manova (2007) to a multi-sector setting. Later, I show that by making the same assumptions as Chaney (2007), I can close the model in general equilibrium. Importantly. the predictions based on the partial-equilibrium solutions are unchanged in general equilibrium.

1.3.1 The Environment

Consider an open economy with N countries. All goods are potentially tradable across countries. While the homogeneous (numéraire) goods are freely traded, differentiated-good firms face fixed and variable trade costs to export. The variable cost takes the form of an "iceberg" transportation cost. Specifically, for a unit of a variety in sector s shipped from country i to country j, only a fraction $1/\tau_{ij} < 1$ arrives in the destination. The higher τ, the higher the variable trade cost. In addition, to export to country j, a firm in country i has to pay an up-front fixed cost f_{ij} in units of the numéraire.[20] For simplicity, I assume symmetric variable and fixed trade costs between any two trade partners, i.e. $\tau_{ij} = \tau_{ji}$ and $f_{ij} = f_{ji}$.

I consider only equilibria of which all countries produce some numéraire goods. This condition will hold as long as the expenditure share of the numéraire $(1-\alpha)$ is large enough, or trade costs for differentiated goods are high enough. Provided that per worker endowment of general skills is $\widehat{h}_i$ and the homogeneous-good sector is active, all workers' life-time incomes in country i equal $\widehat{h}_i$. Thus, for notational simplicity, I denote country $i's$ nominal wage $w_i = \widehat{h}_i$.

To construct an empirical framework to test the extensive margin of trade in the following sections, I introduce heterogeneous firm productivity into the model. Upon setting up a firm, the employer draws costlessly an exogenous productivity parameter ϵ, which determines part of the firm's labor productivity. As in Helpman, Melitz and Yeaple (2004), firms from different sectors draw $\epsilon's$ from the same Pareto distribution over bounded support $[1, \epsilon_H]$,[21] with the

[20] Examples of the fixed export costs include costs for setting up a distribution network, research on the foreign markets, and so on.

[21] The assumption of Pareto distribution of exogenous productivity, orginally proposed by Melitz (2003), was adopted by a series of papers, such as Chaney (2007), Helpman, Melitz and Rubinstein (2007), among others. See Helpman, Melitz and Yeaple (2004) for evidence that the sample distributions of firm size in the U.S. and Europe are approximated closely by Pareto distribution.

cumulative distribution function of ϵ equal to

$$\Pr\left(\epsilon < \epsilon'\right) = G\left(\epsilon\right) = \left(1 - \epsilon^{-\xi}\right) / \left(1 - \epsilon_H^{-\xi}\right),$$

where $\xi > \sigma - 1$ is a measure of the dispersion of $\epsilon's$ across firms.[22] The smaller ξ, the more concentrated $\epsilon's$ are around the lower bound. which is normalized to 1. Importantly, ϵ is drawn before hiring, which becomes common knowledge once it is drawn.

1.3.2 Sectoral Export Thresholds for a Foreign Market

Denote $\Theta_{is} = \Theta\left(\phi_i, \lambda\left(s\right)\right)$, and the employer's net surplus from exporting to j in sector s, $\widetilde{\pi}_j\left(\epsilon, \phi_i, \lambda\left(s\right)\right) = \widetilde{\pi}_{ijs}\left(\epsilon\right)$. From (8), I can express the employer's net surplus from exporting to j as:

$$\widetilde{\pi}_{ijs}\left(\epsilon | \epsilon \geq \epsilon^*_{ijs}\right) = \frac{b_s Y_j}{P_{js}^{1-\sigma}} \left(\frac{\Theta_{is}\tau_{ij}}{\epsilon\eta}\right)^{1-\sigma} \frac{\left(1 - \phi\lambda\eta\right)\left(1 - \eta\right)}{1 - \lambda\eta} - f_{ij},$$

where Y_j is the aggregate spending of j, P_{js} is the price index of goods in sector s and country j, and ϵ^*_{ijs} is the productivity threshold above which firms export to j (to be determined below). Notice that the "iceberg cost" $\tau_{ij} > 1$ enters the employer's net surplus equation through "marking up" the domestic unit price in (1.8). Evidently, all else being equal, a firm in i exports more to j if Y_j and/or P_{js} are higher.

More importantly, the employer's net surplus depends on the term of endogenous comparative advantage due to exporter i's labor laws, Θ_{is}. Since firms in country i find it profitable to export to j only if the expected net surplus is sufficient to cover the fixed export cost, f_{ij}, exporting firms are only a subset of existing firms. Specifically, the productivity threshold ϵ^*_{ijs} is determined by the break-even rule $\pi_{ij}\left(\epsilon\right) = 0$ as

$$\epsilon^*_{ijs} = \frac{\Psi_{is}\tau_{ij}}{P_{js}} \left(\frac{b_s Y_j}{f_{ij}}\right)^{\frac{1}{1-\sigma}}, \tag{1.9}$$

where

$$\Psi_{is} = \Theta_{js} \left(\frac{\left(1 - \phi\lambda\eta\right)\left(1 - \eta\right)}{1 - \lambda\eta}\right)^{\frac{1}{1-\sigma}}.$$

[22]This assumption ensures that the distribution of firm sales has a finite mean in equilibrium.

With the presence of fixed trade costs, there are increasing returns to exporting at the firm level. Therefore, ϵ_{ijs}^{*} is increasing in fixed trade costs, f_{ij}, and is decreasing in j's income, Y_j and the sectoral price level, P_{js}. Notably, the impact of labor laws on ϵ_{ijs}^{*} is summarized by the following lemma:

Lemma 2 (Firm Selection into Exporting): All else being equal, the productivity thresholds for exporting are lower when labor laws become more protective. Moreover, the productivity thresholds are reduced by more in sectors for which firm-specific skills are more important.

Proof: See Appendix

This is a direct result from Proposition 1, which states that the employer's net surplus $\widetilde{\pi}_{ijs}$ is increasing in workers' bargaining power, *ceteris paribus*, and proportionally more so for the more firm-specific skill-intensive sectors. Hence, the "required" exogenous productivity ϵ to sustain the exporting status decreases, more so in more specific skill-intensive sectors.

Without firm-level data for a large sample of countries, Lemma 2 cannot be tested empirically. However, given a measure N_{is} of firms in country i and sector s, and a distribution $G(\epsilon)$ of firm productivity, the fraction of firms exporting in sector s is $0 < 1 - G\left(\epsilon_{ijs}^{*}\right) < 1$ with $\epsilon_{ijs}^{*} \in (1, \epsilon_H)$. In other words, at the country level, Lemma 2 can be interpreted as the likelihood of country i's exporting to a given country, which implies the following testable proposition.

Proposition 2 (Extensive Margin of Trade): Among a country's trading partners, those with more protective labor laws are more likely to export in more firm-specific skill-intensive sectors.

1.3.3 Sectoral Export Volumes for a Foreign Market

Next, I consider the impact of labor protection on sectoral export volumes in the theoretical framework of Helpman, Melitz and Rubinstein (2007). By rewriting the demand level, A, in (1.7) in terms of the sectoral price (P_{js}) and aggregate spending (Y_j) in country j, firm revenue from exporting to j is expressed as:

$$x_{ijs}\left(\epsilon|\epsilon \geq \epsilon^*_{ijs}\right) = \frac{b_s Y_j}{P_{js}^{1-\sigma}}\left(\frac{\Theta_{is}\tau_{ij}}{\epsilon\eta}\right)^{1-\sigma}.$$

By aggregating $x_{ijs}\left(\epsilon|\epsilon \geq \epsilon^*_{ijs}\right)$ across all firms in sector s that export to j, I obtain the sectoral volume of exports from i to j as follows (see derivation in appendix):

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

where N_{is} is the number of firms in sector s of country i, which is assumed to be exogenous for the moment, and

$$V_{ijs} = \left\{\begin{matrix} \int_{\epsilon^*_{ijs}}^{\epsilon_H} \epsilon^{\sigma-1} dG\left(\epsilon\right) & \text{if } \epsilon^*_{jis} \leq \epsilon_H \\ 0 & \text{otherwise} \end{matrix}\right\}.$$

The sectoral export volume, X_{ijs}, increases with the number of producers, N_{is}, because for a given fraction of exporting firms, a bigger mass of firms implies more exports. In addition, X_{ijs} increases with the sectoral price level of the importing country, P_{js}, because P_{js} is higher when the goods market in the foreign country is less competitive. *Ceteris paribus*, firms export more to j to make profits in a less competitive goods market, resulting in higher export volumes at the sector level.

With ϵ following a Pareto distribution over bounded support $[1, \epsilon_H]$, X_{ijs} can be solved in closed form as

$$X_{ijs} = \frac{b_s N_{is} Y_j}{\left(\eta P_{js}\right)^{1-\sigma}}\left(\Theta_{is}\tau_{ij}\right)^{-(\sigma-1)} W_{ijs}, \tag{1.10}$$

where

$$W_{ijs} = \max\left\{\left(\frac{\epsilon_H}{\epsilon^*_{jis}}\right)^{\xi-(\sigma-1)} - 1, 0\right\}. \tag{1.11}$$

These equations imply that labor protection affects the sectoral volume of exports through two channels. The first channel is the intensive-margin channel. From Lemma 1, more protective labor laws, *ceteris paribus*, increase productivity. Higher firm productivity is translated into lower prices (given a constant mark-up over marginal cost), and therefore higher firm and sectoral export volumes. This positive impact is more pronounced in firm-specific skill-intensive industries.

The second channel is the extensive margin, as already discussed in Lemma 2. For a given foreign market, a higher ϕ_i implies more exporting firms in a given sector, *ceteris paribus.* The positive impact is more pronounced when specific skills become more important in production. Since both channels imply positive effects of labor protection on exports, *ceteris paribus,* the combined effects of labor laws on trade flows are summarized by the following proposition.

Proposition 3 (Intensive Margin of Trade): Among a country's trading partners, those with more protective labor laws export relatively more in more firm-specific skill-intensive sectors.

Proof: see appendix.

1.3.4 General Equilibrium

This section discusses how the model can be closed in general equilibrium. The sector-level gravity equation derived in general equilibrium will be used as the specification for traditional gravity estimation using OLS. To close the model in general equilibrium, I follow Chaney (2007) to make the following three assumptions. First, instead of imposing the firm free-entry condition, I assume that the number of firms in each sector is proportional to the size of the economy, $w_i L_i$.[23] Second, profits exist due to heterogeneous firm productivity, which are distributed back to workers through a global mutual fund. I assume that each worker in country i owns w_i shares of a global mutual fund, which collects profits from firms, and distributes π per share without transaction costs to each shareholder. Therefore, aggregate income of country i equals $w_i (1 + \pi) L_i$, where the dividend per share π is

$$\pi = \frac{\sum_{i,j}^{N} \sum_{s}^{S} w_j L_j \left[\int_{\epsilon_{ijs}^{*}} \pi(\epsilon) \, dG(\epsilon) \right]}{\sum_{j}^{N} w_j L_j}.$$

Finally. I assume that $\epsilon_H \to \infty$. Notice that for Proposition 2 to hold, ϵ_H needs to be

[23]Eaton and Kortum (2002) make a similar assumption by taking the set of goods as exogenously given.

bounded. Otherwise, the "likelihood" of exporting is not defined. The assumption that $\epsilon_H \to \infty$ is just an approximation so that closed-form solutions can be obtained in general equilibrium. One should not interpret this as a contradiction to the effects of labor laws on the extensive margin of trade.

Under these assumptions, the ideal price index for goods in sector s and country i is expressed as

$$P_{is} = \left[\int_{\omega\in\Omega_{is}} p_{is}(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}} = \left[\sum_{j}^{N} w_j L_j \int_{\epsilon^*_{jis}} \left(\frac{\Theta_{js}}{\epsilon\eta}\right)^{1-\sigma} dG(\epsilon)\right]^{\frac{1}{1-\sigma}}. \tag{1.12}$$

By substituting ϵ^*_{ijs} from (1.9) into P_{is}, I obtain the equilibrium sectoral price in country j as follows (see derivation in appendix):

$$P_{js} = \mu_1 Y_j^{\frac{1}{\xi}+\frac{1}{1-\sigma}} \Delta_j, \tag{1.13}$$

where μ_1 is a sector-specific constant,[24] and $\Delta_j^{-\xi} = \sum_{i}^{N} \frac{Y_i\Theta_{is}^{-\xi}}{1+\pi} \tau_{ij}^{-(\xi-(\sigma-1))} f_{ij}^{-\frac{\xi-(\sigma-1)}{\sigma-1}}$. Δ_j is an index of the remoteness of country j from the rest of the world. It accounts for the impact of fixed and variable trade costs j imposes on other countries. The more geographically remote j is, the higher the average trade costs it has to bear, and therefore a higher price level for sector s. Notice that Δ_j is similar to the term denoted as "multilateral resistance" in Anderson and van Wincoop (1998). While in their paper, a country's multilateral resistance depends on its trading partners' respective multilateral resistances, here Δ_j summarizes the effects on the sectoral price of j's trading partners' nominal income, Y_i, and their degrees of labor protection, Θ_{is}, weighted by the respective distances from its trading partners. For instance, suppose that country j is close to country i, τ_{ij} and f_{ij} are likely to be low. Thus, if country i has high nominal income (high Y_i), P_{js} decreases for all sectors because being close to a rich country i implies more varieties shipped to country j with low trade costs.

With aggregate variable $A_{js} = P_{js}^{\sigma-1} b_s Y_j$ now solved solely as a function of Y_j, I can express the volume of firm-level exports, x_{ijs}, and the productivity threshold for exporting, ϵ^*_{ijs}, in

[24] $\mu_1 = \frac{1}{\eta}\left(\frac{\xi-(\sigma-1)}{\xi}\right)^{\frac{1}{\xi}} \left(\frac{(1-\lambda\eta)b_s}{(1-\phi\lambda\eta)(1-\eta)}\right)^{\frac{1}{\xi}+\frac{1}{1-\sigma}}$

terms of parameters and the destination's income as:

$$
\begin{aligned}
x_{ijs}\left(\epsilon | \epsilon \geq \epsilon_{ijs}^{*}\right) &= \mu_2 \Delta_j^{\sigma-1} Y_j^{\frac{\sigma-1}{\xi}} \left(\frac{\Theta_{is}\tau_{ij}}{\epsilon\eta}\right)^{1-\sigma}, & (1.14) \\
\epsilon_{ijs}^{*} &= \mu_3 \Delta_j^{-1} Y_j^{-\frac{1}{\xi}} \tau_{ij} f_{ij}^{\frac{1}{\sigma-1}} \Psi_{is}, & (1.15)
\end{aligned}
$$

where μ_2 and μ_3 are sector-specific constants.[25] Perhaps surprisingly, x_{ijs} is increasing in the remoteness of j, Δ_j. The intuition is that when country j is far from any other country in the world, the relative distance between i and j is shorter. However, this "remoteness" effect is likely to be dominated by both fixed and variable trade costs (f_{ij} and τ_{ij}), which deter exports and increase the exporting threshold as shown in the equations.

To illustrate that Proposition 3 (on the intensive margin of trade) continues to hold in this context, I derive X_{ijs} as:

$$
X_{ijs} = \mu_4 Y_i Y_j \left(\frac{\Delta_j}{\Psi_{is}}\right)^{\xi} \frac{1}{1-\phi_i \lambda(s)\eta} \tau_{ij}^{-\xi} f_{ij}^{-\frac{\xi-(\sigma-1)}{\sigma-1}}, \quad (1.16)
$$

where μ_4 is a sector-specific constant (see derivation in appendix).[26] As in a standard gravity equation, X_{ijs} is decreasing in both variable and fixed trade costs, and increasing in the product of incomes of the trading partners. Importantly, the comparative statics of ϕ and λ for sector-level exports derived in partial equilibrium, summarized in Proposition 2 in section 1.3.2, continue to hold here.[27]

Finally, the labor market clears in each economy, as long as the homogeneous-good sector is active in all countries.

---

[25] $\mu_2 = b_s \gamma_1^{\sigma-1}$ and $\mu_3 = b_s^{\frac{1}{1-\sigma}} \gamma_1^{-1}$.

[26] $\mu_4 = \frac{\xi(1-\gamma\eta)\eta^{\xi}(1+\pi)^{-1}}{\xi-(\sigma-1)} b_s^{\frac{\xi}{\sigma-1}} \mu_1^{\xi}$

[27] However, with the assumption of $\epsilon_H \to \infty$, the prediction of the extensive margin of trade no longer holds. It is important to note that this assumption is needed to close the model in general equilibrium. Empirical evidence for the extensive margin of trade reported later in this paper requires ϵ distributed over a bounded support, regardless of whether $G(\epsilon)$ is Pareto or not.

1.4 Empirical Framework

In the rest of the paper, I seek to test the theoretical predictions for the intensive and extensive margins of trade. To this end, I follow Manova (2007) in implementing Helpman, Melitz and Rubinstein's (2007) two-stage estimation procedure to estimate bilateral trade flows at the sector level. The first stage is a selection equation, based on the solution of ϵ^*_{ijs} in section 1.3.2, while the second stage is a gravity equation, based on the solution of X_{ijs} in section 1.3.3. Implementing this procedure achieves two goals. First, the first-stage estimation tests the theoretical prediction on the extensive margin of trade. Second, according to HMR, this two-stage procedure serves as a structural framework for correcting two potential biases in the traditional gravity estimates using OLS: the Heckman sample selection bias from a dataset with many zeros, and a bias due to firm self-selection into exporting. In essence, I use the predicted probability of exporting in each sector from the first-stage estimation to construct regressors in the second stage to correct the two biases. Before developing the framework for two-stage estimation, I first specify the equation for traditional gravity estimation.

1.4.1 Baseline Empirical Specification

To derive the econometric specification of the gravity equation, I assume stochastic trade costs. For variable trade costs, let $\tau_{ijs}^{\sigma-1} \equiv D_{ij}^{\vartheta} e^{-u_{ijs}}$, where D_{ij} represents the distance (broadly defined) between i and j, and $u_{ijs} \sim N\left(0, \sigma_u^2\right) \forall s$ captures any (symmetric) unmeasured trade frictions for the country pair at the sector level. For fixed trade costs, let $f_{ij} \equiv \exp\left(\psi_{ex,i} + \psi_{im,j} + \varphi\psi_{ij} - v_{ijs}\right)$, where $v_{ijs} \sim N\left(0, \sigma_v^2\right)$ represents unobserved fixed trade costs for the country pair. $\psi_{ex,i}$ is a measure of observed fixed export costs in country i (to any destination); $\psi_{im,j}$ captures the observed trade barrier imposed by j on all importers; ψ_{ij} represents other observed fixed trade costs that are specific to the country pair.

The baseline empirical results of the paper are based on estimating the empirical counterpart of bilateral exports (X_{ijs}) solved in general equilibrium (equation (1.16)), in which the extensive margin is subsumed. Taking log over (1.16) yields a log-linear sector-level bilateral trade flow equation as follows:

$$\ln X_{ijs} = \alpha + \beta Labor_i \times Spec_s + \delta_s + \delta_i + \delta_j - \varphi C_{ij}^f - \vartheta C_{ij}^v + \chi_{ijs}, \tag{1.17}$$

where the explanatory variable of interest, $Labor_i \times Spec_s$, is an interaction of exporter i's degree of labor protection with sector s's firm-specific skill intensity.[28] According to Proposition 3, when labor laws become more protective (higher $Labor_i$), $\ln X_{ijs}$ is relatively higher in specific skill-intensive sectors (higher $Spec_s$). Therefore, Proposition 3 predicts $\beta > 0$. α is a constant and δ_s is a sector fixed effect, which are derived from $\ln \mu_4$ (see (16)). $\delta_i = \ln Y_i - \frac{\xi-(\sigma-1)}{\sigma-1}\psi_{ex,i}$ is an exporter fixed effect; $\delta_j = \ln Y_j - \frac{\xi-(\sigma-1)}{\sigma-1}\psi_{im,j} + \xi\Delta_j$ is an importer fixed effect; $C_{ij}^f = \frac{\xi-(\sigma-1)}{\sigma-1}\psi_{ij}$ and $C_{ij}^v = \frac{\xi}{\sigma-1}\ln D_{ij}$ are vectors of fixed and variable trade costs between a country pair, respectively; $\chi_{ijs} \equiv u_{ijs} + v_{ijs}$ is an error term coming from both unmeasured variable and fixed trade costs.

1.4.2 Empirical Specification for Two-Stage Estimation

There are two potential biases in the OLS estimates. The first bias is the Heckman (1979) sample selection bias. My sample shows that about 50% of the countries do not trade with each other in 1995.[29] At the sector level, about 80% of the observations contains zero trade flows. This non-random selection induces a positive correlation between the unobserved trade frictions (u_{ijs} and v_{ijs}) and the observed ones ($\psi's$ and D_{ij}). Intuitively, with only positive trade flows included in the sample, countries with high observed trade costs that trade with each other (high D_{ij} for example) are likely to have low unobserved trade frictions. Hence, excluding the out-of-sample zeros from the regression induces a downward bias (closer to 0) in the estimates of the determinants of trade flows. To correct the selection bias, I include the inverse Mills' ratio of a standard Heckman (1979) two-stage estimation in my second-stage equation. In particular, the inverse Mills' ratio is imputed using the predicted probability of exporting (by sector) from the first-stage estimation.

Furthermore, HMR posit that in a world with firm heterogeneity, firm self-selection into exporting may lead to overestimation in the traditional estimates of the gravity equation using OLS. To illustrate this type of bias, I relax the three assumptions of Chaney (2007), and take

[28] The interaction term proxies for $\xi \ln \Psi_{is} - \ln(1 - \phi_i \lambda(s)\eta)$ in the model.

[29] It means that country i does not export to country j , or vice versa. This number is very close to what HMR (2007) find.

log over equation (1.10) to obtain the following log-linear econometric specification:

$$\ln X_{ijs} = \alpha' + \beta' Labor_i \times Spec_s + n_{is} + p_{js} - \vartheta d_{ij} + \omega_{ijs} + \delta'_s +'_i + \delta'_j + u_{ijs}. \qquad (1.18)$$

With stochastic τ_{ijs} and f_{ij} specified above, this specification includes a set of fixed effects: δ'_s, δ'_i and δ'_j (sector, importer and exporter fixed effects). α' is a constant and $d_{ij} = \ln D_{ij}$ is the (log) bilateral distance.[30]

Here, two modifications of the baseline specification (1.17) worth discussion at length. First, according to (1.10), the volume of exports to country j in sector s depends on the (log) number of firms $n_{is} = \ln N_{is}$ in sector s of country i, and the (log) sectoral price level $p_{js} \equiv \ln P_{js}$ in sector s of country j.

Second, in contrast to (1.17), this specification includes a term $\omega_{ijs} = \ln W_{ijs}$, which captures two features in the econometric model. First, in equation (1.11), ω_{ijs} is expressed as a function of the exporting productivity threshold ϵ^*_{ijs}. In the model, the fixed trade costs f_{ij} affect trade flows only through the extensive margin by determining the fraction of exporting firms. When the level of fixed costs increases, fewer firms export, thus decreasing the sectoral volume of exports. Therefore, the estimated low export volumes can be results of a lower export volume per firm, or fewer exporting firms, or both. For this reason, in equation (1.18), f_{ij} is subsumed in ω_{ijs}, which implies that u_{ijs} comes only 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 elasticities of trade flows with respect to trade frictions and exporters' labor protection. These two particular features of ω_{ijs} suggest that including ω_{ijs} is essential for obtaining consistent estimates of the effects of institutions on trade flows. Omitting ω_{ijs}, similar to any omitted variables problem, results in overestimation of all estimates in the trade flow equation.

For the purpose of correcting both types of biases, I follow HMR in implementing a two-stage estimation procedure parametrically. To this end, in the following section, I outline the specification of the first-stage selection equation, from which I obtain predicted probability of exporting for each country-pair-sector observation. Using these predicted values, I impute an

[30] $\alpha' = (\sigma - 1)\ln\eta$; $\delta'_i = \ln w_i$, $\delta'_j = \ln Y_j$

estimated $\widehat{\omega}_{ijs}$ based on equation (1.9). Since the implementation of the two-stage procedure is discussed in detail in HMR, readers are referred to their paper for the details of this procedure.

Firm Selection Into Exporting (Foundation of the First-stage Estimation)

I derive the econometric specification for testing the extensive margin of trade based on equation (1.11). In theory, when there are positive trade flows between i and j in sector s, $W_{ijs} > 0$. Therefore, I define a latent variable $Z_{ijs} = \left(\epsilon_H/\epsilon^*_{jis}\right)^{\sigma-1}$ such that $W_{ijs} = Z^{\delta}_{ijs} - 1$ is a monotonic function of Z_{ijs}, where $\delta = \frac{\xi-(\sigma-1)}{\sigma-1}$ (see (1.11)), and $W_{ijs} > 0$ if and only if $Z_{ijs} > 1$. With ϵ^*_{ijs} solved explicitly in (1.9), I can express the latent variable as

$$Z_{ijs} = \left(\frac{\epsilon_H P_{js}}{\Psi_{is}\tau_{ij}}\right)^{\sigma-1} \frac{b_s Y_j}{f_{ij}}.$$

This equation serves as the foundation of the first-stage estimation. Using the fixed and variable trade costs specified above, I obtain the log-linear specification for the first-stage estimation as

$$z_{ijs} \equiv \ln Z_{ijs} = \alpha^z + \beta^z Labor_i \times Spec_s + p_{js} + \delta^z_s + \delta^z_i + \delta^z_j - \vartheta^z d_{ij} - \varphi^z \psi_{ij} + e_{ijs},$$

where $e_{ijs} = u_{ijs} + v_{ijs} \sim N\left(0, \sigma^2_u + \sigma^2_v\right)$ is an i.i.d. error term;[31] δ^z_s, δ^z_j and δ^z_i are sector, importer and exporter fixed effects, respectively. α^z is a constant term and ψ_{ij} is a measure of observed fixed trade costs between a country pair.[32]

With positive trade flows, $W_{ijs} > 0$ and $Z_{ijs} > 1$, implying a positive $\ln Z_{ijs}$. Since Z_{ijs} is unobservable in the data, I use an indicator variable $I_{ijs} \in \{0, 1\}$ to represent $\ln Z_{ijs}$. Specifically, I_{ijs} equals 1 if trade flows are observed from i to j in sector s (i.e. when $W_{ijs} > 0$ in the model), and 0 otherwise. I therefore estimate the selection equation by a Probit model as:

$$\begin{aligned} \rho_{ijs} &= \Pr\left(I_{ijs} = 1 \mid \text{observed vars.}\right) \qquad (1.19) \\ &= \Phi\left(\alpha^* + \beta^* Labor_i \times Spec_s + p_{js} + \delta^*_s + \delta^*_i + \delta^*_j - \vartheta^* d_{ij} - \varphi^* \psi_{ij}\right), \end{aligned}$$

[31] u_{ijs} and v_{ijs} are assumed to be uncorrelated. Therefore, u_{ijs} and v_{ijs} are jointly normal. By construction, however, e_{ijs} is correlated with u_{ijs} in the gravity equation.

[32] $Labor_i \times Spec_s$ reprensents $(1-\sigma)\ln \Psi_{is}$;
$\delta^z_j = \ln Y_j - \psi_{im,j}$; $\delta^z_i = -\psi_{ex,i}$;
$\gamma^z_s = \ln b_s$;

where $\Phi(.)$ is the c.d.f. of a unit-normal distribution. All starred coefficients represent the original ones (with superscripts 'z') divided by σ_e, the standard deviation of e. This coefficient transformation is essential if a unit-normal distribution of the error term is assumed.

This Probit estimation serves two purposes. First, it tests Proposition 2. Second, it allows me to impute $\widehat{\omega}_{ijs}$, a regressor to be included in the second-stage estimation to account for the extensive margin of trade. Although Z_{ijs} is unobservable and obtaining an estimate of W_{ijs} seems impossible, I can use predicted probabilities of exporting at the sector level, $\widehat{\rho}_{ijs}{}'s$, from estimating (19) to impute the estimated latent variable as $\widehat{z}^*_{ijs} = \Phi^{-1}\left(\widehat{\rho}_{ijs}\right)$. In turn, I estimate W_{ijs} according to (1.11) as $\widehat{W}_{ijs} = \left\{\widehat{Z}^{*\delta_z}_{ijs} - 1, 0\right\}$, where $\delta = \frac{\sigma_e(\xi-(\sigma-1))}{\sigma-1}$ and $\widehat{Z}^*_{ijs} = \exp \widehat{z}^*_{ijs}$.[33] As a result, the required regressor $\omega_{ijs} = \ln W_{ijs}$ that corrects the bias due to firm self-selection into exporting takes the functional form of $\ln\left\{\exp\left(\delta_z \widehat{z}_{ijs}\right) - 1\right\}$. Appendix 1.8.2 discusses in detail how a consistent estimate of ω_{ijs} is imputed using the first-stage estimates.

1.5 Data

1.5.1 Sector Proxies for firm-specific skill intensity

For the purpose of testing the theoretical predictions, I construct sector proxies for firm-specific skill intensity, which to my knowledge, were not 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, 2007) in using returns to firm tenure in the U.S. as evidence of the presence of firm-specific skills. Several alternative theories can explain an upward-sloping wage profile due to firm tenure. They include, among others, theories of incentive contracts to elicit workers' effort (Lazear, 1981), asymmetric information about workers' abilities (Katz and Gibbons, 1991) and wage compression due to search frictions in labor markets (Acemoglu and Pischke, 1999). I abstract from these theories, and instead adopt the most common and original explanation as the basis to construct my sector proxies.

Specifically, I estimate the wage equation by including employees' job tenure with their current firms (and its squared term). To capture different returns to firm tenure across sectors,

[33] σ_e is multiplied in front of the exponent of equation (11) because in the Probit model, all variables, including the predicted value, are divided by σ_e. See HMR (2007) for details.

I interact an individual's job tenure with the dummy of the sector she currently belongs to. The theory of firm-specific human capital predicts a higher estimated coefficient on the interaction term of the sector for which firm-specific skills are more important in production.

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

$$\begin{aligned} \ln w_{kmst} &= \sum_s Sec_s \left(\beta_{1s} Firm\_Ten_{kmt} + \beta_{2s} Firm\_Ten^2_{kmt}\right) \\ &\quad + \gamma_1 Work\_Exp_{kt} + \gamma_2 Work\_Exp^2_{kt} + Cont_{kmt} + \Gamma_{kmst} + \varepsilon_{kmst}. \end{aligned}$$

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. $Firm\_Ten_{kmt}$ is the worker self-reported tenure with the current employer.

I use the estimates of the coefficients on $Firm\_Ten_{kmt}$ and its squared term (β_{1s}, β_{2s}) to construct the sector proxies of specific skill intensity as follows:

$$Spec_s^T = \widehat{\beta}_{1s} \times T + \widehat{\beta}_{2s} \times T^2,$$

where $Spec_s^T$ is the predicted return to T years of firm tenure (up to a squared term). It is important to note that the estimated $\widehat{\beta}_{2s}$'s are small, and the bilateral correlation between any two $Spec_s^T$ $\forall\ T \in [1, 10]$ is always higher than 95%. Hence, the results of the following empirical analyses are insensitive to the choice of this tenure duration. For simplicity, I choose $T = 5$ as the benchmark to construct my baseline sector measures of specificity.

To account for the unexplained match-specific productivity which affects the decision to continue a relationship, I include a continuation dummy $Cont$, which equals 1 if it is not the first year of tenure. I also control for workers' experience in the labor market, $Work\_Exp_{it}$ (and its squared term) to parse out the effects of general (transferable) skills on wages. As in most wage equations, I include a set of controls in the regression (Γ_{kmst}), which include education (and its squared term); a dummy for union membership; and sector, occupation (at the 1-digit level), state and year fixed effects.

It is often argued that ε_{kmst} can be correlated with the unobserved workers' ability or employer's characteristics. For example, a more capable worker is more likely to stay with her employer for a longer period of time (due to a lower probability of firing or higher tolerance to her employer), or a worker prefers to stay with a productive firm. These unobserved characteristics are obviously correlated with firm tenure. To parse out these unobserved components, I follow Altonji and Shakotko (1987) in using the deviation of employer tenure from its mean of the current employment spell $(Firm\_Ten_{ijt} - \overline{Firm\_Ten_{ij}})$ as an instrument for firm tenure. The idea is that this "deviation" operation eliminates the time-invariant, match-specific unobserved effects. They claim that the "deviated" firm tenure is a valid instrument as it is orthogonal to the time-invariant unobserved worker and match characteristics by construction. Similarly, I use deviations from means as instruments for labor market experience and the continuation indicator.[34]

Data on wages, employees' tenure and other workers' characteristics are taken from the Panel Study of Income Dynamics (PSID) dataset for 9 waves over 1985-1993.[35] I use U.S. as the reference country for two reasons. First, I am limited by data availability to construct these measures for a large sample of countries. Second, according to the model, a flexible labor market in the U.S. implies that investments in firm-specific skills are less for all sectors compared to countries with more protective labor laws. Hence, if one can observe differences in tenure effects across sectors in the U.S., these effects will probably be magnified in countries where labor laws are more protective. The bottom line is that identification does not require the level of returns to tenure to be exactly the same across countries. However, it does depend on the ranking remaining stable across countries.[36]

Following the literature on the effects of seniority on wages, I use a PSID sample that includes males who are heads of households, aged between 18 and 64, worked for at least 500 hours in a year, and earned real hourly wages of at least \$2 (in 1990 dollars). Furthermore, because for a large sample of countries, trade flow data are available only for manufacturing sectors, I include only observations from manufacturing sectors in the PSID sample. Then

[34]This approach is recently used by Kambourov and Manovskii (2007) to study the importance of occupation-specific tenure effects.

[35]I choose this sample period because of concerns about data quality.

[36]The approach of using sector measures constructed using U.S. data originates from Rajan and Zingales (1998). In their study of the effects of countries' financial development on differential growth by sector, they use sector measures of dependence on external finance, which are constructed using data of U.S. publicly-listed firms. Subsequent empirical studies on comparative advantage have used the same approach. See Romalis (2003), Levchenko (2007), Nunn (2007) and Manova (2007), among others.

I use the variable-construction procedure proposed in Kambourov and Manovskii (2007) to improve the quality of the data. In particular, this procedure aims at making an individual's self-reported values of tenure and experience to be consistent across years (See Appendix B). All manufacturing sectors are included in estimating the return to firm tenure by sector. Although tenure effects (β_{1s}, β_{2s}) can potentially be estimated for all manufacturing sectors, I exclude the estimates of the sectors that have fewer than 40 observations in the cleaned PSID sample (after applying the standard filters mentioned in Appendix B). At the end, I obtain a list of 32 sector measures of firm-specific skill intensity under the PSID classification (which has 76 sectors in total at the 3-digit level).[37] Among these 32 measures, 28 of them are significantly different from 0 at the 5% significance level.[38]

Readers may be concerned of the validity of the empirical results based on a sample with about half of the sectors missing the proxies for specific skill intensity. Nevertheless, the fact that a sector has sufficient observations to remain in the final sample implies that it is a major employing industry in the U.S. (at least during the sample period). It turns out that the included sectors account for more than 60% of global manufacturing trade flows in 1995, including the out-of-sample countries (to be discussed below).

Appendix Table A2 lists the estimates of 5-year returns to tenure of 32 sectors included in the regression analyses. For the bottom 8 sectors, the average firm-tenure effects are negative. There are at least two possible explanations for this. First, if the average nominal wage growth in a sector is lower than inflation, the average real wage is decreasing in that sector. Second, since I control for working experience in the regression, the partial effects of firm-specific skills can well be negative for sectors in which general skills account for a substantial part of real wage growth. In this situation, staying with the same firm for long may reduce the accumulation of general skills, and therefore earnings. Nevertheless, in the sample of 32 sectors, 24 of them show positive estimated returns to firm tenure. For example, a worker who stays with the same employer for five years in the sector of "Construction and Material Handling Machines," which

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

[38]Estimates which 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 suffer from the same problem.

ranks the highest in firm-specific skill intensity, experiences a mean real wage growth due to firm tenure of 41.5% over 5 years, equivalent to an annual growth of 7.2%.

Finally, these 32 sector proxies are normalized between 0 and 1, and mapped to 67 SIC87 3-digit categories (out of 116 categories).[39] The mapping algorithm, especially for issues related to multiple mapping, is described in detail in section 1.8.2 (Appendix B).

1.5.2 Other Country-level and Sector-level Data

Industry-level data on bilateral exports in 1995 are adopted from Feenstra (2000) World Trade Flows Dataset. I choose this year for its proximity to the time period for which labor regulation indices and other country-level data are available. To unify the definition of a sector, which varies across data sources under different industry classifications, I define a sector as an SIC87 3-digit category. Since Feenstra's trade data are classified under the SITC (rev.2) 4-digit classification, I first aggregate unilateral export volumes across SITC 4-digit codes belonging to the same SITC 3-digit category, and convert the SITC 3-digit codes to SIC 3-digit codes using the concordance file on Feenstra's website.[40] Similarly, for other sector-level data under classification systems different from the SIC system, I use publicly available concordance files to convert different industry codes to the SIC codes. The sources of the concordance files and the mapping algorithms between different systems are discussed in detail in Appendix B. The resulting dataset of sector-level characteristics contains 116 SIC87 3-digit categories, which suffice to cover all observations in Feenstra's trade data set. The availability of specific skill intensity proxies reduces the number of sectors from 116 to 67 in the sample.

Data on labor law protection of 84 countries are taken from Botero et al. (2004).[41] The authors reviewed legal documents of each country in the late 90's to codify the degree of regulations of labor markets through employment, collective relations and social security. For the purposes of the current study, I use the average of two indices available in their paper –

[39] The original SIC87 3-digit classification has 140 sectors. However, using the concordance file from Feenstra's website (see appendix), 117 SIC87 3-digit sectors suffice to cover all observations in the trade dataset.

[40] 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.

[41] The Botero et al. (2004) dataset contains 85 countries. Here, I do not include Taiwan in my sample, as trade costs data for Taiwan are not available.

"Employment Laws" index and "Collective Relations" index. The "Employment Laws" index represents costs associated with firing and employment contract adjustment. Specifically, it is an average of four subindices: (i) alternative employment contracts, (ii) costs of increasing hours worked, (iii) cost of firing workers, (iv) dismissal procedures. The "Collective Relations" index is an average of two subindices: (i) labor union power and (ii) collective disputes. A higher index is associated with more stringent labor laws. Appendix Table A1 lists the countries' indices of labor law protection in the sample. Among the 84 countries, the two countries with the most protective labor laws (according to the average of the two indices) are Kazakhstan (0.731) and Portugal (0.729), while the two countries with the most flexible labor regulations are Jamaica (0.195) and Malaysia (0.188).

For the purpose of estimating the gravity equation, I obtain bilateral "trade costs" variables from different sources. The first source is a data set from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), which contains information on geographical variables and colonial relationships. For missing data, I refer to Glick and Rose (2002) and CIA World Factbook to augment the CEPII data. Second, I obtain information on whether two countries are signatories of a regional trade agreement (RTA) from the websites of WTO and various regional trade blocs. Finally, I obtain information for whether two countries share a common legal origin from Botero et al. (2004). See Appendix B for more details of these variables. Other country-level and sector-level variables used in the empirical analysis are described in detail in Appendix B.

The final sample contains 84 countries and 67 SIC 3-digit sectors, which captures more than 60% of global manufacturing trade flows in 1995, including the out-of-sample countries and sectors.

1.6 Results

1.6.1 Cross-country Correlation between Labor Protection and Industrial Specialization

Before testing the predictions about the effects of labor laws on export patterns in the structural framework developed in section 1.4, I first present reduced-form cross-country evidence to verify whether countries with protective labor laws tend to export more in specific skill-intensive sectors. To this end, I construct a country's proxy for firm-specific skill intensity of exports as follows:

$$XSpec_i = \sum_s \left(\frac{X_{is}}{X_i}\right) Spec_s, \tag{1.20}$$

where X_{is} is the value of country i's exports (in US 2000 dollars) to the rest of the world in sector s, X_i is country $i's$ total exports. $Spec_s$ is the measure of sector s's firm-specific skill intensity constructed in section 1.5.

The model predicts that $XSpec_i$ is positively correlated with workers' bargaining power in country i, ϕ_i. As mentioned in the introduction, Figure 1-2 confirms this prediction using data on countries' exports in 1995. The positive correlation is also preserved among the OECD countries (Figure 1-3).[42]

To show the correlation between the two indices more formally, I regress $XSpec_i$ on the measure of labor protection, according to the following specification:

$$XSpec_i = \alpha + \beta Labor\_Protect_i + Z_i + e_i, \tag{1.21}$$

where $Labor\_Protect_i$ is country i's index of labor protection, Z_i is a set of controls of country i's characteristics, e_i is the error term, and α is a constant. Table 1 presents the cross-country regression results. The regression for column (1) corresponds to Figure 1-2. The positive and significant correlation ($\widehat{\beta} = 0.196$, t-stat= 2.61) between $XSpec_i$ and labor protection is consistent with the theoretical predictions of this paper on comparative advantage. In columns (2) through (4), I include countries' per capita endowments of human capital, physical capital, natural resources, and per capita income in the regressions to control for other country characteristics that may drive my results.[43]

Since firm-specific investments are non-contractible in the model, the underinvestment problem becomes more severe in countries with less developed contracting institutions. As a result,

[42]These correlations remain robust even after I purge the partial effect of education on $XSpec_i$. This purging excludes the possibility that higher content of firm-specific skills in exports is due to a more educated labor force, who have lower costs of human capital investments. It also provides an indirect evidence confirming that my measure of firm-specific skills is not strongly correlated with general human capital.

