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Essays on International Trade and Development

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ABSTRACT

This dissertation consists of three essays. Using firm-level data from Korea, the first and second chapter examine Korean firms' offshoring strategies and the impact of these offshoring activities on firm-level employment in Korea. In the third chapter, the recent pattern of wage inequality is decomposed using an individual-level Korean labor income survey. This dissertation finds the role of industry capital intensity and firm productivity in the differential choices of global sourcing such as vertical FDI and foreign outsourcing. Also, this dissertation finds that input substitutability and firm exports can affect the impact of offshoring on firms' domestic labor demand. Finally, this dissertation finds various workers' characteristics that have affected wage inequality across various quartiles.

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CHAPTER I

Introduction

Global fragmentation of production in the form of multinational corporations and foreign outsourcing is commonly observed these days, and has had an enormous impact on patterns in the world volume of trade. Accordingly, this global sourcing, so-called “offshoring”, has been conjectured to affect the labor market in various ways. Through this dissertation, I first explore firm-level offshoring behavior and then examine how it is linked to firm-level labor demand. Also, I study another important issue of labor market outcome - namely, wage inequality - which constitutes a first step towards more extensive understanding of how globalization, including offshoring, has been affecting income inequality across workers.

In the first chapter, firms’ different global sourcing strategies are investigated. Firms’ types of intermediate input sourcing strategy - i.e., firm boundary - are often classified into four categories: domestic vertical integration, foreign vertical integration (FDI), domestic outsourcing, and foreign outsourcing. Understanding the systematic factors that drive firms’ optimal choice of one of these organizations is important to gain a better understanding of the global firms that are likely to change the structure of the world volume of trade. My empirical hypotheses on firm organization are based on two benchmark models of the property rights literature in the field of international trade. Due to the fixed cost of offshoring and the contract incompleteness that commonly exists in intermediate input production, property rights models indicate that capital intensity and firm productivity are two key elements affecting the choice of firm organization. Using Korean firm-level panel data and various econometric identifications with a special focus on causality, I provide more robust empirical support for the predictions of the property rights models. First, it is found that the preference for vertical integration increases with industry capital intensity. Firm-level productivity is confirmed as the key determinant of the type of global sourcing that is chosen. With greater capital intensity, higher productivity leading to offshoring moves firms toward vertical FDI rather than foreign outsourcing. The empirical result on firms' dynamic sourcing behavior further strengthens other findings and provides further support for the predictions of the property rights models.

The second chapter, co-authored with Devashish Mitra and Priya Ranjan, examines the relationship between offshoring and firm-level domestic employment. Politicians and the media have blamed offshoring for high unemployment rates, and this issue still remains controversial among trade economists. In this paper, we first develop a small country model of offshoring, as an extension of Demidova and Rodriguez-Clare (2013), and using firm-level data from Korea, we then empirically investigate the model's implications in regard to offshoring, exports, and employment at the firm level. We first find that input and output trade cost reductions increase both firm-level exports and imports at both intensive and extensive margins, which also validate our trade cost measurement. This paper also finds that the average impact of the input trade cost on firm employment can switch from positive to negative depending on the average input substitutability or complementarity, which is a crucial condition for whether the cost reduction from offshoring induces a labor demand increase or decrease. Our results also confirm a new channel of positive offshoring impact on domestic employment, namely, expansion of offshoring firms' exporting. These results are fairly robust to specification, including instrumental variables estimation and propensity score matching with difference-in-difference estimation, which could effectively handle potential endogeneity issues between offshoring and firm-level employment.

In my third chapter, co-authored with Pallab Ghosh, we closely examine the pattern of wage inequality in Korea during 1998-2007. The issue of income inequality (or income polarization) has recently been a major concern among many countries, including South Korea. Also, patterns of wage inequality vary widely across different countries (e.g., US vs. France). This study of the case of South Korea provides a meaningful contribution to the literature in that South Korea was one of the few countries to experience high economic growth and decreasing wage inequality from the 1980s to mid 90s; however, South Korea is now ranked second among the OECD countries when it comes to the rate of rise in inequality. Also, this inequality has purportedly been exacerbated by the Asian financial crisis in the late 1990s.

Previous studies have found possible contributing factors to wage inequality from mean-based estimations. Due to the fact that the pattern of income inequality has varied across various income levels, we apply Machado and Matas decomposition (2005), which allows us to decompose the changes in the wage density into the composition effect, wage structure effect and residual effect. This method also allows a counterfactual exercise for computing the contributions of individual factors. By comparing our estimated wage density function between 1998 and 2007, we could first observe that the middle class has been shrinking (i.e., polarization). Also, one of our major findings indicates that an increase in education significantly affected the gap between the high-income class and the middle class, which supports the SBTC hypothesis. Furthermore, we found no significant effect of labor union on the wage gap between the middle class and low-income class, suggesting a weak role of the Korean labor union in wage redistribution. This study, as a thorough investigation of wage inequality patterns through advanced methods, would be a meaningful basis for the empirical exploration of the role of offshoring on wage inequality, which has been known since the work of Feenstra and Hanson (1997) to increase the relative wages of skilled workers in both offshoring and host countries.

CHAPTER II

Firm Boundaries and Global Sourcing : Evidence from South Korea

2.1 Introduction

Global fragmentation of production, which often takes the form of multinational corporations, is commonly observed these days. In 2000, US intra-firm trade accounted for 46% of total imports (Bernard et al., 2010). Also, 35% of world trade in 2001 was conducted within the network of multinationals (UNCTAD, 2002; Helpman, 2006). Reflecting the growing importance of global sourcing in the domestic economy, fear of offshoring led to the enactment of anti-offshoring laws in the United States such as the Bring Jobs Home Act in 2012.

There have also been various types of production fragmentation. Intel's manufacturing is done solely in its own manufacturing plants all around the world, while almost all Nike products are manufactured in Asian factories that are owned by subcontractors. Literature on global sourcing more formally classifies the boundaries of firms according to the type of input sourcing. As Figure 2.1 illustrates, if a headquarter firm owns a subsidiary to acquire intermediate inputs, that is called 'vertical integration', 'in-house production' or 'intra-firm trade'. With outsourcing, on the other hand, intermediate inputs are obtained from independent suppliers through subcontracting. Within the same ownership choice, firm boundaries can be further segmented by sourcing locations. Multinational corporations that mostly source from foreign affiliates are standard examples of vertical foreign direct investment (FDI) firms, whereas foreign outsourcers mainly acquire inputs from foreign independent providers. 'Offshoring' is term that encompasses both FDI and foreign outsourcing.

Relationship-specific investments are also a common phenomenon. That is, both headquarter-provided inputs and supplier's inputs are combined in production such that a well-maintained relationship becomes crucial. Antràs (2003) mentions a study by Dunning (1993) which shows that the cost of capital investments for intermediate input production such as machinery is often shared between two firms. According to the survey on the global sourcing strategy conducted by PricewaterhouseCoopers in 2008, the single biggest concern for global firms about future sourcing was input quality control. Accordingly, they planned to invest more in managerial effort associated with input customization. Due to vendor non-performance, a significant portion of multinational firms replaced outsourcing with in-house sourcing to reduce potential risks in their joint manufacturing process (Deloitte, 2012).

This paper empirically explores why global firms engage differently in production fragmentation. Drawing empirical implications from the property rights models that explain different sourcing behaviors in an environment of relationship-specific production and contract incompleteness, this study aims to identify the key factors affecting the ownership choice (vertical integration vs. outsourcing), global sourcing (or offshoring), and choices between vertical FDI and foreign outsourcing.

According to the model proposed by Antràs (2003), the relative importance of headquarters or the supplier in joint production determines a firm's ownership choice, because the effort of the more important player would contribute more to joint surplus. Thus, if joint production relies more on the headquarter input such that the consideration of supplier's suboptimal effort is relatively unimportant, the optimal option for headquarters would be vertical integration as that would provide headquarters with a greater revenue share of the joint surplus. In Antràs and Helpman (2004), differences in fixed costs across the four organizational choices can make the Antràs (2003) effect not always hold. Thus, even under greater headquarter importance, foreign outsourcing could be an optimal choice for lower-productivity firms that cannot afford the fixed cost of vertical integration. FDI would be the choice for the most productive firms.

Using Korean firm-level panel data, this paper finds that the likelihood of firms acquiring inputs mostly from related parties (vertical integration) is positively related with industry capital intensity, which can effectively capture the importance of headquarter activity. Also, estimation results show that higher firm-level productivity induces the foreign making decision (FDI) against the foreign buying choice (outsourcing) in industries that are more capital-intensive. In those that are less capital-intensive, a different pattern is observed in that higher productivity would induce firms to become a foreign outsourcer. Firm-level productivity is also estimated to increase the probability of offshoring, regardless of industry capital intensity. Additionally, it is found out that domestic outsourcing firms also resort to vertical FDI as a result of an increase in productivity.

The results of this paper are in line with the main predictions of Antràs (2003) and Antràs and Helpman (2004). Although these property rights models have generated empirically testable implications regarding the volume of trade, mark-up and welfare, empirical validations hardly exist possibly due to data limitations. Also, most existing firm-level empirical studies have analyzed the sourcing behaviors of European firms. This paper contributes to the further development of the property rights literature by providing empirical evidence for the case of South Korea.

The observed prevalence of global fragmentation or intrafirm trade cannot be explained by studies of horizontal FDI, which are driven mainly by the foreign market access motive. According to Antràs and Yeaple (2014), traditional FDI theories have not yet provided complete models in that they fail to explain the different choices of multinational corporations regarding foreign production.

Among the approaches to analyzing firm boundaries, the transaction cost approach assumes that transaction costs are reduced by integration in contrast to contracting out to other firms (outsourcing), while property rights models specify equally important transaction cost within firm boundaries. Accordingly, in the context of the transaction cost model, the greater prevalence of outsourcing in the United States relative to Korea and Japan is explained by the greater market competition in the United States (Grossman & Helpman, 2002). The results of this paper which are in line with the property rights models of Antràs (2003) and Antràs and Helpman (2004), provide another interpretation namely, that the goal of securing higher bargaining power through ownership affects the different sourcing mode choices of Korean firms.

Lastly, this empirical evidence of property rights models would not be limited to the case of Korean firms. A feature of South Korean FDI (including vertical and horizontal FDI) is that the amount of outward FDI is slightly higher than that of inward FDI. That is, Korea is open to foreign direct investment at both direction. According to OECD resport, the average ratio of FDI inward stock to GDP from 2009 to 2013 is 13.4% and outbound FDI ratio is 15.9%. A similar FDI behavior is found among the small open economies in OECD member countries including Austria, Canada, Greece, Israel, Italy and Norway, which permits to understand the results of this paper in more glabal context.

The paper is structured as follows. In Section 2.2, I briefly review previous empirical work on firm boundary choices based on property rights models. In Section 2.3, the hypotheses drawn from the reference models are introduced. In Section 2.4, the data source and binary dependent variable construction are described. In Section 2.5, estimation strategies and results are provided. Robustness checks for selected results with different sourcing definition is provided in Section 2.6. Section 2.7 summarizes the research and provides limitations and possible development.

2.2 Related Literature

Earlier empirical studies on the determinants of firm organization are based on product- and industry-level data for the case of the United States. Focusing mostly on the share of intra-firm imports in total imports, the prevalence of intra-firm imports was found to be positively associated with capital intensity and R&D intensity (Antràs, 2003, Yeaple, 2006), and capital and skill intensity (Nunn & Trefler, 2008; Bernard et al., 2010), and all capital, R&D, and skill intensity (Nunn & Trefler, 2013). Also, it was found that industries where capital intensity is high and productivity is more dispersed have a larger share of intra-firm imports (Nunn & Trefler, 2008; 2013).

Firm-level data with sourcing information has been relatively scarce. Based on 1999 Japanese manufacturing data, Tomiura (2007) found non-econometric evidence that high-productivity firms resort to FDI rather than outsourcing. Defever and Toubal (2007; 2012), using a 1999 French multinational company dataset, found a systematic relationship among outsourcing, higher productivity, and direct measure of the firm-level relationship-specific input intensity.[1] Corcos et al. (2013) used the same French data but took the sample selection bias into account by combining external customs data. They found that firm-level capital intensity, productivity and judicial institutions are key determinants of product-level trade with related parties. Kohler and Smolka (2012) examined sourcing premia by analyzing a Spanish panel dataset from 2006 to 2008, and found that the productivity of FDI firms are the highest among the four types of firms. By using 1998 Italian firm-level data, Federico (2012) also found support for predictions of property rights models: capital intensity and productivity are determinants of domestic and foreign integration decisions.

This paper is distinct from previous works in several ways. First, the analysis is based on panel data so that the unobserved firm heterogeneity is suitably controlled through fixed-effect estimation, which is missing from the studies based on industry-level data and firm-level cross-sectional data.[2] Also, panel data analysis makes it possible to take into account potential endogeneity bias in the choice of firm organization and to examine changes in sourcing mode with productivity growth. Second, unlike previous studies that look into the

[1]This opposite result to the A&H (2004) prediction is due to the opposite assumption of the fixed-cost ordering.

[2]Kohler and Smolka (2012) is based on Spanish panel dataset; however, inferences are drawn from a population average estimator.

sourcing participation behavior, this paper focuses more on the main sourcing behavior for each, which I believe is in line empirical counterpart of the optimal sourcing mode.[3]

2.3 Hypotheses on Firm Organization

2.3.1 Ownership Choice

To examine the ownership choice between vertically integrated sourcing and outsourcing, my hypothesis is drawn from the Antràs (2003) model. According to this model, the final good producer (i.e., the headquarter firm) makes relationship-specific investment with the input supplier. Each partys true level of effort (or investment) is not observable or verifiable. Due to the greater outside option of having property rights, headquarters generally takes a greater revenue share under integration. If one party expects that the other would receive a greater revenue share (*ex post*), then that party would have an incentive to underinvest (*ex ante*). To reduce this hold-up inefficiency arising from incompleteness of contract, the choice of organization is dictated by the relative importance of headquarters and the input supplier. Therefore, allowing a greater revenue share to the intermediate input supplier through outsourcing is optimal when the marginal return on supplier investment is higher. Similarly, headquarter should be given a higher revenue share through vertical integration if headquarter investment would increase the joint surplus more than investment by the intermediate input supplier. Based on this theoretical framework, the following testable implication can be drawn:

- **Hypothesis 1** : Vertically integrated sourcing is more likely to be chosen as industry capital intensity increases. Additionally, this prediction would be independent of the location choice (i.e., foreign or domestic sourcing).

[3] Kohler and Smolka (2012) also looked into the main sourcing choice behavior but not within the context of property rights models.

Hypothesis 1 assumes that the relative importance of headquarter-provided input in the joint production is captured by industry-level capital intensity. As mentioned earlier, Antràs (2003) provides detailed evidence that the cost of capital investment is more commonly shared between the headquarter and input suppliers than the cost of labor. This premise has also been empirically supported by most previous studies. Although Antràs (2003) deals with ownership choice between two sourcing modes (vertical integration vs. outsourcing) without consideration of location choice, this paper additionally investigates whether capital intensity plays a role in the choice among all four sourcing modes.

2.3.2 The Role of Productivity

The second hypothesis on the role of firm-level productivity is drawn from Antràs and Helpman (2004), which introduces productivity heterogeneity and fixed-cost differences across different organization choices. From Antràs (2003), the profit-maximizing choice of headquarters in lower-capital-intensity industries is outsourcing, all else held equal; however, here, the fixed cost is assumed to be lower with outsourcing than with vertical integration. Thus, outsourcing is obviously the dominating choice in the relatively low-capital-intensity industries. Now, productivity determines whether to buy inputs from a foreign subcontractor or domestic independent supplier. Finding a foreign supplier would incur more cost (fixed cost), but inputs would be cheaper due to the lower variable cost in the foreign country. Thus, the more productive firms that can afford the fixed cost for the variable cost saving from foreign production are more likely to be foreign outsourcers. This is summarized in Figure 2.2 (left panel).

In relatively capital-intensive industries, vertically integrated sourcing is optimal according to Antràs (2003). Unlike the case of lower-capital-intensity industries, the final good producer would face a trade-off due to the greater fixed cost of vertical integration. Thus, high-productivity firms capable of bearing that fixed cost would optimally choose vertical integration, while others would decide to buy. That is, given the location choice (i.e., whether it is foreign or domestic), vertical integration would be positively associated with higher productivity. Another fixed cost between foreign versus domestic will determine location choice. Again, foreign sourcing (offshoring) will be selected by high-productivity firms. This is summarized in Figure 2.2 (right panel).

The equilibrium pattern of firm organization illustrated in Figure 2.2 is the benchmark prediction of Antràs and Helpman (2004). That is, depending on the imposed fixed-cost assumption and the magnitude of the gap between the foreign and domestic variable costs, some options would be dominated by others. Only the prediction on the FDI choice in high-capital-intensity industries and the prediction of the foreign outsourcing choice in low-capital-intensity industries are not sensitive to the model parameters. Thus, we have the second proposition as follows:

- **Hypothesis 2** : The likelihood of choosing foreign vertical integration (FDI) is positively associated with total factor productivity in capital-intensive industries. Also, foreign outsourcing is more likely to be chosen with a productivity increase in less-capital-intensive industries. Combining these two statements, there should be a positive productivity effect on the likelihood of offshoring regardless of industry capital intensity.

2.3.3 Dynamic Behavior

Taking advantage of panel data, the dynamics of the sourcing mode can also be analyzed. Based on Figure 2.2, domestic outsourcing is a viable sourcing mode in both types of industries for low-productivity firms. If this prediction holds over time, then we can expect that FDI would also be an available option for already participating domestic outsourcing firms as the productivity increases. Whether this dynamic behavior along the productivity increases interacts with industry capital intensity is an empirical question. Thus, another testable hypothesis can be drawn as follows:

- **Hypothesis 3**: An increase in productivity could lead to the first-time FDI participation of domestic outsourcing firms.

2.4 Data and Sourcing Variables

2.4.1 Data Source

The dataset used for this research is drawn from the Korean firm-level panel, The Survey of Business Activity, from 2006 to 2010. This annual survey conducted by Statistics Korea covers all firms with more than 0.3 million (in USD) of capital stock and 50 regular workers across all industries. Sourcing information, such as the amount of outsourcing and intrafirm trade, can be found along with balance sheet information. According to the published manual, the sales from this survey are 80% of those from the Korea Industrial Productivity (KIP) database in 2007. That is, the sample firms selected are quite representative of firms in Korea.

The estimation mainly focuses on manufacturing which consists of 82 (3-digit) industries. After removing invalid observations where the amount of outsourcing or intrafirm trade was greater than total operating cost, the sample consisted of 7,298 firms and 27,499 observations. In the estimation, firms owned by parent firms (where at least 50% of stock share was owned by other firms), were excluded in order to focus on the behavior of true headquarter firms.[4] Ultimately, the target sample consisted of 23,389 observations.

2.4.2 Dependent Variables Construction

In this section, I describe the continuous sourcing variables in the raw data and the method I use to transform them into binary variables that will be used as dependent variables in the main analysis.

[4] According to Nunn and Trefler (2013), the behavior of firms owned by parent firms differed significantly from those of true headquarter firms.

2.4.2.1 Latent Sourcing Variable

Two types of sourcing information were extracted from the data: the value of intra-firm trade and the total value of subcontracting. The definition of intra-firm trade is the amount of import and domestic purchase from affiliates who own at least 20% stock share. Subcontracting value consists of subcontracting amount from affiliates and from unrelated parties. To be in line with the theoretical framework that classifies firm boundaries by ownership, I define the sum of intra-firm trade and subcontracting from affiliates as the total amount of vertically integrated sourcing. Then, subcontracting with unrelated parties is defined as the total amount of outsourcing. Unlike most previous studies, this study does not use the amount of arms-length trade as a measurement of outsourcing since the subcontracting of unrelated parties seems to represent the concept of outsourcing more directly.

Finally, the two generated vertical integration and outsourcing variables are decomposed by the origin of inputs: whether inputs are obtained domestically or from abroad. That is, the sum of intra-firm import and subcontracting with foreign affiliates constitute the total amount of vertical FDI. Also, the total amount of foreign outsourcing (FO) is the total subcontracting cost with foreign unrelated parties. Using the domestic counterpart, the amount of domestic integration (DI) and domestic outsourcing (DO) are similarly generated.

2.4.2.2 Binary Dependent Variable

One of four organization choices (FDI, FO, DI, DO)[5] is assigned to each firm-year observation by using continuous sourcing variables; however, this process is not as simple as it seems due to the multiple sourcing behaviors in the real world. That is, many firm-year observations contain a positive amount of multiple sourcing modes. So, if a firm is involved in FDI and domestic outsourcing in the same year, then it is not obvious whether this firm should be regarded as an FDI or DO firm that year. Figure 2.3 illustrates this prevalence of

[5]FDI denotes the vertical foreign direct investment, FO denotes the foreign outsourcing, DI denotes domestic vertical integration, and DO denotes domestic outsourcing.

multiple sourcing activities found in the sample. The first thing to notice is that very few observations show a single sourcing strategy. Except for pure domestic outsourcing, the sum of pure domestic vertical integration, pure FDI, and pure foreign outsourcing observations account for only 4% of total observations. About 16% of observations show two sourcing strategies, while triple sourcing strategies account for 4%. Finally, about 0.9% of the observations contain positive amounts of all four sourcing modes.[6] The remaining observations are domestic firms with no outsourcing or offshoring of any kind.

To solve this complexity, the binary dependent variable indicating one of four firm boundaries is constructed in one of two ways: by mutually exclusive (main sourcing) criteria or by mutually inclusive (participation) criteria. Figure 2.4 summarizes the results of this binary dependent variable construction.

In the left panel of Figure 2.4, firm boundaries are defined based on its main sourcing choice among the four alternatives. For example, an observation i at time t is assigned to FDI as :

$$y_{it} = 1, \quad if FDI_{it} = max[DI_{it}, DO_{it}, FDI_{it}, FO_{it}], \qquad and \quad y_{it} = 0, \quad otherwise$$

Likewise, the same rule is applied to assign the other organization choices (FO, DI, and DO).

The right panel of Figure 2.4 shows the distribution of observations on the dependent variable constructed by the participation criterion. For example, the FDI binary dependent variable using the participation criterion is constructed as follows:

$$y_{it} = 1, \qquad if FDI_{it} > 0, \qquad and \qquad y_{it} = 0, \qquad otherwise$$

Of the two types of binary dependent variables, the main sourcing variable is closer in

[6]The ratio of foreign outsourcing is very small in the data in contrast to previous studies which found that foreign outsourcing is a more common practice than integrated sourcing. This is due to the different definitions of outsourcing: unrelated party subcontract sourcing vs. arms-length trade.

spirit to theories that examine the equilibrium choice of firm organization. For this reason, my main estimations will use the main choice as the dependent variable. The participation variable is additionally used as a robustness check.[7]

An interesting pattern demonstrated in Figures 2.3 and 2.4 is that a relatively small proportion of Korean manufacturing firms is involved in offshoring activity (13% of total observations). Within offshoring, FDI (11%) is more prevalent than foreign outsourcing (4%). Comparing studies that use similar definitions of outsourcing and intra-firm imports, only 5% of Japanese firms in 1998 were involved in global sourcing (Tomiura, 2007); in Spain, however, almost 40% of firms resorted to offshoring (Kohler & Smolka, 2011).

2.5 Estimation and the Results

2.5.1 Hypothesis 1

2.5.1.1 Estimation Method

Equation (2.1) is the econometric specification of Hypothesis 1 in Section 2.3.1.

$$Pr(y_{it} = 1) = \Lambda(\beta CAP_{it} + X'_{it}\delta + \mu_i) + \upsilon_{it} \tag{2.1}$$

Here, y_{it} is the binary dependent variable either for vertical integration or outsourcing. The vertical integration binary variable is defined by combining the constructed FDI main choice and domestic integration choice (DI) binary variable shown in Figure 2.4. Additionally, each FDI and DI choice variable is used separately as a dependent variable. Likewise, the outsourcing binary dependent variable includes both domestic (DO) and foreign outsourcing

[7] Instead of discrete variable transformation, using a continuous sourcing variable - i.e., a proportion of each sourcing mode within a firm's total amount of sourcing seems to handle the multiple sourcing practice in the data; however, the focus of this paper is sourcing behavior at an extensive margin that often requires a significant amount of changes in sourcing amount. For this reason, transformed binary dependent variables are mainly used in the estimation.

(FO) main choice, and each outsourcing choice is also regressed along the lines of Equation (2.1).

The key regressor, CAP_{it}, is the capital intensity of the industry to which the firm belongs, and is defined as the ratio of industry physical capital (tangible asset) to total wage bill. As explained earlier, this capital intensity aims to capture the relative importance of headquarter input in the joint production. Instead of firm-level, industry-level capital intensity is adopted following Antràs (2003). In addition, this works around the issue of reverse causality.[8] To check robustness, other industry-level intensities possibly related with headquarter activity are included as well. Following the literature, these are R&D intensity (ratio of total R&D expenditure to total sales) and advertising cost intensity (ratio of total advertisement cost to total sales). Instead of skill intensity or human capital intensity, which are used in the existing literature, this paper introduces a new measure i.e., management intensity (the ratio of total headquarter workers in management operation to the total number of workers). In some specifications, another firm-level regressor i.e., firm size (total employment), is included as well.[9] All RHS variables are transformed into logarithms in order to minimize the sensitivity of my regression results to outlying observations. Finally, Equation (2.1) is estimated by a fixed-effects conditional logit estimator.

2.5.1.2 Estimation Results

Table 2.1 shows summary statistics for all explanatory variables used in this paper. From the table, we can see enough within variation of capital intensity to identify Equation (2.1).[10] Within variations in other industry-level intensities are approximately one-third or two-third of the between variation.

[8] Corcos et al. (2012) found that firm-level capital intensity also determines intrafirm-trade participation; however, I think that using firm-level capital intensity opens the possibility of endogeneity bias in this case.

[9] From Table 1, we can see that the within variation of firm size is very small relative to the between variation. Thus, firm size in this case could be a proper firm-level control.

[10] According to Kims (2013) study that calculates the capital intensity in Korea over the past 20 years from the Mining and Manufacturing Survey, the capital intensities of Korean industries increased 20% during 2006-2009, which is consistent with the pattern found here.