[43]Appendix B describes these variables in detail.

one may argue that the positive correlation between labor laws and specialization in specific skill-intensive sectors are results of cross-country differences in contracting institutions. By including the measure of the quality of judicial environment in column (5), I find a positive but insignificant coefficient on judicial quality, while that on labor protection continues to be significant.

Recent research argues that industrial specialization due to trade may in turn affect institutions (Acemoglu et al., 2005; Do and Levchenko, 2007). In light of this argument, I use legal origins (British, French. German, Scandinavian legal origins, with the Socialist legal origin as the excluded variable) as instruments for labor protection, and estimate (1.21) using 2SLS in columns (6) and (7). Legal origins are also used by Botero et al. (2004) as instruments in their study of the effects of labor regulations on labor market outcomes.[44] The results from the second stage of the 2SLS estimation show that controlling for reverse causality, labor protection induces specialization in specific skill-intensive sectors. Although a country's legal origin can be used to isolate countries' variation in labor market institutions unaffected by trade flows, they may affect specialization through other channels, such as contracting institutions. Therefore, when interpreting these results, one should keep in mind that legal origins may not satisfy the exclusion restrictions.[45]

1.6.2 The Impact of Labor Laws on Export Volumes

In this section, I test whether labor protection affects countries' intensive and extensive margins of trade by estimating sector-level gravity equations. The baseline results for testing the intensive margin are based on traditional gravity estimation using OLS. After presenting the results from OLS estimation, I implement the two-stage estimation procedure based on specifications (1.18) and (1.19) in section 1.4.

Each observation in the sample represents a bilateral trade relationship in each sector. Since a pair of countries can appear twice in the sample, there are altogether 467,124 potential

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

[45]Nunn (2007) also uses legal origins as instruments for contracting institutions, and discusses that these instruments may not satisfy the exclusion restritcions. This is why I do not use legal origins in the following gravity estimation, even though the IV regression results also support the main predictions of the paper (in unreported results).

bilateral relationships (84×83×67). In my sample, about half of the countries do not trade with each other in 1995. This is consistent with the findings in HMR for the 80's. At the sector level, about 80% of the potential trade relationships are zeros.[46]

First, I estimate (1.17) using OLS. In column (1) of Table 2, I regress (log) export volume from i to j in sector s ($\ln X_{ijs}$) on the interaction term of labor protection with firm-specific skill intensity. I find a positive point estimate on the interaction term ($\widehat{\beta} = 0.382$, $t - stat = 4.19$), which supports Proposition 3. As specified in (1.17), included in the regression are exporter, importer and sector fixed effects. Moreover, I always cluster standard errors by importer-exporter pair to account for the correlation of unobserved trade barriers (u_{ijs} and ν_{ijs}) common across sectors for each country pair.

To control for observable trade costs and distances that may affect the revealed patterns of trade, I include 9 "trade costs" variables between two trading partners in the regression. Consistent with the traditional gravity estimates, the estimated coefficients on these "trade costs" variables show that two countries trade relatively more with each other if (i) they are closer to each other, (ii) share a common border, (iii) have majority of the populations speaking a common language, (iv) have ever been in a colonial relationship after 1945, (v) are signatories of a regional trade agreement, (vi) share the same legal origin. The estimates of the remaining three "trade costs" dummies: (vii) whether the countries shared the same colonial power ever in the past, (viii) whether one of the countries is landlocked and (ix) whether one of the countries is an island are of expected signs, but are statistically insignificant. Unless specified otherwise, all regressions in the remainder of the empirical analyses include the entire set of "trade costs" as controls.

The sectoral volume of exports depends on the competitiveness in the sector of the importing country, which according to (1.18), is captured by p_{js} ($\ln(P_{js})$) in equilibrium. In the absence of measures of sectoral prices for a large sample of countries, I proxy p_{js} by the interactions of country $j's$ price level of consumption (relative to the U.S.) with sector dummies.[47] In column (2), I re-run the regression of column (1) by including these interactions, and find that the baseline estimates remain almost identical.

[46]Manova (2007) finds that 75% of potential trade flows is 0 at a more aggregated industry level (28 ISIC sectors).

[47]Manova (2007) also uses the same interaction terms as the baseline proxies for importers' sectoral prices.

Column (3) takes into account the Heckscher-Ohlin determinants of comparative advantage by including interactions between countries' factor endowments and sectors' factor intensities. Controlling for the effects of per capita endowments of capital and human capital on export volumes. labor market institutions remain a significant determinant of comparative advantage. Additionally, column (4) controls for the effect of per capita endowments of natural resources on trade flows.

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 set of labor laws of Germany, the country at the 90th quartile, the resulting difference between the average unilateral export volume of industrial inorganic chemicals (highly firm-specific skill-intensive, about 75th percentile in the distribution) and that of communications equipment (highly general skill-intensive, about 10th percentile in the distribution) will be 12 percentage points.[48]

According to (1.18), the sectoral volume of exports also depends on the number of producers in the exporting country. In light of this, column (5) presents the results of the regression with the (log) number of firms in the exporter's sector included as a control.[49] The baseline estimates again remain statistically significant.

In the following section of robustness checks, I start from the regression of column (4), and progressively include more interactions. I use this specification instead of the one in column (5) because of concerns of 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.[50]

---

[48]This comparative statics exercise is based on the estimates in column (4). Formally, this "diff-in-diff" result is derived from the following formula $\exp\left[\triangle \ln X_{ijs}^{i'} - \triangle \ln X_{ijs'}^{i'}\right] = \exp\left[\widehat{\beta} \triangle Labor_i^{i'} \times \triangle Spec_s\right] \simeq 1.12$

where $\widehat{\beta} \simeq 0.486$, The difference in the indices of labor protection between Germany and the U.S. is $\triangle Labor_i^{i'} = 0.65 - 0.24$, and the difference in specificity between the two industries is $\triangle Spec_s \simeq 0.67 - 0.12$. Notice that this "diff-in-diff" exercise has no prediction on the direction of the change in exports of either sector.

[49]The measure for the number of firms per sector in 1995 is from UNIDO 2005 dataset, which is disaggregated at the ISIC 3-digit industry level (28 industries).

[50]In unreported results, when the (log) number of firms by sector is added as a regressor, the estimated coefficient on Labor Law Rigid × Firm-Spec becomes even more economically and statistically significant.

Robustness Checks

In Table 3, I check whether the baseline results are driven by alternative hypotheses proposed in the existing literature on institutional comparative advantage. For this purpose, I re-run the regression of column (4) in Table 2 by progressively adding more interactions as controls.

First, one may claim that since uncertainty of firm sales deters workers' ex-ante investments in firm-specific skills, the sector measure of firm-specific skill intensity may be highly correlated with sales volatility. If this is the case. the results in Table (2) can be interpreted as supporting evidence for Cuñat and Melitz (2007). who show both theoretically and empirically that countries with flexible (rigid) labor markets specialize in volatile (stable) sectors. To address this concern, first, I find a small and positive bilateral correlation between sales volatility and specific skill intensity in my sample of 67 sectors (*corr.* = 0.11). This suggests that specific skill intensity and sales volatility do not seem to capture similar sector characteristic. To address the Cuñat-Melitz hypothesis that may overturn my results, I re-run regression (4) in Table 2 by adding an interaction of a country's labor protection with sectoral sales volatility. The results in column (1) support the Cuñat-Melitz prediction: countries with rigid labor laws export less in the more volatile sectors. In column (2), I use another sector measure of volatility – sectoral gross job flow rates in the U.S. from Davis, Haltiwanger and Schuh (1996). This measure captures different degrees of instability of an employer-employee relationship across sectors. I find a negative coefficient on the interaction using sectoral job flows rates, which is again consistent with Cuñat and Melitz (2007). Importantly, sectoral differences in specific skill intensity remain an independent and important aspect through which labor laws affect trade patterns.

Next, I examine whether the effects of contracting institutions drive my results. As discussed in the model, another important determinant of comparative advantage concerning firm-specific investments is the quality of a country's contracting institutions. In the present context, in countries with more developed contracting institutions, the underinvestment problem becomes less severe, which may result in specialization in specific skill-intensive exports. Furthermore, recent literature on institutional comparative advantage shows that countries with better contracting institutions specialize in contract-dependent sectors (Levchenko, 2007; Nunn, 2007).

It is interesting in its own right to study this theory in a bilateral-trade set-up.[51] In column (3), I control for this channel by including an interaction of the quality of judicial system and sectors' dependence on contract enforcement, the same interaction term used by Nunn (2007). Specifically, a sector's dependence on contract enforcement is proxied by the average market thickness of the upstream industries of that sector (see Appendix B for definition). Using this sector measure, I find supporting evidence for the existing literature on contract enforcement and trade. Importantly, my conclusion regarding labor market institutions as a source of comparative advantage remains unchanged.

In the last column of Table 3, I report beta coefficients to compare the economic significance of the respective institutional channels of comparative advantage. An increase of one standard deviation in the labor law interaction term is associated with an increase of 0.05 standard deviation in the natural log of the volume of exports to a country. While it seems small, the economic significance is in fact substantial (as already discussed in the US-Germany hypothetical exercise in the previous sub-section). As a comparison, the beta coefficient on the labor-law-job-flow interaction is -0.06, while that on the legal-contract interaction is 0.09.[52]

After controlling for the variables of the alternative hypotheses in the regressions, I examine in Table 4 whether other country characteristics, other than labor market institutions, cause countries to specialize in specific skill-intensive sectors. I do this by adding interactions of specific skill intensity with different countries' characteristics one at a time into regression (4) of Table 3. First, I find that richer countries specialize in specific skill-intensive sectors (column (1)). An explanation is that the labor force in richer countries tends to have higher education, and therefore lower costs of investments in human capital. Columns (2) and (3) confirm this claim: Higher education and higher capital endowment enhance exports of specific skill-intensive goods.

Second, I find that countries with better contracting institutions also specialize in these sectors (column (4)). This result is consistent with the hypothesis that firm-specific investments are often subject to hold-up problems. When a country's contracting institutions improve, the

[51] A recent paper by Chor (2007) also examines empirically how cross-country differences in contracting institutions affect export patterns in a bilateral trade flow specification.

[52] Chor (2007) finds the same order of magnitude of the beta coefficients on these institutional comparative advantage interactions.

underinvestment problem becomes less severe, implying a comparative advantage in specific skill-intensive sectors. I also find evidence that a country's financial development matters in the present context in column (5). All these regressions include interaction terms of factor endowments, and the two alternative hypotheses studied earlier. Importantly, the estimate on the interaction of labor protection with specific skill intensity remains significant throughout the above robustness checks.

1.6.3 First-stage Estimation of the Extensive Margin of Trade

Next I present the empirical results of the two-stage estimation outlined in section 1.4. In particular, I disentangle the impacts of labor market institutions on trade patterns into that for firm selection into exporting, and that for export volumes.

Proposition 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 its empirical counterpart, formulated as a Probit equation in (1.19). The dependent variable is an indicator which is equal to 1 if positive trade flows are observed from country i to country j in sector s, and 0 otherwise.

As suggested by the model, I estimate (1.19), including exporter, importer, sector fixed effects, proxies for sectoral prices in the importing country, and the 9 gravity "trade costs" variables. Table 5 presents the results of the first-stage Probit estimation.

Estimated coefficients on all "trade costs" variables have the same signs (although not always significant) as those of the trade flow equation reported in Table 3. These results suggest that most trade frictions have the nature of both fixed and variable costs. Importantly, the estimates across all four specifications show that countries with more protective labor laws are more likely to export to another country in specific skill-intensive sectors. These findings support Proposition 2, and are robust to the inclusion of variables for other sources of comparative advantage, including factor endowments, contracting institutions, and the volatility channel through which labor market institutions can affect trade flows (reported in columns (3) and (4)).

Based on the model, a higher probability of exporting is a direct result of a larger fraction of existing firms self-selecting into exporting. Therefore, as mentioned in HMR, even without firm-level data, Lemma 2 can be verified based on the empirical results at the country-sector level. In other words, the results in Table 5 can be interpreted as follows: relatively more firms self-select into exporting in the specific skill-intensive sectors in countries where labor laws are more protective.

1.6.4 Second-stage Estimation of the Trade Flow Equation

Finally I examine whether labor regulations still affect trade patterns, after I correct both types of biases in OLS estimation parametrically as discussed in section 1.4. I implement the second-stage trade flow equation (1.18) controlling for the effects of firm self-selection into exporting. To correct for the bias due to this unobserved firm heterogeneity, I include an estimate of ω_{ijs} as a regressor. As discussed in section 1.8.1, a consistent estimate of ω_{ijs} in (1.18) is $\widehat{\omega}_{ijs} \equiv \ln\left[\exp\left(\beta_z\left(\widehat{z}^*_{ijs} + \widehat{\bar{e}}^*_{ijs}\right)\right) - 1\right]$, where $\widehat{z}^*_{ijs} = \Phi^{-1}\left(\widehat{\rho}_{ijs}\right)$, and $\widehat{\bar{e}}^*_{ijs} = \phi\left(\widehat{\rho}_{ijs}\right) / \Phi\left(\widehat{\rho}_{ijs}\right)$. Both equations depend on the predicted probability of exporting $\widehat{\rho}_{ijs}$ (by sector), which I obtain for each country-sector observation from the first-stage Probit estimation. Additionally, to correct the Heckman selection bias, I include the inverse Mills' ratio $\widehat{\bar{e}}^*_{ijs}$ as a stand-alone regressor. Because $\widehat{\omega}_{ijs}$ is a non-linear function of $\widehat{z}^*_{ijs}$ and $\widehat{\bar{e}}^*_{ijs}$, I first estimate (1.18) using a Maximum Likelihood Estimator.

To correct the Heckman selection bias, a variable that satisfies the exclusion restrictions is needed. This variable has to affect countries' selection into exporting, but not export volumes. I choose the dummy variable for whether at least one country is an island as the excluded variable for the following reason: while the island dummy is never significant (though always negative) in the OLS estimation of the trade flow equation, it becomes strongly significant in the first-stage selection equation (as shown in Table 1.5). In words, this variable predicts that an island country appears to present a high fixed trade cost for firms, which deter firms' selection into export markets, and therefore reducing the likelihood of a country's exporting to any countries. However, once this hurdle is overcome, it does not seem to impair trade flows. One possible explanation is that the costs for transportation over sea are similar to those on land, but their respective fixed costs can be different.[53]

Table 1.6 presents the results of the second-stage MLE estimation. With all regressors from the first-stage but the island dummy included, the interaction term of labor protection

[53]This excluded variable is also used in Manova (2007).

remains positive and significant. This result is insensitive to the inclusion of the interactions for the Heckscher-Ohlin sources of trade and the two alternative hypotheses tested in Table 1.3 (unreported in the table to conserve space). As robustness checks, I relax the assumption of a Pareto distribution of firm-level productivity and joint normality of the unobserved fixed and variable trade costs (u_{ijs} and v_{ijs}). To this end, I control directly for the predicted probability of exporting by categorizing all country-pair-sector level predicted probability, $\widehat{\rho}_{ijs}$'s into 50 bins, and use dummies for each bin in an OLS second-stage regression. The results presented in Panel B of Table 1.6 confirm the findings of the MLE estimation. In sum, the regression results from the two-stage estimation support the OLS findings.

Perhaps surprisingly, almost all estimated coefficients are bigger than the OLS counterparts in Tables 1.2 and 1.3. These results imply that the downward Heckman selection bias dominates the upward bias arising from omitting the extensive margin of trade in OLS estimation. This result is different from the conclusion of HMR, who find that the upward bias dominates. A possible explanation for our differences is that there are more zeros in my sector-level bilateral trade flow data than their aggregate country-level data, which increase the economic significance of the Heckman selection bias. Table 1.7 summarizes the estimated coefficients on the labor law interaction from the estimations using OLS, MLE, OLS with 50 bins for predicted probability, and OLS with the Heckman correction but without the extensive-margin control, respectively. The four columns in the table are parallel to those in Table 1.6. Evidently, the coefficients from the OLS estimation with only the Heckman correction is substantially bigger than the traditional OLS estimates, which suggests a possible net downward bias in the OLS estimates after controlling for the extensive margin of trade.

1.7 Conclusions

This paper identifies a new source of comparative advantage arising from the interaction between workers' investments in firm-specific skills and labor regulations. Importantly, I show that this endogenous channel of comparative advantage is independent of the examined sectoral volatility channel through which labor market institutions affect trade patterns.

I develop a simple model to show that workers, when given more bargaining power by labor laws, have more incentives to acquire firm-specific skills relative to general skills. Embedding this model in an multi-sector open-economy framework shows that countries where law laws are more protective specialize in firm-specific skill-intensive sectors. In particular, for a given importer, countries with more protective labor laws export relatively more (the intensive margin), and are more likely to export (the extensive margin) in industries for which firm-specific skills are more important.

By estimating sector-level gravity equations on a sample of 84 countries and 67 sectors, I find supporting evidence for the theoretical predictions. Importantly, the empirical results are robust to the correction of the biases arising from countries' selection into trade partners, and firm self-selection into exporting. The empirical findings are independent of other sources of comparative advantage, including factor endowments, income, and contracting institutions.

In work in progress, I construct sector measures of firm-specific skill intensity for more sectors using a longer time series of PSID data. Future research includes constructing sector measures of specific skill intensity using data of other countries, and extending the model to multiple periods with hiring and firing so that different aspects of labor laws can be discussed. A potential direction of this research is to examine how trade openness, by affecting workers' skill acquisition, may reinforce the persistent differences in labor market institutions across countries.

1.8 References

[1] Acemoglu, Daron, Pol Antràs and Elhanan Helpman [2007], "Contracts and Technology Adoption," *American Economic Review*, Vol. 97, No. 3, pp. 916-943.

[2] Acemoglu, Daron, Simon Johnson and James A. Robinson [2005], "The Rise of Europe: Atlantic Trade, Institutional Change and Economic Growth," *American Economic Review*, vol. 95, no. 3, pp. 546-579

[3] Acemoglu, Daron and Jorn-Steffen Pischke [1999], "The Structure of Wages and Investment in General Training," *Journal of Political Economy*, vol. 107, no. 3, pp. 539-572.

[4] Altonji, Joseph and Robert Shakotko [1987], "Do Wages Rise with Job Seniority?" *Review of Economic Studies*, Vol. LIV, pp. 437-459.

[5] Altonji, Joseph and Nicolas Williams [2005], "Do Wages Rise with Job Seniority? A Reassessment." *Industrial and Labor Relations Review*, 58, no.3.

[6] Anderson, James and Eric van Wincoop [2003], "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review*, Vol. 93, No. 1, pp. 170-192.

[7] Antràs, Pol [2003], "Firms, Contracts, and Trade Structure," *Quarterly Journal of Economics*, Vol. 118, No. 4, pp. 1375-1418.

[8] Antràs, Pol [2005], "Incomplete Contracts and the Product Cycle," *American Economic Review*, Vol. 95, No. 4, pp. 1054-1073.

[9] Antràs, Pol and Elhanan Helpman [2004], "Global Sourcing," *Journal of Political Economy*, Vol. 112, No. 3, pp. 552-580.

[10] Antweiler, Werner and Daniel Trefler [2002], "Increasing Returns and All That: A View From Trade," *American Economic Review*, vol. 92(1), pp. 93-119.

[11] Balmaceda, Felipe [2005], "Firm-Sponsored General Training," *Journal of Labor Economics*, vol. 23, pages 115–133.

[12] Bartelsman, Eric and Wayne Gray [1996], "The NBER Manufacturing Productivity Database," Technical Working Paper 205. National Bureau of Economic Research.

[13] Becker, Gary [1964], *Human Capital: A Theoretical Analysis with Special Reference to Education*, New York: Columbia University Press.

[14] Belot, Michèle, Jan Boone, and Jan van Ours [2007], "Welfare-Improving Employment Protection," *Economica*, vol. 74, pp.381-396.

[15] Blanchard, Olivier and Francesco Giavazzi [2003], "Macroeconomic Effects of Regulation and Deregulation in Goods and Labor Markets," *Quarterly Journal of Economics*, Vol. 118, No. 3, pp 879-907.

[16] Botero, Juan, Simeon Djankov, Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer [2004], "The Regulation of Labor," *Quarterly Journal of Economics*, Vol. 119, Issue 4, pp.1339-1382.

[17] Brecher, Richard [1974], "Minimum Wage Rates and the Pure Theory of International Trade," *Quarterly Journal of Economics*, vol. 88, Issue 1 pp. 98-116.

[18] Brügemann, Björn [2003], "Trade Integration and the Political Support for Labor Market Rigidity," Yale University Manuscript.

[19] Buchinsky, Moshe, Denis Fougère, Francis Kramarz and Rusty Tchernis [2005], "Interfirm Mobility, Wages, and the Returns to Seniority and Experience in the U.S.," IZA Discussion Paper, No. 1521.

[20] Casas-Arce, Pablo [2006], "Firm Provision of General Training and Specific Human Capital Acquisition," Universitat Pompeu Fabra Manuscript.

[21] Chaney, Thomas [2007], "Distorted Gravity: The Intensive and Extensive Margins of International Trade," University of Chicago Manuscript.

[22] Chor, Davin [2007], "Unpacking Sources of Comparative Advantage: A Quantitative Approach," Singapore Management University manuscript.

[23] Costinot, Arnaud [2006], "On the Origins of Comparative Advantage," University of California, San Diego Manuscript.

[24] Cuñat, Alejandro and Marc Melitz [2007], "Volatility, Labor Market Flexibility, and the Pattern of Comparative Advantage," NBER Working Paper No. 13062.

[25] Davidson, Carl, Lawrence Martin, and Steven Matusz [1999], "Trade and Search Generated Unemployment," *Journal of International Economics*, Vol. 48, pp.271-299.

[26] Davidson, Carl and Steven Matusz [2006], "Long-run Lunacy, Short-run Sanity: A Simple Model of Trade with Labor Market Turnover," *Review of International Economics*, vol.14, pp.261-276.

[27] Davis. Donald [1998], "Does European Unemployment Prop up American Wages? National Labor Markets and Global Trade," *American Economic Review*, vol. 88, no. 3, pp. 478-494.

[28] Davis, Donald and James Harrigan [2007], "Good Jobs, Bad Jobs, and Trade Liberalization," NBER Working Paper No. 13139.

[29] Davis, Steven, John Haltiwanger and Scott Schuh [1996], "Job Creation and Job Destruction," Cambridge: MIT Press.

[30] Do, Quy-Toan and Andrei Levchenko [2007], "Comparative Advantage, Demand for External Finance, and Financial Development," forthcoming *Journal of Financial Economics.*

[31] Dornbusch Rudiger, Stanley Fischer, and Paul Samuelson [1977], "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *American Economic Review,* vol. 67, No. 5., pp. 823-839.

[32] Dustmann, Christian and Costas Meghir [2005], "Wages, Experience and Seniority" *Review of Economic Studies*, Vol. 72, Issue 1 pp. 77-108.

[33] Eaton, Jonathan and Samuel Kortum [2002], "Technology, Geography and Trade, " *Econometrica*, vol. 70, no. 5, pp. 1741-1779.

[34] Estevez-Abe, Magarita, Torben Iversen and David Soskice [1999], "Social Protection and the Formation of Skills: A Reinterpretation of the Welfare State," in Varieties of Capi-

talism: The Institutional Foundations of Comparative Advantage (Oxford, U.K.: Oxford University Press).

[35] Feenstra, Robert [2000], World Trade Flows 1980-1997 CD-ROM.

[36] Glick, R. and A. Rose [2002] "Does a Currency Union Affect Trade? The Time-series Evidence." *European Economic Review*, 46(6) p.1125-51.

[37] Griffith, Rachel, Rupert Harrison, and Gareth Macartney [2007], "Product Market Reforms, Labor Market Institutions and Unemployment," *Economic Journal*, vol. 117, p142-p166.

[38] Hassler, John, Jose Rodriguez Mora, Kjetil Storesletten, and Fabrizio Zilibotti [2001], "Unemployment, Specialization, and Collective Preferences for Social Insurance," *The Economics of Rising Inequalities.* Oxford, Oxford University Press, pp. 331-350.

[39] Heckman, James [1979], "Sample Selection Bias as a Specification Error," *Econometrica*, Vol. 47, No.1, pp. 153-161.

[40] Helpman, Elhanan, Marc Melitz and Stephen Yeaple [2004], "Export Versus FDI with Heterogeneous Firms," *American Economic Review*, Vol. 94, pp. 300-316.

[41] Helpman, Elhanan, Marc Melitz and Yona Rubinstein [2007], "Estimating Trade Flows: Trading Partners and Trading Volumes," forthcoming *Quarterly Journal of Economics.*

[42] Helpman, Elhanan and Oleg Itskhoki [2007], "Labor Market Rigidities, Trade and Unemployment," Harvard University Working Paper.

[43] Houseman, Susan [1990], "The Equity and Efficiency of Job Security: Contrasting Perspectives on Collective Dismissal Laws in Western Europe, " *New Development in the Labor Market.* Cambridge, MA: MIT Press, pp.185-211.

[44] Jacobson, Louis, Robert Lalonde, and Daniel Sullivan, "Earnings Losses of Displaced Workers," *American Economic Review*, vol. 83, no. 4, pp. 685-709.

[45] Kambourov, Gueorgui and Iourii Manovskii [2007], "Occupational Specificity of Human Capital," forthcoming *International Economic Review.*

[46] Katz, Lawrence and Robert Gibbons [1991], "Layoffs and Lemons," *Journal of Labor Economics,* vol.9(4), pp.351-380.

[47] Kaufmann, Daniel, Aart Kraay, and Massimo Mastruzzi [2006], "Governance Matters V: Aggregate and Individual Governance Indicators for 1996-2005," World Bank Policy Research Working Paper 4012

[48] Kletzer, Lori [1989], "Returns to Seniority after Permanent Job Loss," *American Economic Review*, vol. 79, no. 3, pp. 536-543.

[49] Kletzer, Lori [1998], "Job Displacement," *Journal of Economic Perspective*, Vol 12, No.1, pp.115-136.

[50] Lazear, Edward [1981] "Agency, Earnings Profiles, Productivity, and Hours Restrictions," *American Economic Review*, vol. 71, no. 4, pp. 606-620

[51] Levchenko, Andrei [2007], "Institutional Quality and International Trade," *Review of Economic Studies*, 74:3, pp. 791-819.

[52] Manova, Kalina [2007], "Credit Constraints, Heterogeneous Firms and International Trade," Stanford University Manuscript.

[53] Masten, Scott, James Meehan, Jr and Edward Snyder [1989], "Vertical Integration in the U.S. Auto Industry: A Note on the Influence of Transaction Specific Assets," *Journal of Economic Behavior & Organization*, Vol. 12, Issue 2, pp. 265-273.

[54] Malcomson, James [1997] "Contracts, Hold-up, and Labor Markets," *Journal of Economic Literature*, vol. 35 pp. 1917-1957.

[55] Matusz, Steven [1996], "International Trade, the Division of Labor, and Unemployment," *International Economic Review*, 37(1), pp.71-84.

[56] Melitz, Marc [2003], "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, Vol 71, No.6, pp.1695-1725.

[57] Monteverde, Kirk and David Teece [1982], "Supplier Switching Costs and Vertical Integration in the Automobile Industry," *Bell Journal of Economics*, Vol. 13, No. 1, pp. 206-213.

[58] Nickell, Stephen [1997]. "Unemployment and Labor Market Rigidities: Europe versus North America," *Journal of Economic Perspectives*, Vol. 11, No. 11, pp.55-74.

[59] Nunn, Nathan [2007]. "Relationship-Specificity, Incomplete Contracts and the Pattern of Trade," *Quarterly Journal of Economics*, Vol. 122, No. 2, pp. 569-600.

[60] Rajan, Raghuram and Luigi Zingales [1998], "Financial Dependence and Growth," *American Economic Review*, Vol. 88, No. 3, pp. 559-586.

[61] Rauch, James [1999] "Networks Versus Markets in International Trade," *Journal of International Economics*. Vol. 48, pp. 7-35.

[62] Roberts, John and Eric Van den Steen [2000], "Shareholder Interests, Human Capital Investments and Corporate Governance," Stanford GSB Working Paper 1631.

[63] Romalis, John [2003], "Factor Proportions and the Structure of Commodity Trade," *American Economic Review* , Vol. 94(1), pp.67-97.

[64] Saint-Paul, Gilles [1997], "Is Labour Rigidity Harming Europe's Competitiveness? The Effect of Job Protection on the Pattern of Trade and Welfare," *European Economic Review*, vol. 41(3-5), pp. 499-506.

[65] Shapiro, Carl and Joseph Stiglitz [1984], "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review*, Vol.74, No. 3, pp. 433-444.

[66] Spector, David [2004] "Competition and the capital–labor conflict," *European Economic Review*, vol. 48 pp. 25-39.

[67] Stole, Lars and Jeffrey Zwiebel [1996a], "Organizational Design and Technology Choice under Intrafirm Bargaining," *American Economic Review*, Vol. 86, No. 1., pp. 195-222.

[68] Stole, Lars and Jeffrey Zwiebel [1996b], "Intra-Firm Bargaining under Non-Binding Contracts," *Review of Economic Studies*, Vol. 63, No. 3., pp. 375-410.

[69] Topel, Robert [1991]. "Specific Capital, Mobility. and Wages: Wages Rise with Job Seniority," *Journal of Political Economy*, Vol. 99(1). pp. 145-176.

[70] Topel, Robert and Michael Ward [1992], "Job Mobility and the Career of Young Men," *Quarterly Journal of Economics*, Vol. 107, No. 2, pp. 439-479.

[71] Wasmer, Etienne [2006]. "General versus Specific Skills in Labor Markets with Search Frictions and Firing Costs," *American Economic Review*, Vol. 94(1). pp.811-831.

[72] World Bank Staff [1997], "Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development," World Bank Publications

1.9 Appendix

1.9.1 Appendix A - Proofs and Derivation

Proof of Lemma 1

Since $\ln f = \frac{\lambda}{1-\lambda\eta}\ln\left(\phi\lambda\eta B\widehat{h}\right) + \frac{1}{1-\lambda\eta}\ln\epsilon\widehat{h}$, I have that $\varsigma_\varphi = \frac{\lambda}{1-\lambda\eta} > 0$, $\frac{\partial\varsigma_\phi}{\partial\phi} = \frac{1}{(1-\lambda\eta)^2} > 0$, and

$$\varsigma_\lambda = \left(\frac{1}{(1-\lambda\eta)^2}\right)\ln\left(\phi\lambda\eta B\widehat{h}\right) + \frac{\eta}{(1-\lambda\eta)^2}\ln\left(\epsilon\widehat{h}\right).$$

where $\varsigma_\lambda > 0$ if $\phi\lambda\eta B\widehat{h}^{1-\eta} > \epsilon^\eta$ and $\varsigma_\lambda \leq 0$ if $\phi\lambda\eta B\widehat{h}^{1-\eta} \leq \epsilon^\eta$. Although the sign of the elasticity of f with respect to λ depends on parameter values, it is increasing with ϕ as shown below

$$\frac{\partial\varsigma_\lambda}{\partial\phi} = \left(\frac{1}{(1-\lambda\eta)^2}\right)\frac{1}{\phi} > 0.$$

■

Rewriting the employer's maximization problem Given that $\widetilde{\pi}(\phi,\lambda,\epsilon) = R(\lambda,\phi,\epsilon) - a(\lambda,\phi)l - \widehat{h}l$, I can rewrite it by substituting $R(\lambda,\phi,\epsilon) = A^{1-\eta}(a(\lambda,\phi)l)^\eta$ where $a(\lambda,\phi) = \left[\phi\lambda\eta B\left(\epsilon\widehat{h}^{1-\lambda}\right)^\eta\right]^{\frac{1}{1-\lambda\eta}}$ from (3).

$$\begin{aligned}
\widetilde{\pi}(\phi,\lambda,\epsilon) &= R(\lambda,\phi,\epsilon) - a(\lambda,\phi)l - \widehat{h}l \\
&= B^{\frac{1}{1-\lambda\eta}}\left[(\phi\lambda\eta)^{\frac{\lambda}{1-\lambda\eta}}\epsilon^{\frac{1}{1-\lambda\eta}}\widehat{h}^{\frac{1-\lambda}{1-\lambda\eta}}\right]^\eta l - \left[\phi\lambda\eta B\left(\epsilon\widehat{h}^{1-\lambda}\right)^\eta\right]^{\frac{1}{1-\lambda\eta}} l - \widehat{h}l \\
&= \left(A^{1-\eta}\epsilon^\eta\right)^{\frac{1}{1-\lambda\eta}}(\phi\lambda\eta)^{\frac{\lambda\eta}{1-\lambda\eta}}(1-\phi\lambda\eta)\left(\widehat{h}l\right)^{\frac{(1-\lambda)\eta}{1-\lambda\eta}} - \widehat{h}l
\end{aligned}$$

Derivation of p, y, R and $\widetilde{\pi}$

Using $\psi(\phi,\lambda) = (\phi\lambda\eta)^{\frac{\lambda\eta}{1-\lambda\eta}}(1-\phi\lambda\eta)$, $l^* = \left(\delta(\lambda)\left(A^{1-\eta}\epsilon^\eta\right)^{\frac{1}{1-\lambda\eta}}\psi(\phi,\lambda)\right)^{\frac{1}{1-\delta(\lambda)}}\widehat{h}^{-1}$;
$f^* = \left[\epsilon\widehat{h}^{1-\lambda}\left(\phi\lambda\eta\left(A/l^*\right)^{1-\eta}\right)^\lambda\right]^{\frac{1}{1-\lambda\eta}}$ and $\delta = \frac{(1-\lambda)\eta}{1-\lambda\eta}$, I derive the price of a variety of firm

with productivity parameter ϵ as

$$\begin{aligned} p(\phi,\lambda,\epsilon) &= A^{1-\eta}(f^* l^*)^{\eta-1} \\ &= \left(\frac{(1-\phi\lambda\eta)(1-\lambda)\eta}{1-\lambda\eta}\right)^{\lambda-1}\left[\epsilon^{-1}(\phi\lambda\eta)^{-\lambda}\right] \\ &= \frac{\Theta(\phi,\lambda)}{\epsilon\eta}, \end{aligned}$$

where $\Theta(\phi,\lambda) = \widetilde{\lambda}\left(\frac{1-\lambda\eta}{1-\phi\lambda\eta}\right)^{1-\lambda}\left(\frac{1}{\phi}\right)^{\lambda}$ and $\widetilde{\lambda} = (1-\lambda)^{-(1-\lambda)}\lambda^{-\lambda}$. Similarly, $R(\epsilon) = Ap(\epsilon)^{1-\sigma} = A\left(\frac{\Theta(\phi,\lambda)}{\epsilon\eta}\right)^{1-\sigma}$ and $y(\epsilon) = Ap(\epsilon)^{-\sigma} = A\left(\frac{\Theta(\phi,\lambda)}{\epsilon\eta}\right)^{-\sigma}$.

I solve for the net surplus of the employer $\widetilde{\pi}$ starting from equation (1.4) as follows:

$$\begin{aligned} \widetilde{\pi}(\phi,\lambda,\epsilon) &= \left(A^{1-\eta}\epsilon^{\eta}\right)^{\frac{1}{1-\lambda\eta}}\widehat{h}^{\frac{(1-\lambda)\eta}{1-\lambda\eta}}\psi(\phi,\lambda)\, l^{\delta(\lambda)} - \widehat{h}l \\ &= \left[\left(A^{1-\eta}\epsilon^{\eta}\right)^{\frac{1}{1-\lambda\eta}}\psi(\phi,\lambda)\right]^{\frac{1}{1-\delta(\lambda)}}\delta(\lambda)^{\frac{\delta(\lambda)}{1-\delta(\lambda)}}\left[1-\delta(\lambda)\right] \\ &= A\left[\frac{\widetilde{\lambda}}{\epsilon\eta}\left(\frac{1}{\phi}\right)^{\lambda}\left(\frac{1-\lambda\eta}{1-\phi\lambda\eta}\right)^{1-\lambda}\right]^{1-\sigma}\frac{(1-\phi\lambda\eta)(1-\eta)}{1-\lambda\eta} \\ &= A\left(\frac{\Theta(\phi,\lambda)}{\epsilon\eta}\right)^{1-\sigma}\frac{(1-\phi\lambda\eta)(1-\eta)}{1-\lambda\eta}. \end{aligned}$$

■

Proof of Proposition 1

First, it is helpful to sign the elasticities of $\Theta(\phi,\lambda)$ with respect to ϕ and λ. Since $\ln\Theta(\phi,\lambda) = (1-\lambda)\ln\left(\frac{1-\lambda\eta}{1-\phi\lambda\eta}\right) - \lambda\ln\phi$, I have that

$$\frac{\partial\ln\Theta(\phi,\lambda)}{\partial\ln\phi} = -\lambda\left(\frac{1-\phi\eta}{1-\phi\lambda\eta}\right) < 0$$

$$\frac{\partial}{\partial\lambda}\frac{\partial\ln\Theta(\phi,\lambda)}{\partial\ln\phi} = -\left(\frac{1-\phi\eta}{1-\phi\lambda\eta}\right) - \lambda\left(\frac{\phi\eta(1-\phi\eta)}{(1-\phi\lambda\eta)^2}\right) < 0$$

In addition:

$$\begin{aligned}\frac{\partial \ln \Theta(\phi,\lambda)}{\partial \ln \lambda} &= \lambda \frac{\partial \ln \Theta(\phi,\lambda)}{\partial \lambda} \\ &= \lambda\left[-\ln\left(\frac{1-\lambda\eta}{1-\phi\lambda\eta}\right)+\frac{\phi(1-\lambda)\eta}{1-\phi\lambda\eta}-\frac{(1-\lambda)\eta}{1-\lambda\eta}-\ln\phi\right]\end{aligned}$$

Although the sign of $\frac{\partial \ln \Theta(\phi,\lambda)}{\partial \ln \lambda}$ depends on parameter values, the sign of the marginal effect of increasing ϕ is determined as follows.

$$\begin{aligned}\frac{\partial}{\partial \phi}\frac{\partial \ln \Theta(\phi,\lambda)}{\partial \ln \lambda} &= \lambda\left[\frac{\eta(1-2\lambda)+(\lambda\eta)^2\phi}{(1-\phi\lambda\eta)^2}-\phi^{-1}\right] \\ &= \lambda\left[\frac{\eta-\left(2\lambda\eta-\phi(\lambda\eta)^2\right)}{1-\phi\left(2\lambda\eta-\phi(\lambda\eta)^2\right)}-\phi^{-1}\right]<0.\end{aligned}$$

Since the first term inside the square brackets is less than 1. After deriving the comparative statics on $\Theta(\phi,\lambda)$, it is straightforward to do the same for $\widetilde{\pi}(\phi,\lambda,\epsilon)$ as follows.

$$\begin{aligned}\frac{\partial \ln \widetilde{\pi}}{\partial \ln \phi} &= \lambda\sigma\left(\frac{1-\phi\eta}{1-\phi\lambda\eta}\right)-\left(\frac{\lambda}{1-\phi\lambda\eta}\right) \\ &= \lambda\left[\frac{(\sigma-1)(1-\phi)}{1-\phi\lambda\eta}\right]>0.\end{aligned}$$

Direct differentiation gives

$$\frac{\partial}{\partial \lambda}\frac{\partial \ln \widetilde{\pi}}{\partial \ln \phi}>0.$$

Similarly,

$$\begin{aligned}\frac{\partial}{\partial \phi}\frac{\partial \ln \widetilde{\pi}}{\partial \ln \lambda} &= (1-\sigma)\frac{\partial}{\partial \phi}\frac{\partial \ln \Theta(\phi,\lambda)}{\partial \ln \lambda}-\frac{\lambda\eta}{(1-\phi\lambda\eta)^2} \\ &= (\sigma-1)\lambda\left[\phi^{-1}-\frac{1-\left(2\lambda\eta-\phi(\lambda\eta)^2\right)}{1-\phi\left(2\lambda\eta-\phi(\lambda\eta)^2\right)}\right]>0.\end{aligned}$$

Repeating the same steps for prices and revenue yields:

$$\frac{\partial \ln p}{\partial \ln \phi}<0; \qquad \frac{\partial}{\partial \lambda}\frac{\partial \ln p}{\partial \ln \phi}<0; \qquad \frac{\partial}{\partial \phi}\frac{\partial \ln p}{\partial \ln \lambda}<0$$

$$\frac{\partial \ln R}{\partial \ln \phi} > 0; \qquad \frac{\partial}{\partial \lambda}\frac{\partial \ln R}{\partial \ln \phi} > 0 \qquad \frac{\partial}{\partial \phi}\frac{\partial \ln R}{\partial \ln \lambda} > 0.$$

■

Proof of Lemma 2

Denote $\Theta_{js} = \Theta\left(\phi_j, \lambda(s)\right)$ and $\Psi_{js} = \Psi\left(\phi_j, \lambda(s)\right)$. Recall that $\epsilon^*_{ijs} = \frac{\Psi_{is}\tau_{ij}}{P_{js}}\left(\frac{b_s Y_j}{f_{ij}}\right)^{\frac{1}{1-\sigma}}$ where $\Psi_{is} = \Theta_{is}\left(\frac{(1-\phi\lambda\eta)(1-\eta)}{1-\lambda\eta}\right)^{\frac{1}{1-\sigma}}$.

Consider the elasticity of $\Psi(\phi, \lambda)$ with respect to ϕ

$$\frac{\partial \ln \Psi_{is}}{\partial \ln \phi} = -\frac{\lambda\eta(1-\phi)}{1-\phi\lambda\eta} < 0$$

The partial impacts of higher λ or ϕ on the elasticity are

$$\frac{\partial}{\partial \lambda}\frac{\partial \ln \Psi_{is}}{\partial \ln \phi} = -\frac{\eta(1-\phi)}{(1-\phi\lambda\eta)^2} < 0,$$

$$\begin{aligned}\frac{\partial}{\partial \phi}\frac{\partial \ln \Psi_{is}}{\partial \ln \lambda} &= \frac{\partial}{\partial \phi}\left[\frac{\partial \ln \Theta_{is}}{\partial \ln \lambda} + \frac{\lambda\eta}{1-\sigma}\left[\frac{1-\phi}{(1-\phi\lambda\eta)(1-\lambda\eta)}\right]\right] \\ &= \lambda\left[\frac{1-\left(2\lambda\eta-\phi(\lambda\eta)^2\right)}{1-\phi\left(2\lambda\eta-\phi(\lambda\eta)^2\right)} - \phi^{-1}\right] < 0.\end{aligned}$$

Therefore,

$$\frac{\partial \ln \epsilon^*_{ijs}}{\partial \ln \phi} < 0 \qquad \frac{\partial}{\partial \lambda}\frac{\partial \ln \epsilon^*_{ijs}}{\partial \ln \phi} < 0 \qquad \frac{\partial}{\partial \phi}\frac{\partial \ln \epsilon^*_{ijs}}{\partial \ln \lambda} < 0$$

Consider two exporters, i and k, which are identical beside that labor laws are more rigid country i than k, i.e. $\phi_i > \phi_k$. The ratio of the cutoffs of exporting to j between two exporters is $\frac{\epsilon^*_{ijs}}{\epsilon^*_{kjs}} = \frac{\Psi_{is}}{\Psi_{ks}} < 1$ with $\frac{\phi_i}{\phi_k} > 1$. Therefore, $\frac{\partial}{\partial \lambda}\frac{\partial \ln \epsilon^*_{ijs}}{\partial \ln \phi} < 0$ and $\frac{\partial}{\partial \phi}\frac{\partial \ln \epsilon^*_{ijs}}{\partial \ln \lambda} < 0$ imply that $\frac{\epsilon^*_{ijs}}{\epsilon^*_{kjs}}$ is decreasing in λ.■

Proof of Proposition 3

Recall that $X_{ijs} = \frac{b_s N_{is} Y_j}{(\eta P_{js})^{1-\sigma}}\left(\Theta_{is}\tau_{ij}\right)^{-(\sigma-1)} W_{ijs}$ where $W_{ijs} = \left\{\left(\frac{\epsilon_H}{\epsilon^*_{jis}}\right)^{\xi-(\sigma-1)} - 1, 0\right\}$. From Lemma 2, I show that $\epsilon^*_{jis}/\epsilon^*_{kis}$ is decreasing in λ if $\phi_i > \phi_k$. Therefore, $\forall W_{ijs} > 0$, W_{ijs}/W_{kjs} is increasing λ. Similarly, given $\phi_i > \phi_k$, $X_{ijs}/X_{kjs} > 1$. From Proposition 1 that $\frac{\partial}{\partial \phi}\frac{\partial \ln \Theta(\phi,\lambda)}{\partial \ln \lambda} < 0$

and $\frac{\partial}{\partial\lambda}\frac{\partial \ln\Theta(\phi,\lambda)}{\partial \ln\phi} < 0$, X_{ijs}/X_{kjs} is increasing in λ.■

Derivation of P_{js} in General Equilibrium

Denote $\Theta_{js} = \Theta\left(\phi_j, \lambda(s)\right)$ and $\Psi_{js} = \Psi\left(\phi_j, \lambda(s)\right)$. With ϵ following a Pareto distribution, and the assumptions that $\epsilon_H \to \infty$ and $N_{js} = w_j L_j$, sectoral price of goods s in country j becomes

$$
\begin{aligned}
P_{js} &= \left[\sum_j^N w_j L_j \left(\frac{\eta}{\Theta_{js}}\right)^{\sigma-1} \int_{\epsilon^*_{jis}} \epsilon^{\sigma-1} dG(\epsilon)\right]^{\frac{1}{1-\sigma}} \\
&= \left[\sum_j^N w_j L_j \left(\frac{\eta}{\Theta_{js}}\right)^{\sigma-1} \frac{\xi}{\xi-(\sigma-1)} \left(\epsilon^*_{jis}\right)^{\sigma-1-\xi}\right]^{\frac{1}{1-\sigma}}.
\end{aligned}
$$

By substituting $\epsilon^*_{jis} = \frac{\Psi_{js}\tau_{ij}}{P_{js}}\left(\frac{b_s Y_j}{f_{ij}}\right)^{\frac{1}{1-\sigma}}$ from (1.9) into the equation, I obtain

$$
\begin{aligned}
P_{js}^{1-\sigma} &= \sum_j^N w_j L_j \left(\frac{\eta}{\Theta_{js}}\right)^{\sigma-1} \frac{\xi}{\xi-(\sigma-1)} \left(\frac{\Psi_{js}\tau_{ij}}{P_{is}}\right)^{\sigma-1-\xi} \left(\frac{b_s Y_i}{f_{ji}}\right)^{\frac{\sigma-1-\xi}{1-\sigma}} \\
&= \sum_j^N w_j L_j \left(\frac{\eta}{\Theta_{js}}\right)^{\sigma-1} \frac{\xi}{\xi-(\sigma-1)} \left(\Theta_{js}\left(\frac{(1-\phi\lambda\eta)(1-\eta)}{1-\lambda\eta}\right)^{\frac{1}{1-\sigma}}\right)^{\sigma-1-\xi} \left(\frac{b_s Y_i}{f_{ji}}\right)^{\frac{\sigma-1-\xi}{1-\sigma}} \\
&= \sum_j^N w_j L_j \frac{\xi}{\xi-(\sigma-1)} \left(\frac{\Theta_j}{\eta}\right)^{-\xi} \left(\frac{(1-\phi\lambda\eta)(1-\eta)}{1-\lambda\eta}\frac{b_s Y_i}{f_{ji}}\right)^{\frac{\sigma-1-\xi}{1-\sigma}} \left(\frac{P_{is}}{\tau_{ji}}\right)^{1+\xi-\sigma}
\end{aligned}
$$

Rearranging gives

$$
P_{js} = \mu_1 Y_i^{\frac{1}{\xi}+\frac{1}{1-\sigma}} \Delta_i,
$$

where $\Delta_i{}^{-\xi} = \sum_j^N \frac{Y_j \Theta_{js}^{-\xi}}{1+\pi} \tau_{ji}^{-(\xi-(\sigma-1))} f_{ji}^{-\frac{\xi-(\sigma-1)}{\sigma-1}}$ and $\mu_1 = \frac{1}{\eta}\left(\frac{\xi-(\sigma-1)}{\xi}\right)^{\frac{1}{\xi}} \left(\frac{(1-\phi\lambda\eta)(1-\eta)b_s}{1-\lambda\eta}\right)^{\frac{1}{\xi}+\frac{1}{1-\sigma}}$.■

Derivation of X_{ijs} in General Equilibrium

Denote $\Theta_{js} = \Theta\left(\phi_j, \lambda(s)\right)$ and $\Psi_{js} = \Psi\left(\phi_j, \lambda(s)\right)$. From (10) and (11), $X_{ijs} = \frac{b_s N_{is} Y_j}{(\eta P_{js})^{1-\sigma}} \left(\Theta_{is}\tau_{ij}\right)^{-(\sigma-1)} W$ where $W_{ijs} = \left\{\left(\frac{\epsilon_H}{\epsilon^*_{jis}}\right)^{\xi-(\sigma-1)} - 1, 0\right\}$. With the assumption that $N_{is} = w_i L_i$, the volume of sectoral exports is $X_{ijs} = w_i L_i \int_{\epsilon^*_{ijs}}^{\epsilon_H} x_{ijs}(\epsilon) G(\epsilon)$. Substituting $x_{ijs}(\epsilon) = \mu_2 \Delta_j^{\sigma-1} Y_j^{\frac{\sigma-1}{\xi}} \left(\frac{\Theta_{is}\tau_{ij}}{\epsilon\eta}\right)^{1-\sigma}$ from equation (1.14), I have

$$X_{ijs} = \mu_2 Y_i \Delta_j^{\sigma-1} Y_j^{\frac{\sigma-1}{\xi}} \left(\Theta_{is}\tau_{ij}\right)^{-(\sigma-1)} V_{ijs}.$$

where

$$V_{ijs} = \begin{Bmatrix} \int_{\epsilon^*_{ijs}}^{\epsilon_H} \epsilon^{\sigma-1} dG(\epsilon) & \text{if } \epsilon^*_{jis} \leq \epsilon_H \\ 0 & \text{otherwise} \end{Bmatrix}$$

With the assumption that $\epsilon_H \to \infty$, substituting $\epsilon^*_{jis} = \mu_3 \Delta_j^{-1} Y_j^{-\frac{1}{\xi}} \tau_{ij} f_{ij}^{\frac{1}{\sigma-1}} \Psi_{is}$ from equation (1.15) delivers the following:

$$\begin{aligned} X_{ijs} &= \frac{\xi}{\xi-(\sigma-1)} w_i L_i \mu_2 \Delta_j^{\sigma-1} Y_j^{\frac{\sigma-1}{\xi}} \left(\frac{\Theta_{is}\tau_{ij}}{\eta}\right)^{1-\sigma} \left(\Psi_{is}\gamma_3 \Delta_j^{-1} Y_j^{-\frac{1}{\xi}} \tau_{ij} \left(f_{ij}\right)^{\frac{1}{\sigma-1}}\right)^{\sigma-1-\xi} \\ &= \frac{\xi(1+\pi)^{-1}}{\xi-(\sigma-1)} \mu_2 \mu_3^{\sigma-1-\xi} Y_i Y_j \left(\frac{\Delta_j}{\Psi_{is}}\right)^{\xi} \left(\frac{1-\lambda\eta}{(1-\phi\lambda\eta)(1-\eta)}\right) \tau_{ij}^{-\xi} f_{ij}^{-\frac{\xi-(\sigma-1)}{\sigma-1}} \\ &= \mu_4 Y_i Y_j \left(\frac{\Delta_j}{\Psi_{is}}\right)^{\xi} \frac{1}{1-\phi\lambda\eta} \tau_{ij}^{-\xi} f_{ij}^{-\frac{\xi-(\sigma-1)}{\sigma-1}} \end{aligned}$$

where $\mu_4 = \frac{\xi(1-\lambda\eta)\eta^{\xi}(1+\pi)^{-1}}{(1-\eta)[\xi-(\sigma-1)]} b_s^{\frac{\xi}{\sigma-1}} \mu_1^{\xi}$.■

The Consistent Estimate of ω_{ijs}

Since u_{ijs} is correlated with observable trade frictions (d_{ij}) due to the Heckman sample selection, and ω_{ijs} is correlated with u_{ijs} because the error term of the selection equation is $e_{ijs} = u_{ijs} + v_{ijs}$, I cannot use the predicted value $\widehat{z}^*_{ijs}$ alone, which contains e_{ijs}, to obtain a consistent estimate for ω_{ijs}. According to HMR, consistent estimation of ω_{ijs} requires controlling for firm selection into exporting conditional on positive exports, ie. $\overline{\omega}_{ijs} = E\left[\omega_{ijs}|I_{ijs}=1\right]$, and the standard Heckman correction for sample selection bias, $E\left[u_{ijs}|I_{ijs}=1\right] = corr\left(u_{ijs}, e_{ijs}\right)\left(\sigma_u/\sigma_e\right)\widehat{\overline{e}}^*_{ijs}$. Both terms depend on $\widehat{\overline{e}}^*_{ijs} = \phi\left(\widehat{z}^*_{ijs}\right) / \Phi\left(\widehat{z}^*_{ijs}\right)$, the inverse

Mills' ratio. Thus, the consistent estimate of the latent variable, $\overline{z}^*_{ijs}$ and $\overline{\omega}_{ijs}$ are $\widehat{\overline{z}}^*_{ijs} = \widehat{z}^*_{ijs} + \widehat{\overline{e}}^*_{ijs}$ and $\widehat{\overline{\omega}}^*_{ijs} \equiv \ln\left\{\exp\left(\beta\widehat{\overline{z}}^*_{ijs}\right) - 1\right\}$ respectively. Therefore, I include both $\widehat{\overline{e}}^*_{ijs}$ and $\widehat{\overline{\omega}}^*_{ijs}$ as regressors in the second-stage trade flow equation.

1.9.2 Appendix B - Dataset Construction and Definition of Variables

I. Improving the quality of the PSID data for the construction of sector proxies for firm-specific skill intensity

The sample for constructing the sector proxies for firm-specific skill intensity includes observations in the PSID dataset (1985-1993) which satisfy the following filters in order:

1) Following the related literature, the sample is restricted to white male heads of households, aged 18 to 64, who worked in manufacturing sectors for at least 500 hours in a year, and earned real hourly wages of at least $2 (in 1990 dollars).

2) I follow the exact procedures reported in the "Variable Construction Procedures" section in Kambourov and Manovskii (2007) to enhance data quality. In essence, this procedure identifies an employer switch whenever the reported length of present employment is smaller than the time elapsed since the last interview date. The same rule applies to sector switches. An updated employee's time-series of firm tenure is constructed based on her corrected sequence of firm and sector switches. The procedure also checks consistency of the reported tenure and working experience, and make adjustments accordingly. For example, a worker may report to have worked for 8 years in the previous interview, but report 8 years again a year later. In this case, 1 year is added to the previously reported experience. Similar corrections are made for the subsequent reported experience of the same worker accordingly.

3) An individual might report to have been with the same employer, but have switched sector. In that case, within the same employer-specific job spell, the sector that appears more than half of the time is identified to be the sector for that spell. If no sector appears more than 50% of the time within a spell, all observations of that spell are dropped from the sample. This rule excludes 17% of the observations in the restricted sample after applying filter 1.

4) Only sectors that have at least 2 observations in any given year, at least 25 unique individuals, and at least 40 observations are kept in the sample.

II. Mapping industry codes from different classification systems

1. Mapping census codes to SIC72 codes The concordance file is taken from Appendix 2 of 1981 PSID wave XIV documentation. Since the number of categories under the census classification is 76 (The original classification has 81 sectors, but 5 of them have no mapping to SIC72 codes.), while the number of SIC72 categories is 143. I restrict a SIC72 code from being mapped to more than one census code. For the same reason, some census categories have more than one SIC72 match. For the SIC72 categories that have more than one census maps (282, 331, 333, 334, 335. 336. 339, 357, 379), I use the average of the specific skill intensity measures across the census categories belonging to the same SIC category as the measure for that SIC category. At the end, each of the 143 SIC72 code is mapped into a census code.

2. Mapping SIC72 (3-digit) codes to SIC87 (3-digit) codes The concordance file is taken from Bartelsman and Gray (1996) at the NBER-CES Manufacturing Industry Database.[54] Of the 140 SIC87 3-digit codes, 136 remain the same as the SIC72 codes. For those SIC87 (3-digit) categories that have multiple SIC72 (3-digit) categories identified, I choose the SIC72 one that commands the largest value of shipment. As a result, 143 SIC72 3-digit categories are mapped into 140 SIC87 3-digit categories.

3. Mapping SITC (4-digit rev. 2) codes to SIC87 (4-digit) codes Mapping SITC (4-digit rev.2) into SIC87 (4-digit) requires first converting each of the classification systems to the Harmonized system (HS 10-digit). The concordance file for mapping SITC (4 digit revision 2) codes to HS codes is taken from Feenstra's website[55]. The concordance file for mapping SIC87 (4-digit) codes to HS codes is taken from Peter Schott's website[56]. Following Nunn (2007), I use the number of 10-digit Harmonized-system categories shared between two codes from different classification systems to decide which SIC code to use for a given SITC code. When more than one SIC codes are identified for a SITC code, the SIC code that shares more HS10 categories with that SITC code is used. For some rare cases, a SITC code has multiple SIC codes tied in the number of HS10 categories shared (It happens for 26 SITC codes out of 760 total). In those situations, I manually choose a unique match. As a result, 116 SIC87 codes suffice to cover all SITC codes. Twenty-three SIC87 codes are redundant in the trade dataset.

III. Bilateral Variables

[54] http://www.nber.org/nberces/

[55] http://cid.econ.ucdavis.edu/usixd/wp5515d.html

[56] http://www.som.yale.edu/faculty/pks4/sub_international.htm

Bilateral Export Volumes at the Sector Level : From Feenstra (2000), for the year 1995. Sector-level bilateral exports data are categorized at the 4-digit SITC (4-digit rev. 2) level.

Bilateral "Trade Costs": From the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).[57] Physical distance between two countries is calculated using the great circle formula. Other "trade costs" variables include 1) a "Common Language" dummy equal to 1 if at least 9% of the population in each country's speaks a common language; 2) a "Colony" dummy equal to 1 if a country had been a colony of the other; 3) a "Common colonizer" dummy equal to 1 if both countries had been colonized by the same colonial power after 1945; 4) a "Border" dummy equal to 1 if the countries share a common land border; 5) an "Island" dummy equal to 1 if one of the countries is an island; 6) a "Landlocked" dummy equal to 1 if one of the countries is landlocked. 7) a "Legal" dummy equal to 1 if both trade partners share the same legal origin (British, French, German, Scandinavian). I refer to Rose (2004) and CIA World Factbook to augment the CEPII data, so all these "trade costs" variables are available for all country pairs in my sample.

Trade Partnership: I include dummies to capture the effect due to trade agreements signed between trade partners. The dummies are constructed based on information from the websites of WTO and various regional trade blocs. Trade agreement dummies include 1) an "RTA" dummy equal to 1 if both countries are signatories of one of the following regional trade agreements: EU, US-Isreal, NAFTA, Canada-US, CARICOM, PATCRA, ANZ-CERTA, CACM, MERCOSUR, ASEAN, SPARTECA.

IV. Country Characteristics

Labor Regulations: From Botero et al. (2004).[58] A country's labor protection index is an unweighted average of two indices: "Employment Laws" index and "Collective Relations" index. The "Employment Laws" is an unweighted average of the following four subindices of the

[57] http://www.cepii.fr/anglaisgraph/bdd/distances.htm
[58] http://www.economics.harvard.edu/faculty/shleifer/Data/labor_dataset_qje_dataforweb_2005.xls

labor market: (1) Alternative employment contracts (2) Costs of increasing hours worked (3) Costs of firing workers, (4) Dismissal procedures. The "Collective Relations" index includes (1) Labor Union Power and (2) Collective Disputes. With Taiwan excluded from the sample due to missing "trade costs" data on bilateral variables, the sample for the baseline regression contains 84 countries. Indices are constructed by the authors based on countries legal documents in the late 90's.

Factor Endowments: Physical capital endowment and human capital endowment are taken from Antweiler and Trefler (2002). A country's stock of physical capital is natural log of the average capital stock per worker. The stock of human capital is the natural log of the ratio of workers that completed high school to those that did not. The measures used are from 1992, the closest year of which data are available. Fifty-six of the countries in my sample have both of these measures.

Natural resources endowment is adopted from the World Bank's "Expanding the Measure of Wealth" dataset. A country's stock of raw materials is the natural log of the estimated dollar value of natural resources stock per worker. Natural resources included in this measure are 1) pastureland, 2) cropland, 3) timber resources, 4) nontimber forest resources, 5) protected areas and 6) subsoil assets. Fifty countries in my sample have this measure.

Price Level of Consumption: From the Penn World Tables. It is the PPP over the value of consumption divided by the exchange rate. By construction, the price level of the U.S. is set equal to 1, such that cross-country price levels can be compared within a year. All countries in my sample have this measure.

Quality of the Judicial System: From Kaufmann, Kraay, and Mastruzzi (2006). Data to construct this measure were collected in 1996 by World Bank staff. The measure I use is a composite of 3 subindices, which include i) perceptions of incidence of crime; ii) the effectiveness and predictability of judiciary; iii) the enforceability of contracts. The original measure ranges from -2.5 to 2.5, with a higher number indicates better judiciary. Following Nunn (2007), I rescale it to range between 0 and 1. All countries in my sample have this measure.

Financial Development: From Beck et al.'s (2000) Financial Structure and Economic Development. Equal to the amount of credit extended by banks and other financial intermediaries to the private sector divided by GDP. I use the value from 1995. Sixty-nine of the countries in my sample have this measure.

V. Industry Characteristics

Factor Intensities: Sources are from Bartelsman and Gray's (1996) US Manufacturing Database, maintained by the National Bureau of Economic Research. I consider a 4-factor production function (Skilled, Unskilled Labor, Capital and Materials) as in Levchenko (2007). Material intensity (s_m) is the ratio of the value of material costs to the sum of value added and material costs. Capital intensity (s_k) is 1 minus the share of total payroll in value added, multiplied by 1 minus the material intensity ($1 - s_m$). Skilled labor intensity (s_h) is the ratio of non-production worker to total employment multiplied by the share of labor in value added, then multiplied by the 1 minus the material intensity ($1 - s_m$). This standard methodology ensures that the sum of intensity measures is equal to 1 minus labor intensity ($1 - s_l$), which is always excluded from the regressions due to perfect colinearity with the other intensity measures. Since original data are disaggregated at the 4-digit level. First I average intensity measures for each 4-digit categories over 1991-1996, the last year of which data are available. The average value of the 4-digit categories belonging to each 3-digit category is used as the measure for that 3-digit sector.[59] Measures for 140 manufacturing sectors are available.

"Contract Dependence" From Nunn (2007). A sector is considered more contract-dependent if a larger fraction (by value) of its inputs are *not* sold on an organized exchange, according to the classification constructed by Rauch (1999). Since his measures are grouped into BEA IO categories, I use the mapping algorithm from Nunn (2007) to map them into SIC87 categories. For cases in which multiple IO categories are identified as maps for a given

[59]Alternatively, I can use the median of the intensity measures at the 4-digit SIC level as my 3-digit level measure. The piecewise correlation between the measure using the mean and that using the median is about 0.98 for the intensity measures. Expectedly, the empirical results using two different mesaures are unchanged. For this reason, averages are used for other sector measures when original measures are available at a more disaggregated industry level.

SIC category, the IO category with the greatest number of shared HS codes is used. After applying this procedure, three SIC 4-digit categories remain to have multiple IO categories identified. For these cases, I manually pick the unique crosswalk. As a result, 389 SIC87 4-digit categories have the "contract dependence" measure. The average value of across the 4-digit categories belonging to each 3-digit is used as the measure for that 3-digit sector. Measures for 137 manufacturing sectors are available.

Sales Volatility From Cuñat and Melitz (2007), through E-mail communication. It is equal to the employment-weighted standard deviation of sales growth for publicly listed firms in the 1980-2004 Compustat data set. All 3-digit SIC sectors have this measure.

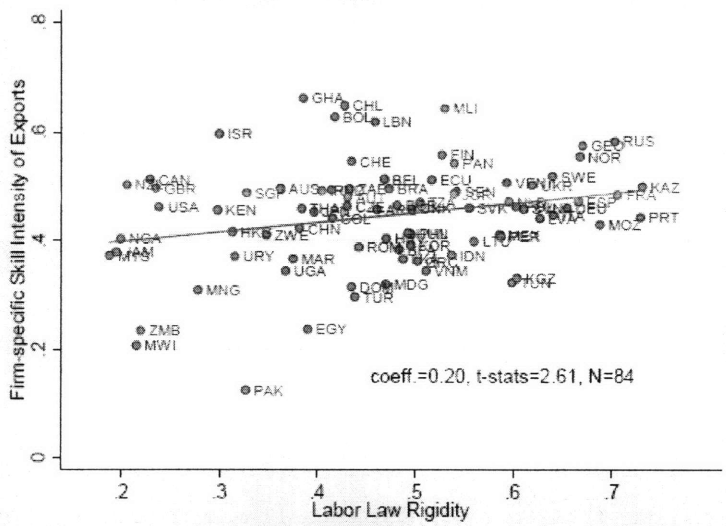
Gross Job Flows From an updated dataset of Davis, Haltiwanger and Schuh (1996) at Haltiwanger's website.[60] The rate of gross job flows for a sector is defined as the average of job creation and destruction rates. The job creation rate of a sector is defined as the employment-weighted average of employment growth across plants within that sector. The job destruction rate of a sector is defined as employment-weighted average of the absolute value of negative employment growth across plants within that sector. I use the annual series of gross job flows over 1972-1998. First, I compute the employee-weighted average over the SIC 4-digit category belonging to each SIC 3-digit category. The final measure is a time-series average for each SIC 3-digit category over 1972-1998. All 3-digit SIC sectors have this measure.

Dependence on External Finance From Rajan and Zingales (1998). It is defined to be the fraction of total capital expenditure over 1980-1989 not financed by internal cash flow. Computed based on the publicly listed firms in the Compustat dataset. Original data are constructed at the ISIC (rev.2) 3-digit industry level. I manually map them into SIC87 2-digit, and then into 67 SIC87 3-digit categories in my sample. Averages are used when a mapping goes from a less aggregated code to a more aggregated code.

[60] http://www.econ.umd.edu/~haltiwan/download.htm

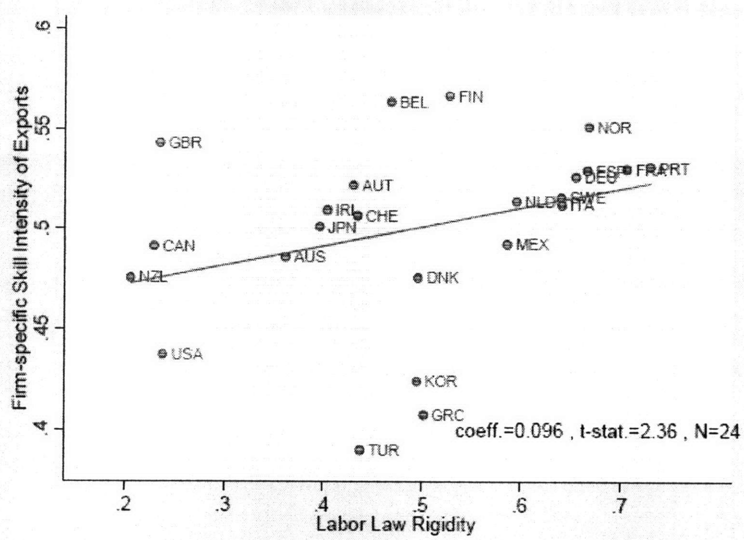
1.10 Tables and Figures

Figure 1-2: Countries' Firm-specific Skill Intensity of Exports and Labor Protection (Full Sample)



A country's firm-specific skill intensity of exports is computed according to equation (1.20) in the text. It is equal to the export-weighted average across 67 sector proxies of firm-specific skill intensity, of which each sector measure is weighted by the sector share of total exports of the country.

Figure 1-3: Countries' Firm-specific Skill Intensity of Exports and Labor Protection (OECD Countries)



A country's firm-specific skill intensity of exports is computed according to equation (1.20) in the text. It is equal to the export-weighted average across 67 sector proxies of firm-specific skill intensity, of which each sector measure is weighted by the sector share of total exports of the country.

Table 1.1: Labor Protection and Specialization in Firm-specific Skill-Intensive Goods

This table examines the effects of labor protection on specialization patterns, based on regression specification (1.21).

Dependent Variable = Firm-specific Skill Intensity of Exports: $XSpec_i$

	(1) Baseline	(2) K/L + H/L	(3) Resources	(4) Income	(5) Legal Inst	(6) 2SLS (1)	(7) 2SLS (2)
Labor Protection	**0.196**	**0.205**	**0.281**	**0.271**	**0.289**	**0.250**	**0.306**
	(2.61)**	**(2.52)****	**(3.02)*****	**(3.01)*****	**(3.09)*****	**(1.78)***	**(2.09)****
Human Capital: ln(H/L)		0.192	0.203	0.182	0.140	0.173	0.146
		(1.66)	(1.61)	(1.40)	(1.08)	(1.38)	(1.16)
Capital: ln(K/L)		-0.014	-0.029	-0.065	-0.048	-0.063	-0.049
		(-0.76)	(-1.41)	(-1.58)	(-1.03)	(-1.55)	(-1.05)
Resources: ln(Resource/L)			0.033	0.030	0.034	0.030	0.034
			(1.96)*	(1.76)*	(1.93)*	(1.67)	(1.87)*
Income Level: ln(GDP/L)				0.058	0.012	0.059	0.011
				(1.09)	(0.16)	(1.10)	(0.14)
Judicial Quality					0.184		0.187
					(1.42)		(1.42)
R^2	0.06	0.16	0.24	0.26	0.29	0.26	0.26
# countries	84	56	50	50	50	50	50

Note: Huber-White robust t-statistics are in parentheses.
***, ** and * denote 1%, 5% and 10% significance levels.
See Appendix B for detailed description of variables.
In columns (6) and (7), legal origins are used as instruments for labor protection.

Table 1.2: Labor Protection and Export Volumes

This table examines the effects of labor protection on bilateral exports volumes, based on regression specification (1.17).

Dependent Variable: (ln) bilateral exports from i to j by sector: $\ln(X_{ijs})$

	(1) Baseline	(2) with P_{ijs}	(3) + K/L & H/L Endowments	(4) + Natural Resources	(5) Controlling # Exporting Firms
Labor Protect. x Spec.	**0.382**	**0.379**	**0.350**	**0.485**	**0.560**
	(4.19)***	**(4.12)*****	**(3.78)*****	**(5.06)*****	**(6.04)*****
ln(distance)	-0.558	-0.566	-0.603	-0.628	-0.651
	(-22.87)***	(-23.04)***	(-22.81)***	(-21.60)***	(-22.44)***
Common Colonizer	0.015	0.051	-0.004	0.020	0.001
	(0.43)	(0.51)	(-0.04)	(0.14)	(0.01)
Ever Colony	0.296	0.301	0.333	0.345	0.353
	(4.26)***	(4.31)***	(4.79)***	(4.81)***	(4.88)***
Common Language	0.183	0.178	0.169	0.189	0.194
	(3.55)***	(3.43)***	(3.16)***	(3.24)***	(3.28) ***
Common Border	0.664	0.665	0.651	0.586	0.578
	(7.28)***	(7.31)***	(6.23)***	(5.52)***	(5.34) ***
Common Legal Origin	0.246	0.252	0.252	0.257	0.259
	(6.59)***	(6.76)***	(6.11)***	(5.97)***	(5.99) ***
RTA Members	0.356	0.370	0.343	0.308	0.301
	(5.37)***	(5.58)***	(4.63)***	(3.78)***	(3.64) ***
Any Landlocked	-0.248	-0.233	-0.305	0.585	-0.368
	(-1.22)	(-1.14)	(-1.45)	(-1.84)*	(-1.77)*
Any Island	-0.152	-0.143	-0.130	-0.114	-0.097
	(-1.16)	(-1.10)	(-0.98)	(-0.65)	(-0.57)
ln(K/L) x Capital Intensity			-0.100	-0.157	-0.163
			(-0.83)	(-1.25)	(-1.32)
ln(H/L) x Skill Intensity			6.557	9.563	7.276
			(17.76)***	(23.64)***	(18.64)***
ln(Resource/L) x Mat. Intensity				1.331	1.309
				(11.24)***	(10.98)***
R^2	0.46	0.47	0.50	0.51	0.53
# exporters	84	84	56	50	50
# clusters	2,527	2,527	2,211	2,096	2,068
# observations	94,255	94,255	77,332	70,485	69,430

Note: All regressions include exporter, importer and sector fixed effects.
Standard errors are clustered by importer-exporter pair. t-statistics are in parentheses.
***, ** and * denote 1%, 5% and 10% significance levels respectively.
See Appendix B for detailed description of variables.

Table 1.3: Labor Protection and Export Volumes (with Alternative Hypotheses)

This table examines the effects of labor protection on bilateral exports volumes, based on regression specification (1.17). Additional interactions are added progressively to column (4) in Table 1.2.

Dependent Variable: (ln) bilateral exports from i to j by sector: $\ln(X_{ijs})$

Interactions:	(1) Labor Law x Volatility	(2) Labor Law x Volatility	(3) Legal Inst. x Contract	(4) Contract & Vol.	(5) Contract & Vol.	(6) Contract & Vol. (betas)
Measure of Volatility	Sales Volatility	Gross Job Flows	-	Sales Volatility	Gross Job Flows	Gross Job Flows
Labor Protect. x Spec.	**0.556**	**0.536**	**0.486**	**0.558**	**0.537**	**0.048**
	(5.85)***	**(5.31)*****	**(5.05)*****	**(5.84)*****	**(5.29)*****	**(5.29)*****
Labor Law x Volatility	-2.644	-3.448		-2.646	-3.461	-0.057
	(-3.75)***	(-4.39)***		(-3.75)***	(-4.36)***	(-4.36)***
Judicial x Contract Dep.			1.352	1.053	1.063	0.091
			(2.47)**	(2.48)**	(2.49)**	(2.49)**
R^2	0.52	0.52	0.52	0.52	0.52	0.52
# exporters	50	50	50	50	50	50
# clusters	2,096	2,096	2,096	2,096	2,096	2,096
# observations	70,485	70,485	70,485	70,485	70,485	70,485

Controls: 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
9 trade frictions variables; exporter, importer and sector fixed effects.

Note: Standard errors are clustered by importer-exporter pair. t-statistics are reported in parentheses.
***, ** and * denote 1%, 5% and 10% significance levels respectively.
Column (6) reports standardized coefficients of those in column (5).
See Appendix B for detailed description of variables.

Table 1.4: Labor Protection and Bilateral Export Volumes (Controlling for Country Characteristics)

This table examines the effects of labor protection on bilateral exports volumes, based on regression specification (1.17). Additional interactions are added progressively to column (4) in Table 1.3.

Dependent Variable: (ln) bilateral exports from i to j by sector: $\ln(X_{ijs})$

Exporters' Characteristics	(1) Income	(2) Human Capital	(3) Capital	(4) Judicial Quality	(5) Fin. Dev.	(6) All (w/ sales vol.)	(7) All (w/ job flows)
Labor Protect. x Spec.	**0.496**	**0.749**	**0.393**	**0.566**	**0.583**	**0.336**	**0.288**
	(5.28)***	**(7.57)*****	**(4.13)*****	**(6.06)*****	**(6.05)*****	**(2.75)*****	**(2.31)****
ln(rgdp per cap.) x Spec.	0.308					-0.136	-0.134
	(9.76)***					(-1.18)	(-2.51)**
ln(H/L) x Spec		0.307				-0.117	-0.117
		(7.42)***				(-1.60)	(-1.59)
ln(K/L) x Spec			0.269			0.258	0.260
			(9.72)***			(3.15)***	(3.17)***
Judicial x Spec				1.359		1.509	1.501
				(9.94)***		(5.59)***	(5.55)***
ln(credit/L) x Spec.					0.161	-0.168	-0.168
					(4.07)***	(-3.00)***	(-3.00)***
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52
# exporters	50	50	50	50	50	50	50
# clusters	2,096	2,096	2,096	2,096	2,079	2,079	2,079
# observations	70,485	70,485	70,485	70,485	70,278	70,278	70,278

Controls: 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; 5) Labor Law Rigidity and Sales Volatility; 6) Quality of Legal System and Contract Dependence.
9 trade frictions variables; exporter, importer and sector fixed effects.

Note: Standard errors are clustered by importer-exporter pair. t-statistics are reported in parentheses.
***, ** and * denote 1%, 5% and 10% significance level respectively.
See Appendix B for detailed description of variables.

Table 1.5: Labor Protection and Firm Selection into Exporting (First-Stage Probit Est.)

This table examines the effects of labor protection on the extensive margin of trade, based on regression specification (1.19). Columns (1) through (3) have the same set of controls as column (1), (2) and (4) in Table 1.2. Similarly, column (4) corresponds to column (4) in Table 1.3.

Dependent Variable: Indicator equal to 1 if positive trade flow is observed from i to j in s

	(1) Baseline	(2) Baseline (with P_{ijs})	(3) + K/L + H/L + Resources	(4) Alternative Hypotheses
Labor Law x Spec.	**0.614**	**0.619**	**0.706**	**0.724**
	(10.05)***	**(9.98)*****	**(9.43)*****	**(9.77)*****
Labor Law x Volatility				-0.902
				(-1.50)
Legal x Contract Dep.				1.206
				(5.41) ***
ln(K/L) x Capital Intensity			0.106	0.030
			(1.42)	(0.42)
ln(H/L) x Skill Intensity			6.853	6.649
			(22.69)***	(21.59) ***
ln(Resource/L) x Mat. Intensity			1.095	1.128
			(16.50)***	(16.97)***
ln(distance)	-0.631	-0.643	-0.703	-0.703
	(-35.15)***	(-35.07)***	(-39.40)***	(-39.40)***
Common Colonizer	-0.109	-0.109	-0.042	-0.043
	(-1.10)	(-1.09)	(-0.32)	(-0.32)
Ever Colony	0.280	0.290	0.387	0.386
	(4.42)***	(4.43)***	(5.23)***	(5.22)***
Common Language	0.259	0.260	0.310	0.310
	(8.06)***	(7.94)***	(8.29)***	(8.30) ***
Common Border	0.334	0.340	0.292	0.292
	(3.35)***	(3.35)***	(1.98)**	(1.98)**
Any Landlocked	-0.174	-0.172	-0.150	-0.149
	(-1.84)*	(-1.77)*	(-1.15)	(-1.15)
Any Island	0.200	-0.204	-0.120	-0.119
	(-3.67)***	(-3.57)***	(-2.12)**	(-2.12)**
Common Legal Origin	0.223	0.226	0.154	0.154
	(9.24)***	(9.21)***	(6.47)***	(6.47)***
RTA Members	0.106	0.106	0.049	0.049
	(2.17)**	(2.16)**	(0.88)	(0.88)
R^2	0.54	0.55	0.55	0.55
# exporters	84	84	50	50
# clusters	3,486	3,486	2,875	2,875
# observations	461,563	461,563	274,700	274,700

Controls: exporter, importer and sector fixed effects; interactions of importers' CPI with sector dummies.

Note: Standard errors are clustered by importer-exporter pair. z-statistics are reported in parentheses. ***, ** and * denote 1%, 5% and 10% significance level respectively. See Appendix B for detailed description of variables.

Table 1.6: Labor Protection and Export Volumes (Second-Stage MLE Estimation)

This table reports the second-stage gravity estimation results corresponding to the first-stage in Table 1.5. δ(from w_{ijs}) is the variable controlling for the extensive margin of trade. e_{ijs} is the inverse Mills' ratio correcting the Heckman selection bias. See section 1.4.2 for details.

Dependent Variable: (ln) of bilateral export from i to j in sector s: $\ln(X_{ijs})$

Panel A: Maximum Likelihood				
Interaction Terms	(1) Baseline	(2) Baseline (with Pijs)	(3) + K/L + H/L + Resources	(4) Alternative Hypotheses
Labor Law x Spec.	**0.534**	**0.491**	**0.605**	**0.669**
	(5.74)*	**(5.23)***	**(6.25)***	**(6.93)***
Labor Law x Volatility				-2.250
				(-3.43)***
Legal x Contract Dep.				1.090
				(2.68)***
δ(from w_{ijs})	0.063	0.053	0.068	0.069
	(2.26)**	(2.39)**	(4.00)***	(3.83)***
e_{ijs}	1.730	1.607	1.614	1.619
	(22.53)***	(21.33)***	(20.40)***	(20.44)***
Panel B: Most flexible specification: OLS using 50 bins for predicted probability				
Labor Law x Spec.	**0.468**	**0.403**	**0.513**	**0.571**
	(4.72)*	**(4.08)***	**(4.94)***	**(5.51)***
Labor Law x Volatility				-2.237
				(-3.29)***
Legal x Contract Dep.				0.972
				(2.33)**
R^2	0.50	0.51	0.56	0.56
# exporters	84	84	50	50
# clusters	2,527	2,527	2,096	2,096
# observations	94,255	94,255	70,484	70,485

Controls: all 8 trade friction variables (no island dummy), exporter, importer and sector fixed effects. Interaction terms as indicated for each column.

Note: Standard errors are clustered by importer-exporter pair. z-statistics are reported in parentheses. ***, ** and * denote 1%, 5% and 10% significance level respectively. See Appendix B for detailed description of variables.

Table 1.7: Estimates on Labor Law Interaction using Different Econometric Methods

This table summarizes the estimated coefficients on labor law interaction from regressions (1) to (4) in Table 1.6, using different econometric methods. Row (1) shows the traditional OLS estimates. Row (2) reports the MLE estimates in Table 1.6. Row (3) shows the estimates of the OLS regressions using 50 bins for predicted probability of exports. Row (4) shows the estimates of the second-stage trade flow equation, using OLS with Mills' ratio included to correct the Heckman selection bias, but without controlling the extensive margin of trade.