Table 2.2 provides estimation results pertaining to Equation (2.1). Columns 2-4 contain results related to the choice between vertical integration and outsourcing choice estimation. From the results in the first row (i.e., estimation without firm controls), we can see that higher capital intensity increases the likelihood of all types of vertical integration choices and decreases outsourcing choice probabilities (except for foreign outsourcing). Within vertical integration, the impact of capital intensity is larger on the choice of foreign direct investment (FDI) than on domestic integration (DI). Among the outsourcing choices, the effect of capital intensity on domestic outsourcing (DO) seems to dominate. Also, these estimated effects of capital intensity are not sensitive to the inclusion of firm-level controls (second row).

Table 2.3 shows estimation results with additional industry-level intensities.[11] First, when domestic and foreign choice are combined (columns 2 and 5), capital intensity still affects the ownership choice differently, which is evident in the opposite signs of capital intensity effect estimates between vertical integration estimation (column 2) and outsourcing estimation (column 5). The effects of management intensity and R&D intensity are partially consistent with that of capital intensity. The greater the share of management workers, the lower the likelihood of outsourcing; furthermore, the greater the R&D intensity, the higher the probability of vertical integration. The effect of advertising cost intensity, however, turns out to decrease the likelihood of being mainly a vertical integration firm, which is opposite to the expected sign.

Columns 3 and 6 compare the effects of industry intensities on the foreign ownership choices. Although no statistically significant effect can be found from foreign outsourcing regression, capital intensity still has a positive effect on the likelihood of being a mainly FDI firm. The last columns of each block (columns 4 and 7) compare different patterns within domestic sourcing modes. These results support the predictions of Antràs (2003): the positive effect of capital intensity on domestic vertical integration and the negative effects of capital and management intensity on domestic outsourcing. No other statistically significant

[11]The same firm control (i.e., firm size) is included. Estimation results without firm control are still the same, but they are not provided in order to save space.

effects against the model are estimated. Combining results from Tables 2.2 and 2.3, firms' integration choices are estimated as highly related with industry capital intensity, which is consistent with our first hypothesis. Management intensity and R&D intensity are also important.[12] And these firm-level estimation results confirm findings from previous studies based on industry data.

2.5.2 Hypothesis 2

2.5.2.1 Estimation Methods

Estimation Equation (2.2) is specified for Hypothesis 2 in Section 2.3.2.

$$Pr(y_{it}) = \Lambda(\beta^j TFP_{it} + X'_{it}\delta^j + \mu_i) + v_{it} \qquad j = H, L \tag{2.2}$$

Here, y_{it} is a binary dependent variable either for FDI choice, foreign outsourcing (FO) choice or offshoring choice. The offshoring binary variable is constructed by combining FDI and foreign outsourcing (FO) binary variables. The key regressor is firm-level total factor productivity, TFP_{it}, which is estimated by the Levinsohn-Petrin semiparametric method and is a standard technique in the literature.[13] Assuming common production technology for each 2-digit industry, total factor productivity is obtained after estimating value-added form production function.

According to Hypothesis 2, the effect of productivity is expected to differ by industry type, so Equation (2.2) is estimated separately for each sub-sample. The sample is split based on industry capital intensity. This is done to test whether the effect of productivity on the firm's organization decision varies by level of headquarter importance. A high-capital-intensity industry here (j = H) is defined as one with a five-year average capital intensity

[12] The inclusion of year FE effect makes all the industry-level intensities statistically insignificant. The inclusion of time dummy variables might absorb too much within variations in the industry-level variables. To check for this, a random effect estimation was performed and the same effects shown in Tables 2.2 and 2.3 were found. Also, RE results are not sensitive to the inclusion of year FEs.

[13] The Olley-Pakes method was also applied to construct TFPs, as it has a high correlation, 0.8, with the Levinshon Petrin TFP. This paper mainly uses LP productivity.

above the mean, median, or 75^{th} percentile. Also, a low-capital-intensity industry (j = L) is one with a capital intensity below the mean, median or 25^{th} percentile. As before, Equation (2.2) is estimated by fixed effects conditional logit.

2.5.2.2 Issue on Endogeneity bias

Endogeneity bias may arise from the possible correlation between productivity and the error term in Equation (2.2). For example, higher productivity can increase the amount of FDI as well as other types of sourcing. Then, changes in other sourcing amounts can affect the probability of being a FDI firm. Also, there would be reverse causation from FDI to productivity. So, the included RHS variable, TFP, could be correlated with the error term. If the productivity is correlated only with the unobservable time-invariant firm heterogeneity term, μ_i, then potential endogeneity bias can be controlled by fixed-effect estimation; however, the estimation would suffer from endogeneity bias when productivity is correlated with the idiosyncratic error component, v_{it}. To control for this possibility, an IV estimation is conducted.

Since the baseline estimation equation is non-linear, instead of the conventional IV technique, a control function approach (which is flexible to functional form) is adopted. As an instrumental variable for the contemporaneous TFP, the first lag of TFP is used. This is a valid instrumental variable for the following reasons. First, it is evident that the lag of TFP is correlated with the current TFP. Second, when the first lag of TFP is included in the original estimation equation (in addition to current TFP), no lagged productivity effect is found. That is, the first lag of TFP affects the sourcing decision only through the current TFP. One might think this counterintuitive based on the fact that FDI usually takes time to begin; however, the dependent variable here is the binary variable that indicates the maximum sourcing type. In this case, the productivity shock in 2006 could affect the amount of foreign direct investment in 2008, but not be large enough to make the amount the maximum out of all modes.

Using an instrumental variable, a two-step estimation is performed. In the first stage (Equation (2.3)), the current TFP is regressed on the first lag of TFP and the same included RHS variable. Since this first-stage regression is a dynamic model, Arellano and Bond two-step GMM estimation is applied to obtain consistent coefficients. In the second stage (Equation (2.4)), the residuals obtained from the first-stage estimation are included to control for the potential endogeneity bias. Standard errors throughout this paper are obtained by bootstrapping with 399 replications.

$$First\ Stage: \qquad TFP_{it} = \rho TFP_{i,t-1} + X'_{it}\eta + u_{it} \tag{2.3}$$

$$Second\ Stage: \qquad Pr(y_{it}) = \Lambda(\beta^j TFP_{it} + X'_{it}\delta^j + \gamma^j \hat{e_{it}} + \mu_i) + v_{it}, \quad j = H, L \tag{2.4}$$

2.5.2.3 Results : FDI choice

Table 2.4 shows the estimation result of Equations (2.2) and (2.4) for the FDI choice estimation. The upper half of the table presents the TFP effects obtained from the high-capital-intensity subsample, and the lower half presents the results for the low-capital-intensity subsample.

From the results pertaining to estimation Equation (2.2), provided in the first and second row on each side (upper and lower half), we can see the positive and statistically significant TFP effect across all kinds of sample partitionings (above mean, median, and 75th percentile of capital intensity) in the high-capital-intensity industry. Also, this positive productivity effect is not sensitive to the inclusion of firm size and year fixed effects. The year fixed effect here can capture macro shocks, including exchange rate changes during sample periods. In the low-capital-intensity subsample, positive TFP effects are still prevalent; however, the TFP effects become statistically indistinguishable from zero in industries with the lower capital intensities. This is consistent with results from Nunn and Trefler (2012). In terms of the magnitude of the TFP effects, estimated coefficients in low-capital-intensity sectors are approximately two-thirds of those in high-capital-intensity sectors.[14]

As mentioned in the previous section, a two-step estimation (Equations (2.3) and (2.4)) was performed to check whether the baseline estimation results (shown in rows 1 and 2) were confounded due to the potential endogeneity bias. From the first-stage regression (Equation (2.3)), the estimated coefficient of the first lag of TFP is found to be 0.833 and the reported Wald statistic is 111.38 with a corresponding p-value is 0.000. The AR (1) test rejects the null hypothesis of first-order serial correlation, and the AR(2) test does not reject the second-order serial correlation at the 5 % significance level. When year-fixed effects are included in both stages, the estimated coefficient of the first lag of TFP is 0.307 with a p-value of 0.000. The Wald statistic is 300.03. Also, the null hypothesis of first-order serial correlation is still rejected and second-order serial correlation is not rejected even at very low significance levels, indicating no misspecification in the first-stage estimation with or without year-fixed effects.

The third row of the top and bottom panels of Table 2.4 provide second-stage estimation (Equation (2.4)) results. After controlling for potential endogeneity bias, positive and statistically significant TFP effects are found only in capital-intensive industries. Based on the magnitude of the estimates, the TFP effect becomes larger upon instrumenting in the case of high-capital-intensity industries. The downward bias of the baseline estimate indicates that it may have failed to capture a possible channel through productivity affects the choice in favor of FDI. That is, a productivity shock can favorably affect the foreign outsourcing decision in the capital-intensive sector, which in turn can prevent the firm from being primarily an FDI firm.[15] Consistent with the claim, the correlation between first-stage and second-stage residuals in the two-step estimation turns out to be negative and statistically significant.

[14] One of the drawbacks of the panel logit estimation method is that calculating the marginal effect of the independent variables is infeasible. Additionally, LPM FE estimation was conducted and very similar patterns of TFP effect were found. Although the Linear Probability model could not incorporate the non-linearilty, inferred marginal effect on FDI choice in above-median industry (i.e., without firm control and year-fixed effect) indicates that a 10% increase of TFP would increase FDI main choice probability by 0.13%.

[15] The positive correlation between productivity and foreign outsourcing participation in capital-intensive industries can be found from Table 2.10.

In the low-capital-intensive subsample, the estimated coefficient of control function i.e., the first-stage residual is not statistically significant. That is, in the less-capital-intensive sectors, enodogeneity bias might not exist.

2.5.2.4 Results : Foreign outsourcing and offshoring choice

The foreign outsourcing choice estimation can be found from Table 2.6. From the baseline estimation (shown in the first and second row), no conclusions can be drawn as no estimated TFP effects are statistically significant. The dramatically different patterns between foreign outsourcing and previous FDI estimation results can be seen from the two-step estimation results (shown in the third row). Now, we can see the positive and statistically significant TFP effect in the less-capital-intensive subsample, which is the opposite of what was seen in the case of FDI. Again, there might be another effect of productivity on the foreign outsourcing choice through the effect of TFP on domestic outsourcing decisions.[16] This possible correlation between TFP and the error term is corrected using the control function approach.

The effect of productivity on offshoring choice is shown in Table 2.7. Since the offshoring-dependent variable is constructed by combining FDI and FO dependent variables, the positive and statistically significant TFP effects are found in the middle range of the capital intensities, which is somewhere between the results for the FDI and FO choices.

Overall, Hypothesis 2 seems to be supported by empirical evidence. It is found that higher productivity leads to higher likelihood of FDI choice in capital-intensive industries. Foreign outsourcing likelihood is positively related to productivity in the less-capital-intensive industries when potential endogeneity is controlled for. Offshoring choice seems to resemble FDI choice possibly due to the greater prevalence of FDI activity among Korean manufacturing firms.

[16] The empirical finding that productivity affects domestic outsourcing participation is omitted to save the space but can be provided on request.

2.5.3 Hypothesis 3

This section provides a description of the process to analyze the Hypothesis 3 by a discrete time duration model.

Jenkins (1995) provides a simple practical approach for the discrete-time duration analysis when the sample is selected at a certain state (stock sample) and interviewed over a fixed interval. After first showing that the conditional survivor probability only requires data between the sample selection and the interview periods, the paper shows that sequence likelihood can be expressed as a usual binary dependent variable regression likelihood, such as logit or probit. That is, we can apply the standard binary dependent regression technique to the duration type analysis after data reorganization.

For Hypothesis 3, the selected base sample consists of firms that continuously participate in domestic outsourcing from 2006 to 2010 and do not participate in FDI activity in the initial year (i.e., 2006). Then, the event is defined as their first time participating in FDI activity. The time-varying regressor that affects the occurrence of this event is firm-level total factor productivity. As part of the data reorganization, observations after the event year (FDI participation year) are dropped since the unit of analysis is now the years of event occurrence rather than the firms. Different from duration type studies that also focus on survival time hazard rate estimation, this paper focuses primarily on the effect of the time-varying regressor on the event given the relatively short time periods. Finally conventional logit estimation is applied using the binary-dependent variable on FDI participation along with the time-varying regressor, i.e., productivity. Also, year dummy variables are included.

Table 2.7 shows the results of discrete time duration analysis. From the estimation with full sample (column 1), we can clearly see that the total factor productivity affects domestic outsourcing firms' FDI participation over time. The estimated average marginal effect is 0.007. That is, a 10% increase in TFP corresponds to about a 0.1% increase in the probability of starting FDI. In the estimation with partitioned sample (columns 2-7), the

TFP effect does not differ across capital intensity when the sample is split by the mean of capital intensity; however, when it is compared with the median subsamples, we can see that the positive TFP effect exists only in capital-intensive industries. Also, the magnitude of TFP impact becomes larger than full sample estimation. In the subsamples with extreme value of capital intensity, the estimated sign is reversed but is not statistically distinguishable from zero.

Generally, in the dynamic context, TFP improvement plays a role in domestic outsourcing firms decision about foreign sourcing involvement. This is in line with Hypothesis 3; however, these estimated TFP effects are not robust to the inclusion of firm controls. This may be due to the simple discrete type of approach adopted here which is unable to incorporate unobserved firm heterogeneity. Although this evidence of dynamic behavior can supplement the empirical exploration of the firm organization, a continuous time duration model with data on longer time periods that can also handle with firm heterogeniety would strengthen the results in this section.