	1	2	3	4
(1) Coeff. from OLS	0.382	0.379	0.485	0.558
(2) Coeff. from MLE	0.534	0.491	0.605	0.668
(3) Coeff. from "50-bins" OLS	0.468	0.403	0.513	0.571
(4) Coeff. with only Heckman Correction	0.814	0.768	0.911	0.983

Appendix Tables

Table A1.1: Countries and their Labor Protection Indices in the Sample

Country	Labor Protection	Country	Labor Protection	Country	Labor Protection
Kazakhstan	0.731	Ecuador^{klr}	0.517	Egypt^{klr}	0.390
Portugal^{klr}	0.729	Vietnam^{r}	0.511	Ghana^{klr}	0.385
France^{klr}	0.706	Tanzania^{klr}	0.504	Thailand^{klr}	0.383
Russian Fed.	0.703	Greece^{klr}	0.502	China^{r}	0.381
Mozambique^{r}	0.688	Denmark^{klr}	0.496	Morocco^{klr}	0.375
Georgia	0.670	Philippines^{klr}	0.496	Uganda^{r}	0.367
Norway^{klr}	0.667	Korea^{klr}	0.495	Australia^{klr}	0.362
Spain^{klr}	0.666	Hungary	0.492	Zimbabwe^{klr}	0.347
Germany^{klr}	0.654	Sri Lanka^{klr}	0.487	Singapore^{kl}	0.327
Italy^{klr}	0.640	Burkina Faso^{r}	0.483	Pakistan^{klr}	0.326
Sweden^{klr}	0.640	Bulgaria	0.481	Uruguay^{klr}	0.315
Latvia	0.627	Brazil^{klr}	0.473	Hong Kong^{kl}	0.313
Ukraine	0.619	Croatia	0.470	Israel^{kl}	0.299
Slovenia	0.611	Madagascar^{klr}	0.470	Kenya^{r}	0.297
Kyrgyz Republic	0.604	Belgium^{klr}	0.468	Mongolia	0.277
Poland	0.603	Argentina^{klr}	0.461	United States^{klr}	0.238
Tunisia^{klr}	0.598	Lebanon	0.458	United Kingdom^{klr}	0.235
Netherlands^{klr}	0.595	Romania	0.442	Canada^{klr}	0.229
Venezuela^{klr}	0.593	Turkey^{klr}	0.438	Zambia^{klr}	0.220
Peru^{klr}	0.587	Dominican Rep.^{klr}	0.434	Malawi^{klr}	0.215
Mexico^{klr}	0.586	Switzerland^{r}	0.434	New Zealand^{klr}	0.205
Lithuania	0.560	South Africa^{kl}	0.433	Nigeria^{kl}	0.199
Armenia	0.560	Austria^{klr}	0.430	Jamaica^{kl}	0.195
Slovak Republic	0.555	Czech Republic	0.430	Malaysia^{klr}	0.188
Senegal^{r}	0.542	Chile^{klr}	0.427		
Panama^{klr}	0.540	Bolivia^{klr}	0.417		
Jordan^{r}	0.539	Colombia^{klr}	0.415		
Indonesia^{klr}	0.537	India^{klr}	0.414		
Mali^{r}	0.530	Ireland^{klr}	0.404		
Finland^{klr}	0.528	Japan^{klr}	0.396		

Labor protection index is the unweighted average of "Employment Law" index and "Collective Relations" index from Botero et al. (2004). Superscripts 'k' and 'l' indicate that the country has both physical capital and human capital endowments measures from Antweiler and Trefler (2002). Superscript 'r' denotes that the country has the natural resources endowment measure from the World Bank. See Appendix B for detailed description of these measures.

Table A1.2: Sector Measures of Firm-specific Skill Intensity

Census Code	Industry Category (SIC 72)	5-yr Ten.	Scaled	Num. Obs
179	Construction and material handling machines (353)	0.415	1.000	58
109	Miscellaneous wood products (244, 249)	0.397	0.972	43
259	Miscellaneous manufacturing industries (39)	0.388	0.957	87
187	Metalworking machinery (354)	0.377	0.940	61
289	Beverage industries (208)	0.355	0.907	81
328	Pulp, paper, and paperboard mills (261-263, 266)	0.290	0.806	59
357	Drugs and medicines (283)	0.279	0.790	56
338	Newspaper publishing and printing (271)	0.258	0.757	72
228	Ship and boat building and repairing (373)	0.227	0.709	97
347	Industrial chemicals (281)	0.221	0.700	51
189	Electronic computing equipment (3573)	0.218	0.696	155
269	Dairy products (202)	0.218	0.695	45
158	Fabricated structural metal products (344)	0.217	0.694	85
337	Paperboard containers and boxes (265)	0.148	0.589	81
219	Motor vehicles and motor vehicle equipment (371)	0.088	0.496	319
227	Aircraft and parts (372)	0.065	0.460	192
168	Miscellaneous fabricated metal products (341,343, 347, 348, 349)*	0.064	0.459	73
118	Furniture and fixtures (25)*	0.050	0.438	143
108	Sawmills, planing mills, and mill work (242, 243)	0.044	0.428	106
339	Printing, publishing, and allied industries, *not* newspapers (272-279)*	0.039	0.420	235
208	Electrical machinery, equipment, and supplies n.e.c. (361-369)	0.033	0.410	121
239	Scientific and controlling instruments (381, 382)	0.025	0.399	60
287	Bakery products (205)	0.006	0.351	61
268	Meat products (201)*	0.012	0.342	93
389	Footwear, except rubber (313, 314)*	-0.017	0.334	45
387	Miscellaneous plastic products (307)	-0.044	0.293	143
319	Apparel and accessories (231-238)	-0.049	0.284	84
197	Machinery, except electrical, n.e.c. (355, 356, 358, 359)	-0.080	0.238	158
247	Optical and health services supplies (383-385)	-0.132	0.157	67
207	Radio, T.V., and communication equipment (365, 366)	-0.152	0.127	59
379	Rubber products (301-303, 306)	-0.159	0.115	94
317	Yarn, thread, and fabric mills (221-224, 228)	-0.234	0.000	79

* denotes *not* significant at the 5% level

Table A1.3: Summary Statistics of Sector-level Variables (SIC87 3-digit)

	Min	10th	25th	50th	75th	90th	Max	Std. Dev	No. Obs
Firm-Spec	0.000	0.116	0.273	0.403	0.667	0.919	1.000	0.270	80
K Intensity	0.130	0.207	0.254	0.313	0.359	0.425	0.765	0.101	140
H Intensity	0.028	0.053	0.063	0.082	0.104	0.150	0.283	0.046	140
Mat. Intensity	0.190	0.346	0.418	0.483	0.558	0.649	0.845	0.123	140
Sales Vol.	0.090	0.124	0.138	0.157	0.193	0.233	0.351	0.170	140
Job Flows	0.075	0.127	0.163	0.187	0.224	0.253	0.393	0.005	140
Contract Dep.	0.331	0.672	0.802	0.954	0.974	0.994	1.000	0.150	137

Note: 116 of 140 sectors suffice to cover all SITC (rev. 2 4-digit) sectors in Feenstra's (2000) dataset of trade flows.

Table A1.4: Correlation between Sector-level Variables (SIC87 3-digit)

	Firm-Spec	K Intensity	H Intensity	Mat. Intensity	Sales Vol.	Job Flows
K Intensity	0.048					
H Intensity	0.128	0.629				
Mat. Intensity	0.047	-0.854	-0.663			
Sales Vol.	0.115	0.002	0.084	0.064		
Job Flows	-0.066	-0.123	-0.050	-0.018	0.077	
Contract Dep.	-0.148	0.399	0.436	-0.565	-0.095	0.317

Table A1.5: Summary Statistics of Country Variables

	Min	10th	25th	50th	75th	90th	Max	Std. Dev	No. Obs.
Labor Law	0.188	0.238	0.382	0.471	0.573	0.654	0.731	0.140	84
ln(real GDP/L)	6.186	6.851	7.945	8.830	9.703	10.038	10.284	1.088	84
ln(H/L)	-7.820	-6.398	-5.216	-4.335	-3.424	-3.206	-2.957	1.277	56
ln(K/L)	-4.535	-3.270	-2.178	-1.582	-1.170	-0.830	-0.334	0.960	56
ln(Resource/L)	6.780	7.549	7.901	8.567	9.114	9.748	10.841	0.899	60
ln(Credit/GDP)	-3.326	-2.433	-1.607	-0.974	-0.305	0.014	0.509	0.913	69
Judicial Quality	0.240	0.339	0.428	0.537	0.755	0.899	0.972	0.203	84

Table A1.6: Correlation between Country Variables

	Labor Law	ln(real GDP/L)	ln(H/L)	ln(K/L)	ln(Resource/L)	ln(Credit/GDP)
ln(real GDP/L)	0.268					
ln(H/L)	0.328	0.936				
ln(K/L)	0.197	0.831	0.832			
ln(Resource/L)	-0.037	0.490	0.555	0.567		
ln(Credit/GDP)	0.145	0.753	0.704	0.667	0.277	
Judicial Quality	0.054	0.847	0.714	0.656	0.414	0.700

Chapter 2

Spillovers from Foreign Direct Investment in China: The Role of Ownership

2.1 Introduction

Attracting foreign direct investment (FDI) has been high on the development agenda of many developing countries' governments. It is believed that FDI can improve the host country's balance of payments, promote exports, and complement other economic policies to induce growth through employment creation and technology transfer. Hence, governments often employ a variety of policies, including tax exemptions, tax holidays, tariff reduction and subsidies for infrastructure and exports to attract FDI.

Among the benefits brought by FDI, productivity spillovers have received the most attention by policy makers, who believe that technology and know-how of foreign firms will be diffused to domestic firms and enhance their productivity. As such, there exists a vast literature searching for positive productivity spillovers from FDI. However, in contrast to the previously widely-held belief, recent studies based on micro-level panel data mostly find either insignificant or negative spillovers from FDI in the same sector. The disconnect between these recent findings and the conventional view of positive productivity spillovers from FDI is succinctly summarized by Dani

Rodrik (1999), who remarks "Today's policy literature is filled with extravagant claims about positive spillovers from FDI, [but] the hard evidence is sobering."

Yet, maximizing productivity spillovers remains an important objective of FDI policies in many developing countries. Among these policies, domestic equity ownership in foreign invested projects was often enforced by policy makers, who believed that advanced knowledge would be first transferred to the local partners in joint-ventures. then spill over to the rest of the economy. From the foreign investors' point of view, however, restricting sole foreign ownership limits their ability to internalize the benefits of possessing superior technology and know-how. This concern is particularly relevant in countries with poor rule of law, where contracts cannot be effectively enforced to restrict know-how "leakage." As such, foreign investors often prefer to increase equity ownership, hoping that the associated control rights can enhance their ability to prevent knowledge dissipation. Thus, the tension between governments and foreign investors over equity ownership urges one to ask the question: "Does the ownership structure of foreign affiliates really matter for productivity spillovers?"

The objective of this paper is two fold. First, using firm-level panel data of more than 90,000 Chinese manufacturing firms over the period from 1998 to 2001, I examine whether there exist productivity spillovers from FDI in China. In particular, I follow the recent literature by Javorcik (2004) and Blalock and Gertler (2006) to disentangle spillover effects into horizontal (intra-industry) and vertical (inter-industry) spillovers. Although there are already studies on productivity spillovers in China, to my understanding, this study covers the most recent years for which data are available, and the most comprehensive sample of manufacturing firms. The second contribution of this paper is to examine whether the structure and nationality of foreign ownership affects the magnitude of spillovers. In particular, I examine spillovers from majority, minority and wholly owned foreign firms. Moreover, specific to the Chinese economy, I examine whether higher equity participation by ethnic-Chinese foreign investors is associated with higher productivity spillovers to domestic firms.

To verify whether FDI affects domestic firm productivity, I use two methods to measure firm total factor productivity (TFP). First, I use a firm's Solow residual computed based on a sector-specific production function as my baseline measure of TFP. Second, I estimate a Cobb-Douglas production function for each sector; then for each firm, I take the difference between the actual log of output and the predicted log of output as my second TFP measure. To correct for the bias in the firm estimated TFP due to firm endogenous input selection, I adopt the semi-parametric two-stage estimation procedure of Olley and Pakes (1996) to obtain consistent estimates of input elasticities.

To capture the scope of horizontal spillovers, I follow the existing literature to use the share of output produced by foreign affiliates in a sector. For vertical spillovers from FDI to local input-supplying firms through backward linkages, I use coefficients from the input-output table for China to represent linkages across sectors. Specifically, the proxy for vertical spillovers for a local intermediate-input supplier is a weighted average of foreign presence across the firm's downstream sectors, with the weights equal to the corresponding downstream sectors' shares in aggregate expenditure on intermediate inputs produced by the sector the firm belongs to.

With the measures of firm TFP and the scope of spillovers constructed, I test for the existence of spillovers by regressing firm productivity growth on the first differences of the horizontal and vertical spillover measures, respectively. I find that higher foreign penetration is associated with lower domestic-firm productivity growth in the same sector. The negative impact is economically meaningful. A one standard-deviation increase in the share of output produced by foreign affiliates (a 4 percentage-point increase) in the same sector is associated with about 1 percentage-point decline in domestic-firm productivity growth.

These findings are consistent with the recent studies which also find negative horizontal spillovers. The authors of these studies attribute the observed negative spillovers to competition arising from foreign entry. The argument is based on the condition of increasing returns to scale due to the existence of fixed costs of production. When foreign firms "steal" market shares from domestic firms, the latter will have to spread fixed costs over a lower level of output, resulting in lower observed productivity.

In contrast to the recent literature, I find no evidence of vertical spillovers through backward linkages at the national level. In other words, when more foreign firms operate in a sector, the average productivity of their domestic suppliers is unaffected. Nevertheless, I find that higher foreign presence in the downstream sectors located in the same province is associated with lower domestic-firm productivity growth. While these findings are new, an explanation similar to the one for the well-documented negative horizontal spillovers can be applied here.

On the one hand, downstream foreign firms transfer superior know-how to domestic input suppliers. hoping to improve their performance. On the other hand, theoretical models of FDI show that multinational firms can import intermediate inputs and crowd out demand for locally produced intermediate inputs (Rodriguez-Clare, 1996; Markusen and Venables, 1999). Under the condition of firms' increasing returns to scale, lower demand for locally-produced inputs implies higher average costs, which leads to lower observed productivity. Therefore, *a priori*, there is no presumption that higher foreign penetration in downstream sectors is always associated with positive backward spillovers, although it is the dominating view in the literature (Javorcik, 2004; Blalock and Gertler, 2006; Javorcik and Spatareanu, 2008). In the current study, I find that for China, the positive knowledge-diffusion effects and negative "crowding-out" effects happen to cancel out at the national level, with the negative effects dominating at the province level.

Next, I examine whether foreign firms of different ownership structures are associated with different degrees of spillovers. To this end, I use information on equity ownership by different types of investors to construct measures for the presence of minority, majority and wholly owned foreign firms in each sector, respectively. I find that compared to joint-ventures, wholly and majority owned foreign firms are associated with more negative horizontal spillovers. On the other hand, the ownership structure of foreign affiliates does not appear to affect spillovers through backward linkages at the national level. Nevertheless, I find negative vertical spillovers within the same province, and that these negative spillovers came only from wholly owned foreign firms, but not joint ventures. These results support the general theme of the paper that wholly owned foreign firms are more able to prevent knowledge dissipation or less willing to transfer technology to the locals, letting the "crowding-out" effects dominate at the province level.

Furthermore, I explore whether foreign ownership by different source countries affects the pattern of spillovers. Since the majority of foreign direct investment came from Hong Kong, Macau and Taiwan, I focus on the differences between spillovers from ethnic-Chinese and non-Chinese foreign investors, respectively. According to the recent work on the relationship between ethnicity and knowledge diffusion (Agrawal et al., 2007; Kerr, 2007), ethnic-Chinese foreign investors should have a higher propensity for knowledge dissipation. In contrast to the prediction of the theory on ethnic-network effects, I find that the presence of ethnic-Chinese foreign firms are associated with lower domestic-firm productivity in the same sector, although I find no relationship between ethnic-Chinese foreign ownership and vertical spillovers.

Finally, I examine whether the observed productivity spillovers associated with different ownership structures vary across different subsamples of recipient firms. I find that negative horizontal spillovers are particularly strong for domestic enterprises that are state-owned, technologically backward and located in inland provinces. Importantly, the effects are more pronounced for spillovers from wholly owned foreign firms than joint ventures across the board. These findings suggest that the entry of foreign firms into a sector forces less productive firms to reduce production, possibly enhancing the long-run average productivity of the host economy.

The rest of the paper is organized as follows. Section 2.2 reviews the literature on productivity spillovers from FDI, and how the ownership structure of foreign affiliates affects the spillover patterns. Section 2.3 describes the data set used in the empirical analysis. Section 2.4 presents a brief history of FDI in China. Section 2.5 formalizes the empirical strategy. Section 2.6 reports the findings and the final section concludes.

2.2 Theories of Productivity Spillovers from FDI and Related Literature

2.2.1 Horizontal Spillovers

Productivity (efficiency) spillovers from FDI to domestic firms are the most researched topic in the literature on the benefits of FDI.[1] Theories argue that domestic firms benefit from the entry of foreign firms through imitation, competition, arms-length transactions, and worker turnover (Kokko, 1996). Specifically, when more foreign affiliates operate in a sector of the host economy, domestic firms enhance their productivity by imitating foreign production technologies. They will also invest more in product development and quality assurance, or simply allocate resources more efficiently to stay competitive. Reinforcing these two channels is the turnover of workers, who bring with them the knowledge acquired from foreign managers when they move from

[1] See Gorg and Greenway (2004) for an extensive review of the vast literature on FDI spillovers.

foreign affiliates to domestic firms. Likewise, domestic business partners of jointly-invested projects can apply management skills acquired from their foreign partners in projects of their own.

Consistent with these theoretical predictions, early empirical studies based on industry-level data find evidence of positive spillovers. Among them, a pioneering study by Caves (1974) finds that a higher share of output produced by foreign firms is associated with higher average productivity for Australian manufacturing industries in the 60s. Subsequently, Globerman (1979) also finds a positive correlation between the two for Canadian industries in the 60s. More recently, Blomstrom and Wolff (1994) find that in Mexico, productivity growth and convergence to the productivity frontier of the U.S. affiliates were faster in manufacturing sectors with higher penetration of multinationals.

The conclusions of these pioneering empirical studies have been questioned for the problems of reverse causality and omitting time and industry effects. The common criticism is that foreign investors tend to "cherry-pick" high-productivity sectors to invest, and therefore, it is hard to determine the direction of causality using sector-level data. Recent studies based on micro-level (firms or establishments) panel data cast doubt on the evidence of positive spillovers, and find either insignificant or negative intra-industry spillovers. Among them, Haddad and Harrison (1993) find no significant relationship between the level of FDI and domestic-plant productivity growth in the same sector for Morocco in the late 80s; Aitken and Harrison (1999) find a negative relationship between the two for Venezuelan manufacturing industries for the 70s and 80s, followed by similar findings for the 90s by Djankov and Hoekman (2000) on Czech Republic, Konings (2001) on Bulgaria and Romania,[2] and Javorcik (2004) on Lithuania. The authors of this literature put forth the possibility of negative efficiency spillovers arising from foreign firms stealing market shares from domestic firms. Specifically, when there are fixed costs of production, a lower level of output dispersed over the same fixed costs would imply lower observed productivity. They hypothesize that this "market-stealing" effect can dominate the positive benefits of knowledge dissipation from FDI, resulting in negative productivity spillovers.

The findings for developed countries are more encouraging. Keller and Yeaple (2005) and Haskel, Pereira and Slaughter (2007), find evidence for positive horizontal spillovers for manu-

[2] Konings (2001) finds no spillovers to domestic firms in Poland.

facturing plants in the U.S. and U.K., respectively. Nevertheless, according to a comprehensive review by Gorg and Greenway (2004), among 24 firm-level panel studies, only 5 of them find positive spillovers, of which 4 of them are from developed countries, with Ghana being the only developing country having positive spillovers from FDI.

There have been several papers on FDI spillovers in China.[3] Liu (2008) also uses firm-level panel data and finds negative horizontal spillovers to manufacturing firms in China. He extends the study by examining the dynamic aspects of spillovers, and finds that despite the negative contemporaneous correlation between foreign penetration and domestic-firm productivity, there is a time lag for positive productivity spillovers to realize.[4] He attributes the lag of positive spillovers to managers' substituting production time for foreign know-how acquisition. There are several differences between his work and mine. First, his data set covers the first half of the 90s for medium- to large-sized firms, while mine covers the late 90s for all firms with at least five employees. Importantly, our focuses are different. He takes on a more novel path to explain the negative contemporaneous horizontal spillovers, focusing on the delay of spillovers due to manager's acquisition of foreign know-how, and I adopt a more conventional approach of using competition effects to explain negative spillovers. I also focus on how the structure of ownership of foreign firms affects the pattern of spillovers.

This paper is closely related to a recent study by Abraham, Konings and Slootmaekers (2007), which also examines productivity spillovers from FDI in China. The authors focus on horizontal spillovers, and how the magnitude of spillovers varies across recipient firms with different characteristics. Importantly, using a data set of publicly-listed, medium- and large-sized firms, they find positive horizontal spillovers, and that joint-ventures are responsible for most of the positive externalities.[5] Consistent with their findings, I find that joint-ventures are associated with less negative spillovers. In contrast to their findings, I find negative horizontal spillovers to domestic firms. To my understanding, there are at least two explanations for our drastic differences. First, the average firm size in their data set is bigger, and it is

[3]See Hale and Long (2007) for a review of this literature.

[4]Specifically, Liu (2008) interacts a time trend with the horizontal spillover term, and finds that the coefficient on the interaction is positive and significant.

[5]Specifically, Abrahams et al. (2007) use a data set compiled by Bureau van Dijk, which contains publicly listed firms, or firms with at least 150 employees, annual turnover (output) of at least 10 million USD, or total assets of 20 million USD.

possible for them to find positive spillovers while I find negative spillovers. Supporting this conjecture, Gorodnichenko et al. (2007) find positive spillovers in a sample of firms with more than 30 employees in 17 emerging market economies, but not in a sample when smaller firms are included. Recent literature (Tybout, 2001; Helpman, Melitz and Yeaple, 2004) also shows that larger firms are on average more productive. Second, our regression specifications are different. They run a level regression with firm controls, but not firm fixed effects, while I use a first-difference specification, which removes firm fixed effects on productivity. The existence of unobserved firm characteristics that affect productivity can possibly explain our different conclusions. Along these lines, Hale and Long (2007) review several studies that find positive spillovers in China, and argue that the findings could disappear once firm fixed effects are controlled for.

2.2.2 Vertical Spillovers

The lack of observed positive horizontal spillovers from FDI leads researchers to search for spillovers across industries through forward and backward linkages. The hypothesis is that through forward linkages, productive foreign firms in the input-supplying sectors provide better intermediate inputs, which would enhance downstream domestic-firm productivity. Through backward linkages, foreign firms have incentives to transfer knowledge to the upstream intermediate-input suppliers, hoping to improve the quality of the intermediate inputs. Supporting these theories are case studies which show that knowledge is transferred from downstream foreign affiliates to upstream domestic suppliers through intensive monitoring, training, and assistance and supervision in the implementation of new technologies (Moran, 2001). Consistent with these observations, recent studies using micro-level data find evidence showing that increased foreign presence is associated with higher productivity (level or growth) of domestic input-supplying firms. This literature includes earlier work by Blalock (2001) on Indonesia, and Schoors and van der Tol (2002) on Hungary, followed by Javorcik (2004) on Lithuania and Javorcik and Spatareanu (2008) on Romania.

Similar to horizontal spillovers, in theory, vertical spillovers do not have to be unambiguously positive. Theoretical models by Rodriguez-Clare (1996) and Markusen and Venables (1999) posit that foreign firms sourcing intermediate inputs from abroad would "crowd-out" the demand for locally-produced inputs. They predict that the share of intermediate inputs sourced locally by multinationals is increasing in the distance between the multinational headquarters and the subsidiaries in the host country. Javorcik and Spatareanu (2008) use this theory to explain their findings of negative vertical spillovers from European foreign affiliates to Romanian manufacturing firms. Similarly, Liu (2008) reports negative vertical spillovers through backward linkages in China. In sum, although the majority of findings in recent literature finds positive vertical spillovers, particularly through backward linkages, the conclusions on the net effects of vertical spillovers remain mixed.

2.2.3 The Impact of Different Ownership Structures of Foreign Firms on Spillovers

Domestic equity ownership requirement has been an important part of FDI policies in China and other developing countries. Policy makers believed that foreign knowledge would be more effectively transferred to the domestic parties within jointly owned firms, and eventually spill over to the rest of the economy. The argument has been put forth by Blomström and Sjöholm (1999), who claim that a local shareholder in a foreign-invested project often acquires proprietary technology which she can use in projects of her own.

From the foreign investors' point of view, however, restricting wholly foreign ownership reduces their ability to internalize the benefits of possessing superior technology and know-how. When contracts cannot be written or enforced to restrict know-how "leakage", foreign investors will choose to increase equity ownership, hoping that the associated control rights can enhance their ability to prevent knowledge dissipation. The predominance of wholly and majority owned foreign enterprises in developing countries is consistent with this claim. Survey findings also show that more advanced technology is deployed in wholly and majority owned foreign firms in India (Ramachandaram, 1993) and China (Long, 2005).[6] Consistently, Desai, Foley and Hines (2004) find that compared to minority owned foreign firms, wholly and majority owned foreign subsidiaries in host countries receive more investments in intangible assets from their parent firms.

[6] In particular, Long (2005) finds that 39.7% of the majority owned and 31.7% of the solely owned foreign firms use the same advanced technology as the parent companies; while the numbers for domestic majority owned and equally-shared joint ventures are 5.8% and 22.6%, respectively.

At first sight, it seems that more technology transfer from the parents to the majority owned foreign subsidiaries implies more spillovers. However, as foreign parent firms tend to deploy more sophisticated know-how to their affiliates in the host economy, the resulting wide technology gap between majority owned foreign firms and domestic enterprises may dampen the potential for spillovers. In addition, the very reason why foreign investors choose to increase their equity ownership in foreign affiliates is to prevent knowledge dissipation. Stronger protection of knowledge externalities, along with a wider technology gap between local and foreign firms, implies that higher foreign equity participation impedes spillovers, both within and across industries.

For vertical spillovers through backward linkages, it has been argued that joint ventures are also associated with more knowledge transfer to intermediate-input suppliers than wholly owned foreign firms. The rationale is that joint ventures are more likely to source locally with the help of domestic partners (Javorcik and Spatareanu, 2008). Therefore, through more direct contacts with local suppliers, joint ventures are associated with more knowledge spillovers to domestic firms through backward linkages. Reinforcing this is a reduction in imports of intermediate inputs by joint-ventures relative to wholly owned foreign enterprises, which results in less crowding-out to the demand for locally-produced inputs.

Finally, there has been a growing literature which emphasizes the role of ethnicity in promoting knowledge transfer. Kerr (2007) shows that ethnicity of scientists is an important determinant of global patent citation. In addition, Agrawal et al. (2007) develop a model to understand the optimal spatial concentration of socially-proximate inventors. They predict that although both co-location and co-ethnicity facilitates knowledge diffusion among inventors, it's the latter that gives rise to a higher marginal benefit for innovation. While these theories imply that ethnic-Chinese foreign affiliates would transfer more knowledge to the locals than the non-Chinese foreign firms, Huang et al. (2008) find that ethnic-Chinese foreign affiliates in China did not command higher returns to equity or assets than non-Chinese multinationals in the late 90s.

2.3 FDI in China

Since 1979, the year the Chinese government opened its economy to foreign capital and trade flows, China has implemented a variety of policies to attract FDI. These policies gave foreign-invested enterprises favorable treatments, such as tax credits and subsidies for exports and infrastructure. Along with China's incredible growth in the past 25 years, these policies have been very successful in promoting FDI inflows. As illustrated in Figure 2-1, inward FDI flows to China increased by more than a thousand times in the past 25 years, from 57 million US dollars in 1981 to 70 billion US dollars in 2006. Evidently, FDI inflows picked up substantially after the famous "southern journey" endorsing economic reforms made by the late Deng Xiaoping in 1992. Since 1993, China has been the biggest recipient country of FDI among developing countries. In 2006, China's FDI inflows (69.5 billion USD) accounted for 18% of the total FDI flows to developing countries. The value is 80% of the total FDI flows to Latin America and the Caribbean, about the same as the amount to Eastern European transition economies, and twice as large as those to Africa (United Nations, 2007). In short, FDI has played an important role in fueling China's economic growth by promoting exports, creating jobs, and providing capital to productive business activities which were inadequately financed by the inefficient financial market.

Turning to the distribution of FDI, by the end of 200,[7] more than 80% of historical FDI flows were in the form of greenfield investment (Long, 2005). As reported in Table 2.1 (the last column), 60% of the total cumulated FDI went to the manufacturing sector, followed by real estate as the second largest recipient sector, which received 15% of the total. Given that China has been relying mainly on manufacturing output for growth, it is not surprising to see such a large share of FDI going to the manufacturing sector. Another explanation is that investments in many non-manufacturing sectors were prohibited by the Chinese government.[8] Turning to the source countries of FDI, East Asian economies have been the major source, because of their proximity and ethnic connection to mainland China. As of 2002, the top three FDI source countries were Hong Kong, United States and Japan, with Hong Kong itself contributed more

[7]2002 is the most recent year for which the statistics are available from China Ministry of Commerce.

[8]See the Law of People's Republic of China upon Foreign Wholly Owned Enterprises for details.

than half of the total realized FDI stock (See Table 2.2 for details).[9]

In addition to using FDI as a main source of foreign capital to support growth, the Chinese government was also concerned about knowledge transfer from foreign firms. To facilitate knowledge transfer, in addition to financial incentives, the Chinese government laid out a series of guidelines and rules for foreign investors to follow, aiming at maximizing transfers of technology and management skills to domestic firms.[10] These rules diverted FDI to the "strategic" sectors where know-how transfers were believed to be the most beneficial for economic development. There were clauses which required foreign firms to satisfy minimum export and performance requirements regularly. Perhaps the most stylized FDI regulation in China is domestic equity requirement. Wholly foreign-owned enterprises were basically prohibited unless they promised to bring advanced technology and equipment to benefit domestic firms. With China's accession to WTO in 2001, this restriction was removed and a lot of previously jointly owned foreign affiliates turned into wholly owned foreign firms (Long, 2005).[11]

2.4 Empirical Strategy

2.4.1 Baseline Specification

To examine whether foreign presence affects domestic-firm productivity through both the horizontal and vertical channels, I regress the growth rate of firm TFP (defined as the first difference of the natural log of productivity) on the first differences of the measures for horizontal and vertical spillovers, respectively. I use first differences of all variables to remove all unobserved firm characteristics that affect the level of productivity.[12] First-differencing also removes sector

[9]Notice that Taiwan stood at number 4 on the list. However, Long (2005) points out that many Taiwanese businessmen invested in mainland China through Hong Kong, Virgin Islands and the Cayman Islands to avoid restrictions imposed by the Taiwanese government. He speculates that the actual value of FDI stock from Taiwan can be 2 to 3 times higher than what was recorded, making Taiwan the second largest FDI source for mainland China.

[10]These guidelines and rules include the Law of People's Republic of China upon Foreign Wholly Owned Enterprises, Law of the People's Republic of China upon Sino-Foreign Joint Ventures, and Guiding Directory on Industries Open to Foreign Investment.

[11]Unfortunately, the data set which I have access to ends in 2001. A fruitful topic of future research is to examine whether and how the spillover patterns changed after the restriction on sole foreign ownership was lifted as a result of China's accession to WTO in 2001.

[12]One can of course argue that productivity growth rate is also firm-specific, and therefore firm fixed effects have to be controlled for in a first-difference specification. It will be ideal to do so if I have a longer time series. Adding firm fixed effects in a 3-year unbalanced panel will greatly reduce the degree of freedom, and restrict

and region fixed effects on firm productivity to alleviate the endogeneity problem arising from foreign investors' selection into productive sectors or regions. Moreover, since foreign investors "cherry-pick" productive firms to invest, including foreign firms in the sample would lead to overestimation of the true spillover effects. As such, I include only domestic manufacturing firms for all the regressions in this paper.[13] Formally, the regression specification takes the following form:[14]

$$\Delta \ln TFP_{ijrt} = \alpha + \beta_H \Delta H_{jt} + \beta_V \Delta V_{jt} + \eta_C \Delta Conc_{jt} + \eta_I \Delta \ln Imp_{jt} + f_j + f_r + f_t + e_{ijrt} \quad (2.1)$$

where i, j, r, t stand for firm, sector, region and year, respectively. Δ denotes the change of the corresponding variable from year $t-1$ to t; $\ln TFP_{ijrt}$ is firm i's log of total factor productivity. H_{jt} and V_{jt} are measures for horizontal and vertical spillovers for sector j, respectively (to be discussed below). Positive $\beta's$ are interpreted as evidence of positive spillovers. While earlier studies based on industry-level data rely on cross-sector variation of FDI to identify the effects of spillovers, this specification instead relies on cross-sector variation of changes in FDI. Figures 2-2 and 2-3 illustrate that all 22 ISIC sectors have their measures of H_{jt} and V_{jt} varying over time, which do not appear to be highly correlated. As a confirmation, Pearson correlation between ΔH_{jt} and ΔV_{jt} is 0.05. See Appendix Table A2.3 for the correlation matrix between the key spillover measures.

$Conc_{jt}$ is a firm-concentration index of sector j in year t. It is measured by a 10-firm Herfindahl index, defined as the square root of the sum of the squares of value-added shares produced by the top 10 producers (by sales) in the sector in each year. A higher $Conc_{jt}$ corresponds to less competition in the goods market. This control is included because of the hypothesis that stiffer competition is associated with higher average firm productivity. Imp_{jt} is the value of imports in sector j, capturing the effects of import competition on firm productivity.

f_j, f_r and f_t stand for sector, region and year fixed effects, respectively. In a first difference

identification based on limited within-firm variation in a short time series.

[13]Joavorcik and Spatareanu (2008) also include only domestic firms in their empirical analysis for the same concern.

[14]Notice that this specification is very reduced-form. Because of data limitation, it is impossible to separate horizontal spillovers into the knowledge-diffusion and competition effects. If data permit, future research should examine these effects separately.

specification, these fixed effects represent the trends of productivity growth that are specific to a sector, region or year. Finally, e_{ijt} is an error term, assumed to be uncorrelated with the regressors.

Unless otherwise specified, standard errors for all regressions in this paper are clustered at the sector-year level to take into account the correlation between observations belonging to the same industry and year. Moulton (1990) points out that for micro-level regressions, when the regressors are aggregates at a higher level (in this case, at the sector-year level), estimated errors from OLS without clustering will be seriously downward biased.

2.4.2 Measuring Firm TFP

To estimate the magnitude of spillovers from FDI, I use two methods to measure firm total factor productivity (TFP). First, I compute Solow residuals based on sector-specific constant returns to scale production functions. Second, by relaxing the assumption of constant returns to scale, I estimate a Cobb-Douglas production function for each sector. Then for each firm, I take the difference between the predicted and actual log value-added as my second measure of firm TFP. To deal with the problem of firm endogenous input selection, I adopt a two-stage version of the Olley-Pakes (1996) semi-parametric estimation procedure to correct for the bias in the estimated input elasticities.

Solow Residuals

I assume that all firms in a sector produce with the same constant returns to scale production technology, with capital and labor as inputs.[15] As such, I compute the Solow residual for a firm as:

$$\ln TFP_{ijt} = y_{ijt} - labor\_shr_j \times l_{ijt} - (1 - labor\_shr_j) \times k_{ijt}, \tag{2.2}$$

where subscripts i, j and t refer to firm, sector and year, respectively; y_{ijt} is the natural logarithm of output, measured in value-added terms; l_{ijt} and k_{ijt} stand for the natural logarithms

[15] Ideally, I would compute Solow residuals based on a 3-factor production function, with materials as an additional input, and gross output instead of value-added as the firm output measure. Even though real output measure is available in the Chinese data set, reliable data and price deflators for material inputs are not. Therefore, I use a 2-factor model, similar to Liu (2008).

of labor and capital stock, respectively. $labor\_shr_j = \frac{w_j L_j}{P_j Y_j}$ is the time-invariant share of wage bill in total value-added of sector j, of which data are obtained from OECD (2002) for the year 1997, disaggregated at the ISIC (Revision 3) 2-digit level, with 22 industries. This is also the data set from which I obtain the input-output coefficients (see Section 2.5 below).

Cobb-Douglas Production Function Estimation with Olley-Pakes Correction

Second, to estimate a firm TFP, I assume sector-specific Cobb-Douglas production functions, but relax the assumption of constant returns to scale in production. I regress log output (in terms of value added) on log capital and labor as:

$$y_{ijt} = \alpha + \gamma_j^k k_{ijt} + \gamma_j^l l_{ijt} + \epsilon_{ijt}, \tag{2.3}$$

where subscripts i, j and t refer to firm, sector and year, respectively. ϵ_{ijt} is an error term (e.g. measurement error). Since the underlying Cobb-Douglas production function is sector-specific, $\gamma's$ are also sector specific, and I estimate equation (2.3) for each sector separately. With input elasticities estimated, firm j's TFP is computed as the difference between the actual log value-added and the predicted log value-added, i.e. $\ln TFP_{ijt} = y_{ijt} - \widehat{\gamma_j^k} k_{ijt} - \widehat{\gamma_j^l} l_{ijt}$.[16]

It is well-known that firms' choices of inputs are endogenous to unobserved productivity of the firm. Suppose there exists a firm efficiency term ω_{ijt} which is observed to the firm, but not to the researchers. Then the term ϵ_{ijt} is composed of ω_{ijt} and some measurement error, which is now correlated with the regressors. Thus, the OLS estimates of $\gamma's$ will be biased upward. To correct for this bias, I follow the existing literature (e.g. Javorcik, 2004; Blalock and Gertler, 2006; Liu, 2008) to implement a two-step version of the Olley-Pakes (1996) estimation procedure to obtain consistent $\gamma's$ and unbiased estimates of firm TFP. The Olley-Pakes estimation uses investment as a proxy for ω_{ijt}. The identifying assumption is that investment is monotonically increasing in ω_{ijt}, conditional on capital. Capital is a quasi-fixed factor of production, and responds to ω_{ijt} only in a lagged fashion through contemporaneous investment. Then the return to labor can be estimated consistently by non-parametrically inverting investment and

[16]Notice that as long as I control for sector fixed effects in all my regressions, it does not matter whether I subtract the sector-specific constant term from the actual log value-added or not.

capital to proxy for the unobserved shock.[17] See Section 2.9.3 (Data Appendix) for details of the Olley-Pakes estimation, and Appendix Table A2.1 for the estimated input elasticities for each sector.

2.4.3 Constructing Proxies for Spillovers

To capture the scope of horizontal spillovers, I follow the existing literature to use the share of output produced by foreign affiliates in the same sector. A firm is considered foreign if it has at least 10% equity shares owned by foreigners. Based on this definition, I construct a sector's measure of horizontal spillovers as the share of output produced by foreign affiliates in the sector, formally as

$$H_{jt} = \sum_{i \in \mathcal{F}_j} Y_{it} / \sum_{i \in A_j} Y_{it},$$

where Y_{it} is the value of output (measured in value-added terms in 1997 constant yuans). A_j is the set of all firms (both foreign and domestic) in sector j. $\mathcal{F}_j \subset A_j$ is the set of foreign firms. Likewise, I define the horizontal spillover term for minority, majority, jointly and wholly owned foreign firms respectively as:

$$H_{jt}^{g} = \sum_{i \in \mathcal{F}_j^{g}} Y_{it} / \sum_{i \in A_j} Y_{it},$$

where $g \in \{\text{min, maj, } 100, jv\}$; $\mathcal{F}_j^{\text{min}}$ represents the set of foreign affiliates with less than (inclusive) 50% of equity shares owned by foreign investors, $\mathcal{F}_j^{\text{maj}}$ represents the set of foreign affiliates with more than (exclusive) 50% of equity shares owned by foreign investors, and $\mathcal{F}_j^{100}$ and $\mathcal{F}_j^{jv}$ represent the sets of foreign affiliates with 100% foreign equity and less than 100% foreign equity, respectively. By construction, $H_{jt} = H_{jt}^{min} + H_{jt}^{maj}$ and $H_{jt} = H_{jt}^{100} + H_{jt}^{jv}$.

To examine the scope of vertical spillovers through backward linkages, for a firm in sector j, I construct a proxy for foreign presence in the downstream sectors to which sector j supplies

[17] The Olley-Pakes estimation requires each observation included in the estimation to have positive investment. In my panel data set, about 10% of the observations have non-positive investments, and are excluded from the estimation procedure. Alternatively, one can use a similar two-stage estimation procedure by Levinsohn and Petrin (2003), which uses material inputs, instead of investments, to proxy for firm unobserved productivity. However, limited availability of data on material inputs prevents me from adopting the Levinsohn-Petrin approach.

its intermediate inputs as:

$$V_{jt} = \sum_{k \neq j} \alpha_{jk} H_{kt},$$

where α_{jk} is the proportion of sector j's output used by sector k. In other words, V_{jt} is a weighted average of H_{kt}'s across the sectors (k's) buying inputs from sector j. Notice that since I do not have detailed information on firms' intermediate-input sourcing, I implicitly assume that all firms in the same sector have the same input-output linkages to other sectors, and assign the same input-output coefficients (α_{jk}'s) to all firms in the same sector.

To study the relationship between the ownership structure of foreign affiliates and the degree of spillovers, I construct proxies for vertical spillovers from wholly, jointly, majority, and minority owned foreign affiliates, respectively, using the corresponding horizontal spillover measures. Formally,

$$V_{jt}^{g} = \sum_{k \neq j} \alpha_{jk} H_{kt}^{g}$$

where V_{jt}^{g} represents the degree of vertical spillovers from foreign firms belonging to group g, where $g \in \{\text{min, maj, 100}, jv\}$, as defined above for horizontal spillovers. Table 2.4 lists the summary statistics of all the spillover measures used in the empirical analyses.

2.5 Data

I use firm-level panel data adopted from National Bureau of Statistics of China (NBSC) to conduct my empirical analysis. The data set contains the population of manufacturing firms in China with sales in excess of 5 million yuans (about 600,000 USD) for each year between 1998 and 2001. It is estimated that the data set covers about 85-90% of total output in most manufacturing industries.

In addition to detailed financial statement data, it includes information on equity ownership in each firm, which allows researchers to measure the extent of foreign presence in each sector. While the data set provides no information about the nationality of all foreign investors in each firm, it does record the share of equity owned by overseas ethnic Chinese from Hong Kong, Macau or Taiwan. Therefore, I can construct separate measures for foreign presence of ethnic Chinese and non-Chinese investors, respectively. Furthermore, the data set contains information on different types of domestic owners, which are categorized into 4 different types – 1) governments (either local or central government), 2) collective owners (e.g. township and villages cooperatives) 3) institutional investors and 4) domestic private investors. With these information, I can examine whether the magnitude of spillovers differs across domestic enterprises with different types of ownership.

I focus on a sub-sample of the data set of firms with at least 5 workers in each year in the panel. I drop observations with negative values for important variables (See Section 2.9.1 for details about the cleaning procedure). After removing unusable observations, the final unbalanced panel contains 330,508 observations, with 71,644, 96,183, 91,933 and 73,748 observations for 1998, 1999, 2000 and 2001, respectively.[18] Of these observations, 80% are for domestic firms, defined as enterprises with less than 10% foreign equity.

The data set contains data on firms' gross output in current and constant (1997) prices, value-added and capital in current prices, and the number of employees. First, I obtain firm-specific implicit output deflators by dividing gross output in current prices by gross output in constant prices. I use these deflators to deflate the nominal value of value-added to obtain real value-added, which I will use as my measure of output in the construction of firm TFP measures.[19] Labor is measured by the total number of employees, instead of hours worked, due to the lack of data. Capital stock is measured as the net value of fixed assets, deflated by province-specific weighted average of separate cost indices for investments in construction and installation, purchases of equipment and instruments, available in various issues of the China's Statistical Yearbook (1999-2002).

To construct the proxies for the extent of foreign presence in each sector, I adopt the Chinese input-output table for the year 1997 from the OECD Input-Output Database (2002). For each sector, it contains information on the total value of output used as intermediate inputs by all sectors. Based on these values, for a given sector, I calculate the input share in its total intermediate-input sales of each of its downstream sectors. Since in the OECD data set, a sector is defined as an ISIC (revision 3) 2-digit category, while in the Chinese firm census data

[18]The balanced panel (containing firms which present in all 4 years) contains 31,289 firms.

[19]Data on the costs of "intermediate inputs" are available for a subset of firms in the data set. However, simple calculation shows that this measure contains much more than material inputs, which were included as an input in productivity estimation in previous literature (e.g., Aitken and Harrison (1997) and Javorcik (2004)).

set, it is classified under the Chinese NBSC system (at a more disaggregated level), I use the concordance file available in the China's Industrial Statistical Yearbook to map all Chinese NBSC industrial code to 22 ISIC 2-digit categories. Then I use the input-output coefficients as weights to construct proxies for vertical spillovers for each firm (as discussed in Section 2.4.3). From the same data set, I also take data on labor income and value-added to obtain sectoral labor shares for the construction of Solow residuals, and import and export data as control variables in the regressions.

2.6 Results

2.6.1 Baseline Results

The empirical analysis begins by examining whether there are spillovers within sectors (horizontal) and across sectors through backward linkages (vertical). As discussed in section 2.2, *a priori*, we do not know whether spillovers exist in either channel, and if so, whether they are positive or negative. Horizontal spillovers would be expected to be positive if the positive effects of knowledge diffusion dominate other negative effects, such as the competition effects. Similarly, we would observe positive vertical spillovers if multinational firms transfer enough knowledge to the upstream domestic firms, offsetting the possibility of negative crowding-out effects arising from imports of intermediate inputs.

The baseline regression analysis, based on specification (2.1), is performed on the sample of domestic firms, i.e. firms with less than 10% foreign equity. Results are reported in Table 2.5. All regressions include sector, province and year fixed effects to capture sector- and province-specific trends, and any economy-wide demand and supply shocks. Firm-specific productivity is measured as Solow residuals according to equation (2.2). I first exclude the controls of firm concentration and import penetration in the sector. In column (1), I find a negative and significant relationship between an increase in the share of output produced by foreign affiliates (ΔH_{jt}) and the productivity growth of domestic firms in the same sector. The coefficient on the horizontal spillover measure is statistically significant (at the 5% significance level) and economically meaningful. A point estimate of -0.238 implies that one standard-deviation increase in the change in foreign share of output in the same sector, ΔH_{jt} (i.e. a 4% increase from the mean equal to 2%) is associated with a 0.95 percentage-point decline in domestic-firm TFP growth.

In column (2), I regress firm productivity growth on the first difference of the vertical spillover term, ΔV_{jt}. The coefficient on ΔV_{jt} is insignificant at any conventional statistical significance level. In other words, productivity growth of a local input supplier is unrelated to the foreign presence in its downstream sectors (the sectors to which it supplies intermediate inputs). When I include both ΔH_{jt} and ΔV_{jt} as regressors in column (3), ΔH_{jt} remains a significant source of spillovers. In column (4), I control for a sector's firm concentration and import penetration. The coefficients on both the Herfindahl index and the volume of imports are statistically insignificant. These results are consistent with Nickell (1996), who points out that theoretical predictions on the impact of competition on productivity growth are ambiguous. Likewise, it is difficult to establish a causal relationship between a sector's volume of imports and firm productivity. Nevertheless, the findings of negative horizontal spillovers and 0 vertical spillovers remain robust across all four columns.

Researchers have argued that there can be a time lag for positive productivity spillovers to realize (Liu, 2008). In a level regression specification, adding lagged values are more important. In a first-difference specification, however, it is unclear whether lagged changes in foreign presence are related to the firm productivity growth at present. Irrespectively, in column (5), I include the lagged values of the first difference of the spillover terms. The coefficients on both the lagged spillover terms are insignificant, consistent with the claim that the lag of foreign knowledge absorption by domestic firms may offset some of the contemporaneous negative competition effects.[20] In column (6), I deviate from the baseline specification of this paper by running a level regression. I continue to find evidence of negative horizontal spillovers, but not vertical spillovers. However, one should be careful in interpreting the results from a level specification without fixed effects, which are removed in a first-difference specification. Finally, I use a second-difference specification to verify the findings in column (7). The coefficient on the horizontal spillover term continues to be negative, as in the first-difference specification, but is

[20] It is possible that a one-year lag is insufficient to account for the time lag of FDI spillovers. However, the short time horizon of the data set does not allow me to control for more lagged values. With a longer time series, studying the dynamic effects of spillovers is an interesting area of research.

no longer statistically significant.[21] This result is consistent with the findings from the regression when lagged values of spillovers are used. If locals need time to acquire foreign knowledge, an increase in foreign presence for two years (second differences) is likely to be associated with more knowledge transfer, which may offset more of the short-run competition effects.

If the net negative effects are due to the dominance of the negative competition effects, we should expect lower output growth of domestic firms associated with an increased foreign presence in a sector. In Table 6, I repeat the analogous analyses I did in Table 5, by replacing a firm's Solow residual growth by its value-added growth. In column (1), I find that the coefficient on the horizontal spillover measure is also negative and significant (at 5% significance level), consistent with the conjecture that foreign presence is associated with decreased domestic production in the short run. The point estimate of -0.257 means that a 4 percentage-point (one standard deviation) increase in the first difference of within-industry foreign presence is associated with about 1 percentage-point decline in output growth.

The magnitude of the coefficient seems too small to explain the net negative horizontal spillovers on TFP growth. To illustrate the point, consider the following simple exercise. Suppose that the production function of a representative domestic firm in a sector is $Y = A(Y_f)\,X^{\eta}$, where Y represents firm output, X represents cost-minimizing choices of inputs, and Y_f denotes an exogenous level of foreign output in the sector. The function $A(Y_f) > 0$ represents firm TFP, and is increasing in Y_f to capture positive knowledge transfer from foreign firms. For convenience, I assume that $A(Y_f) = Y_f^a$. Furthermore, increasing returns to scale due to firms' decreasing average costs implies $\eta > 1$. On the demand side, to capture the negative competition effects, suppose that demand for domestic products is negatively related to the exogenous level of foreign output in the sector. Therefore, abstracting from other determinants of demand, I denote demand for goods in a sector as $Y_d = B(Y_f)$, with $B'(Y_f) < 0$. For expositional purposes, I assume $B(Y_f) = Y_f^{-b}$, with $b > 0$. Taking log on both supply and

[21] With the sample size decreases by half from the baseline sample, readers should interpret the results from a second-difference regression with caution.

demand functions, I obtain the following system of two equations

$$\begin{aligned} y &= a y_f + \eta x \\ y_d &= -b y_f \end{aligned}$$

where lower cases stand for log values. In equilibrium, a firm's output and Solow residual $(y-x)$ can be expressed in terms of y_f as:

$$\begin{aligned} y &= -b y_f, \\ y - x &= \left(a - (\eta - 1)\, b\right) \frac{y_f}{\eta}. \end{aligned}$$

Assume for the moment that gross knowledge transfer from FDI has a negligible impact on productivity, i.e. $a = 0$. The coefficient on y_f on the output regression is $-b$, while that for the productivity regression is $-\left(\frac{\eta-1}{\eta}\right) b$. The estimated coefficients from the corresponding regressions ($-b$ =-0.257; $-\left(\frac{\eta-1}{\eta}\right) b$ =-0.238) imply returns to scale η of 13.5! Such an implausible implied returns to scale can be a result of measurement errors in micro-level production data for developing countries. For example, if capital is over-measured, or is heavily under-utilized in reality but not captured in the data, measured productivity will be downward biased. In addition, materials are an important input of production. Although I use value-added as my measure of output, which already takes the omission of materials as an input into account, if changes in material inputs are not controlled for (because of data limitation), estimated impact of FDI on productivity growth can be biased away from 0. That said, further research is needed to fully understand the inconsistency between the results from the output and productivity regressions. Readers should interpret the magnitude of the spillover effects of FDI with this caveat in mind.

As reported from columns (2) to (4) of Table 2.6, I find a negative relationship between changes in foreign presence in a sector and domestic-firm value-added growth, consistent with the findings in Table 2.5. Similarly, I find no relationship between foreign equity participation in a local firm's downstream sectors and its value-added growth. These results remain robust after I control for changes in firm concentration and imports in the same sector. In column (5), I find a positive coefficient on the lagged horizontal spillover term (significant at the 10%

significance level), implying that an increase in foreign presence in a sector with a year lag is associated with an increase in value-added growth of domestic firms. With the caveat of the significance level in mind, this result is consistent with the argument about the time lag of FDI spillovers. Finally, in column (7), I find evidence of negative horizontal spillovers based on a specification using second differences.

To check the robustness of the results, in Table 2.7, I conduct the identical analyses of Table 2.5, using Olley-Pakes estimated TFP growth as the dependent variable. Consistent with the results in Table 2.5, besides the regression with lagged spillover terms, I find negative and significant coefficients on the horizontal spillover term (ΔH_{jt}) across all specifications. The magnitudes of the coefficients are also comparable with those reported in Table 2.5. Likewise, I also find no evidence of vertical spillovers (ΔV_{jt}).

In sum, I find strong evidence supporting contemporaneous negative relationship between higher foreign presence and domestic-firm productivity growth in the same sector (i.e. horizontal negative spillovers) and no evidence of vertical spillovers. The first set of results supports the recent literature which finds negative horizontal spillovers from FDI (Aitken and Harrison, 1999; Djankov and Hoekman, 2000; Konings, 2001; Javorcik, 2004). The second set of results contrasts the findings of positive vertical spillovers through backward linkages in recent literature (Javorcik, 2004; Blalock and Gertler, 2006; Javorcik and Spatareanu, 2008). Although the negative competition effects are the dominant explanation for the observed net negative horizontal spillovers, I find no consistent results from the output regressions to support the argument.

2.6.2 Within-Province Spillovers

Next, I examine whether productivity spillovers from FDI take place within and across provinces, respectively. To this end, I decompose the measure for nation-wide horizontal spillovers into two separate measures, one for own-province horizontal spillovers, another one for spillovers from other provinces (cross-province spillovers). Specifically, the degree of own-province horizontal spillovers is measured by the share of output produced by foreign affiliates in both the same sector and province where the firm operates. The degree of horizontal spillovers from other provinces is measured by the share of output produced by foreign affiliates in the same sector, but located outside the province where the firm operates. The procedure to construct the vertical spillover measures is similar. Specifically, to construct the within-province vertical spillover proxy for a domestic firm, I use the same input-output coefficients taken to construct the nation-wide spillover measures, along with within-province horizontal spillover measures, to compute a weighted (weighted by input-output coefficients) average of the foreign presence in a firm's downstream sectors in the same province. Similarly, I construct the cross-province vertical spillover proxies, using the same input-output matrix, and the measures of cross-province horizontal spillovers.

To test whether spillovers exist both within and across provinces, in Table 2.8, firm productivity growth is regressed on own- and cross-province spillover terms, respectively. In column (1), using a firm's Solow residual as the measure of TFP, I find support for negative own-province horizontal spillovers (at 10% significance level), but also negative vertical spillovers from downstream foreign firms within the same province. The coefficient on the own-province vertical spillover is negative and significant (at 1% significance level), with a large magnitude. A one standard-deviation increase in the own-province vertical spillover measure (ΔV_own_{jt}) (a 1% increase from the mean of 2%) is associated with an average of 0.57 percentage-point decline in the productivity growth of domestic firms located in the same province.

In column (2), I replace all own-province spillover measures by their corresponding cross-province measures to examine whether productivity can "spill over" to firms in other provinces. I find evidence of negative horizontal spillovers from foreign firms in the same sector to a domestic firm located in a different province. Importantly, the coefficient on the cross-province horizontal spillover term is statistically significant, and bigger in magnitude than that for within-province spillovers. While for vertical spillovers, no cross-province spillovers are found. These results, together with those in column (1), are confirmed in column (3) when variables for both own- and cross-province spillovers are included as regressors. Nevertheless, I do not find support for negative spillovers when I use lagged values of spillover terms in column (4). From columns (5) to (8), I repeat the same regressions in columns (1) to (4), using the Olley-Pakes estimated TFP as the dependent variable. The results remain almost quantitatively identical.

These findings suggest that proximity to foreign firms is an important determinant of the net effects of spillovers, and can be explained by the particular situation of economic fragmentation in China. First, the theory emphasizing knowledge dissipation due to workers' turnovers can explain the observed different magnitudes of negative horizontal spillovers for within and between provinces. It is well-known that due to governments' restriction, cross-province worker mobility is low in China. As suggested by earlier literature (e.g. Kokko, 1996), if workers bring foreign know-how to domestic firms when they move from foreign to domestic firms, increased foreign presence in a province is more likely to transfer knowledge to domestic firms located nearby, rather than to those located in a different province. Hence, more pronounced knowledge diffusion effects within the same province can offset more of the competition effects, resulting in less negative horizontal spillovers from foreign to domestic firms in the same province than from other provinces.

Moreover, in contrast to the existing findings, I find negative vertical spillovers within the same province. These results are consistent with the hypothesis that imports of intermediate inputs by multinationals can crowd out demand for locally produced inputs. An explanation is that until recently, a majority of foreign direct investment in China were for labor-intensive final-stage assembly (Henley et al., 1999), which involved a lot of imported intermediate inputs. According to the theoretical models of Rodriguez-Clare (1996) and Markusen and Venables (1999), imported intermediate inputs substitute for locally-produced inputs, and can force less productive domestic input suppliers to reduce production or shut down.[22] Similar to the explanation for negative horizontal spillovers, under the condition that firms produce with fixed costs, the resulting short-run increasing returns to scale in production implies that crowding-out by downstream foreign firms will lead to negative vertical spillovers.

An important question is why the crowding-out effects through backward linkages are observed only within provinces, but not across provinces. As for the case of negative horizontal spillovers, economic fragmentation in China can shed light on this phenomenon. In addition to underdeveloped transportation infrastructure, fierce political and economic competition between provinces increase cross-province trade barriers in China (Kumur, 1994; Young, 2000), especially for differentiated products (Huang and Wei, 2002). As a result of high trade costs

[22]In unreported results, when I regress value-added growth on the own-province vertical spillover term, I find a significant and negative coefficient on the latter. This result shows that foreign entrants in the downstream sectors of a firm did crowd out demand for its intermediate inputs. Similar to the earlier discussion about the required returns to scale, however, I do not find a sufficiently large coefficient in the corresponding output regression to explain the magnitude of the negative vertical spillovers. Further research is needed.

between provinces, a recent study by Amiti and Javorcik (2006) find that both market and supplier accesses are important determinants for the location of foreign firms in China, with the latter being relatively more important. Thus, in an economically fragmented market, domestic and foreign firms are more likely to source inputs from firms operating in the same province. When foreign firms enter a sector, the crowding-out effects are particularly strong for the local intermediate-input suppliers, but weak for suppliers located farther away. A stronger crowding-out effect in the neighborhood of a domestic input supplier, therefore, can explain the existence of negative vertical spillovers at the province level, but not at the national level.

2.6.3 Ownership Structure and Spillovers

The second part of the empirical analyses examines whether the structure of ownership and the nationality of owners of foreign firms affect the extent of spillovers. First, I focus on the differences between spillovers associated with wholly and jointly owned foreign firms (joint-ventures), respectively. Recent literature posits that joint ventures are associated with more knowledge spillovers in the same sector. For vertical spillovers, joint-ventures are more likely to source locally with the help of the domestic partners, enhancing the potential for knowledge transfer to the intermediate-input producers through backward linkages (Javorcik and Spatareanu, 2008). Therefore, for both horizontal and vertical spillovers, it is expected that higher spillovers are associated with joint ventures. Specific to the findings of negative horizontal spillovers in this paper so far, wholly owned foreign firms are expected to be responsible for more negative spillovers.

To formally study different spillover effects associated with different ownership structures, I decompose nation-wide horizontal spillovers into two separate measures: a measure associated with wholly owned foreign firms and another one for joint-ventures. As discussed in Section 2.4.3, the proxy for horizontal spillovers from wholly owned foreign firms is measured by the share of output produced by these firms in the same sector. By construction, the share of the remaining output produced by foreign affiliates is the spillover measure for joint-ventures. Likewise, I decompose the vertical spillover proxy into measures for spillovers from wholly and jointly owned foreign affiliates, respectively.

Table 2.9 shows the results of the regressions for spillovers associated with foreign firms with different ownership structures. In column (1), I regress firm TFP growth on the first differences of the four spillover terms associated with wholly and jointly owned foreign firms. The coefficients on the two horizontal spillover measures are negative and significant, suggesting that both jointly and wholly owned foreign firms are responsible for lower domestic-firm productivity growth in the same sector. Importantly, the coefficient for wholly owned foreign firms is bigger than that for joint-ventures (-0.525 compared to -0.294, although their difference is not statistically significant). This result is consistent with the conjecture that joint-ventures tend to transfer more knowledge to the locals, offsetting more of the negative competition effects. In contrast, foreign presence in either form of ownership structure does not lead to vertical spillovers.

These findings remain robust to the inclusion of controls of the Herfindahl index and import growth of the sector (column (2)). In column (3), when lagged values of spillover terms are used instead of contemporaneous values, results become insignificant. When I use second-differences for all variables in column (4), I find that the coefficient for wholly-owned foreign firms is about 5 times the size of that for joint-ventures. The difference is statistically different (p-value of the test for same coefficients is equal to 0 at two decimal places).[23] Repeating the same exercises using the Olley-Pakes estimated TFP yields quantitatively similar results (columns (5) - (8)) .

Parallel to the study of own-province spillovers in Table 2.8, regressions in Table 2.10 examine whether the relationship between the ownership structure of foreign firms and spillovers is observed both within and across provinces. To this end, I decompose the measures of spillovers (horizontal or vertical) for each ownership structure (sole or joint ownership) into measures for within- and cross-province spillovers. As such, I obtain eight different spillover measures, four for own-province spillovers: four for cross-province spillovers. Formally, the regression specification including all eight spillover measures takes the following form:

$$\begin{aligned}\Delta \ln TFP_{ijrt} \;=\;& \alpha + \beta_1 \Delta H\_own^{100}_{jrt} + \beta_2 \Delta H\_own^{jv}_{jrt} + \beta_3 \Delta V\_own^{100}_{jrt} + \beta_4 \Delta V\_own^{jv}_{jrt} \\ & + \beta_5 \Delta H\_other^{100}_{jrt} + \beta_6 \Delta H\_other^{jv}_{jrt} + \beta_7 \Delta V\_other^{100}_{jrt} + \beta_8 \Delta V\_other^{jv}_{jrt} \\ & + \eta_C \Delta Conc_{jrt} + \eta_I \Delta \ln Imp_{jrt} + f_j + f_r + f_t + e_{ijrt},\end{aligned}$$

[23]Because of the reduced sample size, readers should interpret these results with caution.

where i, j, r and t continue to stand for firm, sector, region and time, respectively. The suffix "*_own*" stands for own-province spillovers, and "*_other*" stands for cross-province spillovers, superscripts "100" and "jv" represent wholly and jointly owned foreign firms, respectively.

In columns (1), the growth of a firm's Solow residual is regressed on the four measures for own-province spillovers. I find negative horizontal spillovers from wholly owned foreign firms, but not from joint-ventures. The difference between the coefficient on the measure for wholly-owned horizontal spillovers and that for joint-ventures is statistically different at the 5% significance level. These results are consistent with the main prediction of the paper that joint-ventures are associated with more knowledge spillovers. Turning to vertical spillovers, I find negative vertical spillovers from wholly owned foreign firms to local input suppliers in the same province, while no such relationship is observed for joint-ventures. Importantly, the coefficients on the two vertical spillover measures are significantly different at the 1% significance level.

In column (2), consistent with the findings in Table 2.8, I find no cross-province vertical spillovers from either jointly or wholly owned foreign firms. As discussed earlier, the mechanism of economic fragmentation can be an explanation. For cross-province horizontal spillovers, I find evidence of negative spillovers from joint ventures, but not wholly owned foreign firms. These results are in contrast to the prediction that wholly-owned foreign firms are associated with more negative horizontal spillovers. Including all eight spillover terms for own- or cross-province spillovers associated with different ownership structures do not overturn the results obtained in column (1) and (2). Repeating the same analyses using Olley-Pakes estimated TFP also yields quantitatively similar results (columns (4) through (6)).

To check the robustness of the findings of spillovers from jointly and wholly owned foreign firms, I examine whether majority owned foreign enterprises (foreign firms with more than 50% foreign equity) are associated with more negative spillovers than minority owned foreign enterprises (those with less than 50% foreign equity). In Table 2.11, I find that increased presence of majority owned foreign firms is associated with more negative horizontal spillovers, whenever the coefficients on both the majority- and minority-owned spillover terms are statistically significant. The findings remain robust in second-difference specifications (columns (4) and (8)) , and when Olley-Pakes estimated TFP growth is used (columns (5) through (8)). In sum, except columns (3) and (7), when lagged spillover terms are used, the coefficient on horizontal spillovers associated with majority owned foreign firms is always negative and significant at the 1% significance level, with a magnitude higher than that for minority-owned foreign firms (although the coefficients are not statistically different). These results are consistent with the findings in Table 2.9.

2.6.4 Nationality of Foreign Investors

Besides studying the spillover effects of different equity-sharing structure between domestic and foreign owners in foreign firms, I consider another dimension of equity ownership that can be related to spillovers – the nationality of foreign investors. If data permit, it would be ideal to examine how different source countries of FDI are related to the degree of spillovers. However, the data set contains only information on whether a firm's foreign investors are from Hong Kong, Macau and Taiwan (ethnic-Chinese henceforth) or other countries. Given that a majority of foreign direct investment came from these three regions (See Table 2.2), it is still important to study whether there exist different spillover patterns from ethnic-Chinese vis-à-vis non-Chinese foreign firms.

Recent literature emphasizes the role of ethnicity in enhancing knowledge diffusion (Kerr, 2007; Agrawal, 2007). Kerr (2007) finds that scientists are more likely to cite patents by others belonging to the same ethnic group. The direct implication to this paper is that ethnic-Chinese foreign investors should be associated with more know-how transfer, and therefore higher spillovers. To test this hypothesis, I construct measures for spillovers associated with ethnic-Chinese and non-Chinese foreign firms, respectively. Specifically, the ethnic-Chinese spillover measure is the share of output produced by foreign firms with at least 50% ethnic-Chinese equity, i.e. equity owned by Hong Kong, Macau and Taiwan investors. Correspondingly, the remaining share of output produced by foreign firms will be considered a source of spillovers from non-Chinese foreign affiliates.

In contrast to the predictions of the theory on ethnic-network effects, as reported in Table 2.12, I find that increased presence of ethnic-Chinese foreign firms in the same sector is associated with lower domestic-firm productivity growth, while the entry of non-Chinese foreign firms does not appear to matter at all. The coefficient on the ethnic-Chinese spillover measure is always negative and significant (at 1% significance level), independent of whether I use a second-difference specification (columns (4) and (8)) or Olley-Pakes estimates as measures of firm productivity (columns (5) through (8)). Importantly, when I use lagged changes in foreign presence (columns (3) and (7)) as the explanatory variable of interest, I find evidence of negative vertical spillovers from ethnic Chinese foreign firms, and positive vertical spillovers from the non-Chinese ones. The first set of results is consistent with the findings of negative horizontal spillovers from ethnic-Chinese foreign affiliates, while the second set of results supports the existing literature which finds positive vertical spillovers through backward linkages (Javorcik, 2004; Blalock and Gertler, 2006) .

The findings of negative horizontal spillovers from ethnic-Chinese firms are puzzling. One is tempted to think that ethnic Chinese firms are on average less technologically advanced than non-Chinese foreign firms, and therefore are associated with less knowledge transfer.[24] However, lower productivity also implies lower sales by ethnic-Chinese foreign affiliates, and smaller competition effects. Thus, the net spillover effects from ethnic-Chinese firms should be ambiguous, according to the productivity-competition framework of the paper. One has to deviate from this framework to explain the puzzle.

An explanation is that compared to other foreign investors, ethnic-Chinese foreign investors mainly invest in small scale, labor-intensive projects, often focusing on processing of imported inputs for re-export (Henley et al., 1999). Moreover, because of their proximity and therefore relatively lower communication costs with their subsidiaries in mainland China, ethnic-Chinese foreign owners leave a larger fraction of skill-intensive business services at home, letting more low-skilled final-stage assembly work to be done in mainland China. Increased presence of this sort of foreign presence, compared to those from other countries, have less potential for technology spillovers. A study by Huang et al. (2008) provides evidence for this conjecture. Using the same data set I use, they find that ethnic-Chinese foreign firms do not appear to command higher returns on asset or equity than non-Chinese foreign firms. They explain this by showing that ethnic-Chinese parent firms tend to invest less in intangible assets in their subsidiaries in mainland China, than non-Chinese foreign parents. That said, further research

[24]For instance, geographical proximity and ethnic connection of Hong Kong, Macau and Taiwan to mainland China may imply lower fixed costs of entry for the ethnic-Chinese investors. If only more productive firms find it profitable to pay the fixed costs of FDI, lower fixed costs for ethnic Chinese foreign investors implies lower average productivity for their foreign affiliates, compared to non-Chinese foreign firms. For a formal analysis, see Melitz (2003) and Antras and Helpman (2004), among others.

is needed to fully understand the puzzle.[25]

2.6.5 Different Types of Recipient Firms

Finally, I examine the spillover patterns across various ownership structures over different subsamples of domestic firms. First, I divide the sample of domestic firms into groups of state-owned and non state-owned enterprises, respectively. Different from private enterprises, state-owned enterprises have softer budget constraints and have little incentive to stay competitive. They are therefore less responsive to changes in the market environment and are more reluctant to adopt new technologies. As such, state-owned enterprises are expected to experience more negative spillovers.

I define a firm as state-owned if it has more than 50% state-government equity. Using this rule, 28% of the domestic firms in the sample are classified as state-owned enterprises. Columns (1) through (4) in Table 2.13 show that productivity growth of state-owned enterprises is negatively associated with increased presence of both wholly and jointly owned foreign firms in the same sector, but is unaffected with their presence in the downstream sectors. Importantly, the coefficient on the measure of horizontal spillovers from wholly owned foreign firms is twice as big as that for joint-ventures. Turning to the subsample of non-state-owned firms, I find no productivity spillovers through either horizontal or vertical channel, independent of the ownership structure of foreign firms. In sum, state-owned enterprises bear very negative horizontal spillovers from FDI, particularly from wholly owned foreign firms, possibly due to their lower adoptability to new technology and softer budget constraints.

Second, I consider the subsamples of exporters and non-exporters, respectively. By directly interacting with importing firms, exporters can acquire know-how directly from foreign importers, in addition to FDI. Hence, their productivity growth should be less sensitive to the entry of foreign firms into the domestic economy. I define a firm as an exporter if it exported in all four sample years. As such, 16% of the domestic firms are classified as exporters. Columns (5) through (8) in Table 2.13 show that exporters' productivity growth is unaffected by the presence of either wholly or jointly owned foreign firms through both vertical and horizontal

[25] A direction of research is to examine whether ethnic-Chinese foreign firms receive different tax treatments, compared to domestic and non-Chinese foreign firms, respectively.

channels. For the subsample of non-exporters, I find strong evidence of horizontal spillovers, mainly from joint-ventures. In sum, I find evidence supporting the hypothesis that productivity of exporters is less sensitive to FDI, compared to non-exporters.

Third, I consider the subsamples of domestic firms located in coastal and inland provinces, respectively. Since coastal provinces in China are more developed than inland provinces, FDI are unevenly distributed, with the highest concentration of FDI in coastal regions. If geographical proximity to FDI plays an important role for spillovers, as I already showed in the exercise comparing within- and cross-province spillovers, we should expect different spillover patterns between coastal and inland provinces. In columns (1) through (4) in Table 2.14, I find no relationship between foreign penetration in a sector and productivity growth of domestic firms in coastal provinces. However, for the sample of domestic firms in inland provinces, I identify strongly negative horizontal spillovers.

It should be noted that these results do not contradict the conclusions of within-province negative horizontal spillovers reported earlier. Within-province negative spillovers can be explained by a possibility of competition effects dominating the knowledge-diffusion effects. As shown in Tables 2.8 and 2.10, cross-province spillovers arise from foreign firms in both the same and other provinces. For domestic firms in inland provinces, staying far away from the center of FDI in the coastal regions may imply less knowledge diffusion arising from interaction with foreign firms and worker turnovers. Therefore, with very low knowledge diffusion and relatively high competition effects from foreign firms in other provinces (as shown in Table 2.8), domestic firms in inland provinces are likely to be hurt more by foreign entry in other provinces.

Finally, I consider the subsamples of technology leaders and laggards, respectively. Technology leaders are domestic firms with TFP (Solow Residuals or Olley-Pakes TFP estimates) in the top 50 percentile in a sector. Recent literature finds that the technology gap between domestic recipient firm and foreign firms determines the extent of knowledge transfer (Aghion et al., 2005; Gorodnichenko et al., 2007), with technology transferability decreases with the gap. More negative spillovers are therefore expected for technology laggards. As shown in columns (5) through (8), the average productivity growth of technology laggards is negatively related to the presence of wholly and jointly owned foreign firms, with the former having a three-time bigger impact than the latter (the coefficients are statistically different at the 5% significance level when Solow residuals are used as the TFP measures). Nevertheless, I find no evidence of positive spillovers from FDI to technology leaders.

The findings of negative spillovers mainly from the sample of state-owned, technologically backward and non-exporters imply that FDI have disciplinary effects on the host economy by forcing inefficient firms to reduce production. If that is the case, we should observe a positive relationship between increased foreign presence in a sector and overall sectoral productivity growth. To explore this relationship, in Table 2.15, I regress the growth rate of a sector's weighted average of TFP (either Solow residuals or Olley-Pakes estimates) on changes in the sector's foreign presence.[26] As expected, I find positive coefficients on both the horizontal and vertical spillover terms. However, only when I exclude sector fixed effects and use Olley-Pakes estimated productivity growth as the dependent variable, do I find statistically significant coefficients on the horizontal spillover term. Readers should interpret these results with two caveats. First, sector-level regressions examining spillovers are often subjected to the problem of reverse causality. Second, with a short time series, it is difficult to fully capture the long-term positive productivity effects of FDI on overall sectoral productivity. In short, this is a first step to explore the cleansing effects of FDI, which were underemphasized in the previous literature. Preliminary evidence seems to suggest that FDI is associated with higher overall sectoral productivity growth.

2.7 Conclusions

This paper achieves two goals. The first goal is to examine whether there exist horizontal and vertical spillovers through backward linkages in China. Using a rich panel data set of Chinese manufacturing firms, I find evidence showing that FDI is associated with lower domestic-firm productivity in the same sector. These results are consistent with the recent literature which attributes negative horizontal spillovers to the dominance of negative competition effects over positive knowledge-diffusion effects of FDI.

[26] To calculate sectoral productivity, first, for both Solow residuals and Olley-Pakes estimated TFP, I standardize $\ln TFP$ for all firms using sector-specific mean and standard deviation of the variable. Then I take the exponent of a firm's standardized $\ln TFP$ to obtain the level of firm TFP. Then for each year, I compute the weighted average of the levels of productivity of firms belonging to the same sector, using firms' output share in the sector as weights. Sectoral productivity is the log of this weighted average.

I find no evidence of vertical spillovers from FDI at the national level. However, I find that increased foreign presence in the downstream sectors in the same province is associated with lower productivity growth of local intermediate-input suppliers. This phenomenon can be a result of negative crowding-out effects arising from multinationals' imports of intermediate inputs, which are particularly strong in the economically fragmented Chinese market.

The second goal of the paper is to examine whether the structure of ownership of foreign affiliates affects the magnitude of spillovers. It was believed that jointly owned foreign affiliates are associated with more knowledge spillovers than wholly owned foreign firms. Consistent with this prediction, I find that wholly owned foreign firms account for a larger share of negative horizontal spillovers, compared to joint ventures. For vertical spillovers, I find no evidence showing that the ownership structure of foreign firms matters. I also examine whether ethnic-Chinese FDI is associated with more knowledge transfer and therefore higher spillovers, than non-Chinese FDI. In contrast to the prediction of the theory on ethnic-network effects, I find that ethnic-Chinese FDI is associated with much more negative horizontal spillovers than non-Chinese FDI.

Finally, I investigate whether the findings of negative spillovers are observed across different sub-samples of domestic firms. I find that mainly the domestic firms that are state-owned, technologically backward and located in inland provinces experience negative horizontal spillovers. These results imply that FDI could exert disciplinary effects on the host economy by forcing inefficient firms to reduce production.

In sum, this paper presents a static view of a negative relationship between FDI and domestic-firm productivity growth. It should be noted that I find no relationship between lagged changes in foreign presence and domestic-firm productivity growth. In other words, this paper does not propose governments to restrict FDI inflows, nor reject the claim that FDI can bring know-how and management skills to the host economy. Owing to the short time series of the data set, it is difficult to study the dynamic effects of foreign entry in a sector on firm productivity. In research in progress, I use an extended panel data set of Chinese manufacturing firms with a longer time series to study the dynamic productivity effects of FDI, and also the impact of the removal of domestic equity requirement in foreign firms after China's accession to WTO in 2001.

2.8 References

[1] Abraham, Filip, Jozef Konings and Veerle Slootmaekers [2007], "FDI Spillovers in the Chinese Manufacturing Sector: Evidence of Firm " CEPR Discussion Paper No. 6573.

[2] Aghion Philippe, Nick Bloom, Richard Blundell, Rachel Griffith, and Peter Howitt [2005], "Competition and Innovation: An Inverted U Relationship" *Quarterly Journal of Economics*, Vol. 120, No. 2, pp.701-728.

[3] Agrawal, Ajay, Devesh Kapur and John McHale [2007], "Birds of a Feather - Better Together? Exploring the Optimal Spatial Distribution of Ethnic Inventors," NBER Working Paper No. W12823.

[4] Aitken, Brian J. and Ann E. Harrison [1999], "Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela" *American Economic Review*, Vol. 89, No. 3, pp. 605-618.

[5] Amiti, Mary and Beata Javorcik Smarzynska [2006], "Trade Costs and Location of Foreign Firms in China," mimeo, Federal Reserve Bank of New York. forthcoming *Journal of Development Economics.*

[6] Antràs, Pol and Elhanan Helpman [2004], "Global Sourcing," *Journal of Political Economy*, Vol. 112, No. 3, pp. 552-580.

[7] Blalock, Garrick [2001], "Technology from Foreign Direct Investment: Strategic Transfer through Supply Chains," University of California, Berkeley, manuscript.

[8] Blalock, Garrick and Paul J. Gertler [2008], "Welfare gains from Foreign Direct Investment through technology transfer to local suppliers," *Journal of International Economics,* Vol. 74, Issue 2, pp. 402-421.

[9] Blomström, Fredrik and Sjoholm, Fredrik [1999], "Productivity Growth in Indonesia: The Role of Regional Characteristics and Direct Foreign Investment," *Economic Development and Cultural Change*, University of Chicago Press, vol. 47(3), pp. 559-84.

[10] Blomström, Magnus and Edward N. Wolff [1994], "Multinational Corporations and Productivity Convergence in Mexico" NBER Working Paper No. 3141.

[11] Caves, Richard [1974], "Multinational Firms, Competition, and Productivity in Host-Country Markets," *Economica*, New Series, Vol. 41, No. 162, pp. 176-193.

[12] Desai, Mihir A., C. Fritz Foley and James R. Hines, Jr. [2004], "The costs of shared ownership: Evidence from international joint ventures " *Journal of Financial Economics*, Vol. 73, No. 2, pp. 323-374.

[13] Djankov, Simeon and Bernard Hoekman [2000], "Foreign Investment and Productivity Growth in Czech Enterprises," *World Bank Economic Review*, Vol. 14, No. 1, pp. 49-64.

[14] Globerman, Steven [1979], "Foreign Direct Investment and 'Spillover' Efficiency Benefits in Canadian Manufacturing Industries," *Canadian Journal of Economics*, vol. 12(1), pp. 42-56.

[15] Gorg, Holger and David Greenway [2004], "Much ado about nothing? Do domestic firms really benefit from foreign direct investment?" *World Bank Research Observer*, 19, pp.171-197

[16] Gorodnichenko, Yuriy, Jan Svejnar, and Katherine Terrell [2007], "When Does FDI Have Positive Spillovers? Evidence from 17 Emerging Market Economies" IZA Discussion Papers no, 3079.

[17] Haddad, Mona and Ann Harrison [1993], "Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco" *Journal of Development Economics*, Vol. 42, No. 1, pp. 51-74.

[18] Hale, Galina and Cheryl Long [2007], "Are there productivity spillovers from foreign direct investment in China?," Working Paper Series 2006-13, Federal Reserve Bank of San Francisco.

[19] Haskel, Jonathan E. , Sonia C. Pereira , Matthew J. Slaughter [2007], "Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms?, " *Review of Economics and Statistics*, Vol. 89, No. 3, pp. 482-496.

[20] Helpman, Elhanan, Marc Melitz, and Stephen Yeaple [2004], "Export versus FDI with Heterogeneous Firms." *American Economic Review*. Vol. 94, No. 1, pp. 300-316.

[21] Henley, John, Colin Kirkpatrick and Georgina Wilde [1999], "Foreign direct investment in China: Recent trends and current policy issues," *World Economy*, Vol. 22 Issue 2, pp. 223-258.

[22] Huang, Yasheng, Li Jin and Yi Qian [2008], "Does Ethnicity Pay? Evidence from Overseas Chinese FDI in China," MIT Sloan Research Paper No. 4690-08

[23] Huang, Lin and Shang-Jin Wei [2002], "One China, Many Kingdoms? Using Individual Product Prices to Understand Local Protectionism in China," mimeo, International Monetary Fund, Washington, DC.

[24] Javorcik, Beata Smarzynska [2004], "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? The Search for Spillovers through Backward Linkages." *American Economic Review* Vol. 94, No. 3 pp. 605-627.

[25] Javorcik, Beata Smarzynska and Mariana Spatareanu [2008], "To share or not to share: Does local participation matter for spillovers from foreign direct investment?" *Journal of Development Economics*, Vol. 85 (1-2), pp. 194-217.

[26] Keller, Wolfgang and Stephen Yeaple [2005], "Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States", Kiel Institute for the World Economy.

[27] Kerr, William R. [2007], "Ethnic Scientific Communities and International Technology Diffusion," Harvard Business School Working Paper 06-022. forthcoming *Review of Economics and Statistics*.

[28] Kokko, Ari [1996], "Productivity spillovers from competition between local firms and foreign affiliates," *Journal of International Development,* Vol. 8, No. 4 , pp. 517 - 530.

[29] Konings, Jozef [2001], "The effects of foreign direct investment on domestic firms : Evidence from Firm Level Panel Data in Emerging Economies," *Economics of Transition* Vol. 9 No 3 pp. 619 - 633.

[30] Kumar, Anjali [1994]. "China: Internal Market Development and Regulation" NetLibrary, Incorporated. NetLibrary, Inc.

[31] Levinsohn, James and Amil Petrin [2003], "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, Vol. 70, No. 2, pp. 317–341.

[32] Liu, Zhiqiang [2008]. "Foreign Direct Investment and Technology Spillovers: Theory and Evidence " SUNY Buffalo Working Paper. Forthcoming *Journal of Development Economics.*

[33] Long, Guoqiang [2005]. "China's Policies on FDI: Review and Evaluation." in *Does Foreign Direct Investment Promote Development? (Ed.* Theodore H. Moran, Edward M. Graham, Magnus Blomstrom, Edward M. Graham) Peterson Institute for International Economics.

[34] Markusen, James and Anthony Venables [1999]. "Foreign direct investment as a catalyst for industrial development," *European Economic Review*, Vol. 43, No. 2, pp. 335-356.