2.6 Participation Behavior

As a robustness check, estimation Equations (2.1) and (2.2) are estimated with participation-dependent variables. Although participation of a particular type of sourcing does not necessarily mean that it is firms optimal sourcing choice, we can expect the same determinants, capital intensity and productivity, and impact on the pattern of participation behavior. This conjecture is empirically confirmed and presented in this section.

Table 2.8 shows the estimation results of Equation (2.1) for Hypothesis 1. The effect of capital intensity is still estimated to be positive and statistically significant on the participation of vertical integration, including FDI and DI. Comparing the estimated magnitude with those in Table 2.2, a larger impact of capital intensity on the FDI participation is now estimated. This is a reasonable result as firms should first participate in FDI in order for FDI to be their main choice. Different from the results in Table 2.2, a positive capital intensity effect on outsourcing participation is estimated; however, no statistical inference can be drawn from these estimates.

The impact of productivity on the FDI and foreign outsourcing participation decision can be found from Tables 2.9 and 2.10. Still, the FDI participation decision is affected by the total factor productivity only in the higher-capital-intensive subsamples. Also, the magnitude of the effect of TFP on FDI participation is higher than on FDI as the main choice, which can also be reconciled with the relative ease of FDI participation (compared to being a primarily FDI firm). A significant difference between main choice behavior and participation behavior is found from the foreign outsourcing regression. Although the results for the case of lower-capital-intensive industries are similar, TFP does actually increase foreign outsourcing participation probability in the capital-intensive sector. Accordingly, we can infer from the results that firms would join both foreign outsourcing and FDI as productivity grows but the effect on FDI participation is stronger in capital-intensive industry. To summarize, except for the case of foreign outsourcing, Hypotheses 1 and 2 still hold even with participation-dependent variables.

2.7 Summary and Conclusion

Analyzing different patterns of global sourcing behavior is useful to understand today's globally linked economy. Property rights models of global sourcing in particular pay attention to the role of contract incompleteness. Due to the roles of contract incompleteness and the fixed cost of global sourcing, models by Antràs (2003) and Antrà and Helpman (2004) theoretically find that capital intensity and productivity are the two key elements that drive the different offshoring choices.

Using Korean firm-level panel data, I have empirically investigated the determinants of firms' organizational choices. The main predictions of the two benchmark property rights models, Antràs (2003) and Antràs and Helpman (2004), are validated by my study. Consistent with the findings in the literature, the positive association between capital intensity and the internalization decision is found across different specifications. After controlling for the potential endogeneity in the sourcing choice through a two-stage control function method, the results lead to the conclusion that higher productivity with greater (lower) capital intensity induces a choice of foreign integration (outsourcing). These main results are supplemented by the examination of dynamic behavior of domestic outsourcing firms that show potential FDI participation with improving productivity over time. Some of the sourcing participation behaviors turn out to be different from the main sourcing behaviors. This would be an interesting topic for further investigation.

Effects are identified through fixed effects estimation which only uses changes in firms' sourcing status over the years; however, the main estimation results are not specific to the fixed effects logit estimation. Quite similar results are obtained from a linear probability model (LPM) with firm-fixed effects. Random effects estimation is not appropriate in this study because it is reasonable to assume that firm-level productivity is correlated with unobservable firm heterogeneity. The Hausman test based on the LPM also supports the fixed-effects assumption.

CHAPTER III

Offshoring, Exports and Employment : Theory and Evidence from Korean Firms

3.1 Introduction

In large parts of the developed world, manufacturing employment has been declining. This decline has coincided with increasing globalization, mainly taking the form of greater openness to international trade. In order to understand the role of international trade in the decline of manufacturing employment we first need to understand whether it is coming about through the exit of firms from the manufacturing sector or a decline in employment at the firm level. As pointed out by Groizard, Ranjan and Rodriguez-Lopez (2014), in the US computer and peripheral equipment industry, the period 2001-2010 was one which experienced a sharp 44 percent decline in employment and a 28 percent decline in the number establishments, indicating that employment in the industry declined both through firm exit as well as reductions in employment at the firm level. At the same time the industry witnessed a significant rise in input and final good trade.

Turning to a late industrializer, namely Korea, we find something similar. Between 1991 and 2012, manufacturing employment has declined from 5.2 million to 4.2 million, while its manufacturing share of employment has fallen from 28 percent to 17 percent (Source: OECD). In this paper, we study whether there is a decline in firm-level employment in response to greater trade openness. In particular, we want to look at how firm-level employment is related to input and output trade. However, it needs to be realized right at the outset that there could be considerable heterogeneity in how firms react to greater possibilities for input and output trade. For example, these possibilities can provide some firms with the opportunity to import inputs, which could either be substitutes for or complements to inputs produced by workers in-house, depending on which firm employment could go up or down in response to greater input imports. Also, greater export and import possibilites will benefit the relatively productive firms that will be able to compete with foreign firms in the world market, while they could hurt the less productive firms who will not be able to survive foreign competiton or might in response shrink their output and employment.

To study various possible employment outcomes related to trade, we extend the small country trade model with firm heterogeneity, developed by Demidova and Rodriguez-Clare (2013) as an extension of the well-known Melitz (2013) model. In the Demidova-Rodriguez-Clare model we incorporate offshoring (along with final goods trade). Our theory predicts that a decrease in the trading cost of final goods will lead to losses for non-exporting firms in employment due to the "selection effect," equivalent to greater effective competititon in the domestic market. Our model predicts that in addtion to such an effect, exporting firms also experience an opposing effect: an increase in their labor demand due to an increase in exports as exporting costs are lower. However, when there is a decrease in the offshoring cost or the cost of importing inputs, we should expect non-offshoring firms (whether exporting or not) to suffer losses in employment due to the "selection effect" or greater effective competition primarily driven by the lower prices charged by each offshoring firm (due to the cost reduction brought about by offshoring). Offshoring firms experience another effect on their labor demand, which is an increase in it due to the productivity effect (or cost reduction) when inputs produced by in-house labor and imported inputs are complements. Among the offshoring firms, those that export as well will also experience a positive exporting effect: a lower cost of production or higher productivity will help expand exports and in turn employment.

Our theoretical model acts as a useful guide for empirically investigating the firm-level employment effects of offshoring and final goods trade, especially when it comes to the effects that are heterogeneous across firms. However, there are important aspects of the real world that our theoretical model does not capture, but which might show up in the results of our empirical investigation. Firstly, we do not allow for a competitive effect of offshoring on the market for the import-competing intermediate input (domestic substitute of the foreign input). When the offshoring cost (trading cost of the offshored input) goes down, a larger fraction of firms would offshore, which could depress the price of the import-competing intermediate input through a fall in its demand. Thus, it is quite possible that then there would be a positive productivity effect not only in the case of offshoring firms but also other firms. Secondly, we also take the intrinsic productivity of each firm as a given throughout after a firm's draw from a given distribution. The only change we see is in effective productivity (a decline in unit cost) that results from greater offshoring due to a fall in the trading cost of the offshored input. There is no other productivity effect of trade in our model, in the form of learning, R&D etc. There is, however, overwhelming evidence showing a positive productivity effect of import competition which makes firms more efficient.

We perform our empirical investigation using firm-level data from Korea. The firm-level Korean panel data are drawn from Survey of Business Activity (SBA) for the years 2006-2011. Our empirical work also requires trade costs for final goods as well as separately for intermediate goods or inputs. We use tariffs from the World Integrated Trade Solution (WITS), which need aggregation and concording to the Korean 3-digit classification. Transport costs are constructed at the 3-digit level by adjusting the US transport costs (for disaggregate categories) for different distances between Korea and its various major trading partners, which is followed by import-weighted aggregation, and then a process of concordance. The trade costs are the sum of import tariffs and transport costs. From the final goods trade costs, we create input trade costs using the input-output table for Korea, along with some additional concordance. In addition, we need measures of output and input elasticities of substitution, which are derived from the elasticities of substitution in Broda and Weinstein (2006) and from Rauch (1999), again requiring further aggregation and concording as well as transformation using the input-output matrix.

Our empirical analysis yields several results, most of them consistent with our theory and/or our economic intuition. We find that input and output trade cost reductions increase both the volume of firm-level exports and imports as well as the number of firms exporting and the number importing. Also, there is a strong positive association between firm-level exports and firm-level imports of inputs. We next look at the direct impact of trade costs on firm-level employment. As expected from theory, the impact of the input trade cost on firm employment changes from positive to negative as we move from the subsample of firms in industries where inputs are on average substitutable to the subsample of firms in complementary input industries. We also find that, on the whole, greater imports are associated with greater employment, indicating that on average the imported inputs are complementary to firm-level employment. Consistent with our theoretical predictions, the magnitude of the postive employment effect of input imports is greater for exporting firms and in firms in industries where inputs are relatively more complementary. These results are fairly robust to specification, including instrumental variables estimation, which we perform to address the simultaneity of employment and imports.

While we use an instrumental variables approach to address our problem of simultaneity, we also use an alternative approach of difference-in-difference with propensity score matching similar to the one used by Girma, Geenaway, and Kneller (2003). Import status and employment might be simultaneously determined as both are ultimately functions of the firm's intrinsic productivity, i.e., larger firms (firms with higher output and employment levels) are the ones that are likely to offshore (import inputs). Across all our difference-in-difference specifications (with propensity score matching) importing (of inputs) leads to higher domestic firm-level employment as well as firm-level exports. There is also some evidence that imports have a bigger positive impact on employment for exporting firms and this impact keeps going up with the level of exports. Moreover, as found with our other regressions, here as well the employment increasing impact of importing inputs from abroad is greater when input complementarity is higher.

In many ways, the paper closest to ours is the one by Groizard, Ranjan and Rodriguez-Lopez (2013). Using estbalishment level data from Californian manufacturing industries from 1992 to 2004, they find that, consistent with the prediction of trade models with heterogeneous firms, a decline in trade costs (input as well as output) is associated with job destruction (creation) in the least (most) productive establishments, with firm death most likely in the case of the least productive establishments. Interestingly, the effects of input trade costs on job creation or destruction at the establishment level are greater in magnitude than those of output trade costs. Note that this paper, unlike ours, does not look at the interaction between importing and exporting or the role of input substitutability or complementarity in the determination of firm-level employment.

The earliest related work which looks at the heterogeneous impact of trade on firm or plant-level employment is Levinsohn (1999), who finds that in Chile, during their period of trade reforms (1979-86), there were substantial inter-plant differences in the rates of job creation and destruction based on plant size, with the smallest plants three times more likely to destroy jobs through firm death but experiencing smaller magnitudes of job contraction or destruction through contraction or expansion compared to the largest plants. The latter results are along the lines of the findings of Biscourp and Kramarz (2007), who use French firm-level manufacturing data from 1986 and 1992.

There are empirical studies that, similar to ours, try to separate the effects of input and final-good trade costs but on other firm-level outcomes. The main outcome variables to have been studied in that literature are plant-level productivity (Amiti and Konings, 2007 and Topolova and Khandelwal, 2011) and the range of goods produced at the firm-level (Goldberg, Khandelwal and Pavcnik, 2010). There is considerable evidence from these studies that reductions in trade costs, especially in input trade costs, can result in increases in firm/plant productivity and the product variety at the level of the firm. While these outcome variables are quite different, one could easily see how the impact of trade and trade costs on these outcome variables could constitute additional channels through which trade and trade costs affect employment.

3.2 The Model

We extend the small country trade model of Demidova and Rodriguez-Clare (2013) to incorporate offshoring (along with final goods trade). Here the country of interest is called Home which trades with rest of the world.

3.2.1 Preferences and Demand

The total size of the workforce in Home is $\mathbb{L}$, which is also the number of individuals in the economy. Individuals' preferences are defined over a number of differentiated, non-numeraire goods and a homogeneous, numeraire good. In particular, the utility function for the representative consumer is given by

$$\mathbb{U} = H + \sum_{i=1}^{N} \frac{\eta}{\eta - 1} Z_i^{\frac{\eta-1}{\eta}}, \tag{3.1}$$

where H denotes the consumption of the homogeneous good, $Z_i = \left(\int_{\omega \in \Omega_i} z_i^c(\omega)^{\frac{\sigma_i - 1}{\sigma_i}} d\omega \right)^{\frac{\sigma_i}{\sigma_i - 1}}$ is the CES consumption aggregator of a continuum of differentiated varieties within the ith differentiated good or sector, and η is the elasticity of demand for Z_i (η governs the substitutability between homogenous and differentiated goods). In Z_i, $z_i^c(\omega)$ denotes the consumption of variety ω, Ω_i is the set of differentiated varieties available for purchase, and $\sigma_i > 1$ is the elasticity of substitution between varieties. We assume that $\sigma_i > \eta$ so that differentiated-good varieties (within a differentiated good or sector) are better substitutes for each other than for the homogeneous good.

For differentiated goods, the representative individual's demand for variety ω of the ith differentiated good is given by $z_i^c(\omega) = \frac{p_i(\omega)^{-\sigma}}{P_i^{1-\sigma}} P_i Z_i$, where $p_i(\omega)$ is the price of variety ω, $P_i = \left[\int_{\omega \in \Omega_i} p_i(\omega)^{1-\sigma_i} d\omega\right]^{\frac{1}{1-\sigma_i}}$ is the price of the CES aggregator Z_i, and hence, $P_i Z_i$ is the household expenditure on differentiated varieties of good i. Given the quasi-linear and additively separable utility in (3.1), it follows that $Z_i = P_i^{-\eta}$, and therefore, the aggregate demand for variety ω of the ith differentiated good is given by

$$z_i^d(\omega) = p_i(\omega)^{-\sigma_i} P_i^{\sigma_i - \eta} \mathbb{L}. \tag{3.2}$$

The homogeneous good, H, is produced by perfectly competitive firms using domestic labor only. One unit of domestic labor produces one unit of the homogeneous good. This fixes the domestic wage at 1 as long as some homogenous good is produced, which we assume to be the case. Therefore, the income of each household simply equals 1. We assume that the parameters are such that $P_i Z_i \equiv P_i^{1-\eta} < 1$ for all i, so that a typical individual has enough income to buy all differentiated goods.