[35] Melitz, Marc [2003], "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, Vol. 71, No. ? pp. 1695-1725.

[36] Moran, Theodore [2001], "How Does FDI Affect Host Country Development? Using Industry Case Studies to Make Reliable Generalization" *Does Foreign Direct Investment Promote Development?* Edited by Theodore H. Moran, Edward M. Graham,

[37] National Bureau of Statistics of China [2002], "China's Industrial Statistical Yearbook" China Statistics Press, Beijing, China.

[38] National Bureau of Statistics of China [2002], "China's Statistical Yearbook," , China Statistics Press, Beijing, China.

[39] Nickell, Stephen J., [1996], "Competition and Corporate Performance," *Journal of Political Economy*, Vol. 104(4), pp. 724-46.

[40] OECD [2002], Input-Output Tables (2002 edition). http://www.oecd.org/document/ OECD, Paris.

[41] Olley, G. Steven and Ariel Pakes [1996]. "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, Vol. 64, No. 6, pp. 1263-1297.

[42] Ramachandran, Vijaya [1993], "Technology transfer, Firm Ownership, and Investment in Human Capital," *Review of Economics and Statistics* Vol. 75, No. 4, pp. 664-670.

[43] Rodrik, Dani [1999], "The New Global Economy and Developing Countries: Making Openness Work," Overseas Development Council Policy Essay Number 24, Washington, DC.

[44] Rodriguez-Clare, Andres [1996], "Multinationals, Linkages, and Economic Development" *American Economic Review*, Vol. 86, No. 4, pp. 852-873.

[45] Schoors, Koen and Bartoldus van der Tol [2002], "Foreign Direct Investment Spillovers Within and Between Sectors: Evidence from Hungarian Data " Ghent University Working Paper.

[46] Tybout, James [2001], "Plant- and Firm-Level Evidence on "New" Trade Theories" *Handbook of International Trade*, Kwan Choi and James Harrigan (ed.), Vol.1, pp. 388-417.

[47] UNCTAD [2007], "World Investment Report 2007," United Nations, Geneva.

[48] Young, Alwyn [2000], "The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China" *Quarterly Journal of Economics*, Vol. 115, No. 4, pp. 1091-1135.

2.9 Appendix

2.9.1 Data Construction and Cleaning

1. Drop observations with non-positive values for gross output, value-added and fixed assets.

2. Reconstruct the unique firm identifier, based on the 6-digit regional code and the firm identifier.

3. Drop observations with multiple sector affiliation in the four sample years.

2.9.2 Procedures to Construct V_j

1. Assign OECD ISIC (Revision 3) 2-digit code to each observation in the firm panel data set.

2. For each OECD category, compute the share of output produced by foreign firms (defined as firms with at least 10% of foreign equity). These are the measures of horizontal spillovers, H_{jt}.

3. For each year t, multiple H_{jt} to the input coefficient, α_{ij}, for sector $j's$ input sourcing from sector i.

4. Sum up $\alpha_{ij}H_{jt}$ across all $j's$ to obtain the vertical spillover measure,V_i, for sector i.

5. Other vertical measures are obtained similarly by using different $H'_{jt}s$.

2.9.3 Olley-Pakes Estimation

First Stage The first-stage equation of the Olley-Pakes estimation takes the following form:

$$y_{it} = \alpha + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \epsilon_{it}, \tag{2.4}$$

where l_{it} (ln(labor)) is treated as a variable input and k_{it} (ln(capital stock)) is assumed to be pre-determined at $t-1$. Investment at t, i_{it} is assumed to depend on k_{it} and firm productivity

ω_{it}, which is observed by the firm, but unknown to the researchers. In other words, I can express i_{it} as

$$i_{it} = i\left(k_{it}, \omega_{it}\right).$$

The identifying assumption is that i_{it} is monotonically increasing in ω_{ijt}, conditional on k_{it}. By inverting $i\left(k_{it}, \omega_{it}\right)$. I obtain an expression for ω_{it} in terms of investment and capital stock at year time t as

$$\omega_{it} = \omega\left(i_{it}, k_{it}\right).$$

Substituting this into the regression specification, I obtain

$$y_{it} = \underbrace{\alpha + \beta_k k_{it} + \omega\left(i_{it}, k_{it}\right)}_{h(i_{it}, k_{it})} + \beta_l l_{it} + \epsilon_{it}. \tag{2.5}$$

Denote the unknown function $h\left(i_{it}, k_{it}\right)$ as

$$h\left(i_{it}, k_{it}\right) = \alpha + \beta_k k_{it} + \omega\left(i_{it}, k_{it}\right)$$

Since the functional form of $h\left(i_{it}, k_{it}\right)$ is unknown, I approximate $\omega\left(i_{it}, k_{it}\right)$ by a third-order polynomial in i_{it} and k_{it} to obtain consistent estimates for β_l from estimating (2.5).

Second Stage To estimate β_k, now I consider the expectation of $y_{it+1} - \beta_l l_{it+1}$

$$E\left[y_{it+1} - \beta_l l_{it+1} | k_{it+1}\right] = \alpha + \beta_k k_{it+1} + E\left[\omega\left(i_{it+1}, k_{it+1}\right) | \omega\left(i_{it}, k_{it}\right)\right] \tag{2.6}$$

By assuming that $\omega\left(i_{it}, k_{it}\right)$ follows a first-order Markov process with white noise ξ_t ($\omega_t = \omega_{t-1} + \xi_t$), I rewrite (2.6) as

$$E\left[y_{it+1} - \beta_l l_{it+1} | k_{it+1}\right] = \beta_k k_{it+1} + g\left(\alpha + \omega\left(i_{it}, k_{it}\right)\right)$$

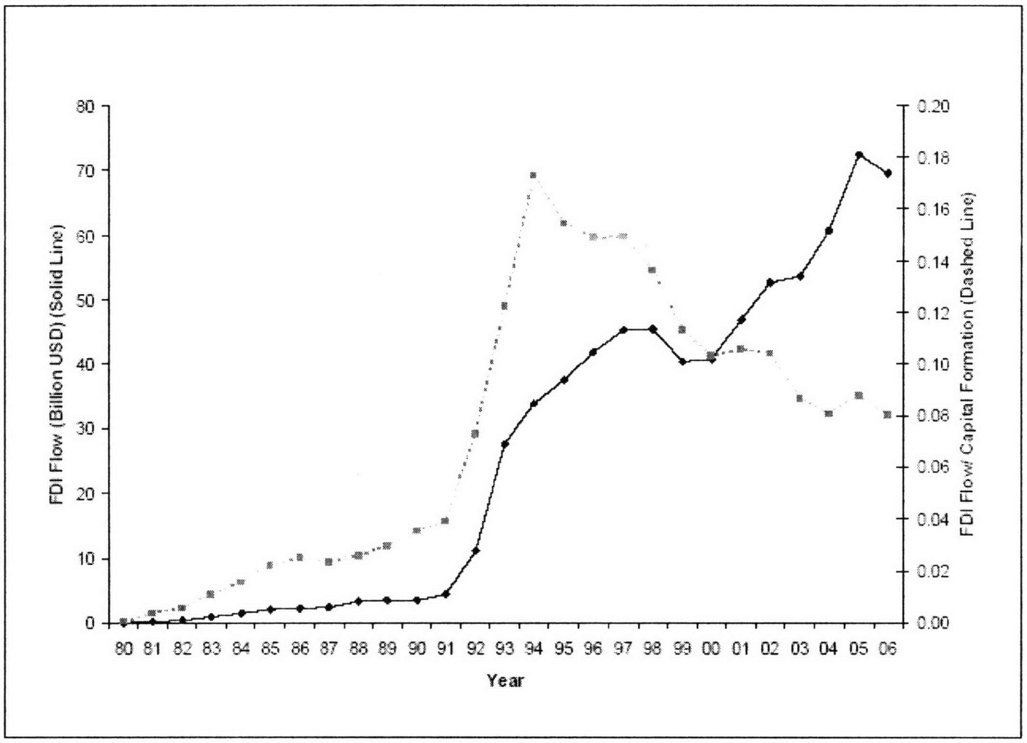
From (2.5), $\omega\left(i_{it}, k_{it}\right) = h\left(i_{it}, k_{it}\right) - \beta_k k_{it} - \alpha$. Hence, using $\widehat{h}\left(i_{it}, k_{it}\right)$ estimated in the first stage, and approximating $g\left(\omega\left(i_{it}, k_{it}\right)\right)$ by a third-order polynomial in i_{it} and k_{it}, I estimate the second-stage equation as

$$y_{it+1} - \widehat{\beta}_l l_{it+1} = \beta_k k_{it+1} + g\left(\widehat{h}\left(i_{it}, k_{it}\right) - \beta_k k_{it}\right) + \xi_{t+1} + \epsilon_{it+1}$$

Since β_k is embedded in non-linear terms of function g, I use non-linear least square method to estimate this equation. According to Olley and Pakes (1996), by restricting the coefficients on k_{it} to be the same both inside and outside the function $g(.)$, the estimate of β_k will be consistent. Readers are referred to Javorcik (2004) for a more detailed description of the implementation of the Olley-Pakes method.

2.10 Tables and Figures

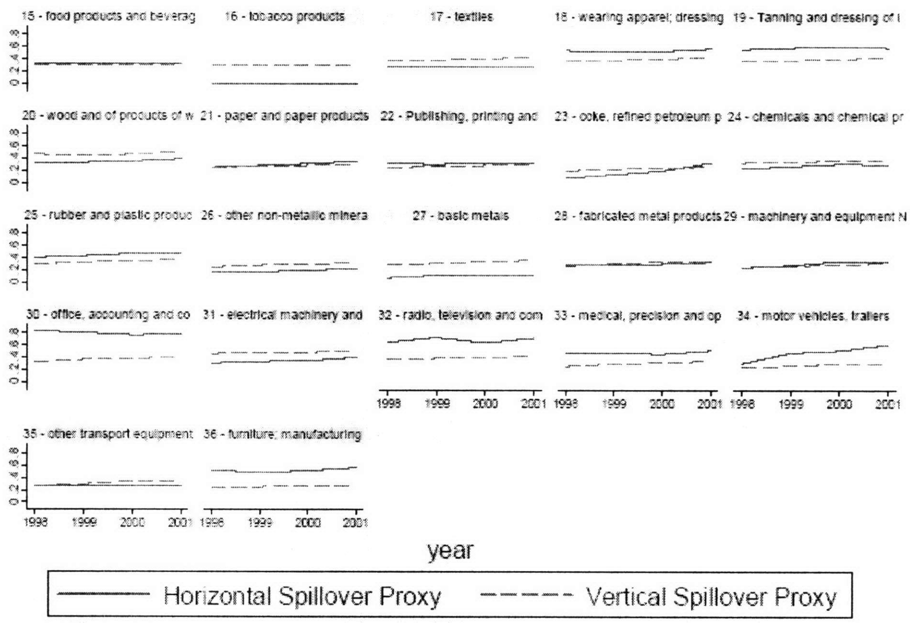
Figure 2-1: Inward FDI Flows and FDI/Capital Formation in China (1980 – 2006)



Source: United Nations World Investment Report (2007).

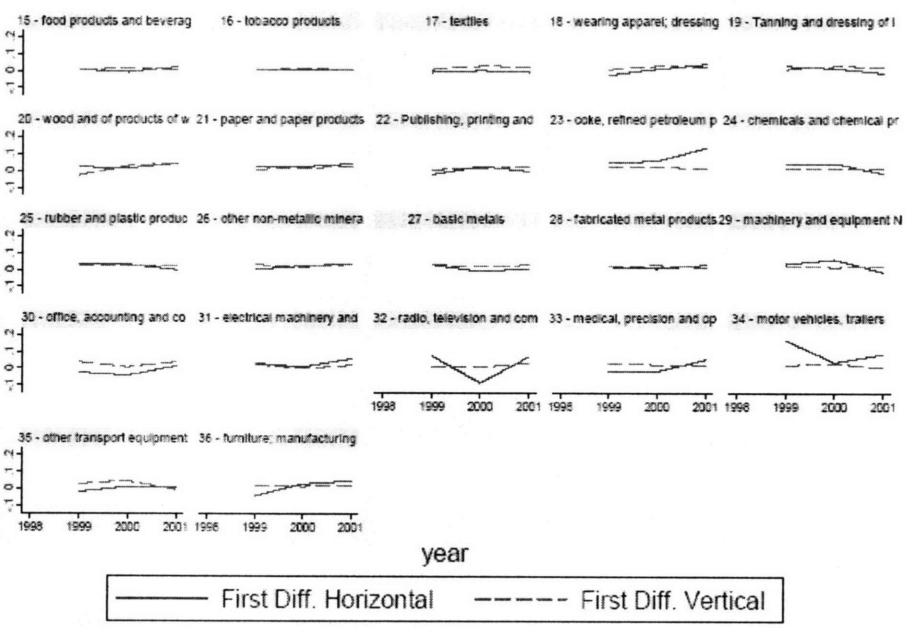
Note: FDI flows are measured in billions of current US dollars. The solid line corresponds to inward FDI flows, associated with the vertical axis on the left. The dashed line corresponds to the share of FDI flows in total capital formation, associated with the vertical axis on the right.

Figure 2-2: Evolution of Horizontal and Vertical Spillovers (1998-2001)



Graphs by ISIC Rev. 3, 2-digit

Figure 2-3: Evolution of First-differences of Horizontal and Vertical Spillovers (1998-2001)



Graphs by ISIC Rev. 3, 2-digit

Figure 2-4: Evolution of Horizontal Spillovers by Ownership Structure (1998-2001)

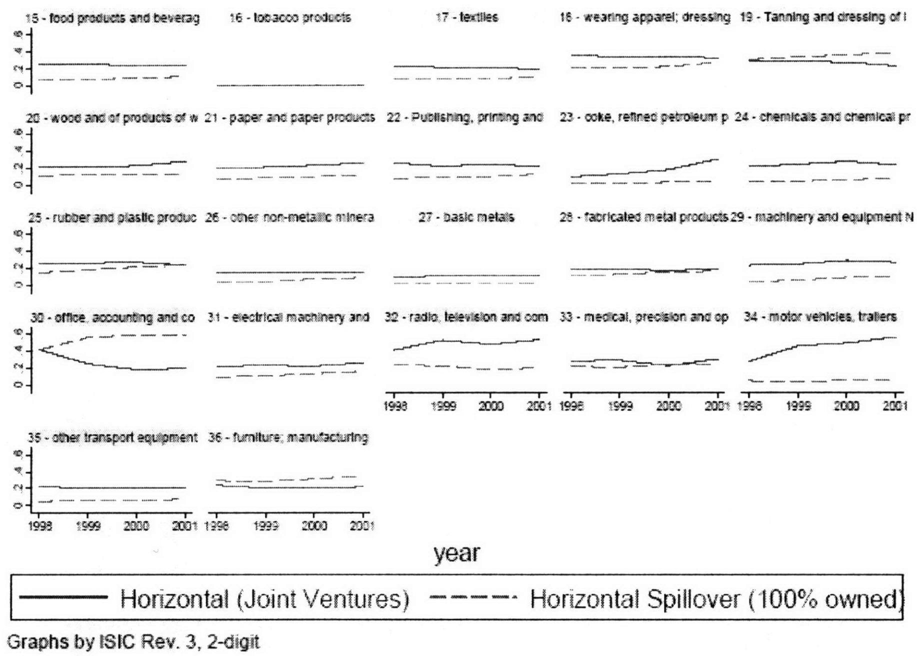


Figure 2-5: Evolution of Vertical Spillovers by Ownership Structure (1998-2001)

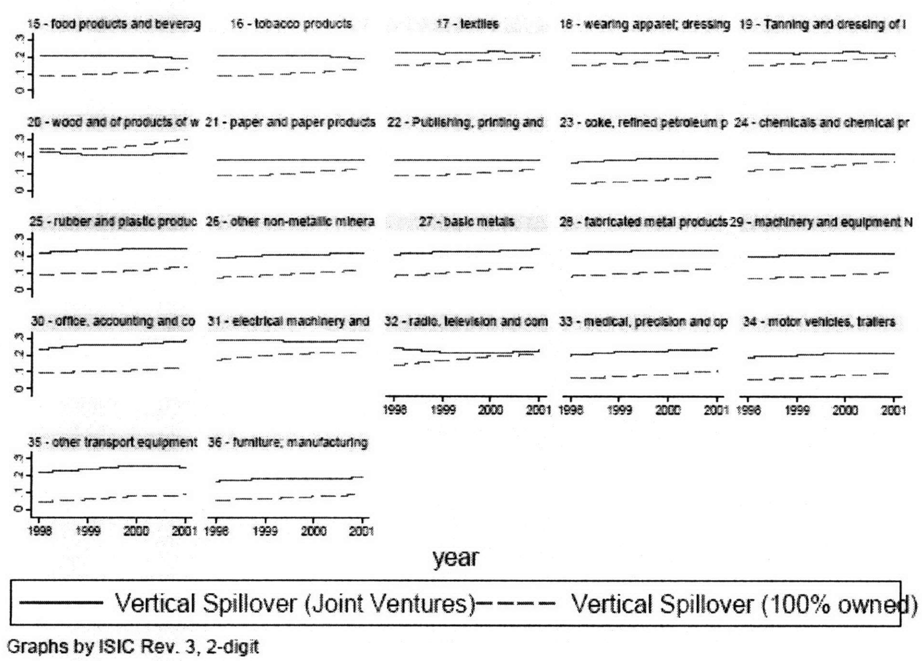


Table 2.1: Distribution of FDI Stock in Different Industries in China (to the end of 2001)

Sector	Cumulated Investment in Foreign Affiliates	Share	Cumulated Foreign Direct Investment in Foreign Affiliates	Share
Manufacturing	491,322	56.15%	214,931	59.76%
Real estate	149,094	17.04%	55,536	15.44%
Social services	56,274	6.43%	23,188	6.45%
Logistics and communication	41,442	4.74%	15,163	4.22%
Electricity, gas and water	49,505	5.66%	11,606	3.23%
Distribution	24,592	2.81%	11,311	3.14%
Construction	21,547	2.46%	7,743	2.15%
Others	13,994	1.60%	7,179	2.00%
Agricultural	9,135	1.04%	4,763	1.32%
R&D and technology service	4,334	0.50%	2,171	0.60%
Mining	3,282	0.38%	1,462	0.41%
Geology investigation	4,237	0.48%	1,412	0.39%
Finance and insurance	2,089	0.24%	1,415	0.39%
Health and sports	2,774	0.32%	1,128	0.31%
Education, culture and films	1,390	0.16%	675	0.19%
Total	875,011	100.00%	359,683	100.00%

Source: China Statistical Yearbook 2002 and Long (2005)

Table 2.2: Top 10 Source Countries of FDI in China (cumulated to the end of 2002 dollars)

	Number of projects	FDI Realized (billions of USD)	Share Among Top 10
Hong Kong	210,876	204.90	51.29%
United States	37,280	39.90	9.98%
Japan	25,147	36.30	9.10%
Taiwan	55,691	33.10	8.29%
Virgin Islands	6,659	24.40	6.10%
Singapore	10,727	21.50	5.37%
South Korea	22,208	15.20	3.80%
United Kingdom	3,418	10.70	2.68%
Germany	3,053	8.00	2.00%
France	2,033	5.50	1.39%

Source: China Ministry of Commerce (2003) and Long (2005)

Table 2.3: Summary Statistics (Firm Level)

	Num. Obs	Mean	Standard Dev.
Value-added (constant 1997 mn yuan)	257,952	95.3460	564.9406
Output (constant 1997 mn yuan)	257,952	400.0462	216.3251
Labor	257,952	363.0409	1295.811
Capital (constant 1997 mn yuan)	257,952	339.8232	3603.0230
TFP Growth (Solow Residuals)	156,447	0.0146	0.7932
TFP Growth (Olley-Pakes Estimated)	156,447	0.0030	0.7843

Note: Summary statistics are for the sample of domestic firms (defined as firms with less than 10% foreign equity). Total number of observations is 323,741, with 79.7% of them associated with domestic firms.

Table 2.4: Summary Statistics (Sector Level)

Sector Level Variables	Num. Obs	Mean	Standard Dev.
Horizontal Spillovers	88	0.3708	0.1876
Wholly-Owned	88	0.1370	0.1288
Joint-Owned	88	0.2337	0.1049
Majority-Owned	88	0.2295	0.1688
Minority-Owned	88	0.1413	0.0756
Ethnic-Chinese	88	0.1826	0.0901
Non-Chinese	88	0.1882	0.1198
Vertical Spillovers	88	0.3386	0.0697
Wholly-Owned	88	0.1218	0.0536
Jointly-Owned	88	0.2169	0.0276
Majority-Owned	88	0.2065	0.0637
Minority-Owned	88	0.1321	0.0148
Ethnic-Chinese	88	0.2214	0.0975
Non-Chinese	88	0.2068	0.0625
Imports (current mn USD)	88	10080.06	13441.92
Exports (current mn USD)	88	10725.5	11329.97
Herfindahl (10-firm)	88	0.0725	0.0619

Sector First-Differences	Num. Obs	Mean	Standard Dev.
ΔHorizontal Spillovers	66	0.0208	0.0390
Wholly-Owned	66	0.0144	0.0230
Joint-Owned	66	0.0065	0.0459
Majority-Owned	66	0.0167	0.0260
Minority-Owned	66	0.0042	0.0390
Ethnic-Chinese	66	0.0083	0.0316
Non-Chinese	66	0.0125	0.0406
ΔVertical Spillovers	66	0.0201	0.0119
Wholly-Owned	66	0.0157	0.0074
Jointly-Owned	66	0.0043	0.0109
Majority-Owned	66	0.0177	0.0094
Minority-Owned	66	0.0023	0.0069
Ethnic-Chinese	66	0.0077	0.0116
Non-Chinese	66	0.0141	0.0122
ln(Imports)	66	0.1363	0.1845
ln(Exports)	66	0.1065	0.1996
Herfindahl Index (10-firm)	66	-0.0017	0.0189

Table 2.5: Horizontal and Vertical Spillovers (Dependent Variable = Solow Residuals)

This table examines the effects of foreign presence on domestic-firm TFP growth through both the horizontal and vertical (backward linkages) channels. The results of first-difference, second-difference and level regressions are reported.

Dependent variable: Solow Residual (Level, First-difference or Second-difference)							
	(1)[f]	(2)[f]	(3)[f]	(4)[f]	(5)[g]	(6)[h]	(7)
Specification	First Diff.	First Diff.	First Diff.	First Diff	First Diff (Lagged)	Level	Second Diff
Horizontal	-0.238**		-0.239**	-0.247**	0.121	-0.502***	-0.367
	(0.110)		(0.111)	(0.115)	(0.113)	(0.125)	(0.220)
Vertical		0.098	0.111	-0.038	-0.553	-0.939	-0.651
		(0.317)	(0.312)	(0.328)	(0.422)	(0.790)	(0.731)
Herfindahl10				0.102	0.343	0.204	0.537
				(0.274)	(0.340)	(0.550)	(0.409)
ln(Imports)				-0.05	0.030	0.014	-0.077*
				(0.041)	(0.031)	(0.042)	(0.043)
Fixed Effects	Y	Y	Y	Y	Y	Y	Y
R-squared	0.003	0.003	0.003	0.003	0.004	0.141	0.006
Number of Obs.	156,447	156,447	156,447	156,447	73,220	257,681	77,051

Notes:

a) A firm's Solow residual is measured according to equation (2.1) in the text.
b) All regressions include a constant, sector, province and year fixed effects.
c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.
d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
e) Only domestic firms (with less than 10% foreign equity) are included in the sample.
f) Columns (1) – (4) use first-differences for all variables.
g) Column (5) uses lagged measures of spillovers. Other variables are not lagged.
h) Column (6) uses levels of all variables, instead of first differences.
i) Column (7) uses second differences of all variables, instead of first differences.

Table 2.6: Horizontal and Vertical Spillovers (Dependent Var. = Value-added)

This table examines the effects of foreign presence on domestic-firm value-added growth through both the horizontal and vertical (backward linkages) channels. The results of first-difference, second-difference and level regressions are reported.

Dependent variable: Value-added (Level, First-difference or Second-difference)							
	(1)[e]	(2)[e]	(3)[e]	(4)[e]	(5)[f]	(6)[g]	(7)[h]
Specification	First Diff.	First Diff.	First Diff.	First Diff	First Diff (Lagged Spillovers)	Level	Second Diff
Horizontal	-0.257**		-0.256**	-0.251**	0.146*	-0.617***	-0.350*
	(0.115)		(0.115)	(0.123)	(0.085)	(0.155)	(0.183)
Vertical		-0.160	-0.146	-0.224	-0.474	-0.271	-0.881*
		(0.347)	(0.345)	(0.360)	(0.502)	(1.059)	(0.511)
Herfindahl10				-0.119	0.141	1.212**	0.134
				(0.301)	(0.441)	(0.568)	(0.346)
ln(Imports)				-0.025	0.034	-0.008	-0.061
				(0.034)	(0.028)	(0.045)	(0.039)
Fixed Effects	Y	Y	Y	Y	Y	Y	Y
R-squared	0.003	0.002	0.003	0.003	0.004	0.089	0.007
Number of Obs.	156,447	156,447	156,447	156,447	73,220	257,681	77,051

Notes:

a) All regressions include a constant, sector, province and year fixed effects.
b) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.
c) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
d) Only domestic firms (with less than 10% foreign equity) are included in the sample.
e) Columns (1) – (4) use first-differences for all variables.
f) Column (5) uses lagged measures of spillovers. Other variables are not lagged.
g) Column (6) uses levels of all variables, instead of first differences.
h) Column (7) uses second differences of all variables, instead of first differences.

Table 2.7: Horizontal and Vertical Spillovers (Dependent Var. = Olley-Pakes Estimated TFP)

This table examines the effects of foreign presence on domestic-firm TFP growth through the horizontal and vertical (backward linkages) channels. The results of first-difference, second-difference and level regressions are reported.

Dependent variable: Olley-Pakes Estimated TFP (Level, First-difference or Second-difference)	(1)[e]	(2)[e]	(3)[e]	(4)[e]	(5)[f]	(6)[g]	(7)[h]
Specification	First Diff.	First Diff.	First Diff.	First Diff	First Diff (Lagged Spillovers)	Level	Second Diff
Horizontal	-0.260**		-0.261**	-0.262**	0.120	-0.527***	-0.393*
	(0.110)		(0.111)	(0.117)	(0.110)	(0.125)	(0.218)
Vertical		0.038	0.053	-0.069	-0.666	-1.021	-0.681
		(0.326)	(0.323)	(0.331)	(0.430)	(0.908)	(0.703)
Herfindahl10				-0.011	0.241	0.535	0.438
				(0.287)	(0.370)	(0.532)	(0.426)
ln(imports)				-0.04	0.031	-0.01	-0.071*
				(0.036)	(0.030)	(0.042)	(0.042)
Fixed Effects	Y	Y	Y	Y	Y	Y	Y
R-squared	0.002	0.002	0.002	0.002	0.003	0.367	0.006
Number of Obs.	156,447	156,447	156,447	156,447	73,220	257,681	77,051

Notes:
a) A firm's TFP is measured based on the Olley-Pakes estimation of a sector-specific Cobb-Douglas production function. See Section 2.9 (Data Appendix) for details.
b) All regressions include a constant, sector, province and year fixed effects.
c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.
d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
e) Only domestic firms (with foreign equity share less than 10%) are included in the sample.
f) Column (5) uses lagged measures of spillovers. Other variables are not lagged.
g) Column (6) uses levels of all variables, instead of first differences.
h) Column (7) uses second differences of all variables, instead of first differences.

Table 2.8: Horizontal and Vertical Spillovers within the Same Province

This table examines horizontal and vertical (backward) spillovers to domestic firms, from foreign firms within and outside the same province.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variables	ΔSolow	ΔSolow	ΔSolow	ΔSolow	ΔOlley-Pakes	ΔOlley-Pakes	ΔOlley-Pakes	ΔOlley-Pakes
Specification	First Diff.	First Diff.	First Diff.	First Diff. Lagged Spillovers	First Diff.	First Diff.	First Diff.	First Diff. Lagged Spillovers
ΔHorizontal (Own Province)	-0.095*		-0.099*	0.050	-0.099*		-0.102*	0.036
	(0.051)		(0.051)	(0.054)	(0.051)		(0.051)	(0.051)
ΔVertical (Own Province)	-0.569***		-0.565***	-0.065	-0.542***		-0.540***	-0.062
	(0.116)		(0.118)	(0.085)	(0.115)		(0.117)	(0.080)
ΔHorizontal (Other Provinces)		-0.188**	-0.196**	0.126		-0.198**	-0.206**	0.114
		(0.087)	(0.082)	(0.130)		(0.086)	(0.082)	(0.123)
ΔVertical (Other Provinces)		0.262	0.104	0.755*		0.199	0.051	0.707*
		(0.247)	(0.225)	-0.394		(0.241)	(0.223)	-0.402
Fixed Effects	Y	Y	Y	Y	Y	Y		Y
Controls		————————	————————	——— Δln(Imports) + ΔHerf10 ———	————————	————————	————————	
R-squared	0.003	0.003	0.003	0.004	0.003	0.002	0.003	0.003
Number of Obs	156,447	156,447	156,447	73,220	156,447	156,447	156,447	73,220

Notes

a) The dependent variable is the first difference of the natural logarithm of firm total factor productivity. In columns (1) - (4), TFP measures are Solow Residuals. In columns (5) - (8), TFP are estimated by Olley-Pakes estimation procedure of a sector-specific Cobb-Douglas production function. See Section 2.9 for details.

b) All regressions include a constant, sector, province and year fixed effects.

c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.

d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

e) Only domestic firms (with foreign equity share less than 10%) are included in the sample.

f) Columns (4) and (8) use lagged measures of spillovers.

Table 2.9: Horizontal and Vertical Spillovers from Joint Ventures and Wholly-owned Foreign Affiliates

This table examines horizontal and vertical (backward) productivity spillovers to domestic firms from jointly-owned (with less than 100% foreign equity) and wholly-owned foreign firms (with 100% foreign equity) respectively

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var	ΔSolow	ΔSolow	ΔSolow	Δ_2Solow	ΔOlley-Pakes	ΔOlley-Pakes	ΔOlley-Pakes	Δ_2Olley-Pakes
Specification	No control	With controls	Lagged spillovers	Second Diff.	No control	With controls	Lagged spillovers	Second Diff
ΔHorizontal (100% owned)	-0.525**	-0.460*	-0.711	-1.588***	-0.488**	-0.442*	-0.775*	-1.586***
	(0.240)	(0.246)	(0.464)	(0.211)	(0.242)	(0.252)	(0.447)	(0.223)
Δ Horizontal (Joint-ventures)	-0.294***	-0.303***	0.031	-0.324**	-0.317***	-0.318***	-0.004	-0.364**
	(0.097)	(0.103)	(0.176)	(0.159)	(0.096)	(0.104)	(0.165)	(0.157)
Δ Vertical (100% owned)	-0.197	-0.225	0.187	-0.661	-0.297	-0.329	0.216	-0.776
	(0.459)	(0.447)	(0.798)	(0.644)	(0.472)	(0.463)	(0.791)	(0.642)
ΔVertical (Joint-ventures)	0.084	-0.046	-1.685*	-0.559	0.059	-0.039	-1.939**	-0.501
	(0.382)	(0.397)	(0.969)	(0.721)	(0.394)	(0.402)	(0.925)	(0.706)
Controls	No	------------ Δln(Imports) + ΔHerf10 ------------			No	------------ Δln(Imports) + ΔHerf10 ------------		
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.003	0.003	0.004	0.006	0.003	0.003	0.003	0.006
Number of Obs.	156,447	156,447	73,220	77,051	156,447	156,447	73,220	77,051
Horizontal 100 = Horizontal JV (p-value)	0.35	0.55	0.06	0.00	0.49	0.63	0.05	0.00
Vertical 100 = Vertical JV (p-value)	0.62	0.75	0.23	0.86	0.54	0.61	0.15	0.63

Notes

a) The dependent variable is the first difference of the natural logarithm of firm total factor productivity. In columns (1) - (4), TFP measures are Solow Residuals. In columns (5) - (8), TFP are estimated by Olley-Pakes estimation procedure of a sector-specific Cobb-Douglas production function. See Section 2.9 for details.

b) All regressions include a constant, sector, province and year fixed effects.

c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.

d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

e) Only domestic firms (with foreign equity share less than 10%) are included in the sample.

f) Columns (3) and (7) use lagged measures of spillovers.

g) The last two rows report the *p*-values of the tests for whether the coefficients on wholly and jointly-owned spillovers are the same.

Table 2.10: Horizontal and Vertical Spillovers from Joint Ventures and Wholly-owned Foreign Affiliates within the Same Province

This table examines horizontal and vertical (backward) productivity spillovers to domestic firms from jointly and wholly owned foreign firms, and from within and outside the same province, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.	ΔSolow	ΔSolow	ΔSolow	ΔOlley-Pakes	ΔOlley-Pakes	ΔOlley-Pakes
ΔHorizontal (100 Own)	-0.261***		-0.258***	-0.274***		-0.271***
	(0.092)		(0.094)	(0.092)		(0.094)
ΔHorizontal (JV Own)	-0.069		-0.075	-0.071		-0.076
	(0.051)		(0.050)	(0.050)		(0.050)
ΔVertical (100 Own)	-1.061***		-1.051***	-1.000***		-0.995***
	(0.231)		(0.236)	(0.227)		(0.231)
ΔVertical (JV Own)	0.075		0.075	0.083		0.087
	(0.107)		(0.105)	(0.106)		(0.104)
ΔHorizontal (100 Others)		0.122	-0.044		0.107	-0.057
		(0.274)	(0.250)		(0.271)	(0.246)
ΔHorizontal (JV Others)		-0.236**	-0.215***		-0.244***	-0.224***
		(0.091)	(0.081)		(0.090)	(0.081)
ΔVertical (100 Others)		0.545	0.175		0.422	0.061
		(0.493)	(0.418)		(0.483)	(0.416)
ΔVertical (JV Others)		-0.072	0.075		-0.053	0.091
		(0.300)	(0.325)		(0.300)	(0.325)
Fixed Effects & Controls	Y	Y	Y	Y	Y	Y
R-squared	0.003	0.003	0.003	0.003	0.002	0.003
Number of Obs.	156,447	156,447	156,447	156,447	156,447	156,447
Hori. (JV Own) = Hori. (100 Own) (p-value)	0.03	-	0.04	0.02	-	0.03
Vert. (JV Own) = Vert. (100 Own) (p-value)	0.00	-	0.00	0.00	-	0.00
Hori. (JV Others) = Hori. (100 Others) (p-value)	-	0.19	0.51		0.20	0.51
Vert. (JV Others) = Vert. (100 Others) (p-value)	-	0.25	0.85		0.36	0.95

Notes:

a) The dependent variable is the first difference of the natural logarithm of firm total factor productivity. In columns (1) - (3), TFP measures are Solow Residuals. In Column (4) – (6), TFP are estimated by Olley-Pakes estimation procedure of a sector-specific Cobb-Douglas production function. See Section 2.9 for details.

b) All regressions include a constant, sector, province and year fixed effects; and controls of Δln(Imports) and ΔHerf10.

c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.

d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

e) The last two rows report the *p*-values of the tests for whether the coefficients on wholly and jointly-owned spillovers are the same.

f) Only domestic firms (with foreign equity share less than 10%) are included in the sample.

Table 2.11: Horizontal and Vertical Spillovers from Minority-owned and Majority-owned Foreign Affiliates

This table examines horizontal and vertical (backward) productivity spillovers to domestic firms from minority- and majority-owned foreign firms respectively. Majority-owned foreign affiliates are foreign firms with more than 50% of foreign equity. The remaining foreign affiliates are defined as minority-owned.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var.	ΔSolow	ΔSolow	ΔSolow	Δ_2Solow	ΔOlley-Pakes	ΔOlley-Pakes	ΔOlley-Pakes	Δ_2Olley-Pakes
Specification	No control	With controls	Lagged spillovers	Second Diff.	No control	With controls	Lagged spillovers	Second Diff.
ΔHorizontal (Majority)	-0.439***	-0.435***	0.009	-0.750***	-0.445***	-0.449***	-0.039	-0.801***
	(0.131)	(0.131)	(0.344)	(0.209)	(0.136)	(0.135)	(0.330)	(0.208)
ΔHorizontal (Minority)	-0.277**	-0.273*	0.068	-0.553***	-0.292**	-0.272*	0.013	-0.572***
	(0.132)	(0.155)	(0.189)	(0.201)	(0.126)	(0.150)	(0.168)	(0.193)
ΔVertical (Majority)	0.218	0.085	-0.375	-0.031	0.11	-0.003	-0.345	-0.07
	(0.405)	(0.385)	(0.602)	(0.900)	(0.401)	(0.384)	(0.567)	(0.869)
ΔVertical (Minority)	-0.303	-0.447	-0.971	-1.753*	-0.27	-0.376	-1.378	-1.764*
	(0.627)	(0.648)	(1.152)	(1.041)	(0.620)	(0.630)	(1.005)	(1.024)
Controls	No		Δln(Imports) + ΔHerf10		No		Δln(Imports) + ΔHerf10	
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.003	0.003	0.004	0.006	0.003	0.003	0.003	0.006
Number of Obs.	156,447	156,447	73,220	77,051	156,447	156,447	73,220	77,051
Horizontal Minority = Horizontal Majority (p-value)	0.35	0.42	0.82	0.51	0.37	0.37	0.83	0.43
Vertical Minority = Vertical Majority (p-value)	0.51	0.50	0.69	0.17	0.62	0.62	0.42	0.18

Notes:

a) The dependent variable is the first difference of the natural logarithm of firm total factor productivity. In columns (1) - (4), TFP measures are Solow Residuals. In columns (5) - (8), TFP are estimated by Olley-Pakes estimation procedure of a sector-specific Cobb-Douglas production function. See Section 2.9 for details.

b) All regressions include a constant, sector, province and year fixed effects.

c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.

d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

e) Only domestic firms (with less than 10% foreign equity) are included in the sample.

f) Columns (3) and (7) use lagged measures of spillovers.

g) The last two rows report the p-values of the tests for whether the coefficients on majority and minority-owned spillovers are the same.

Table 2.12: Horizontal and Vertical Spillovers from ethnic-Chinese and Non-Chinese Foreign Affiliates

This table examines horizontal and vertical (backward) productivity spillovers to domestic firms from Chinese-ethnic and non-Chinese foreign firms respectively. Chinese foreign affiliates are defined as firms with more than 50% equity owned by Hong Kong, Macau and/or Taiwan investors. Non-Chinese foreign affiliates are the rest of the foreign affiliates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var.	ΔSolow	ΔSolow	ΔSolow	Δ_2Solow	ΔOlley-Pakes	ΔOlley-Pakes	ΔOlley-Pakes	Δ_2Olley-Pakes
Specification	No control	With controls	Lagged spillovers	Second Diff.	No control	With controls	Lagged spillovers	Second Diff
ΔHorizontal (Chinese)	-0.424***	-0.428***	-0.198	-0.728***	-0.427***	-0.423***	-0.275	-0.768***
	(0.113)	(0.111)	(0.220)	(0.161)	(0.116)	(0.118)	(0.220)	(0.160)
ΔHorizontal (Non-Chinese)	-0.231	-0.213	0.286*	-0.431*	-0.280**	-0.269*	0.296*	-0.456*
	(0.145)	(0.153)	(0.157)	(0.253)	(0.136)	(0.145)	(0.155)	(0.246)
ΔVertical (Chinese)	-0.288	-0.368	-1.524**	-0.442	-0.337	-0.405	-1.581**	-0.469
	(0.380)	(0.380)	(0.612)	(0.711)	(0.385)	(0.388)	(0.626)	(0.681)
ΔVertical (Non-Chinese)	0.018	-0.121	1.252**	0.046	0.01	-0.076	0.875*	0.073
	(0.359)	(0.377)	(0.533)	(0.876)	(0.360)	(0.379)	(0.515)	(0.837)
Controls	No		Δln(Imports) + ΔHerf10		No		Δln(Imports) + ΔHerf10	
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.003	0.003	0.004	0.006	0.003	0.003	0.003	0.006
Number of Obs.	156,447	156,447	73,220	77,051	156,447	156,447	73,220	77,051
Horizontal (Chinese) = Horizontal (Non-Chinese) (p-value)	0.22	0.19	0.06	0.20	0.33	0.33	0.02	0.17
Vertical (Chinese) = Horizontal (Non-Chinese) (p-value)	0.25	0.36	0.00	0.21	0.19	0.24	0.01	0.17

Notes:

a) The dependent variable is the first difference of the natural logarithm of firm total factor productivity. In columns (1) - (4), TFP measures are Solow Residuals. In columns (5) - (8), TFP are estimated by Olley-Pakes estimation procedure of a sector-specific Cobb-Douglas production function. See Section 2.9 for details

b) All regressions include a constant, sector, province and year fixed effects.

c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses

d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

e) Only domestic firms (with foreign equity share less than 10%) are included in the sample

f) Columns (3) and (7) use lagged measures of spillovers

g) The last two rows report the *p*-values of the tests for whether the coefficients on ethnic-Chinese and non-Chinese spillovers are the same.

Table 2.13: Horizontal and Vertical Spillovers (Different Subsamples)

This table examines horizontal and vertical (backward) productivity spillovers to domestic firms from jointly- and wholly-owned foreign firms, respectively. Subsamples of state-owned /non-state-owned enterprises and exporters/ non-exporters are considered.

Dependent variable: $\Delta\ln(TFP_t) = \ln(TFP_t) - \ln(TFP_{t-1})$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	State-owned Enterprises		Non-state-owned		Export-oriented		Non-export-oriented	
TFP Measure	Solow Resid.	Olley-Pakes	Solow Resid.	Olley-Pakes	Solow Resid.	Olley-Pakes	Solow Resid.	Olley-Pakes
ΔHorizontal (100% owned)	-1.454***	-1.409***	-0.200	-0.193	-0.193	-0.105	-0.428	-0.450
	(0.456)	(0.465)	(0.268)	(0.256)	(0.256)	(0.565)	(0.341)	(0.348)
ΔHorizontal (Joint Ventures)	-0.718***	-0.687***	-0.146	-0.190*	-0.190*	0.029	-0.277**	-0.285**
	(0.165)	(0.172)	(0.098)	(0.097)	(0.097)	(0.223)	(0.128)	(0.126)
ΔVertical (100% owned)	-0.711	-0.419	-0.259	-0.511	-0.511	0.162	-0.562	-0.77
	(0.956)	(1.010)	(0.488)	(0.490)	(0.490)	(1.201)	(0.521)	(0.555)
ΔVertical (Joint Ventures)	0.209	-0.146	-0.184	-0.014	-0.014	0.472	-0.146	-0.198
	(0.767)	(0.837)	(0.373)	(0.338)	(0.338)	(0.694)	(0.479)	(0.496)
Fixed Effects and Controls	Yes							
R-squared	0.004	0.003	0.004	0.004	0.010	0.008	0.003	0.004
Number of Obs.	43,979	43,979	112,468	112,468	22,392	22,392	118,049	118,049
Horizontal JV = Horizontal 100 (p-value)	0.11	0.12	0.84	0.99	0.81	0.96	0.66	0.64
Vertical JV = Vertical 100 (p-value)	0.29	0.76	0.90	0.40	0.78	0.90	0.50	0.39

Notes:

(a) The dependent variables are the first differences of the natural logarithm of firm total factor productivity ($\ln(TFP_t) - \ln(TFP_{t-1})$). TFP measures are either Solow residuals or Olley-Pakes estimated TFP.
(b) All regressions include a constant, sector, province and year fixed effects.
(c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.
(d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
(e) The last two rows report the *p*-values of the tests for whether the coefficients on wholly and jointly-owned spillovers are the same.
(f) Only domestic firms (with less than 10% foreign equity) are included in the sample.
(g) State-owned enterprises are firms with at least 50% state-government equity.
(h) Export-oriented firms are firms that always export in all years in the sample.

Table 2.14: Horizontal and Vertical Spillovers (Different Subsamples Cont')

This table examines horizontal and vertical (backward) productivity spillovers to domestic firms from jointly- and wholly-owned foreign firms, respectively. Subsamples of coastal/ inland domestic enterprises and technology leaders/ technology laggards are considered.

Dependent variable: $\Delta\ln(TFP_t) = \ln(TFP_t) - \ln(TFP_{t-1})$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Coastal		Inland		Technology Leaders		Technology Laggards	
TFP Measure	Solow Resid.	Olley-Pakes	Solow Resid.	Olley-Pakes	Solow Resid.	Olley-Pakes	Solow Resid.	Olley-Pakes
ΔHorizontal (100% owned)	-0.369	-0.343	-0.847*	-0.872*	-0.055	-0.164	-0.890**	-0.934***
	(0.304)	(0.299)	(0.465)	(0.471)	(0.294)	(0.252)	(0.364)	(0.334)
ΔHorizontal (Joint Ventures)	-0.176	-0.209	-0.515***	-0.511***	-0.129	-0.179	-0.463***	-0.465***
	(0.125)	(0.126)	(0.191)	(0.186)	(0.140)	(0.123)	(0.155)	(0.142)
ΔVertical (100% owned)	-0.290	-0.416	-0.500	-0.604	0.144	-0.669	-0.905	-0.334
	(0.605)	(0.594)	(0.680)	(0.671)	(0.641)	(0.574)	(0.675)	(0.662)
ΔVertical (Joint Ventures)	0.632	0.763*	-0.899*	-1.068*	-0.579	-0.262	0.147	-0.096
	(0.481)	(0.456)	(0.535)	(0.548)	(0.484)	(0.404)	(0.600)	(0.582)
Fixed Effects & Controls	Yes							
R-squared	0.003	0.002	0.004	0.004	0.010	0.010	0.007	0.007
Number of Obs.	89,355	89,355	67,092	67,092	77,258	74,606	79,189	81,841
Horizontal JV = Horizontal 100 (p-value)	0.55	0.69	0.48	0.44	0.80	0.95	0.25	0.16
Vertical JV = Vertical 100 (p-value)	0.21	0.08	0.56	0.51	0.28	0.50	0.15	0.73

Notes.

(a) The dependent variables are the first differences of the natural logarithm of firm total factor productivity ($\ln(TFP_t) - \ln(TFP_{t-1})$). TFP is either Solow residuals or Olley-Pakes estimated.
(b) All regressions include a constant, sector, province and year fixed effects.
(c) Standard errors, corrected for clustering at the sector-year level, are reported in parentheses.
(d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
(e) The last two rows report the p-values of the tests for whether the coefficients on wholly and jointly-owned spillovers are the same.
(f) Only domestic firms (with less than 10% foreign equity) are included in the sample.
(g) Coastal provinces include Fujian, Guangdong, Hainan, Heilongjiang, Jiangsu, Jilin, Liaoning, Shandong, Shanghai, Tianjin and Zhejiang.
(h) Technology leaders are firms with TFP in the top 50th percentile.

Table 2.15: Sectoral Productivity Growth and Spillovers

Dependent variable: $\Delta ln(TFP_t) = ln(TFP_t) - ln(TFP_{t-1})$						
	(1)	(2)	(3)	(4)	(5)	(6)
TFP Measures	Solow	Solow	Solow	Olley-Pakes	Olley-Pakes	Olley-Pakes
ΔHorizontal	1.488	1.464	1.648	1.655**	1.630**	1.926
	(0.902)	(0.901)	(1.391)	(0.715)	(0.708)	(1.256)
ΔVertical		1.488	1.906		1.519	2.128*
		(1.089)	(1.711)		(1.084)	(1.190)
Δln(Imports)			0.029			-0.008
			(0.216)			(0.143)
ΔHerf10			-1.865			0.639
			(1.641)			(2.183)
Sector Fixed Effects	N	N	Y	N	N	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
R-squared	0.206	0.218	0.325	0.228	0.241	0.404
Number of Obs.	66	66	66	66	66	66

Notes:

(a) The dependent variables are the first differences of the natural logarithm of the sectoral weighted average of firm total factor productivity.

(b) All regressions include a constant and year fixed effects.

(c) Robust standard errors are reported in parentheses.

(d) ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Appendix Tables

Table A2.1: Olley-Pakes Estimated Input Elasticities by Sector

ISIC	Sector	Labor		Capital		
		Estimate	Std. Dev	Estimate	Std. Dev	Sum
15	Food products and beverages	0.522	(0.014)	0.365	(0.029)	0.887
16	Tobacco products	0.530	(0.104)	0.595	(0.017)	1.125
17	Textiles	0.370	(0.011)	0.333	(0.024)	0.703
18	Wearing apparel	0.525	(0.018)	0.428	(0.037)	0.953
19	Tanning, dressing leather	0.434	(0.017)	0.274	(0.046)	0.708
20	wood and wood products	0.537	(0.023)	0.195	(0.043)	0.732
21	Paper and paper products	0.360	(0.020)	0.323	(0.045)	0.683
22	Publishing, printing and reproduction recorded media	0.388	(0.028)	0.392	(0.066)	0.780
23	Coke, refined petroleum products and nuclear fuel	0.296	(0.039)	0.235	(0.072)	0.531
24	Chemicals and chemical products	0.299	(0.012)	0.409	(0.024)	0.708
25	Rubber and plastics products	0.431	(0.016)	0.412	(0.041)	0.843
26	Other non-metallic mineral products	0.415	(0.011)	0.288	(0.022)	0.703
27	Basic metals	0.312	(0.020)	0.269	(0.045)	0.581
28	Fabricated metal products, except machinery and equipment	0.391	(0.016)	0.361	(0.032)	0.752
29	Machinery and equipment n.e.c.	0.392	(0.014)	0.537	(0.023)	0.929
30	Office, accounting and computing machinery	0.368	(0.071)	0.366	(0.126)	0.734
31	Electrical machinery and apparatus n.e.c.	0.323	(0.017)	0.436	(0.040)	0.759
32	Radio, television and communication equipment	0.405	(0.027)	0.536	(0.041)	0.941
33	Medical, precision and optical instruments, watches and clocks	0.355	(0.036)	0.369	(0.054)	0.724
34	Motor vehicles, trailers and semi-trailers	0.327	(0.027)	0.432	(0.057)	0.759
35	Other transport equipment	0.353	(0.027)	0.494	(0.058)	0.847
36	Furniture; manufacturing n.e.c.	0.541	(0.017)	0.293	(0.038)	0.834

Note: All estimated input elasticities are significant at the 1% significance levels

Table A2.2: Spillover Measures by Sector

ISIC	Sector	Horizontal		Horizontal (100% owned)		Vertical		Vertical (100% owned)	
		Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
15	Food products and beverages	0.323	0.009	0.081	0.017	0.304	0.013	0.105	0.019
16	Tobacco products	0.004	0.001	0.000	0.000	0.304	0.013	0.105	0.019
17	Textiles	0.274	0.007	0.074	0.010	0.399	0.029	0.174	0.026
18	Wearing apparel	0.543	0.022	0.215	0.029	0.399	0.029	0.174	0.026
19	Tanning, dressing leather	0.589	0.020	0.335	0.036	0.399	0.029	0.174	0.026
20	wood and wood products	0.351	0.034	0.122	0.012	0.477	0.030	0.261	0.027
21	Paper and paper products	0.308	0.041	0.087	0.015	0.281	0.021	0.101	0.020
22	Publishing, printing and reproduction recorded media	0.323	0.012	0.093	0.020	0.281	0.021	0.101	0.020
23	Coke, refined petroleum products and nuclear fuel	0.192	0.106	0.021	0.015	0.240	0.028	0.059	0.016
24	Chemicals and chemical products	0.284	0.037	0.049	0.023	0.363	0.023	0.144	0.025
25	Rubber and plastics products	0.448	0.032	0.193	0.041	0.341	0.032	0.107	0.021
26	Other non-metallic mineral products	0.193	0.028	0.054	0.022	0.296	0.031	0.092	0.018
27	Basic metals	0.106	0.014	0.008	0.002	0.333	0.036	0.108	0.023
28	Fabricated metal products, except machinery and equipment	0.307	0.024	0.130	0.024	0.331	0.028	0.102	0.020
29	Machinery and equipment n.e.c.	0.312	0.047	0.061	0.024	0.291	0.027	0.084	0.016
30	Office, accounting and computing machinery	0.800	0.029	0.539	0.082	0.370	0.035	0.109	0.015
31	Electrical machinery and apparatus n.e.c.	0.349	0.042	0.117	0.028	0.487	0.020	0.201	0.022
32	Radio, television and communication equipment	0.690	0.045	0.208	0.030	0.402	0.024	0.177	0.030
33	Medical, precision and optical instruments, watches and clocks	0.489	0.024	0.219	0.019	0.307	0.036	0.085	0.019
34	Motor vehicles, trailers and semi-trailers	0.482	0.129	0.042	0.013	0.283	0.031	0.077	0.019
35	Other transport equipment	0.266	0.010	0.056	0.012	0.310	0.037	0.067	0.019
36	Furniture; manufacturing n.e.c.	0.524	0.033	0.309	0.030	0.253	0.023	0.072	0.015

Table A2.3: Correlation Matrix of Explanatory Variables of Interest

	ΔHorizontal	ΔHorizontal (JV)	ΔHorizontal (100)	ΔVertical	ΔVertical (JV)	ΔVertical (100)	Δln(Imports)	Δherf10
ΔHorizontal (JV)	0.8655	1						
ΔHorizontal (100)	-0.0297	-0.5264	1					
ΔVertical	0.0457	0.0219	0.0338	1				
ΔVertical (JV)	0.0204	-0.0760	0.1862	0.7951	1			
ΔVertical (100)	0.0437	0.1479	-0.2210	0.4402	-0.1946	1		
Δln(Imports)	0.0569	-0.0127	0.1219	-0.0354	0.0178	-0.0835	1	
Δherf10	0.1389	0.2391	-0.2413	0.0041	-0.152	0.2316	0.2307	1

Chapter 3

Political Ideology and Trade Policy: A Cross-country, Cross-industry Analysis

3.1 Introduction

There exists a vast literature on how bipartisan politics affects macroeconomic policies.[1] However, few have studied its impact on trade policies. While empirical studies have examined the relationship between government political ideology and the level of trade protection across countries, to my knowledge, no attempt has been made to investigate how it can shape the structure of trade protection across industries. This paper aims at providing evidence on the relationship between government political ideology and trade protection across sectors. Specifically, I show that left-wing (pro-labor) governments are associated with higher trade barriers in labor-intensive sectors than right-wing (pro-capital) governments, which are associated with relatively higher trade protection in capital- and human-capital intensive sectors.

I take the consensual view that left-wing governments adopt pro-labor stance on policies,

[1]Among these studies, Hibbs (1987), Alesina (1987, 1988), and Roubini and Sachs (1989) find that left-wing parties prefer to undertake expansionary fiscal policies to induce growth, while right-wing parties favor policies that maintain lower spending, lower inflation and balanced budgets.

while right-wing governments adopt pro-capital stance.[2] I consider an open economy with three factors of production – labor, capital and human capital. With free trade, the returns to factors are determined by a country's relative factor endowment, and its structure of trade with the rest of the world. Specifically, according to the Stolper-Samuelson theorem, the real return to a factor decreases when the sector using this factor intensively contracts due to import competition. Therefore, among the importing sectors of a country, a left-wing government, because of its pro-labor stance, would enact relatively higher trade barriers in labor-intensive sectors to enhance the terms of trade favorable for low-skilled workers. On the other hand, a right-wing government, because of its pro-capital stance, would set relatively higher trade barriers in capital- and human-capital intensive sectors, to protect the interests of their constituents.[3]

I test these predictions using a data set of trade barriers and government political ideology for 49 countries and 27 industries in the late 90s. By regressing a country's non-tariff barriers by sector on interaction terms between a government's indicator of ideology and sector measures of factor intensities, I find strong evidence supporting my hypothesis. Specifically, I find that right-wing governments are associated with higher non-tariff barriers in capital- and human-capital intensive sectors, while left-wing governments are associated with higher non-tariff barriers in labor-intensive ones. These sectoral biases on trade protection are particularly pronounced in rich and capital-abundant countries. Moreover, consistent with these findings, I find that right-wing governments are associated with lower tariffs in low-wage and high job-turnover sectors. All these results are robust to controlling for a sector's import penetration and export-output ratios, as well as country and industry fixed effects. They are also robust to the inclusion of the controls for existing theories on the political economy of trade policy. Furthermore, to my knowledge, this paper is the first attempt examining the determinants of trade protection across sectors for a large sample of countries in the 90s.[4]

[2]This approach was adopted, among others, by Blanchard (1985) and Alesina (1987) in developing models of monetary policy in a two-party political system, with the left-wing policy makers attaching a higher weight to unemployment relative to inflation. Alesina and Sachs (1988) find empirical evidence consistent with the predictions of the rational partisan model using U.S. data. Subsequently, Alesina and Roubini (1992) find empirical support using OECD data.

[3]Following Alesina and Rodrik (1991), I consider that a pro-capital stance generally favors owners of all sort of growth-producing assets, including physical capital, human capital, and proprietary technology. Pro-labor policies, on the other hand, favor the unskilled workers.

[4]Lee and Swagel (1997) use a cross-country, cross-sector data set to test several political economy theories of trade policy. Their data set is for the late 80s.

This paper is organized as follows. The next section reviews the related literature. Section 3.3 outlines the theoretical argument of the paper. Section 3.4 formalizes the empirical strategy. Section 3.5 describes the data set used in the empirical analysis. Section 3.6 presents the empirical results and the final section concludes.

3.2 Literature Review

There is a vast literature on the political economy of trade policy.[5] Over the past twenty years, the theoretical literature on endogenous trade protection has taken two diverging paths from the early literature, with one focusing on special interest politics among factor owners across sectors (sectoral lines), the other emphasizing majority voting by voters from different classes (class-cleavage). The seminal "Protection for Sale" model by Grossman and Helpman (1994) belongs to the literature along the sectoral lines. Thanks to their contribution of providing micro-founded structural equations of the level of sector-specific trade protection, most of the recent empirical studies of trade policy have taken a more "structural" route.[6] However, because of the requirement of detailed sector-level data, these empirical studies have mainly focused on a few developed countries. An exception is the study by Mitra, Thomaskos and Ulubasoglu (2002), who find evidence supporting the Grossman-Helpman (1994) model using industry data from Turkey.

The other path of the theoretical literature on trade policy emphasizes the role of class cleavage. Based on the Heckscher-Ohlin framework, the seminal work by Rogowski (1990) associates parties with factors of production, and argues that if a country is relatively abundant with land and capital, the left-wing party would favor trade protection while the right-wing party would vote for freer trade. Therefore, in a bipartisan political system, a government adopts different stances on trade policies depending on which party is in control. This sharp prediction remains untested until recently by a series of papers by Dutt and Mitra (2002, 2005, 2006). Based on a cross-country sample in the 80s, Dutt and Mitra find a U-shaped relationship

[5]Readers are referred Rodrik (1995) of a review on the theoretical literature, and Gawande and Krishna (2003) for a review on the empirical one.

[6]The early empirical studies testing the Grossman-Helpman (1994) model include Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000). Both of them find support for the model using industry data from the U.S.

between governments' left-orientation and countries' levels of trade protection. Specifically, they show that left-wing governments in labor-abundant countries are associated with lower trade barriers than right-wing governments. However, when a country's capital endowment increases, more imports become labor-intensive, and a leftist government will become more protective than a rightist government. My paper is closely related to Dutt and Mitra (2002, 2005, 2006). I extend their cross-country framework for testing the class-cleavage theory to one along the sectoral lines, and examine whether government political ideology shapes the structure of trade protection across sectors.

Because of the dichotomy of the literature on endogenous trade policy, to date, most empirical studies on trade protection use either single-country cross-industry data (empirical studies on specific-factor models), or cross-country aggregate data (empirical studies on class-cleavage models). An exception is Lee and Swagel (1997), who test various early theoretical predictions on trade protection, using a cross-country, cross-industry data set of trade barriers and production in the 80s. I also use a data set with a similar structure, but my goal is to examine whether the predictions of the class-cleavage theory, which have so far been verified at the country level, are observed along the sectoral lines. Another difference between my work and theirs is that this paper uses data from the late 90s, and therefore, presents updated findings for the early theoretical predictions.

3.3 Theoretical Argument

I now outline the theoretical argument underlying the empirical analysis. Consider a two-factor, two-sector small-open economy with intra-industry trade.[7] Factors are free to move across sectors, but not across countries. In each sector, there are many firms producing and selling varieties in monopolistically competitive markets. All varieties in the same sector are produced using the same constant returns to scale production technology, with labor and capital as inputs. There are fixed costs of entry such that free entry drives all firms' profits to zero,

[7] I assume intra-industry trade so that a country imports in all sectors. Thus, any sector-specific trade protection will affect the relative returns to factors. This assumption is not restrictive for my empirical analyses, because the industry data I use are disaggregated at a 2-digit level with 27 industries. With such a low level of disaggregation, most countries import in all sectors.

despite imperfect competition in the goods market.[8] The two sectors differ in factor intensity of production. For simplicity, I assume Cobb-Douglas production functions, with a higher exponent associated with labor input in production in the labor-intensive sector, and vice versa for the capital-intensive one. On the demand side, consumers have two-level Dixit-Stiglitz preferences, with the higher level being a CES aggregate of consumption of goods across sectors, and the lower level for consumption of all available varieties within each sector.

I assume that there are two kinds of factor owners, capitalists who own capital, and workers who own labor. A government can set different tariffs across sectors to gain support from its constituents, either capitalists or workers. Tariff revenue are distributed back to factor owners proportional to their factor incomes. On a unidimensional left-right ideological scale, a left-wing government holds pro-labor stance and prefers to protect the interests of workers rather than capitalists. A right-wing government prefers the opposite. With partial specialization due to monopolistic competition, a country imports all varieties from the rest of the world. When a government sets higher tariffs in the labor-intensive sector, domestic firms in that sector will make higher revenue because of less import competition. Therefore, the labor-intensive sector expands. By the Stolper-Samuelson theorem, the real return to labor increases. Through this channel, a left-wing government would set higher trade barriers in the labor-intensive sector to protect the interests of workers. Based on a similar argument, a right-wing government would enact relatively higher trade barriers in the capital-intensive sector.

This theoretical argument can be generalized to a three factor model, with human capital (skilled workers) being the new factor. If I consider that a pro-capital stance generally favors owners of all sort of growth-producing assets, including physical capital and human capital, while a pro-labor stance favors the unskilled workers,[9] the new factor, human capital, can be combined with physical capital to be considered as a single "capital" input. As such, the above theoretical argument based on a two-factor model is still valid, and is summarized by the following hypothesis.

Hypothesis All else being equal, left-wing (pro-labor) governments have relatively higher trade barriers in labor-intensive sectors, and relatively lower barriers in capital and human-

[8]This free-entry condition also pins down the number of firms.

[9]See Alesina and Rodrik (1991) for an argument.

capital intensive sectors, compared to right-wing (pro-capital) governments.

To reiterate the hypothesis more formally, suppose that a country has multiple industries, which are indexed by j, with higher j corresponding to higher labor intensity. Let TB_j^L and TB_j^R be the trade barrier in sector j set by a left and a right government, respectively. The hypothesis says that $\frac{TB_j^L}{TB_j^R}$ is increasing in j.

3.4 Empirical Strategy

3.4.1 Regression Specification

I test the main hypothesis of the paper using the following specification:

$$
\begin{aligned}
\ln(1+NTB_{cj}^*) &= \alpha + \beta_1 Left_c \times k\_int_j + \beta_2 Left_c \times h\_int_j \\
&\quad + \mathbf{X_j}\gamma + f_c + f_j + \epsilon_{cj} \\
\text{where } NTB_{cj} &= \begin{Bmatrix} NTB_{cj}^* \text{ if } NTB_{cj}^* > 0 \\ 0 \text{ otherwise.} \end{Bmatrix}
\end{aligned}
\tag{3.1}
$$

where c and j stand for country and sector, respectively. α is a constant, and $f's$ are fixed effects.

The dependent variable is the natural logarithm of one plus the coverage ratio of non-tariff barrier (NTB) (to be discussed in Section 3.5). I use NTB as the dependent variable, instead of the tariff level because tariffs have been falling and remained bounded by the World Trade Organization (WTO) requirements across countries, especially in the late 90s when many more countries joined the WTO. In this situation, NTBs have become a more important instrument for governments to protect trade. Supporting this claim, Table 3.2 shows that in the 90s, the average standard deviation of NTBs across countries within the same sector is 11.77%, while that for tariffs is only 1.95%. Furthermore, according to Goldberg and Maggi (1999), tariff levels are often determined cooperatively by governments in regional trade agreements and the WTO (the GATT before 1995). Related to the present discussion, cooperative efforts by governments in tariff formation restrict a government from using tariffs to reflect its political stance. For these reasons, NTB has been the main dependent variable used in the existing literature examining trade protection across sectors.[10] Thus, instead of using a sector's tariff level as the dependent variable, I use it as a control.

I use log value of $1 + NTB$, instead of its level, to avoid results driven by outliers. Using the level of NTB as the dependent variable yields qualitatively similar and significant results. Similarly, log values are used for non-dummy independent variables.[11] In addition, the measure of NTB is a non-negative left-censored limited variable. The non-linearity at $NTB = 0$ requires one to estimate equation (3.1) using a Tobit model.[12]

The explanatory variables of interest are two interaction terms between a government's ideology and a sector's factor intensities, $Left_c \times k\_int_j$ and $Left_c \times h\_int_j$, where k_int_j and h_int_j stand for capital and human-capital intensity of sector j, respectively. With a dichotomous classification of political ideology ("Left" or "Right"), $Left$ is a dummy variable, which equals 1 for a country with a left-wing government in control during the sample period (to be discussed in section 3.5), and equals 0 for a country with a right-wing government. If I add a category for governments holding a neutral political stance, ("Left", "Center" or "Right"), then a country with $Left = 1$ has a left-wing government in control, while those with $Left = 0$ can either have centrist or right-wing governments.

Based on the assumption of constant returns to scale production discussed in Section 3.3, factor intensities of a sector are measured as the average cost shares of corresponding inputs in total value-added of the sector (to be discussed in Section 3.5). Factor intensities (k_int_j and h_int_j) of a sector are assumed to the same across countries. In other words, I treat factor intensities of production as intrinsic properties of production, which do not vary across countries. I obtain these measures based on data from U.S. manufacturing sectors, because of the lack of sectoral production data for a large sample of countries. The assumption of constant factor intensities across countries have been adopted by many recent empirical studies in international trade.[13] Only a weak form of the assumption is needed to hold in the data.

[10]For instance, Trefler (1993) investigates the negative impact of NTBs on imports. Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000) use NTB as their dependent variables to test the Grossman-Helpman (1994) model, which essentially provides analytical solutions to sector-specific ad valorem tariffs.

[11]Lee and Swagel (1997) also use a log functional form for estimation, with $\ln(1 + NTB)$ of a sector as the dependent variable.

[12]For instance, when import penetration is 0 (rarely happens in the data set I am using with such a low-level of disaggregated), NTBs are constrained to be 0.

[13]The approach of using sector measures constructed using U.S. data originates from Rajan and Zingales

Specifically, as long as the sectoral ranking of factor intensities across countries is stable, the proposed effects of this paper can still be identified.[14] Finally, with three factors of production, the condition of constant returns to scale implies $k\_int_j + h\_int_j = 1 - l\_int_j$. As such, the interaction term with l_int_j is excluded from the regressions because of perfect collinearity, unless specified otherwise.

The main hypothesis of this paper predicts a negative coefficient on $Left_c \times k\_int_j$, i.e. $\beta_1 < 0$. A negative β_1 means that all else being equal, a left-wing government has relatively lower NTBs in capital-intensive sectors than a right-wing government. The coefficient on $Left_c \times h\_int_j$, β_2, is also predicted to be negative. Notice that stand-alone factor intensities, k_int_j and h_int_j, are not included as independent variables because they are subsumed in sector fixed effects, f_j. Similarly, the stand-alone term $Left_c$ is excluded as a regressor.[15]

To confirm that my results are not driven by other determinants of trade protection, I include a vector of control variables for the existing theories on trade policy, $\mathbf{X_j}$, suggested by Lee and Swagel (1997). These controls will be discussed in detail in Section 3.6.2.

3.5 Data

Data on tariff and non-tariff barriers (NTB) are obtained from UNCTAD indirectly through the World Bank's "Trade, Protection and Production" data set (Nicita and Olarreaga, 2006). It contains data on production and trade protection for 27 industries (ISIC (Rev. 2) 3-digit sectors), and 74 countries in the late 90s. The measure of NTB of a sector is the percentage of imports subjected to non-tariff measures that have an unfair protection impact. Core non-tariff measures used to construct the NTB measures are (i) price controls, (ii) finance controls, and (iii) quantity controls. To check the robustness of the regression results, I use an alternative

(1998). In their study of the differential impacts of countries' financial development on sectoral growth, they use sector measures of dependence on external finance, which are constructed using data of U.S. publicly-listed firms. Subsequent empirical studies on countries' comparative advantage have adopted the same approach. See Romalis (2003), Levchenko (2007), Nunn (2007) and Manova (2007), among others.

[14]However, if there exists factor intensity reversal across countries, the identification assumption does not hold, and the regression results could be wrong. Readers should interpret the empirical findings in the paper with this caveat in mind.

[15]Alternatively, I can use $Left_c \times l\_int_j$ as the explanatory variable of interest, where l_int_j stands for labor intensity. The coefficient is predicted to be positive. I include two interaction terms so that I can study the impact of political ideology on trade protection in skill-intensive sectors, which has been largely ignored in previous empirical literature.

measure of NTB, which is the percentage of tariff lines (at the HS 6-digit level) that are subjected to non-tariff measures of protection. Similarly, the measure of tariffs in each sector is an import-weighted average of tariff rates applied on goods entering the country.[16] For each country, data on NTBs are only available for one year in the 90s (mostly in 1999), while tariff data can be available for multiple years. As such, I take tariff data from the year closest to the year from which NTB data are taken. Table 3.1 lists the aggregate measures of trade protection of the countries in the sample, and from which year the measures are taken. Table 3.2 lists the averages of trade protection for a cross-section of industries. Data on wages, employment, output, value-added, imports, and exports at the sector level are also taken from the same data set.

Data for government ideology are adopted from the Database of Political Institutions (DPI) (Beck et al., 2001). Following Dutt and Mitra (2005, 2006), I use the ideological orientation indicator ("Left", "Center" and "Right") of the chief executive (that of the chief executive's party) to represent the government ideology for countries with political systems classified as presidential. For countries with political systems classified as parliamentary, I use the ideology indicator of the largest government party; and for those with political systems classified as assembly-elected presidential, I use the average of the ideologies between the chief executive and the largest government party. Then I use the following procedure to denote the ideology of the government. For each country, I record the time series of ideology of the government in the 10 years preceding the year from which I take the NTB data (including the year itself). A country is coded as left-wing (center, right-wing) if a left-wing (center, right-wing) government has been in office for at least 6 years during the 10-year period. A country that has left and right governments in office for exactly 5 years respectively will be coded as center. These include Brazil, Finland, Lithuania, Netherlands, Poland and South Africa. Bolivia and Ukraine had a left and a right government in office for exactly 4 years, and a center government for 2 years. They are also coded as center. To check robustness of the empirical results, I also construct an indicator of government political ideology based a 5-year horizon before the year from which the NTB data are taken. A country is coded as left-wing (center, right-wing) if a left (center,

[16]Applied rates take into account the available data for preferential schemes (i.e. the applied average tariff takes the tariff rates for each partner exporting to the destination country for which the measure is constructed.)

right-wing) government has been in the office for at least 3 years. Other rules used in the construction of the baseline ideology indicator are applied here. Table 3.1 shows the list of countries in the sample along with their government ideology and political systems.

The measures for factor intensities are constructed based on a panel data set of US manufacturing sectors (456 of them at the 4-digit SIC level) from Bartelsman and Gray's (1996). I use a 3-factor constant returns to scale production function (labor, capital, human-capital) to construct my three measures of factor intensities. Capital intensity (k_int) is 1 minus the share of total payroll in value added. Human-capital intensity (h_int) is the ratio of non-production worker payroll to value added. With constant returns to scale in production, labor intensity, l_int takes the residual of value added, which equals $1 - h\_int - k\_int$. Due to perfect collinearity of the three factor intensity measures, l_int is always excluded from the regressions, unless specified otherwise. The original industry data are disaggregated at the 4-digit SIC level. For each 4-digit category, I first calculate the averages of the intensity measures over 1990-1996, the last year from which data are available. Using a publicly available concordance file in Feenstra's (2000), I map each SIC category uniquely to an ISIC category.[17] Then the average of factor intensity measures across all 4-digit categories within the same ISIC category is used as the measure for that ISIC sector.[18] I also consider a 4-sector production function with materials as an additional input of production. Material intensity (m_int) is defined as the ratio of material costs to the sum of value added and material costs. Measures of labor, capital and human capital intensities corresponding to a 4-factor production function are obtained by multiplying the corresponding intensity measures derived from a 3-factor production function by $1 - m\_int$.

In the following empirical analysis, I also use countries' indices of democracy, measures of factor endowment and real GDP per capita. I adopt a country's democracy index from the Freedom House (Gastil) database. The original indices of democracy range from 1 to 7, with a higher value associated with a lower degree of democracy. I rescale the index to range between 0 and 1, with a higher value associated with more democracy. Data on countries' physical capital endowment are adopted from Caselli and Feyrer (2007). Physical capital is constructed using

[17]The mapping rule requires that an ISIC category chosen to be mapped to a SIC sector has to be the one that shares the most HS product lines with that SIC sector among all ISIC categories.

[18]Alternatively, I can use the median of the intensity measures at the 4-digit SIC level as my ISIC measure. The piecewise correlation between the measure using the mean and that using the median is about 0.98.

the perpetual inventory method using times-series data on real investment. Data on countries' per capita human capital are adopted from Caselli (2005), which is defined as the average years of schooling with Mincerian non-linear returns to education. Finally, I take data on real GDP per capita from the Penn World data set by Summers and Heston (2006). While endowment measures are available for the year 1996, data on democracy and GDP are available for every year. For time-series data, I compute their averages over the 10 years preceding the year from which NTB data are taken.

3.6 Results

3.6.1 Baseline

To test the hypothesis of the paper that left-wing governments are associated with lower trade protection in capital and human-capital intensive sectors than right-wing ones, I regress a sector's measure of non-tariff barriers (NTBs) in each country on interactions between the country's ideology and capital and human–labor intensities of the sector, respectively.[19] As discussed in section 3.5, the core NTB measure is the share of imports within a sector that are subjected to non-tariff protective measures by the government. As a first pass, I use a dummy variable, $Left$, which equals 1 for left-wing governments, and 0 for centrist and right-wing governments, as the measure of ideology. Therefore, the coefficients on the interaction terms are interpreted as differential impact of factor intensities on NTBs between the left and the non-left governments.

As reported in column (1) of Table 3.3, the coefficient on the interaction between the "left" dummy and capital intensity of a sector is negative and significant at the 5% significance level. Similarly, a negative and significant coefficient (also at 5% significance level) is found on the interaction term for human-capital intensity. These results suggest that compared to countries with centrist and right-wing governments in control, left-wing governments tend to have lower NTBs in both capital- and human-capital intensive sectors. The stand-alone terms for government ideology and sector factor intensities are not included, as they are subsumed in

[19]Labor intensity is excluded because of perfectly collinearity with the other two factor intensities by construction.

country and sector fixed effects.

In column (2), in addition to the interaction terms for "left" orientation, I include interactions between the dummy for "centrist" governments and capital and human-capital intensities of a sector, respectively. The coefficients on the "center" interactions are negative and significant at the 10% significance level, suggesting that relative to right-wing governments, centrist governments also appear to command lower NTBs in capital- and human-capital intensive sectors. The coefficients on the interaction terms for left-wing governments continue to be negative and significant. These results imply that leftist and centrist governments adopt political stances on trade protection different from right-wing governments along the sectoral dimension under study. Importantly, for a given factor intensity measure, the coefficients on the interaction terms between leftist and centrist governments are not statistically different. In other words, I find no evidence showing that leftist and centrist governments set NTBs differently across sectors, suggesting that I should treat them together as a group on the ideology scale regarding trade policy. As such, in order to gain efficiency, in the remaining regressions, I include only the interaction terms for right-wing governments. In short, in the following empirical analyses, I will compare the structure of trade protection across sectors between right-wing and non-right-wing governments.

With only interactions with the right-wing dummy included, column (3) reports positive and significant (at 1% significance level) coefficients on the interaction terms, implying that countries with dominating control by right-wing governments throughout the 90s are associated with higher NTBs in capital and human-capital intensive sectors in the late 90s.

In column (4), I drop country fixed effects, and include the stand-alone dummy for right-wing governments, and its interactions with the two factor intensity measures. First, I find that right-wing governments tend to have lower NTBs across all sectors on average. This is consistent with the findings by Milner and Judkins (2004), who show that right-wing parties on average announced positions more favorable for free trade in their electoral manifestos than left parties in OECD countries between 1945 and 1998. Consistently, by regressing a country's weighted average of NTBs on its ideology index, Dutt and Mitra (2005) find a positive relationship between a government's left-orientation and trade protection in capital-rich countries. Importantly, the coefficients on the two "right" interaction terms remain significant, and are quantitatively similar to those in column (3) when country fixed effects are controlled for. The McFadden's adjusted R-squared is 0.18, compared to 0.49 in column (3) when country fixed effects are included. This comparison suggests that country characteristics alone account for a substantial variation of NTBs across countries and sectors.

Finally, column (5) reports the regression results with sector fixed effects excluded, but country fixed effects added back as regressors. Without sector fixed effects, I include a sector's capital and human-capital intensities as independent variables. The positive and significant coefficients on the interaction terms confirm that right-wing governments tend to protect capital and human-capital intensive sectors. Furthermore, coefficients on the two stand-alone terms of factor intensities are both negative and significant, suggesting that labor-intensive sectors receive relatively more protection in all countries. These results support the prediction of the equity theory, which emphasizes governments' objective of redistributing income. A relatively higher adjusted R-squared compared to the one in column (4) when country fixed effects are excluded implies that country characteristics alone explain more of the variation of NTBs than sector characteristics.

I conduct two robustness checks for the baseline results. First, I use the political ideology of the dominating party (for example, political ideology of the president in a country under presidential system, as described in Section 3.5) in the 5 years before NTBs were set, instead of 10 years used to construct the baseline measure. Using this indicator of political ideology in the regressions, I implicitly assume that NTBs were determined by the government in a relatively short run. In Table 3.4, I conduct the analogous empirical analyses of Table 3.3, using the new indicator of political ideology. I find that the coefficients on the interaction terms have the same signs as the corresponding ones in Table 3.3, with comparable magnitude. Importantly, besides the interaction terms for centrist governments, all coefficients on the interaction terms remain statistically significant (at least 10% significance level). In column (4) with country fixed effects excluded, the coefficients on the interaction terms become less statistically significant compared to the corresponding ones in Table 3.3. In column (5) when sector fixed effects are excluded, the coefficients on the interactions also become less significant. It is important to note that country fixed effects account for a substantial variation in NTBs across countries. Thus, the significant results from columns (1) through (3) in Table 3.4, when country fixed effects are controlled for, confirm that the convincing findings in Table 3.3 are insensitive to the choice of the time horizon used to construct the ideology indicator.

Second, I use an alternative NTB measure, which is the fraction of Harmonized-System 6-digit categories within an ISIC sector that are subjected to non-tariff protective measures, as the dependent variable. As reported in Table 3.5, the results remain qualitatively the same. In sum, from Tables 3.3 through 3.5, I find strong evidence showing that government ideology has a significant impact on the structure of NTBs across sectors, with sectoral factor intensities in production playing a pivotal role in shaping the cross-industry variation. These findings survive the inclusion of country and sector fixed effects.

3.6.2 Controlling for Existing Hypotheses

The early literature on political economy of trade policy proposes various sector characteristics that affect the level of trade protection. Table 3.6 reports the results of the regressions of import-weighted NTB (as in Table 3.3) on the variables of interest, as well as a number of controls for existing hypotheses on trade protection.

First, it was suggested that large sectors are more able to lobby for trade protection, either because these sectors employ a large fraction of the electorate (Caves, 1976), or serve as an important source of government revenue. Thus, in column (1), I include a sector's employment share as a control for political importance. This is of course an imperfect measure.[20] For instance, one can argue that a small sector occupied by mostly state-owned enterprises in a given country may have more political power than a larger sector. In addition, it is possible that firms in smaller industries find it easier to organize political action groups to lobby for protection. A recent study by Bombardini (2008) shows that sectors with high firm size dispersion receive a higher level of trade protection in the U.S. Her findings are consistent with the seminal work by Olson (1965), who argues that bigger firms are less concerned about free-riding and find it more economically viable to take political actions. Nevertheless, using the size of a sector to proxy for political importance seems to be the best measure I can obtain in a cross-country, cross-industry data set.

[20] Recent empirical studies on U.S. trade policy have used more direct measures, such as an industry's political contribution or fraction of workers belonging to unions to proxy for political importance (Goldberg and Maggi, 1999; Gawande and Bandyopadhyay, 2000).

As reported in column (1) of Table 3.6, I find a negative and significant coefficient on the employment share in the country. suggesting that larger sectors receive less trade protection. This result is consistent with the conjecture that free-riding among firms can be more severe in large sectors, in which political actions are less likely to be taken to lobby for protection. Nevertheless, with uncertainty about whether the size of a sector actually represents political power, readers should interpret this result with caution.

Second, governments sometimes adopt trade policy to enforce equity and social justice. Existing studies find that in developed countries, low-wage and low-productivity sectors ("weak" sectors) are associated with more trade protection (Baldwin, 1985; Lee and Swagel, 1997). To capture these determinants of trade protection across sectors, I also include in column (1) a sector's 10-year average of wages as a control. From the sample of countries in the late 90s, I find no significant coefficient on the wage term to support the equity theory.

Third, the literature of interest group models (Findlay and Wellisz, 1982; Hillman, 1982, Grossman and Helpman, 1994) predicts that a sector's import penetration and export propensity are important determinants of trade protection. Specifically, these models predict that sectors with a larger share of exported output receive more trade protection. The opposite is true for sectors with higher import penetration. On the contrary, early theories on political economy of trade policy argue that sectors that are more threatened by import competition would lobby harder for protection, with the exporting sectors less concerned about "retaliating" imports.[21] Without any prior about which prediction holds true in reality, I include a sector's average (over 10 years) of import penetration, measured by the ratio of imports to domestic use, and its average of export-output ratios as controls. I find no relationship between import penetration and NTBs in a sector. I do, however, find a negative and significant coefficient on export propensity, consistent with the argument that sectors facing less import competition demand less for protection.

Finally, I follow Lee and Swagel (1997) to include $\ln(1+tariff)$ as an exogenous determinant of NTBs in column (1).[22] A positive, significant coefficient on the tariff term suggests that although governments are restricted by WTO regulations to use tariffs to protect trade, tariffs

[21]For instance, based on the U.S. non-tariff barriers, Trefler (1993) finds that sectors with growing import penetration receive more protection.