The firms in Home face the following export demand for their products:

$$z_i^x(\omega) = A p_i^x(\omega)^{-\sigma}.$$

where p_i^x is the price faced by consumers in the export market. However, there is a fixed cost of exporting, f_i^x, and an iceberg trading cost, which has a general component τ_i^x and a firm-specific component which will be discussed later. As a result, not all firms will export. Note that the above demand function captures the idea that the income and price index in the rest of the world are taken as given by Home firms.

As in Demidova and Rodriguez-Clare (2013) we assume there is a fixed number of firms producing varieties of the ith good in the rest of the world denoted by N_i^f. Note that this is the implication of the small country assumption, which means the small country, Home is not able to affect the number of firms in the rest of the world and takes that number as given. However, only a subset of firms in the rest of the world will find it worthwhile to export to Home. These exporting firms from the rest of the world also face a fixed cost of exporting, f_i^f, and an iceberg trading cost, τ_i^f. As a result, only a subset of these firms are able to export to Home. In the rest of the paper, we are going to make the following symmetry assumption: $\tau_i^x = \tau_i^f = \tau_i$.

3.2.2 Production Structure

From now on, in order to avoid clutter we drop the subscript i from our notation. In other words, we are focusing on firms in a given differentiated goods sector (out of several of them). Suppose that after incurring an entry cost of f_E a firm draws a triplet $\psi = (\varphi, t_x, t_o)$ where φ_v is the exogenous productivity of the firm, $t_x \in [1, \overline{t_x}]$ is the firm-specific variable cost of exporting, and $t_o \in [1, \overline{t_o}]$ is the firm specific variable cost of offshoring. ψ is drawn from a distribution $G(\psi)$ with the p.d.f. $g(\psi)$. The production function of a Home firm with triplet ψ and whose productivity is φ is $z(\psi) = \varphi Y(\psi)$, with

$$Y(\psi) = \left[\alpha L(\psi)^{\frac{\rho-1}{\rho}} + (1-\alpha) M(\psi)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}, \tag{3.3}$$

where $L(\psi)$ is a composite of inputs produced *within* the firm, $M(\psi)$ is a composite of inputs procured from *outside* the firm, and $\rho \geq 0$ is the elasticity of substitution between the two types of inputs.[1] We assume that one unit of labor is required to produce one unit of $L(\psi)$.

The composite input $M(\psi)$ can be either procured domestically or it can be offshored. Let $p_s(\psi)$ denote the price paid by a firm with offshoring status s for a unit of composite input $M(\psi)$, for $s \in \{n, o\}$, where n denotes "not offshoring" and o denotes "offshoring". If $M(\psi)$ is procured domestically, then $p_n(\psi) = p_n$ for all ψ, that is, we are implicitly assuming that p_n units of the numeraire good translate into one unit of input $M(\psi)$. If the production of $M(\psi)$ is offshored, a firm has to pay a fixed cost of offshoring, f_o, and a variable cost,

[1] ρ, like some of the other parameters, can vary across the various differentiated goods sectors.

$p_o(\psi)$, per unit of input $M(\psi)$. Let p_M^* denote the price of input M in the foreign foreign country, and let $\lambda > 1$ denote the iceberg cost of offshoring common to all firms and recall that t_o is the firm specific variable cost of offshoring. It follows that

$$p_o(\psi) = \lambda t_o p_M^*, \tag{3.4}$$

so that a decline in λ makes offshoring more attractive. Note that domestic firms have incentives to offshore only if $p_o(\psi) < p_n(\psi) = p_n$.

Given our production function and (3.3), the marginal cost of a firm with triplet ψ and offshoring status s is given by $\frac{c_s(\psi)}{\varphi}$, where

$$c_s(\psi) \equiv \left[\alpha^\rho + (1-\alpha)^\rho p_s(\psi)^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{3.5}$$

is the price of a unit of $Y(\psi)$ for a firm with status $s \in \{n, o\}$. Whenever a firm offshores it must be the case that $p_o(\psi) < p_n$, therefore, $c_o(\psi) < c_n(\psi) = c_n$ as well.

There is a fixed cost of operation, f, for every producing firm. In addition to offshoring, firms can export as well. There is a fixed cost of exporting f_x, an iceberg shipping cost of final goods common to all firms, $\tau > 1$, and a firm specific shipping cost t_x mentioned earlier.

3.2.3 Equilibrium

With CES preferences, the price set by a Home firm with productivity φ_v in the home market is

$$p(\psi) = \left(\frac{\sigma}{\sigma-1}\right)\frac{c_s(\psi)}{\varphi}, \text{ for } s \in \{n, o\} \tag{3.6}$$

The price that a firm charges in the foreign market, if it exports, is given as follows.

$$p^x(\psi) = \left(\frac{\sigma}{\sigma-1}\right)\frac{\tau t_x c_s(\psi)}{\varphi}, \text{ for } s \in \{n, o\} \tag{3.7}$$

Given the above description of the model, there are 4 possible types of firms: Those which sell only domestically and do not offshore, those which export but do not offshore, those which offshore but do not export and those which do both offshoring and exporting.

A firm with triple $(\varphi, t_x,\ t_o)$ chooses the mode that maximizes its net profit. The net profit is given by

$$\pi(\psi;\tau,\lambda)=\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_s(\psi)}{\varphi}\right)^{1-\sigma}\left(\frac{P^{\sigma-\eta}\mathbb{L}+(\tau t_x)^{1-\sigma}AI_x}{\sigma}\right)-f-f_oI_o-f_xI_x \tag{3.8}$$

where I_o is the indicator variable for an offshoring firm and I_x is the indicator variable for an exporting firm.

What condition do we need for the marginal surviving firm to not offshore or export? Suppose the productivity of this firm is $\widehat{\varphi}$. If this firm doesn't export or offshore then

$$\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_n}{\widehat{\varphi}}\right)^{1-\sigma}\frac{P^{\sigma-\eta}\mathbb{L}}{\sigma}-f=0 \tag{3.9}$$

The above gives the value of $\widehat{\varphi}$ for given P. It is shown in the appendix that the sufficient conditions for the marginal surviving firm to neither export nor offshore are

$$\left(\left(\frac{c_n}{c_o(\psi)|_{t_o=1}}\right)^{\sigma-1}-1\right)f<f_o;\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_o(\psi)|_{t_o=1}}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{\tau^{1-\sigma}A}{\sigma}\right)<f_x.$$

The former requires the offshoring fixed cost to be high relative to the fixed cost of operation f.

Now, substituting out $P^{\sigma-\eta}$ in (3.8), the net profits can be written as

$$\pi(\psi,\widehat{\varphi};\tau,\lambda)=\left(\frac{\varphi c_n}{\widehat{\varphi}c_s(\psi)}\right)^{\sigma-1}f+\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_s(\psi)}{\varphi}\right)^{1-\sigma}\left(\frac{(\tau t_x)^{1-\sigma}A}{\sigma}\right)I_x-f-f_oI_o-f_xI_x \tag{3.10}$$

That is, profits are a function of $\widehat{\varphi}$ and triple ψ.

The model is solved using the free entry condition

$$\Pi \equiv \int_{\widehat{\varphi}}^{\infty} \int_{t_o} \int_{t_x} \pi(\psi, \widehat{\varphi}; \tau, \lambda) g(\psi) dt_x dt_o d\varphi = f_e \tag{3.11}$$

In the above t_o denotes $t_o \in [1, \overline{t_o}]$ and t_x denotes $t_x \in [1, \overline{t_x}]$. The proof of existence is given in the appendix. Essentially, the above equation yields a value of $\widehat{\varphi}$. Once we have $\widehat{\varphi}$, we can determine the mode of globalization of each firm given its ψ. A firm chooses the mode that maximizes its net profits from the alternatives listed in (3.10). In general, among active firms, those with low t_x will export, while those with low t_o will offshore. In general, higher productivity firms will engage in offshoring and exporting due to the fixed costs associated with these activities.

Next, we derive the following lemma which is useful in comparative statics below.

Lemma: $\frac{d\widehat{\varphi}}{d\tau} < 0$; $\frac{d\widehat{\varphi}}{d\lambda} < 0$.

That is, decreases in the costs of trading final goods or offshoring both increase the survival productivity cutoff. The result with respect to τ is the standard selection effect in a Melitz model and the result with respect to λ is its analogue for offshoring. Intuitively, a decrease in the cost of offshoring increases the productivity of offshoring firms which increases their sales domestically as well as abroad (for those who export) resulting in a selection effect similar to that for the case of a decrease in the trading cost of final goods. This effect reduces the sectoral price index P (primarily driven by the reduction in the costs and prices and the increases in the sales of the offshoring firms), which in turn has a profit reducing effect. As a result the break-even firm (which is purely domestic both in sales and input use) will be one with a higher productivity.

Since our main aim is in deriving the implications of costs of offshoring and trading final goods on employment, we present the expressions for employment derived in the appendix.

$$L_s(\psi) = \alpha^\rho (\sigma-1) \left(c_s(\psi)^{\rho-\sigma}\right) \left(\frac{\varphi c_n}{\widehat{\varphi}}\right)^{\sigma-1} f + I_x \alpha^\rho \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} c_s(\psi)^{\rho-\sigma} (\tau t_x)^{1-\sigma} \varphi^{\sigma-1} A, \text{ for } s \in \{n, o\},$$

where I_x is an identity function which takes the value 1 if the firm exports, and zero otherwise.

3.2.4 Comparative Statics with respect to τ

$$\frac{dL_s^d(\psi)}{d\tau} = -\alpha^\rho (\sigma-1)^2 \left(c_s(\psi)^{\rho-\sigma}\right) (\varphi c_n)^{\sigma-1} \widehat{\varphi}^{-\sigma} f \frac{d\widehat{\varphi}}{d\tau} > 0$$

That is, there are job losses due to decreased domestic sales arising from the fall in the trading costs of final goods.

$$\frac{dL_s^x(\psi)}{d\tau} = \alpha^\rho (1-\sigma) \left(\frac{\sigma}{\sigma-1}\right) c_s (\psi)^{\rho-\sigma} t_x^{1-\sigma} \tau^{-\sigma} \varphi^{\sigma-1} A < 0$$

There are job gains due to increased exporting. Combining the above results we get the following prediction for different types of firms.

$$\frac{d\log L(\psi)}{d\tau} = -\frac{L^d(\psi)}{L(\psi)} \frac{(\sigma-1)}{\hat{\varphi}} \frac{d\hat{\varphi}}{d\tau} + \frac{L^x(\psi)}{L(\psi)} \frac{(1-\sigma)}{\tau} \tag{3.12}$$

Therefore, for non-exporting firms there will be job losses (since in their case $L(\psi) = L^d(\psi)$ and $L^x(\psi) = 0$), but for exporting firms the impact would be ambiguous.

3.2.5 Comparative Statics with respect to λ

For non-exporting firms, we have the following effects on labor demand.

$$\frac{dL_s^d(\psi)}{d\lambda} = -\alpha^\rho (\sigma-1)^2 \left(c_s(\psi)^{\rho-\sigma}\right) (\varphi c_n)^{\sigma-1} \hat{\varphi}^{-\sigma} f \frac{d\hat{\varphi}}{d\lambda} - (\sigma-\rho)\, \alpha^\rho (\sigma-1) \left(\frac{\varphi c_n}{\widehat{\varphi}}\right)^{\sigma-1} f c_s(\psi)^{\rho-\sigma-1} \frac{dc_s}{d\lambda}$$

When $s = n$, then $\frac{dL_s^d(\psi)}{d\lambda} > 0$ because $\frac{dc_n}{d\lambda} = 0$. So, there are losses due to reduced domestic sales for non-offshoring firms. What our model does not capture is that a fall in the trading cost of the offshorable input, by reducing the demand for this input produced in the domestic market, could depress p_n and therefore also c_n. By assumption, in our model there is transformation of the numeraire good into the intermediate input at a constant rate. However, in reality the domestic supply of this input could be upward sloping because of capacity constraints arising from a limited amount of some required specific factor in the background. In addition, there could be some degree of monopoly in the production of this input. When $s = o$, it is very clear that $\frac{dc_o(\psi)}{d\lambda} > 0$, and in the realistic case of $\sigma > \rho$, there is job creation due to increased productivity of offshoring firms arising from the reduction of offshoring costs. However, as mentioned above, in practice the downward pressure on the domestic price of the offshorable input (not captured in our model) could also increase productivity of purely domestic firms.