[22]For the U.S., Ray (1981) finds no feedbacks from NTBs to tariffs.

and NTBs were used as complements in trade protection.

Next, in column (2), I replace a sector's average wage rate by its average value-added per worker to proxy for the degree of "weakness". Parallel to this, I use a sector's value-added share instead of employment share to capture the political importance of an industry. Consistent with the findings of a negative relationship between employment shares and NTBs in column (1), I also find a negative relationship between value-added shares and NTBs in a sector. However, empirical results show that a sector's labor productivity does not appear to be related to its level of NTBs.

Finally, governments are often under political pressure to protect sectors that have declining comparative advantage relative to the rest of the world. Therefore, we should expect higher protection for declining (sunset) sectors, especially those employing workers with long job tenure and sector-specific skills. To this end, in column (3), in addition to the levels of wage and per-worker value-added, I include their respective 10-year average annual growth rates. Out of these four variables, only the coefficient on wage growth is significant. However, its sign is opposite to what was predicted by the early literature.[23] Next, in column (4), I include the change in a sector's import penetration to control for the demand for protection. I find no evidence that higher import penetration affects trade protection.[24]

In sum, I do not find evidence consistent with all predictions of the early theoretical literature, probably because of a different global economic environment in the 90s compared to earlier decades when those theories were developed, or because my measures of sectoral characteristics are imperfect. Moreover, some of these variables cannot be treated as exogenous determinants of NTBs.[25] Therefore, instead of treating the inclusion of variables as an attempt to test the existing literature, we should treat it as an effort to confirm that my main empirical results are not driven by other determinants of trade protection. Importantly, I always find significant evidence for the class-cleavage theory that right-wing governments are associated with higher

[23]It should be noted that when both country and sector fixed effects are included in the regressions, Lee and Swagel (1997) also find no evidence that low-wage or less productive sectors receive more trade protection.

[24]Trefler (1993) also finds no significant relationship between the level of import penetration and NTB in the same sector, using industry data from the U.S. in the 80s, although he finds a strong positive relationship between an increase in import penetration and the level of NTB.

[25]For example, Trefler (1993) shows that import penetration and NTBs are endogenously determined. By carefully controlling for simultaneity, he finds that NTBs have a restrictive impact on imports 10 times the size obtained from treating NTBs as exogenous.

trade protection in capital and human-capital intensive sectors, compared to non-right-wing governments (columns (1) through (4)).[26]

In column (5), I repeat the exercise in column (1) by using factor intensity measures constructed based on a 4-factor production function (as discussed in section 3.5). In addition to labor, capital and human capital intensities as sectoral characteristics determining the structure of trade protection, I also find that right-wing governments are associated with higher trade protection in material-intensive sectors. The coefficient on the material-intensity interaction term is positive and significant at the 1% significance level. Finally, in column (6), I estimate a model with all controls discussed from columns (1) to (3) included, as well as the three factor intensity measures interacted with the dummy for right-wing governments. The results confirm that the interaction between government political ideology and factor intensities remains an important determinant of trade policies.

3.6.3 Other Sectoral Characteristics Reflecting Workers' Interests

The paper so far has focused on factor intensities as the sector characteristics driving the relationship between governments' political ideology and trade policy. The insight of left-wing government's association with pro-labor trade policies can be tested using other sectoral characteristics related to the importance of labor interests. I seek to test some of them in Table 3.7. First, pro-labor trade policies of left-wing governments should imply more protection in low-wage or low-skill sectors. To this end, I add an interaction term between a country's indicator of right-wing political ideology and the log of average real wage in a sector to the specification in column (1) of Table 3.5 . As reported in column (1) of Table 3.7, a positive and significant coefficient (at 5% significance level) on the new interaction term suggests that relative to left-wing and centrist governments, right-wing governments are associated with more protection in high-wage sectors. This result supports the general theme of the paper that government

[26]Notice that one important determinant that I do not control for is a sector's demand and supply elasticities. Grossman and Helpman (1994) show that trade barriers are more likely to exist for goods with lower own price elasticity of demand. The reason is that trade barriers on goods with inelastic demand will result in a relatively smaller deadweight loss. Similarly, the higher the foreign price elasticity of supply, the more effective trade policy is and the more likely a government is to protect domestic production from import competition. Since detailed elasticity data for a large sample of countries and sectors are not available, I rely on sector fixed effects to capture the impact of elasticities on trade protection, under the assumption that the elasticities of demand and supply of goods in the same sector are constant across countries.

political ideology is reflected in trade policy along the sectoral lines.

Since higher wages in a sector may well be reflecting higher labor productivity. In column (2), I examine whether right-wing governments' protection of high-wage sectors is motivated by the consideration of long-run growth. Using value-added per worker as the measure of labor productivity, I find no evidence showing that right-wing governments tend to protect productive sectors more than leftist and centrist governments. This result, together with the positive coefficient on the interaction term with real wages in column (1), implies that rightist governments protect sectors where workers receive rents, more than leftist governments.

Next, I examine employment risks in a sector as a determinant of trade protection. Job and skill losses associated with deindustrialization remain a major concern of governments in developed countries, especially when pro-labor governments are in control. Pro-labor governments are expected to be more concerned about layoffs, particularly for workers who have acquired firm or sector-specific skills. To test this hypothesis, I interact the dummy for right-wing governments with a sector's proxy of specific-skill intensity, measured by the average returns to firm-specific skills by Tang (2008). The coefficient on the interaction term is negative, consistent with the prediction that left-wing governments protect workers with specific skills more than right-wing governments, but is statistically insignificant. Along this line, workers in sectors with high job turnovers are more susceptible to shocks arising from economic integration, and would receive more protection from a leftist government. In column (4), I include an interaction term between the "right" dummy and a sector's average gross job flow rate constructed by Davis, Haltiwanger and Schuh (1996). I find a negative and significant coefficient on the interaction term, supporting the claim that relative to right-wing governments, left-wing governments tend to protect workers from employment risks by restricting imports more.

3.6.4 Embedding the Framework into Dutt and Mitra (2006)

This paper attempts to test the class-cleavage theory of trade protection along the sectoral lines. As discussed in Section 3.2, the class-cleavage theory predicts that in a country endowed with abundant land and capital, the leftist party favors trade protection while the right party votes for freer trade (Rogowski, 1990). This theory was recently tested by Dutt and Mitra (2002, 2005, 2006) for a sample of countries in the 80s. They show that left-wing governments are associated with higher trade barriers in capital-abundant countries, because of import competition in labor-intensive sectors, but liberalize more in labor-abundant countries. Their idea can be summarized by the following equation:

$$\frac{\partial TB}{\partial Ideology} = a + b\,(K/L)\,.$$

where TB stands for trade barriers, and $Ideology$ measures the degree of left orientation of a government. The authors find empirical support for the theoretical prediction that $a < 0$ and $b > 0$. Embedding my empirical specification in their empirical framework will yield important predictions. In particular, the difference in trade barriers in sector j between left-wing and right-wing governments, all else equal (especially holding (K/L) constant), can be formalized as:

$$TB_j^R - TB_j^L = \left(a^R - a^L\right) + \left(b^R - b^L\right) l\_int_j + \left(c^R - c^L\right)(K/L) + \left(d^R - d^L\right)(K/L) \times l\_int_j, \quad (3.2)$$

where 'L' and 'R' stand for left and right, respectively.

Empirical results so far allow us to sign $a^R - a^L$ and $b^R - b^L$. First, Table 3.3 shows that right-wing governments tend to have lower protection, suggesting that $a^R - a^L < 0$. Second, positive coefficients on the interactions between "right" and capital and human-capital intensities I have found so far imply lower trade barriers by right-wing governments in labor-intensive sectors, suggesting that $b^R - b^L < 0$.

Now consider the signs of $\left(c^R - c^L\right)$ and $\left(d^R - d^L\right)$. The Heckscher-Ohlin model predicts that when a country becomes more endowed with capital, it will import more labor-intensive goods. The intention to protect the interests of labor, therefore, increases across all political parties, with left-wing governments being more protective. As such, increasing a country's capital endowment will increase the divergence of views between left-wing and right-wing parties on issues related to trade policy. This effect of increasing capital endowment implies $c^R - c^L < 0$. Moreover, when more imported goods are labor-intensive, the demand for protection in labor-intensive sectors increases, while that in capital-intensive sectors decreases. Therefore, the views on trade policy of the left and the right parties diverge even more for labor-intensive sectors, implying $d^R - d^L < 0$. In sum, the conjecture is that all coefficients in equation (3.2) are negative, implying that all else being equal, a right-wing government has lower NTBs than a left-wing government in all sectors. The important message is that the difference in NTBs between a right and a left government increases with sector labor intensity, with a higher capital endowment of a country reinforcing the divergence.

To test these hypotheses, I modify equation (3.1) to obtain the following specification:

$$\begin{aligned} \ln(1+NTB^{*}_{cj}) &= \alpha + \beta_1 Right_c \times l\_int_j + \delta_1 \ln{(K/L)}_c \times l\_int_j \\ &\quad + \delta_2 Right_c \times \ln{(K/L)}_c \times l\_int_j \\ &\quad + \gamma \mathbf{X_j} + f_c + f_j + \epsilon_{cj} \qquad (3.3) \\ \text{where } NTB_{cj} &= \left\{ \begin{array}{c} NTB^{*}_{cj} \text{ if } NTB^{*}_{cj} > 0 \\ 0 \text{ otherwise.} \end{array} \right\} \end{aligned}$$

where c and j continue to stand for country and sector, respectively. The structure of the equation is very similar to specification (3.1).

To be consistent with Dutt and Mitra (2005, 2006), who consider a two-factor open economy, I use $(1 - k\_int_j)$ to construct my measure of labor intensity, l_int_j, instead of separating labor into skilled and unskilled as I have done so far. Then I estimate equation (3.2) with three interaction terms: $Right_c \times l\_int_j$, $\ln{(K/L)}_c \times l\_int_j$ and $Right_c \times \ln{(K/L)}_c \times l\_int_j$. Following Dutt and Mitra (2005, 2006), I use the log of per-capita capital endowment to avoid results driven by outliers.[27] The prediction of $d^R - d^L < 0$ implies $\delta_1 > 0$ and $\delta_2 < 0$.

Table 3.8 shows the results of the Tobit estimation of equation (3.3). All regressions include the controls for existing theories on trade policy included in column (1) of Table 3.5. Since Table 3.3 already showed that right-wing governments are more open to trade (i.e., $a^R < a^L$), instead of adding country-level variables to sign $a's$ and $c's$, I include sector and country fixed effects. In column (1), the coefficient on $Right \times l\_int$ is insignificant. An explanation is that since the regression results so far show that right-wing governments protect skilled-intensive sectors relatively more than left-wing governments, mixing high-skilled and low-skilled workers in constructing the measure of labor intensity may weaken the findings that right-wing governments protect unskilled workers relatively less than left-wing governments.

[27]When I use the level of K/L instead, results remain significant.

Nevertheless, the coefficients on $\ln(K/L) \times l\_int$ and $Right \times \ln(K/L) \times l\_int$ are of the expected signs, and are significant at 1% and 5% significance levels, respectively. Therefore, the hypothesis that $\delta_1 > 0$ is confirmed by a positive coefficient on $\ln(K/L) \times l\_int$. It supports the argument that in capital-rich countries, because of import competition, labor-intensive sectors demand for more trade protection. The negative and significant coefficient on $Right \times \ln(K/L) \times l\_int$ supports the prediction that $\delta_2 < 0$. These results are consistent with the general argument that left and right-wing parties/governments diverge on views over issues related to trade liberalization. Their views diverge even more in capital-rich countries, and particularly in labor-intensive sectors.

Next, I separate the skilled and the unskilled from the labor intensity measure as I have done so far in the paper. As such, I extend the two-factor economy model of Dutt and Mitra (2005, 2006), and consider the effects of political ideology on NTBs across sectors with different capital and human-capital intensities. In column (2), I repeat the exercise for column (1) by adding separate interaction terms for capital and human-capital intensities. First, independent of the effects of a country's factor endowment, I find that right-wing governments are associated with higher NTBs in capital-intensive sectors (positive and significant coefficient on $Right \times k\_int$). Reinforcing these effects is an increased policy bias towards capital-intensive sectors by a right-wing government when a country's capital endowment increases (a positive and significant coefficient on $Right \times \ln(K/L) \times k\_int$). This is consistent with the prediction, summarized in equation (3.2), that in capital-rich countries, when the imported goods are labor-intensive, a left-wing government is more likely to protect labor interests than a right-wing government.

The coefficient on $Right \times h\_int$ remains significant and positive. The coefficients on other interactions with h_int, however, are insignificant. This is not surprising given that a higher level of capital endowment should have little effects on trade of human-capital intensive goods. Therefore, in column (3), instead of interacting a sector's skill intensity with a country's measure of capital endowment, I interact it with a country's human capital endowment. Nevertheless, the coefficients on the human-capital intensity interaction terms remain insignificant, despite the fact that the coefficients on capital-intensity interactions continue to be significant. In other words, with my framework incorporated in Dutt and Mitra's (2005, 2006), the class-cleavage theory is verified along the capital-labor line across sectors, but not along the skilled-unskilled line.

3.6.5 Different Samples

Finally, in Table 3.9, I examine whether the observed structure of trade protection across sectors is found in different sub-samples of countries. First, I divide the sample into the OECD and the non-OECD groups. Only in the sample of OECD countries do I continue to find the proposed relationship between government ideology and the structure of protection across sectors (column (1)). For the non-OECD sample, the coefficients on the interaction terms between the "right" dummy and factor intensities are insignificant (column (2)). The natural next step is to consider subsamples of rich (per capita GDP above the median of the sample) and poor countries (per capita GDP below the median of the sample). Consistent with the "OECD" exercise, I find a strong relationship between government ideology and protection patterns for the rich, but not the poor sample (columns (3) and (4)). An explanation is that poor countries usually need capital for growth, and impose less restriction on capital-intensive imports.

Next, I separate the sample into groups of capital-abundant (capital endowment above the median in the sample) and capital-scarce countries, respectively. Using the capital-rich sample, I continue to find that right-oriented governments have relatively higher protection in capital and human-capital intensive sectors (columns (5). No such relationship is observed in the capital-poor sample (columns (6)). On the contrary, right-wing governments in capital-scarce countries appear to be associated with lower protection in capital-intensive sectors than the left-wing governments. These observations are consistent with the findings from the sample of poor countries, in which ideology does not appear to affect trade policy.

Finally, I consider the division of countries into democracies and non-democracies. The consensual view is that democracies are more concerned about social welfare than political contribution. Therefore, if capitalists and skilled workers are associated with more political power, right-wing policy bias to capital and human-capital intensive sectors is expected to be more pronounced in non-democratic countries. In columns (7) and (8), I find no evidence supporting this conjecture. I find that in democratic regimes, right-wing governments protect capital-intensive sectors more, while in non-democratic regimes, human-capital intensive sectors receive more protection. More research is needed to explain these findings.

3.7 Conclusions

This paper extends the class-cleavage theory of trade policy from a cross-country framework to a cross-industry one, and examines whether political ideology can shape the structure of trade protection across sectors. I argue that based on the Stolper-Samuelson theorem, left-wing (pro-labor) governments tend to set higher trade barriers in labor-intensive sectors among importing sectors, and lower trade barriers in capital-intensive and human-capital intensive sectors than right-wing (pro-capital) governments. Using a cross-country, cross-industry data set for the late 90s, I find evidence supporting these predictions. The empirical results are robust to controlling for the existing theories of trade policy, as well as country and sector fixed effects.

In research in progress, I construct cross-country time-series proxies for trade barriers across sectors, by taking the residuals from gravity equation estimation at the sector level. With time-series proxies for trade barriers, I investigate the relationship between changes in government political ideology and the structure of trade protection across sectors.

3.8 References

[1] Alesina, Alberto [1988], "Credibility and Policy Convergence in a Two-Party System with Rational Voters," *American Economic Review*, Vol. 78, No. 4, pp. 796-805.

[2] Alesina, Alberto [1987], "Macroeconomic Policy in a Two-Party System as a Repeated Game," *Quarterly Journal of Economics*, Vol. 102, No. 3, pp. 651-678

[3] Alesina, Alberto and Dani Rodrik [1994]. "Distributive Politics and Economic Growth," *Quarterly Journal of Economics,* Vol.109, No. 2, pp. 465-490.

[4] Alesina, Alberto and Nouriel Roubini [1992], "Political Cycles in OECD Economies," *Review of Economic Studies*, Vol. 59, No. 4, pp. 663-688.

[5] Alesina, Alberto and Jeffrey Sachs [1988], "Political Parties and the Business Cycle in the United States, 1948-1984" *Journal of Money, Credit and Banking*, Vol. 20, No. 1, pp. 63-82.

[6] Baldwin, Robert [1985], "The Political Economy of US Import Policy," MIT Press, Cambridge, MA.

[7] Bartelsman, Eric and Wayne Gray [1996], "The NBER Manufacturing Productivity Database," Technical Working Paper 205. National Bureau of Economic Research.

[8] Blanchard, Olivier J. [1985], "Credibility, Disinflation and Gradualism," *Economics Letters,* Vol. 17, Issue 3, Pages 211-217.

[9] Bombardini, Matilde [2008], "Firm Heterogeneity and Lobby Participation," UBC Working Paper, forthcoming *Journal of International Economics.*

[10] Beck, Thorsten, George Clarke, Alberto Groff, Philip Keefer, and Patrick Walsh [2001], "New tools in comparative political economy: The Database of Political Institutions," 15:1, *World Bank Economic Review*, pp.165-176.

[11] Caselli, Francesco and James Feyrer [2007], "The Marginal Product of Capital," *Quarterly Journal of Economics*

[12] Caselli, Francesco [2005]. "Accounting for Cross-Country Income Differences," Philippe Aghion & Steven Durlauf (ed.), *Handbook of Economic Growth*, edition 1, vol. 1, chapter 9, pages 679-741 Elsevier.

[13] Caves, Richard [1976], "Economic Models of Political Choice: Canada's Tariff Structure," *Canadian Journal of Economics*, Vol. 9, No. 2, pp. 278-300.

[14] Davis, Steven, John Haltiwanger and Scott Schuh [1996], "Job Creation and Job Destruction," MIT Press, Cambridge, MA.

[15] Dutt, Pushan and Devashish Mitra [2002], "Endogenous Trade Policy through Majority Voting: An Empirical Investigation," *Journal of International Economics*, Vol. 58 No. 1, pp.107-134.

[16] Dutt, Pushan and Devashish Mitra [2005], "Political Ideology and Endogenous Trade Policy: An Empirical Investigation, " *Review of Economic Statistics*, vol. 87, No. 1 pp:59-72.

[17] Dutt, Pushan and Devashish Mitra [2006], "Labor versus Capital in Trade-policy: The Role of Ideology and Inequality," *Journal of International Economics*, Vol. 69, No. 2, pp. 310-320.

[18] Feenstra, Robert [2000], World Trade Flows 1980-1997 CD-ROM.

[19] Findlay, Ronald and Stanlislaw Wellisz [1982], "Endogenous Tariffs and the Political Economy of Trade Restrictions and Welfare," in Jagdish Bhagwati (ed.) *Import Competition and Response*, Chicago, IL.

[20] Gawande, Kishore and Pravin Krishna [2003], "The Political Economy of Trade Policy: Empirical Approaches," *Handbook of International Trade*, Eun Kwan Choi and James Harrigan (ed.] vol. 1, no. 1.

[21] Gawande, Kishore & Usree Bandyopadhyay [2000], "Is Protection for Sale? Evidence on the Grossman-Helpman Theory of Endogenous Protection," *Review of Economics and Statistics*, Vol. 82 No. 1, pp. 139-152.

[22] Goldberg, Pinelopi and Giovanni Maggi [1999]. "Protection for Sale: An Empirical Investigation," *American Economic Review*, Vol. 89, No. 5. pp. 1135-1155.

[23] Grossman, Gene Elhanan Helpman [1994], "Protection for Sale," *American Economic Review*, Vol. 84, No. 4. pp. 833-850

[24] Heston, Alan, Robert Summers and Bettina Aten [2006], "Penn World Table Version 6.2," Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

[25] Hibbs, Douglas [1987]. "The American Political Economy: Macroeconomics and Electoral Politics" Harvard University Press, Cambridge, MA.

[26] Hillman, Arye [1982], "Declining Industries and Political-Support Protectionist Motives," *American Economic Review*, Vol. 72, No. 5, pp. 1180-1187.

[27] Lee, Jong-Wha and Phillip Swagel [1997], "Trade Barriers and Trade Flows Across Countries and Industries," *Review of Economics and Statistics*, Vol. 79, No. 3, pp. 372-382.

[28] Levchenko, Andrei [2007], "Institutional Quality and International Trade," *Review of Economic Studies*, 74:3, pp. 791-819.

[29] Manova, Kalina [2007], "Credit Constraints, Heterogeneous Firms and International Trade," Stanford University Manuscript.

[30] Milner, Helen and Benjamin Judkins [2004], "Partisanship, Trade Policy, and Globalization: Is there a Left-Right Divide on Trade Policy?" *International Studies Quarterly*, Vol. 48 No. 1, pp, 95-120.

[31] Mitra, Devashish, Dimitrios Thomaskos and Mehmet Ulubaşoğlu [2002], "Protection for Sale" in a Developing Country: Democracy, vs. Dictatorship," *Review of Economic Statistics*, Vol. 84, No. 3, pp. 497-508.

[32] Nicita, Alessandro and arcelo Olarreaga [2007], "Trade, Protection and Protection 1976-2004," *World Bank Economic Review*.

[33] Nunn, Nathan [2007]. "Relationship-Specificity, Incomplete Contracts and the Pattern of Trade," *Quarterly Journal of Economics*, Vol. 122. No. 2, pp. 569-600.

[34] Olson, Mancur [1965]. "The logic of collective action," Harvard University Press, Cambridge, MA.

[35] Rajan, Raghuram and Luigi Zingales [1998], "Financial Dependence and Growth," *American Economic Review*, Vol. 88, No. 3, pp. 559-586.

[36] Rodrik, Dani [1995], "Political Economy of Trade Policy," Handbook of International Economics, Elsevier, Gene Grossman & Kenneth Rogoff (ed.) , vol. 3, no. 3.

[37] Rogowski, Ronald [1990], "Commerce and coalitions: how trade affects domestic political alignments," Princeton University Press, Princeton, NJ.

[38] Romalis, John [2003], "Factor Proportions and the Structure of Commodity Trade," *American Economic Review* , Vol. 94 (1), pp.67-97.

[39] Roubini, Nouriel and Jeffrey Sachs [1989], "Political and Economic Determinants of Budget Deficits in the Industrial Democracies," *European Economic Review*, Vol. 33 pp.903-938.

[40] Tang, Heiwai [2008], "Labor Market Institutions, Firm-specific Skills, and Trade Patterns," MIT Working Paper.

[41] Trefler, Daniel [1993], "Trade Liberalization and the Theory of Endogenous Protection: An Econometric Study of U.S. Import Policy," *Journal of Political Economy*, Vol. 101, No. 1, pp. 138-160.

3.9 Tables and Figures

Table 3.1 (Country Indicators of Government Ideology and Measures of Protection)

Country	Ideology	Political System	Import-weighted NTB (%)	Import-weighted Tariffs (%)	Year NTB taken	Year Tariff taken
India	Left	Parliamentary	39.079	21.764	1997	1997
El Salvador	Right	Presidential	30.461	7.669	1997	1997
Argentina	Right	Presidential	27.845	11.603	1999	1999
Brazil	Center	Presidential	25.220	13.539	1999	1999
Ecuador	Left	Presidential	22.997	12.051	1999	1999
New Zealand	Right	Parliamentary	22.655	2.998	1999	1999
China	Left	Assembly	20.328	15.114	1997	1997
Greece	Left	Parliamentary	19.545	3.675	1999	1999
Portugal	Right	Parliamentary	18.596	3.438	1999	1999
Denmark	Left	Parliamentary	18.389	3.212	1999	1999
Taiwan	Right	Assembly	17.711	5.322	1999	1999
Italy	Center	Parliamentary	17.676	3.462	1999	1999
United States	Left	Presidential	17.581	1.909	1999	1999
Colombia	Center	Presidential	17.554	10.237	1999	1999
Germany	Right	Parliamentary	17.132	3.309	1999	1999
Switzerland	Right	Parliamentary	16.251	0.000	1996	1996
Chile	Right	Presidential	15.693	9.933	1999	1999
United Kingdom	Right	Parliamentary	15.312	3.140	1999	1999
Romania	Center	Parliamentary	14.858	9.017	1999	1999
France	Left	Parliamentary	14.529	3.404	1999	1999
Uruguay	Right	Presidential	14.397	13.186	1999	1999
Sweden	Left	Parliamentary	14.032	2.957	1999	1999
Austria	Left	Parliamentary	13.864	3.039	1999	1999
Netherlands	Center	Parliamentary	13.417	3.185	1999	1999
Spain	Left	Parliamentary	13.349	3.302	1999	1999
Finland	Center	Parliamentary	13.098	2.799	1999	1999
Ethiopia	Left	Presidential	12.872	17.08	1995	1995
Ireland	Center	Parliamentary	12.338	2.874	1999	1999
Australia	Left	Parliamentary	10.737	4.249	1999	1999
Hungary	Left	Parliamentary	10.599	4.695	1999	1997
Poland	Center	Presidential	10.501	3.935	1999	1999
Japan	Right	Parliamentary	10.319	2.969	1996	1996
Tunisia	Left	Presidential	10.230	26.83	1999	1998
Peru	Right	Presidential	7.086	12.597	1999	1999
Philippines	Center	Presidential	6.741	7.842	1998	1998
Mexico	Left	Presidential	6.530	6.678	1999	1999
Mauritius	Left	Parliamentary	6.440	28.198	1995	1995
Iceland	Right	Parliamentary	6.014	3.526	1996	1996
Turkey	Right	Parliamentary	5.398	6.080	1997	1997
Slovenia	Left	Parliamentary	4.290	11.828	1999	1999
Lithuania	Center	Presidential	3.627	3.032	1999	1997
Bolivia	Center	Presidential	2.846	9.000	1999	1999
South Africa	Center	Assembly	2.627	5.356	1999	1999
Norway	Left	Parliamentary	2.594	0.459	1996	1996
Thailand	Right	Parliamentary	1.669	35.865	1994	1993
Guatemala	Right	Presidential	1.344	6.775	1998	1998
Honduras	Right	Presidential	0.586	8.782	1998	1995
Korea, Rep.	Right	Presidential	0.201	7.657	1996	1996
Ukraine	Center	Presidential	0.083	6.275	1997	1997

Note: Sorted by non-tariff barriers

Table 3.2 (Sectoral Measures of Protection and Factor Intensities)

ISIC Code	Industry	Import-weighted NTB (%)	Std Dev. NTB (%)	Import-weighted Tariffs (%)	Std Dev. Tariffs (%)	Capital Intensity	Human-Capital Intensity
311	Food Products	24.436	8.823	9.109	1.907	0.773	0.082
313	Beverages	23.802	33.230	5.686	2.975	0.772	0.102
314	Tobacco	4.934	34.596	28.864	3.193	0.850	0.059
321	Textiles	43.220	12.344	9.702	3.336	0.599	0.127
322	Apparel, ex. Footwear	45.353	17.869	9.346	4.277	0.585	0.130
323	Leather products	27.931	9.520	6.315	2.350	0.602	0.140
324	Footwear, ex rubber/ plastic	49.634	17.406	9.327	4.312	0.589	0.119
331	Wood products, ex. Furniture	38.447	8.700	2.434	2.382	0.556	0.131
332	Furniture, ex. Metal	0.107	17.626	1.288	0.396	0.590	0.142
341	Paper and products	1.364	7.381	2.719	1.064	0.627	0.125
342	Printing and publishing	1.706	6.596	1.719	2.301	0.700	0.163
351	Industrial chemicals	15.404	7.016	5.007	1.534	0.735	0.111
352	Other chemicals	11.041	8.502	2.649	2.259	0.752	0.126
353	Petroleum refineries	36.750	10.845	3.947	3.856	0.749	0.097
354	Misc. petroleum and coal products	13.533	6.729	2.987	1.501	0.700	0.117
355	Rubber products	5.652	10.500	4.568	0.747	0.582	0.133
356	Plastic products	11.483	11.737	7.296	1.469	0.628	0.134
361	Pottery, china, earthenware	18.850	12.245	5.934	1.761	0.605	0.114
362	Glass and products	0.532	9.294	5.248	0.683	0.624	0.134
369	Other non-metallic mineral products	3.914	9.734	3.247	1.013	0.612	0.141
371	Iron and steel	26.070	6.660	4.231	1.702	0.559	0.146
372	Non-ferrous metals	4.567	6.898	2.473	1.338	0.626	0.135
381	Fabricated metal products	6.288	9.391	3.947	0.935	0.578	0.168
382	Machinery, ex. Electrical	7.954	6.410	2.693	0.990	0.576	0.192
383	Machinery, electrical	10.705	9.858	3.251	0.869	0.616	0.180
384	Transport equipment	13.067	10.767	4.338	2.456	0.576	0.174
385	Professional & scientific equipment	8.199	7.120	2.741	1.168	0.609	0.208

Table 3.3 (Baseline Results)

This table examines whether government political ideology affects the structure of trade protection across sectors with different factor intensities. Tobit regression results (left-censored at 0) are shown.

Dependent Var: ln(1+Non-Tariff Barrier) (Import-Weighted)	(1) Left Interacted	(2) Center Interacted	(3) Right Interacted	(4) Right - no country FE	(5) Right - no sector FE
Right x k-intensity			0.630***	0.632**	0.615**
			(2.63)	(2.36)	(2.33)
Right x h-intensity			1.699***	1.750***	1.686***
			(2.94)	(2.71)	(2.64)
Left x k-intensity	-0.501**	-0.717***			
	(-2.12)	(-2.68)			
Left x h-intensity	-1.282**	-1.888***			
	(-2.24)	(-2.92)			
Center x k-intensity		-0.505*			
		(-1.72)			
Center x h-intensity		-1.426**			
		(-2.00)			
Right				-0.671***	
				(-2.81)	
k-intensity					-0.261*
					(-1.67)
h-intensity					-1.340***
					(-3.51)
Country FE	Y	Y	Y	N	Y
Sector FE	Y	Y	Y	Y	N
Num. of Obs.	1313	1313	1313	1313	1313
Log Likelihood	-170.67	-169.075	-169.453	-365.897	-307.242
LR chi-squared	623.394***	626.583***	625.827***	232.94***	350.249***
McFadden's Adj. R-sq.	0.485	0.485	0.489	0.179	0.257

Notes:
1) t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
2) LR chi-squared stands for likelihood-ratio chi-squared, which tests the difference between the full model and the constant only model.

Table 3.4 (Using Political Ideology of the Controlling Party in the Previous 5 Years)

This table examines whether government political ideology affects the structure of trade protection across sectors with different factor intensities. Different from Table 3, government political ideology equals the ideology of the party with dominating control (3+years) in the previous 5 years. Tobit regression results (left-censored at 0) are shown.

Dependent Var: ln(1+Non-Tariff Barrier)					
	(1) Left interacted	(2) Center Interacted	(3) Right Interacted	(4) Right - no country FE	(5) Right - no sector FE
Right x k-intensity			0.497**	0.504*	0.486*
			(2.15)	(1.94)	(1.91)
Right x h-intensity			1.145**	1.230**	1.153*
			(2.05)	(1.96)	(1.87)
Left x k-intensity	-0.484**	-0.481**			
	(-2.10)	(-2.09)			
Left x h-intensity	-1.321**	-1.311**			
	(-2.37)	(-2.35)			
Center x k-intensity		-0.121			
		(-0.47)			
Center x h-intensity		-0.410			
		(-0.65)			
Right				-0.504**	
				(-2.17)	
k-intensity					-0.259
					(-1.53)
h-intensity					-1.253***
					(-3.04)
Country FE	Y	Y	Y	N	Y
Sector FE	Y	Y	Y	Y	N
Num. of Obs.	1313	1313	1313	1313	1313
Log Likelihood	-170.369	-170.157	-170.774	-305.851	-368.052
LR chi-squared	623.996***	624.421***	623.187***	353.032***	228.63***
McFadden's Adj. R-sq.	0.485	0.481	0.484	0.254	0.173

Notes:
1) t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
2) LR chi-squared stands for likelihood-ratio chi-squared, which tests the difference between the full model and the constant only model.

Table 3.5 (Dependent Variable = HS-line Weighted Non-Tariff Barriers)

Using HS-line weighted non-tariff barrier as the dependent variable, this table shows results of the analogous regressions in Table 3.3. Tobit regression results (left-censored at 0) are shown.

Dependent Var: ln(1+Non-Tariff Barrier) (HS-line-Weighted)	(1) Left Interacted	(2) Center Interacted	(3) Right Interacted	(4) Right - no country FE	(5) Right - no sector FE
Right x k-intensity			0.476**	0.496**	0.459**
			(2.31)	(2.05)	(2.00)
Right x h-intensity			1.258**	1.349**	1.239**
			(2.52)	(2.31)	(2.23)
Left x k-intensity	-0.414**	-0.564**			
	(-2.03)	(-2.45)			
Left x h-intensity	-0.964*	-1.407**			
	(-1.95)	(-2.52)			
Center x k-intensity		-0.353			
		(-1.40)			
Center x h-intensity		-1.043*			
		(-1.70)			
Right				-0.525**	
				(-2.42)	
k-intensity					-0.316**
					(-2.32)
h-intensity					-1.422***
					(-4.28)
Country FE	Y	Y	Y	N	Y
Sector FE	Y	Y	Y	Y	N
Num. of Obs.	1313	1313	1313	1313	1313
Log Likelihood	-52.003	-51.182	-51.554	-291.561	-201.453
LR chi-squared	714.434***	716.077***	715.332***	235.318***	415.534***
McFadden's Adj. R-sq.	0.682	0.679	0.683	0.214	0.389

Notes:
1) t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
2) LR chi-squared stands for likelihood-ratio chi-squared, which tests the difference between the full model and the constant only model.

Table 3.6 (Controlling for Existing Hypotheses)

This table adds a set of control variables to the baseline regressions to control for existing hypotheses. Tobit regression results (left-censored at 0) are shown.

Dependent Var: ln(1+Non-Tariff Barrier) (Import-Weighted)	(1) Baseline Controls	(2) Alt. Comp. Adv. Measures	(3) Declining Industries	(4) Δ Import Penetration	(5) (1) w/ Material Intensity	(6) (4) w/ Material Intensity
Right x k-intensity	0.884***	0.937***	1.238***	1.279***	1.562***	2.468***
	(3.31)	(3.47)	(4.03)	(4.18)	(3.17)	(4.30)
Right x h-intensity	2.296***	2.519***	2.580***	2.660***	4.278***	5.278***
	(3.62)	(3.93)	(3.54)	(3.66)	(3.78)	(4.00)
Right x m-intensity					1.664***	2.697***
					(3.14)	(4.31)
Employment Share	-0.046***		-0.048***	-0.043***	-0.046***	-0.043***
	(-3.95)		(-3.64)	(-3.23)	(-3.96)	(-3.20)
Value-added Share		-0.032***				
		(-2.66)				
Wage	0.024		-0.052	-0.058	0.025	-0.054
	(0.65)		(-0.85)	(-0.95)	(0.67)	(-0.88)
Value-added / Worker		0.054**	0.032	0.034		0.032
		(2.29)	(0.94)	(1.00)		(0.93)
Wage Growth			1.188***	1.164***		1.167***
			(4.19)	(4.11)		(4.13)
Value-added / Worker Growth			-0.16	-0.155		-0.155
			(-0.76)	(-0.74)		(-0.74)
Import/ Dom. Use	-0.016	-0.012	-0.021	-0.014	-0.016	-0.014
	(-1.23)	(-0.95)	(-1.47)	(-0.93)	(-1.25)	(-0.97)
Δ Import/ Dom. Use				-0.124		-0.127
				(-1.26)		(-1.29)
Export/ Output	-0.018**	-0.015	-0.023**	-0.020*	-0.019**	-0.021**
	(-2.01)	(-1.64)	(-2.21)	(-1.94)	(-2.08)	(-2.04)
ln(1+Tariff)	0.068***	0.090***	0.068***	0.065***	0.068***	0.066***
	(3.84)	(4.86)	(3.53)	(3.34)	(3.81)	(3.36)
Country FE	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y
Num. of Obs.	963	940	774	770	963	770
Log Likelihood	-97.844	-92.553	-54.165	-50.934	-97.654	-49.997
LR chi-squared	507.472***	489.635***	468.518***	471.031***	507.852***	472.905***
McFadden's Adj. R-sq.	0.508	0.504	0.562	0.566	0.507	0.567

Notes:
1) t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
2) LR chi-squared stands for likelihood-ratio chi-squared, which tests the difference between the full model and the constant only model.

Table 3.7 (Other Sector Characteristics that Reflect Labor Interests)

This table tests whether right-wing governments set lower non-tariff barriers in sectors where workers' demand for protection is higher. Tobit regression results (left-censored at 0) are shown.

Dependent Var: ln(1+Non-Tariff Barrier) (Import-Weighted)				
	(1)	(2)	(3)	(4)
Interaction	ln(wage)	ln(value-added)	Specific Skills	Job Turnovers
Right x k-intensity	0.514*	0.975***	1.288***	0.789**
	(1.67)	(3.04)	(4.26)	(2.00)
Right x h-intensity	1.868***	2.550***	2.015***	1.328*
	(2.84)	(3.96)	(3.15)	(1.93)
Right x ln(wage)	0.128**			
	(2.40)			
Right x ln(value-added)		-0.006		
		(-0.21)		
Right x Spec. Skills			-0.030	-0.027
			(-0.38)	(-0.35)
Right x Job Turnover				-1.393***
				(-2.81)
Controls	Employment Share, Wage, Import/Domestic Use, Exports/Output			
Country FE	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Num. of Obs.	963	940	738	738
Log Likelihood	-94.603	-93.051	-24.796	-21.419
LR chi-squared	513.955***	488.639***	421.726***	428.481***
McFadden's Adj. R-sq.	0.514	0.5	0.600	0.612

Notes:
1) All regressions include a full set of controls as in Table 3.6, column (1).
2) t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
3) LR chi-squared stands for likelihood-ratio chi-squared, which tests the difference between the full model and the constant only model.

Table 3.8 (Incorporating Dutt and Mitra (2006))

This table incorporates Dutt and Mitra's (2006) idea by interacting government political ideology with a sector's factor intensities and a country's per capita factor endowment. Tobit regression results (left-censored at 0) are shown.

Dependent Var: ln(1+Non-Tariff Barrier) (Import-Weighted)			
Interaction	(1) Labor intensity	(2) Capital & skill intensities	(3) Adding Human Capital Endowment
Right x l-intensity	0.061		
	(0.28)		
Right x ln(K/L) x l-intensity	-0.434**		
	(-2.31)		
ln(K/L) x l-intensity	0.249***		
	(4.71)		
Right x k-intensity		0.568**	0.587**
		(2.00)	(2.07)
Right x ln(K/L) x k-intensity		0.442*	0.466**
		(1.81)	(2.41)
ln(K/L) x k-intensity		-0.327***	-0.253***
		(-4.11)	(-4.50)
Right x h-intensity		2.316***	0.931
		(3.46)	(0.40)
Right x ln(K/L) x h-intensity		0.057	
		(0.10)	
ln (K/L) x h-intensity		-0.228	
		(-1.37)	
Right x ln(H/L) x h-intensity			1.767
			(0.66)
ln(H/L) x h-intensity			-0.614
			(-0.39)
Controls	Employment Share, Wage, Import/Domestic Use, Exports/Output		
Country FE	Y	Y	Y
Sector FE	Y	Y	Y
Num. of Obs.	852	852	852
Log Likelihood	-60.729	-53.256	-54.105
LR chi-squared	483.878***	498.824***	497.125***
McFadden's Adj. R-sq.	0.565	0.58	0.577

Notes:
1) All regressions include a full set of controls as in Table 3.6, column (1).
2) t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
3) LR chi-squared stands for likelihood-ratio chi-squared, which tests the difference between the full model and the constant only model.

Table 3.9 (Different Samples)

This table repeats the baseline regressions with controls (Table 6 column (1)) over different sub-samples. Tobit regression results (left-censored at 0) are shown.

Dependent Var: ln(1+Non-Tariff Barrier) (Import-Weighted)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Samples:	OECD	Non-OECD	Rich	Poor	High K/L	Low K/L	Democracy	Non-democracy
Right x k-intensity	1.582***	-0.111	1.341***	0.081	2.772***	-1.244***	0.873**	-0.003
	(4.26)	(-0.33)	(4.02)	(0.23)	(7.84)	(-3.53)	(2.38)	(-0.01)
Right x h-intensity	3.225***	0.733	2.915***	1.179	4.204***	-0.61	1.436	1.363*
	(3.55)	(0.91)	(3.58)	(1.42)	(5.01)	(-0.73)	(1.60)	(1.67)
Controls	----------Employment Share, Wage, Import/Domestic Use, Exports/Output----------							
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y	Y	Y
Num. of Obs.	453	510	529	434	519	444	500	463
Log Likelihood	29.888	-32.774	-3.214	-7.417	-6.527	-14.979	14.836	-13.79
LR chi-squared	406.959***	285.338***	388.576***	238.452***	361.597***	279.707***	376.105***	311.161***
McFadden's Adj. R-sq	0.867	0.487	0.689	0.571	0.656	0.567	0.762	0.600

Notes:
1) All regressions include a full set of controls as in Table 3.6, column (1).
2) t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.
3) LR chi-squared stands for likelihood-ratio chi-squared, which tests the difference between the full model and the constant only model.