For exporting firms we have the following additional effects.

$$\frac{dL_s^x(\psi)}{d\lambda} = -(\sigma - \rho)\,\alpha^\rho \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} c_s(\psi)^{\rho-\sigma-1} (\tau t_x)^{1-\sigma} \varphi^{\sigma-1} A \frac{dc_s(\psi)}{d\lambda}$$

Now, when $s = n$, then $\frac{dL_s^x(\psi)}{d\lambda} = 0$ because $\frac{dc_n}{d\lambda} = 0$, that is exporting firms that do not offshore, do not experience any change in labor demand. However, as explained above, $\frac{dc_n}{d\lambda} = 0$ only because in our model we assume constant rate of transformation of the numeraire good into the intermediate input. When $s = o$, then clearly in the case of $\sigma > \rho$, we obtain $\frac{dL_s^x(\psi)}{d\lambda} < 0$ because $\frac{dc_o(\psi)}{d\lambda} > 0$. This is the exporting effect of offshoring. That is, a decrease in the cost offshoring induces exporting firms to increase their exporting activities, which creates increased demand for labor.

Combining the above, we have the following results for the 4 types of firms in our model.

$$\frac{d\log L(\psi_v)}{d\lambda} = -\frac{L^d(\psi_v)}{L(\psi_v)} \left(\frac{(\sigma-1)}{\hat{\varphi}}\frac{d\hat{\varphi}}{d\lambda} + \frac{(\sigma-\rho)}{c_o(\psi)}\frac{dc_o(\psi)}{d\lambda} I_o\right) - \frac{L^x(\psi_v)}{L(\psi_v)}\frac{(\sigma-\rho)}{c_o(\psi)}\frac{dc_o(\psi)}{d\lambda} I_o \quad (3.13)$$

The above is going to give us the estimating equation in the empirical exercise.

3.2.6 Empirical Implications

There are a number of empirical implications of our theoretical model.

1. When there is a decrease in τ (the trading cost of final goods):

i. non-exporting firms suffer losses in employment due to the selection effect (increase in $\widehat{\varphi}$)

ii. exporting firms experience two opposing effects: decrease in their labor demand due to decrease in domestic sales, and increase in their labor demand due to increase in exports

2. When there is a decrease in λ (offshoring cost, which is the trading cost of the offshorable input)

i. non-offshoring firms (whether exporting or not) suffer losses in employment due to the selection effect (increase in $\widehat{\varphi}$)

ii. offshoring firms that are non-exporting experience two opposing effects on labor demand: decrease in labor demand due to the selection effect, but increase in labor demand (when $\sigma > \rho$) due to the productivity effect.

iii. offshoring firms, that also export, experience changes in labor demand to meet both domestic and export sales. They experience the same two opposing effects as non-exporting firms as far as their labor demand for domestic sales is concerned. However, they also experience a positive exporting effect (when $\sigma > \rho$). That is, their labor demand increases to meet the export requirements. This last case is produced by an interaction between exporting and offshoring.

Recall that our model is one with a multi-industry setting where different industries have different σ and ρ and that we just suppressed the industry subscripts to minimize clutter in our notation. We, therefore, have some further implications of our theoretical analysis for empirical work.

3. In industries where $\sigma - \rho$ is large, firms experience a strong productivity effect of offshoring which increases their demand for labor. In industries where $\sigma - \rho$ is small firms experience a weaker productivity effect, and hence the demand for labor is less likely to increase. If $\sigma < \rho$, then the firm demand for labor unambiguously decreases in response to offshoring.

It is important to note that there might be important aspects of the real world that our theoretical model does not capture. Firstly, as already mentioned above, when the offshoring cost goes down, we will have a larger fraction of firms offshoring, which can depress the price of the import-competing intermediate input (offshorable input). This can arise as a result of a limited amount of a specific factor in the background required to produce the input domestically or monopoly power in the domestic market for this input. In addition, the Ricardian nature of our numeraire sector fixes the wage in our model. In the absence of such a sector, the price of the domestically produced input might go down even without the features mentioned above. Thus, it is quite possible that a decline in the offshoring cost (trading cost of the offshored input) leads to a positive productivity effect not only in the case of offshorig firms but also other firms.

We also take the intrinsic productivity of each firm as a given after it has drawn its productivity from a given distribution. The only change we see is in effective productivity that results from greater offshoring due to a fall in the trading cost of the offshored input. There is no other productivity effect of trade in our model, in the form of learning, R&D etc. There is overwhelming evidence showing a positive productivity effect of import competition which makes firms more efficient. This comes not only from the imports of inputs but also from the imports of competing foreign products.

3.3 Econometric Methodology

3.3.1 Basic Estimation

We start with the very basic estimating equations that verify how good our trade cost measures are and whether manufacturing firms in Korea respond to changes in trade costs. These estimating equations confirm whether the intensive and extensive margins of trade (imports and exports) respond to changes in our input and output trade cost measures and whether the direction of that response is consistent with our economic intutition. We start with the following equation to study the impact of trade costs on the intensive margin of imports.

$$\ln(Imports_{ijt}) = \alpha_i^M + \alpha_j^M + \alpha_t^M + \beta_1^M \tau_{jt} + \beta_2^M \lambda_{jt} + \varepsilon_{ijt}^M \tag{3.14}$$

where $Imports_{ijt}$ is the value of imports of firm i in industry j in year t. As in the theory section, τ and λ denote trading costs of output and input respectively. These costs vary across industries over time. Note that the imports of firms are mainly intermediate inputs, so $Imports_{ijt}$ captures the extent of offshoring as defined in our theory section. Since we are taking logarithms here, the zero import firms (non-offshoring firms) automatically get dropped from this regression.

To look at the extensive margin of importing we define an importing dummy $IMP_{ijt} \in \{0, 1\}$ and run the following regression.

$$IMP_{ijt} = \alpha_i^{M'} + \alpha_j^{M'} + \alpha_t^{M'} + \beta_1^{M'} \tau_{jt} + \beta_2^{M'} \lambda_{jt} + \varepsilon_{ijt}^{M'} \tag{3.15}$$

While this is a linear probability model, we also run a Probit version of this regression to confirm that the results are unchanged.

Similarly defining $Exports_{ijt}$ as the level of firm exports and $EXP_{ijt} \in \{0, 1\}$ as the exporting dummy, we can run regressions to study the impact of trade costs on the intensive and extensive margins of exports. These equations are analogous to our estimating equations above for imports.

3.3.2 Simple Estimation of the Association Between Offshoring, Exports and Employment

To look at the average impact of changes in trade costs on employment at the level of the firm (of all types: purely domestic and offshoring and/or exporting), we run the following regression: se the following equation to estimate the impact of τ.

$$\ln(L_{ijt}) = \alpha_i^L + \alpha_j^L + \alpha_t^L + \beta_1^L \tau_{jt} + \beta_2^L \lambda_{jt} + \mathbf{Z}_{ijt}\Gamma^L + \varepsilon_{ijt}^L \tag{3.16}$$

where L_{ijt} is firm-level employment observed on an annual basis and $\mathbf{Z}_{ijt}$ denotes the vector of control variables. We run this regression for the overall sample as well as separately for the subsample of firms in industries where inputs are expected to be substitutes of each other and in the subsample of firms in industries where inputs are expected to be complements. We also tried including interactions of these trade cost variables with exporting and importing status dummy variables. While we will very briefly discuss those results, we do not present them since they are inconclusive. This might have something to do with the fact that while our dependent variable is at the firm level, the trade cost variables are at the industry level, thereby providing inadequate variation for identification to take place. As a result, we run the following regression.

$$\begin{aligned} \ln(L_{ijt}) \;\; = \;\; & \alpha_i^{L'} + \alpha_j^{L'} + \alpha_t^{L'} + \beta_1^{L'} \ln(imports_{ijt}) + \beta_2^{L'}(\rho_{jt} - \sigma_{jt}) + \beta_3^{L'} EXP_{ijt} \\ & + \beta_4^{L'}(\rho_{jt} - \sigma_{jt}) \ln(imports_{ijt}) + \beta_5^{L'} EXP_{ijt} \ln(imports_{ijt}) \\ & + \mathbf{Z}_{ijt}\Gamma^{L'} + \varepsilon_{ijt}^{L'} \end{aligned} \tag{3.17}$$

Here ρ_{jt} and σ_{jt} are the elasticities of substitution between inputs and between output varieties at the industry level. As mentioned above, since we are taking logarithms here, the zero import firms (non-offshoring firms) automatically get dropped from this regression.

We, therefore, try a variant of this specification where we replace $ln(imports_{ijt})$ with $ln(1+imports_{ijt})$. This small change in the regression keeps the zero-import observations in the regression. We also run the regression dropping $EXP_{ijt}\ln(imports_{ijt})$ and instead running the regressions separately for exporting and non-exporting firms. These regressions are run as plain OLS and with random firm effects and year fixed effects, with and without industry effects. For the specification without $EXP_{ijt}\ln(imports_{ijt})$, we also run instrumental variable regressions where $\ln(imports_{ijt})$ and $(\rho_{jt}-\sigma_{jt})\ln(imports_{ijt})$ are instrumented by λ_{ijt}, $(\rho_{jt}-\sigma_{jt})$ and $(\rho_{jt}-\sigma_{jt})\lambda_{ijt}$.[2]

3.3.3 Propensity Score Matching and Difference-In-Difference Estimation

As mentioned above, we have run instrumental variable regressions treating $\ln(imports_{ijt})$ and $(\rho_{jt}-\sigma_{jt})\ln(imports_{ijt})$ as endogenous. Import status and employment might be simultaneously determined as both are ultimately functions of the firm's intrinsic productivity. Thus larger firms (firms with higher output and employment levels) are the ones that are likely to offshore (import inputs). To solve this simultaneity or endogeneity problem we run a difference-in-difference regression with propensity score matching. Our method is similar to the one used by Girma, Geenaway, and Kneller (2003).

First, we restrict the target sample to firms that are observed for the entire sample period, 2006-2011. Then, we define an import starter as a firm that became an importer in 2007, 2008, 2009 or 2010. The treatment group here consists of these firms, since our focus in this paper is on importing of inputs (or offshoring). We excluded complicated cases, namely firms that discontinued importing after they first entered the import market. Our control group consists of firms that did not import at all over our full six year sample period.

Matching firms in the treatment group with those in the control group was performed

[2] In this IV specification we drop the level term in $(\rho_{jt}-\sigma_{jt})$ from the right hand side of the second-stage regression since it is completely insignificant by itself and its presence makes the identification of the impact of other variables difficult, if not impossible. Also, there is no real theoretical basis for the inclusion of the level term in $(\rho_{jt}-\sigma_{jt})$ on the right-hand side.

on a cross-section by cross-section (year by year) basis. That is, for each year (2007, 2008, 2009 and 2010), the following probit model is estimated.

$$P(Import\ Starter_{it} = 1) = F(lnTFP_{i,t-1}, lnL_{i,t-1}, (Sales/WageBill)_{i,t-1}, EXP_{i,t-1}) \tag{3.18}$$

For each year for which we run the probit for propensity score matching, our sample for the probit regression consists of firms that start importing that year and those that do not import at all that year. For each import starting firm that year, a firm from the control group that is the closest in terms of the probability of starting importing that year is selected. After matched firms are identified for each year, all observations on matched firms across all years are pooled to create our final matched sample panel dataset.

To make sure our matching has been successful we perform a test of balancing hypothesis, which consists of t-tests of equality of means of the matching variables between the control and treatment groups. We also checked that for the matching variables the standardized bias, mean difference between treatment and control group adjusted by the square root of average sample variance, was small enough after matching. A rule of thumb is that it should ideally be less than 5% (in absolute value) after matching (Caliendo and Kopeinig, 2008).

To find out the impact of importing on the firm's total employment (or export volume), a difference-in-difference regression was run on the matched panel dataset as per the following estimating equation.

$$y_{it} = \phi + \delta_1 IMP_{i,t-1} + f_i + D_t + \xi_{it} \tag{3.19}$$

Here, dependent variable y_{it} is either $\ln L_{it}$ or $\ln(exports_{i,t} + 1)$. And $IMP_{i,t-1}$ is a dummy variable which for firm i takes the value 1 if it is importing in year $t-1$ (and is 0 otherwise). Given the way our matched data set has been created, this variable takes the value 0 for a treatment firm until it starts importing, and from then on the variable takes the value 1 indicating the post import starting periods for firms in the treatment group. Since the impact of importing of inputs on employment might show up with a small lag and because we want to minimize the endogeneity problem, our left-hand side variable of interest is lagged by a year and δ_1 represent the one-year lagged average change in the outcome, y_{it}, attributable to the firm starting to import. We also try including contemporaneous variables. However, since results do not change qualitatively we do not present them.

To test whether importing effect on employment is affected by the volume of exports or the extent of input substitution, we include four other terms as follows:

$$
\begin{aligned}
y_{it} &= \phi' + \delta_1' IMP_{i,t-1} + \delta_2'(\rho_{jt} - \sigma_{jt}) + \delta_3'(exports_{i,t-1} + 1) + \delta_4'(\rho_{jt} - \sigma_{jt}) IMP_{i,t-1} \\
&\quad + \delta_5'(exports_{i,t-1} + 1) IMP_{i,t-1} + f_i' + D_t' + \xi_{it}' \qquad (3.20)
\end{aligned}
$$

3.4 Data Description

3.4.1 Firm-level Variables

The firm-level Korean panel data are drawn from Survey of Business Activity (SBA) for the years 2006-2011. Conducted by Statistics Korea, this survey covers all business entities with a capital stock greater than US$300,000 and employment greater than 50 regular workers. Restricting ourselves to the manufacturing sector, our sample consists of 8,094 firms and 33,098 observations. Our firm-level import, export, sales, capital stock and employment data come from the SBA.

3.4.2 Trade Cost

The sectoral trade cost is an important determinant of offshoring, imports and exports. To match with our firm-level data, the trade cost is constructed at the 3-digit level of the Korean Standard Industrial Classification (KSIC, revision 9). The specifics of the construction of the output and input trade costs are provided in the following subsections.

3.4.2.1 Output Trade Cost

The standard definition of output trade cost in the literature is the sum of the tariff rate and transport cost as a percentage of the value of imports. The import weighted sectoral tariff is arrived at by constructing a import-weighted average of all the 6-digit HS MFN import tariffs from the World Bank's World Integrated Trade Solution(WITS) within each 3-digit industry. We then use our own concordance between HS and KSIC to arrive at the KSIC 3-digit trade costs.

The data on industry transport costs are based on product-level transport costs which are available from "U.S. Imports of Merchandise".[3] Collected by the US census bureau, this dataset contains direct transport cost information for each product from various countries of origin to the US.[4] The product level ad valorem transport cost can be defined as the ratio of import charge to the customs import value, where import charge is the cost of all freight, insurance and other charges in the process of export. The customs import value is the total value of imports at the border excluding duties and import charges.

To use the U.S. transport cost data for the construction of Korean transport costs, we perform the following steps. First, we construct Korea's transport cost at the HS 6-digit level with each of its major trading partners, namely China, Japan, Southeast Asia, EU27, and North America (NAFTA). Since transport cost information between Korea and each of these partners is not available, we use as proxies the distance-adjusted transformations of the U.S. costs of shipping from the same countries. However, for these transformations to result in valid proxies it is important to make sure that the US import structure is close to Korea's, which we actually find to be the case. For example, there is a 98 percent overlap between the products imported by Korea and the US from China, while in the case of imports from the EU this overlap is 94 percent. There is also very significant overlap in

[3]Obtained from Peter Schott's webpage.

[4]Conventionally, matched partner c.i.f. to f.o.b. ratio from UN COMTRADE database is used as a commodity level transport cost measure. However, as Hummels and Lugovskyy (2006) pointed out, this indirect transport cost measure is not usable at the commodity level due to severe measurement error. They found only 10% of the ad valorem shipping costs (at the 2-digit level) to be in the 0-100% range.

products imported from other parts of the world. Finally, industry-level import weighted transport costs are computed after averaging product level costs weighted by imports. When we compute weights to be applied to product-level transport costs of imports from the EU, we use the total amount of imports from all EU27 member countries. Similarly, the sum of NAFTA imports is used for weighting Korea-US transport cost.

Bernard, Jensen, and Schott (2006) calculated U.S. sectoral transport cost using the same data source. The import weighted average for the entire manufacturing sector was 5.6% during the period 1977-81, 4.4% during 1982-86, and 4.1% during 1987-1991. To compare, we also compute the overal manufacturing sector transport cost for Korea. The simple average for the period 2006-2010 turns out to be 2.6%, while the import-weighted average is 1.8%. Considering that our data are more recent, they seem to capture the declining trend.

3.4.2.2 Input Trade Cost

Following Amiti and Konnings (2007), input trade cost is generated by taking the weighted average of the output trade cost with the weights from the Korean input-output table for the year 2005. The input trade cost computed using this method is highly correlated with the output trade cost, 0.89 for 2008 and 0.87 overall. This makes it difficult to identify separately the impact of the input and output trade costs when both trade costs are simultaneously included in the same regression. For this reason, we also construct an alternative input trade cost measure by exclude diagonal elements of the input-output table from our computations. The correlation coefficient between the output trade cost and the alternative input trade cost measure is much lower, 0.61 for 2008 and 0.57 overall.

3.4.2.3 Input Substitutability

Input substitutability significantly affects the overall effect of offshoring on firm level domestic labor demand. In this study, we introduce two measures of input substitutability index used in the estimation.

3.4.2.4 Input Rauch Index

To measure industry input substitutability, we first construct an output substitutability index using the well-known Rauch classification. Rauch (1999) classifies goods into three categories as organized, reference priced, and differentiated. If a good is traded in an organized world exchange, it is considered homogeneous. After assigning a value of 0 to each organized-exchange product, 0.5 to each reference-priced good, and 1 to each differentiated good and using imports as weights, we generate a time varying import weighted output Rauch measure at the 3-digit level.[5] In this way, industries where there is a greater proportion of imports of homogeneous (differentiated) goods will have lower (higher) value of the output Rauch index.[6] Finally, the input Rauch index is constructed using weights from the input-output table the same way these weights were used for constructing the input trade cost. This index can possibly capture the ease of substitution between inputs in production within an industry. If an industry's inputs are mostly homogenous then inputs for this industry are more substitutable. Also, inputs for a sector would be more complementary with more differentiated inputs. That is, our input Rauch index is decreasing (increasing) in the degree of substitutability (complementarity).

3.4.2.5 Input Elasticity of Substitution

The data on output elasticity of substitution are from Broda and Weinstein (2006) and are the estimates of the elasticity of substitution betwen product varieties for the U.S. elasticity of substitution during the period 1990-2001.[7] This output elasticity of substitution estimate for each product (SITC rev.3) is first converted to HS code (6 digit) and is then assigned to KSIC industries using a concordance table we have created. Then using the level of imports

[5] Rauch Classification data is available from Jon Havman's webpage. By combining already created HS07-KSIC concordance table with HS07-SITC ver.2 concordance table from the World Bank database, we could match each Rauch classification to 3 digit Korean industries

[6] According to Rauch (1999), chemical products are typical examples of reference priced good. Our output Rauch index value of Chemical Sectors(201-203) are in the range between 0.5 and 0.7. On the other hands, Flat-Panel Display can be considered as differentiated product as it is usually branded. The index of this industry (Sector 262) turn out to be 1.

[7] The estimates are publicly available at David Weinstein's website.

as weights, 3-digit industry level output elasticity of substitution measure is created. Finally, the input elasticity of substitution measure is obtained by using input-output in the same way we created input rauch index. The correlation between the input elasticity of substitution and the input Rauch index is -0.52.

Table 3.1 provides all the summary statistics of the main variables used in this paper.

3.5 Empirical Results

In Table 3.2 we present regression results which show whether the intensive and the extensive margins of exports are affected by trade costs. All columns in this table show results from the estimation of regressions with random firm effects along with year fixed effects. While OTC denotes output trade cost, ITC denotes input trade cost. In columns (1) and (2), we see a negative and significant impact of input and output trade costs respectively on the intensive margin of exports. A one percentage point reduction in the input trade cost (which is on average more than a 10 percent reduction) leads to a 3.8 percent increase in the intensive margin of exports (in firm-level exports), while a one percentage point reduction in the output trade cost (which is again on average more than a 10 percent reduction) leads leads to a 2.7 percent increase in the intensive margin of exports

At the level of disaggregation at which we are performing our study and at which the input-output table for Korea is constructed, the diagonal elements of the input-output table are large in magnitude. In other words, the input of a 3-digit industry into itself is large, which results in a very high correlation between the input and output tariffs, in turn making it difficult to identify their effects separately when thrown into the right-hand side of a regression simultaneously. Therefore, we construct a modified input trade cost variable based on the off-diagonal elements of the input-output matrix applied to industry-level output trade costs. This is the input trade cost measure, denoted by ITC2 used in all our regressions in which both input and output trade costs are thrown in simultaneously. Column (3) shows the results of such a regression, where again we have random firm effects and year fixed effects. Here a one percentage point decrease (on average a 10 percent decrease) in the input trade cost leads to a 2 percent increase in the intensive export margin. The impact of the output trade cost here is also the same in terms of both sign and magnitude.

From columns (4) through (6), where we look at the extensive margin using linear probability models again with random firm effects and year fixed effects, we see that the impact of a percentage point decrease in the input trade cost is to increase the probability of exporting by 0.004-0.007, while a percentage point decrease in the output trade cost leads to an increase in the probability of importing by 0.003-0.004. Thus, we can conclude from the results presented in Table 3 that input and output trade cost reductions increase both the volume of exports of exporting firms as well as the number of firms exporting. A reduction in input trade costs lowers a firm's cost of production and makes it more competitive in the export market (and raises its profitability of exporting). This can make existing exporting firms export more. It also enables initially non-exporting firms to jump their fixed costs of exporting and start exporting. Note that we have assumed symmetry in the final goods trade costs across exports and imports. Note also that an important component of our measure of trade cost is transport cost. Transport costs are really symmetric even empirically, so a reduction in them either over time within the same industry or as we move from one industry to another over time will mean that the costs of both importing competing products as well as of exporting go down. Therefore, a reduction in the output trade costs will result in an increase in the intensive and extensive margins of exports.

In Table 3.3 we present regression results on how the intensive and the extensive margin of imports are affected by trade costs. Once again, all columns show results from regressions with random firm effects along with year fixed effects. In columns (1) and (2), we see a negative and significant impact of input and output trade costs respectively on the intensive margin of imports. A one percentage point reduction in the input trade cost (more than a 10 percent reduction) leads to a 1.4 percent increase in the intensive margin of imports (in firm-level imports of inputs), while a one percentage point reduction in the output trade cost (again on average more than a 10 percent reduction) leads to a 0.8 percent increase in the intensive margin of imports

Column (3) shows the results of a regression where our modified input trade cost and the output trade cost variables are thrown in simultaenously into the right-hand side. Here a one percentage point decrease (on average a 10 percent decrease) in the input trade cost leads to a 1 percent increase in the intensive import margin. A one percentage point decrease in the output trade cost leads to a 0.5 percent increase in the intensive import margin. From columns (4) through (6), where we look at the extensive margin using linear probability models again with random firm effects and year fixed effects, we see that the impact of a percentage point decrease in the input trade cost is to increase the probability of importing by 0.003-0.004, while a percentage point decrease in the output trade cost leads to an increase in the probability of importing by 0.001-0.002. Thus, we can conclude from the results presented in Table 3.3 that input and output trade cost reductions increase both the volume of imports of importing firms as well as the number of firms importing. While the impact of a reduction in the input trade costs on imports is direct and obvious, a reduction in the output trade costs, through an increase a firm's exports, can lead to a greater demand for inputs, including imported inputs. Similarly it also leads to more firms exporting, which can, due to their bigger market and profits, jump their fixed costs of importing inputs.

Next we look at the association between exports and input imports. In the first two columns, we restrict ourselves to the firm-year observations with positive exports. Here we see that the elasticity of firm exports with respect to input imports lies in the range of 0.23-0.28. Once we include the zero export observations by adding one to the level of exports (columns (3) and (4)), so that the logarithm of (1 + exports) is defined, we see that the elasticity increases to about 0.4. Note that columns (1) through (4) are regressions with random firm effects and year fixed effects. When we switch from random effects to firm fixed effects, the elasticities become quite a bit smaller but qualitatively the results are unchanged.

We have seen that reductions in input and output trade costs lead to a higher likelihood for each firm to export and to import inputs and that the amount that a firm imports and/or exports goes up, with the two being positively associated with each other. We next look at whether these export and import increases translate into increases in the size of domestic employment at the firm level and how these effects, if they exist, vary by the exporting and/or importing status of a firm. We also look at the direct impact of firm-level input imports on firm-level employment.

In Table 3.5, we present the results of our basic regressions where we study the average effect of input and output trade costs on employment. In Table 3.5, we split the sample into the case where intermediate inputs are complements to domestic labor and the case where they are substitutes. There are two ways we do these splits: on the basis of the median of the degree of input substitutability minus the degree of substitutability between varieties of the final product (here on called output substitutability) and, alternatively, based solely on the median degree of input substitutability. Further we use two alternative measures of substitutability, namely the Broda-Weinstein elasticity of substitution and the inverse measure based on the Rauch index.[8] All these regressions are random firm effects regressions with year fixed effects.

For three out of the four cases (three out of the four measures on the basis of which we split our sample), shown in the first four and the last two columns, we see that, as expected from theory, the coefficient of the input trade cost switches sign from positive to negative as we move from the substitutable input subsample to the complementary input subsample. This is true when the sample split is on the basis of the input elasticity of substitution minus the output elasticity of substitution, just the input elasticity of substitution and the input Rauch measure. For a one percentage point decline in the input trade cost (which is more than a 10 percent reduction), employment decreases by 0.3-0.5% in the substitutable input case but increases by 1.4-2.5% in the complementary inputs case. The interpretation of these

[8]The two measures are highly correlated negatively. The correlation between the input elasticity of substitution based on the Broda-Weinstein measure and the input version of the Rauch index is -0.52.

results is that as the input trade costs fall, the intermediate inputs become cheaper. If they are substitutes of in-house inputs produced using domestic labor (or directly of the firm's domestic labor), then this fall in the price of inputs results in these imported inputs taking the place of some of this domestic labor. Thus employment falls in this case. If these foreign inputs are complements to in-house labor, then this fall in their price will lead to an increase in the firm-level demand for domestic labor. It is important to note that this could also mean that a fall in the trade cost could put greater competitive pressure even on the market for domestically produced intermediate inputs (produced outside the final goods firm), thereby also making them cheaper. This would also lead to the same result for non-offshoring firms. The sign also switches in the same way for the coefficient of the output trade cost variable. However, we should not read much into the sign of the output trade cost coefficient as it might just be a combination of all possible effects.[9] When we drop the output trade cost from the regression (results not presented) and replace this modified measure of the input trade cost with the traditional input trade cost measure, that incorporates both diagonal and off-diagonal elements of the input-output table, we get qualitatively very similar results with respect to the input trade costs.

We also tried including interactions of these trade cost variables with exporting and importing status dummy variables. We do not present those results since they are inconclusive. This might have something to do with the fact that while our dependent variable is at the firm level, the trade cost variables are at the industry level, thereby providing inadequate variation for such demanding identification to take place. In Table 3.6, we therefore look at the direct impact of imports. The top panel of Table 6 uses the sample that also includes firms that do not import. In order to include such observations, we have to add 1 to the

[9] On the one hand, purely domestic firms face greater competition from foreign firms and also there is the selection effect, where the marginal firm that continues to operate is a higher-productivity firm when the output trade cost falls. This leads to higher average productivity and lower average marginal cost and average price (across the surviving firms), which reduces firm-level labor demand. Exporting firms increase their employment through a bigger foreign market but decrease their employment through the selection effect in the domestic market. On top of all this, there could be the positive productivity impact of falling trade costs, for which there is considerable support in the existing literature. Finally, as we have discussed earlier, a large part of the inputs are produced within a sector as seen in the large diagonal elements of the input-output matrix. Thus the the output trade costs might be capturing some of the input cost effects.

volume of imports, so that the logarithm of the number can be taken. On the whole, the results here show that greater imports are associated with greater employment. This indicates that on average the imported inputs are complementary to firm-level employment. We also see, consistent with our theoretical predictions, that the magnitude of this effect is greater for exporting firms. Furthermore, also consistent with our theoretical predictions, the employment increasing effect of greater input imports is greater the more complementary the inputs are, which is an implication of the negative and significant coefficient of the interaction of the import term with the difference between the input and output elasticity of substitution. These results are fairly robust to specification. In the lower panel of Table 3.6, we drop the zero import firms. The results are qualitatively absolutely the same, but the coefficient magnitudes, especially of the pure import term is larger in magnitude. Probably since many of the zero import firms also have fairly high employment levels, their inclusion has a dampening impact on the overall positive coefficient.

Clearly, imports are endogenous to the size of the firm, one aspect of which is employment size. We use input trade cost, ITC and its interaction with the difference between the input and output elasticity of substitution, $(\rho - \sigma)$ as instruments. We present these instrumental variables regression results in columns 4, 5 and 6 for the entire sample and for the subsamples of exporting and non-exporting firms separately. The results in the upper and lower panels of Table 3.7 are qualitatively similar to the results in Table 3.6. Once again we see that input imports increase employment. In Table 3.7B the elasticity of employment with respect to imports in the IV case of exporting firms is roughly 0.072 (as opposed to 0.057 for non-exporting firms) when the gap between the input and output elasticities of substitution is zero. For every unit increase in this gap (for more substitutable inputs, holding constant the substitutability between final varieties), this elasticity goes down by up to 0.001. Thus this employment increasing effect for imports is stronger in the case of more complementary inputs. In Table 3.7A, in the IV case the elasticity of employment with respect to imports is positive but insignificant when the substitution elasticity gap is zero. For every unit increase in this gap (for more substitutable inputs, holding constant the substitutability between final varieties), this elasticity goes down by up to 0.001.

We next discuss the validity of our instrumental variables. It is important to note that ITC is included as a regressor in column (3) of Table 3.7 to check the exclusion restriction, i.e., valid instruments affect the dependent variable only indirectly through the endogenous variable. Here ITC turns out to be insignificant and the coefficients of the other two variables (our variables of interest) remain unchanged. Also, the Craig-Donald (C-D) F-statistic for column (4) in panel A of Table 3.7 is 17.46 which exceeds the Stock-Yogo (2005) weak IV test critical value. Thus, going by this test statistic we do not have a weak instrument problem here. Note that this test is based on an assumption of i.i.d. errors. A more robust weak instruments test statistic is the Kleibergen-Paap F-statistic. Its value here turns out to be 19.26 which exceeds 10, its rule-of-thumb critical value (Staiger and Stock, 1997), above which weak identification is ruled out. So using ITC as an instrument for actual level of $(imports + 1)$ seems to satisfy IV validity requirements. Similar test results are obtained for columns (5) and (6) in Table 3.7A. When the estimation is based on the level of imports (not $imports + 1$) in Table 3.7B, we cannot be equally confident that the estimates are free from the weak IV problem. The Kleibergen-Paap F Statistic is 9.52 for column (4) and is 8.88 for column (6). While these numbers are not greater than 10 they are fairly close to 10, so the problem, if any, is not that serious.

We next move to the results for the the difference-in-difference estimation with propensity score matching. In Table 3.8 we see that, for the initial year, the standardized bias prior to matching is very high - in the range of 25-80%. After matching this bias goes down to below 10 percent in all cases and below 5 percent in three out of four cases. While before matching we could easily reject the null hypothesis that the mean of each variable in the treatment group is the same as that in the control group, after matching we cannot reject this null for any of the variables.

In Table 3.9A we see that across all specifications importing (of inputs) leads to higher domestic employment. The OLS regressions show that importing on average increases firm-level employment 34-39 percent. This is based on both variation over time and across firms. However, the random and fixed effects specifications, focusing on the within variation, indicate to us that a firm that becomes an importer experiences a 2- 6 percent increase in employment. In Table 3.9B the dependent variable is $\ln(exports+1)$ in place of $\ln L$. Clearly from these regression results, other things remianing equal, importing is associated with much higher exports. This is quite remarkable since lagged export status was used as one of the variables to carry out the propensity score matching.

In Table 3.10 we find that there is some evidence that imports have a bigger positive impact on employment for exporting firms and this impact keeps going up with the level of exports. Across all specifications the coefficient of the lagged value of $IMP.\ln(exports + 1)$ is positive and in the four specifications involving plain OLS or random effects (with and without year effects) it is both positive and statistically very significant. The negative coefficient of the lagged value of $IMP.(\rho - \sigma)$ shows that the employment increasing impact of importing inputs from abroad is greater when input complementarity is higher. This is intuitive and is consistent with the theory we presented earlier. Note, however, that the coefficient estimate of this term, while negative throughout, is not significant (is not precisely estimated). It is also interesting to note that these regressions indicate the possibility that, when $\rho - \sigma \geq 0$ and $exports = 0$, importing can have a negative impact on employment. This is totally consistent with the predictions of our model. Of course, with high enough values of exports and negative enough values of $\rho - \sigma$, importing by firms begins to have a positive impact on employment. Again this is a result that is totally consistent with the predictions of our model. The results also clearly show that exports by themselves lead to high employment. More specifically, this is seen in the positive and significant coefficients of $IMP.\ln(exports + 1)$ and $\ln(exports + 1)$.

In Table 3.11, in place of the level of exports we use the export status dummy. Once again an employment increasing impact of importing is associated with being an exporter and greater complementarity between inputs. $IMP.(\rho - \sigma)$ now becomes strongly significant in a couple of the cases (the OLS regressions with and without year effects).

3.6 Conclusions

In this paper, we extend the small country trade model with firm heterogeneity, developed by Demidova and Rodriguez-Clare (2013), where we incorporate offshoring (along with final goods trade). Our theoretical model acts as a useful guide for empirically investigating the firm-level employment effects of offshoring and final goods trade, especially when it comes to the effects that are heterogeneous across firms, even though there are important aspects of the real world that our theoretical model does not capture.

We perform our empirical investigation using firm-level data from Korea for the years 2006-2011, and trade costs for final goods as well as separately for intermediate goods or inputs, combining data from different sources and transforming, aggregating and concording according to our needs, specific to the country we study. There was also similar effort involved in creation of our measures of input and output substitution, using other measures already in the literature.

Our empirical analysis yields several results, most of them consistent with our theory and/or our economic intuition. We find that input and output trade cost reductions increase both the volume of firm-level exports and imports as well as the number of firms exporting and the number importing. Also, there is a strong positive association between firm-level exports and firm-level imports of inputs.

As expected from theory, the impact of the input trade cost on firm employment changes from positive to negative as we move from the subsample of firms in industries where inputs are on average substitutable to the subsample of firms in complementary input industries.

We find that, on the whole, greater imports are associated with greater employment, indicating that on average the imported inputs are complementary to firm-level employment. Consistent with our theoretical predictions, the magnitude of the postive employment effect of input imports is greater for exporting firms and in firms in industries where inputs are relatively more complementary. These results are fairly robust to specification, including instrumental variables estimation, which we perform to address the simultaneity of employment and imports.

While we use an instrumental variables approach to address our problem of simultaneity, we also use an alternative approach of difference-in-difference with propensity score matching. Across all our difference-in-difference specifications (with propensity score matching) importing (of inputs) leads to higher domestic firm-level employment as well as firm-level exports. There is also some evidence that imports have a bigger positive impact on employment for exporting firms and this impact keeps going up with the level of exports. Moreover, as found with our other regressions, here as well the employment increasing impact of importing inputs from abroad is greater when input complementarity is higher.

CHAPTER IV

Decomposition of the Changes in Korean Wage Inequality During the Period 1998-2007

4.1 Introduction

Over the last three decades wage inequality has increased substantially in most developed countries, including the United States, Germany and the United Kingdom. South Korea[1] is one of the few countries to have experienced high economic growth and decreasing wage inequality from the 1980s to the mid 1990s. A large amount of literature (see, e.g. Kang and Yun (2008), Chung and Choi (2001), Kim and Topel (1995) has) investigated the reverse trend of wage inequality in Korea and has concluded that, consistent with the Kuznets curve,[2] income inequality in Korea has risen rapidly since the early 1960s and declined from the 1980s to the mid 1990s after reaching a critical level.

Most recently, Lee et al. (2013) have argued that income inequality rebounded sharply in the late 1990s when the Korean economy faced the Asian financial crisis. Kim (2013) claims that after the Asian financial crisis the pattern of Korean income inequality follows to US and UK type inequality (worsening income equality since 1980s) although it had been considered as following Japan-France pattern (remaining relatively stable since the 1980s). Also, recent

[1]By following the convention, from hereafter we denote Korea for South Korea.

[2]Kuznets(1955) predicted that in the process of economic development income inequality first rises, reaches the peak and falls after a certain critical threshold development stage and income level.

studies (e.g. Sung (2014)) show that this rising trend inequality plateaued after the global financial crisis in 2008 possibly due to the recently expanded redistributive policies.

Figure 4.1 illustrates Korean wage gap trends since 1980 across different income groups. Consistent with the literature, we can clearly see the wage inequality worsening after the mid-1990s and stabilizing in 2008. Also, it seems that the driving factor of overall wage gap was fast wage growth of high-wage workers. Kim (2013) also points out that this differential wage gap pattern across income groups became magnified after the 1997 Asian financial crisis possibly due to the expansion of an incentive wage scheme among large business enterprises.

This paper focuses specially on the wage inequality during the period from 1998 to 2007, the most recent period when wage inequality magnified over the previous three decades. Previous studies suggest many reasons for this pattern, including skill- biased technological change (SBTC), the aging population, and changes in the demographic structure. Also many studies, including Yoo (1998), Hyun and Lim (2005), Cho (2008) and Kim(2008), focus on changes in worker characteristics, labor union, and financial crisis; however, their empirical evidences rely upon mean-based estimations. Distribution-based wage decomposition is important in that, as shown in Figure 4.1, the pattern of income inequality has varied across various income levels, and workers different level of skill (e.g., education) are likely to affect the wage distribution at different quartiles. (See, for US, Buchinsky (1994); for Germany, Fitzenberger and Kutz (1997); for Uruguay, Gonzalez and Miles (2001)).

Also it is very possible that changes in job stability - due to the implementation of labor market reforms to overcome the Asian financial crisis - have favored the high-income group. According to Hyun and Lim(2005), the low income group increased from 4.7% in 1996 to 6.6% in 2000. Park and Mah (2011) suggest that the massive FDI inflow and revision of the labor law in 1998 exacerbated wage inequality by allowing employers to terminate workers more easily than before. The sharp decline in job stability during the financial crisis was never reversed to reach previous levels, and played an important role in increasing the Korean wage inequality.

With regard to the effect of labor union, it has been conjectured that labor union in Korea became more representative of the highly skilled workers after the mid-1990s (Lee (2004)) and the major reason for this changed behavior may very well have been the labor reform arising from the financial crisis.

In sum, evidence indicates that various factors of the growing wage gap since the mid-1990s may have impacted different income groups to different extents. As far as we know, this is one of very few studies to deal with the recent Korean wage inequality issue with the distribution-based wage decomposition methodology developed recently in the field of labor economics. Sung (2014a) and Kim and Kim (2012) applied the popular Dinardo et al. (1996) decomposition method to examine the contribution of skill and minimum wage changes. However, their focus had to be limited to specific variables in that the Dinardo et al. (1996) method becomes practically infeasible when there are too many continuous variables.

To decompose the changes in Korean wage inequality, we, in this paper, apply more robust decomposition methods in the literature proposed by, Machado and Mata (2005), to the Korean Labor and Income Panel Survey data for the years 1998 and 2007. Our results suggest that the observed increase in education level can explain about 10% of the increase in the 90/50 wage gap but had no impact on the changes in the 50/10 wage gap. Declining unionization contributed about 5% of the changes in the upper-tail of wage inequality. We also find that a compositional shift in the Korean labor force caused a steep increase in wages in the upper-tail of the distribution.

The paper is structured as follows. Section 4.2 describes the outline of the Machado and Mata (2005) decomposition method and compares this approach with recently developed decomposition methods. In Section 4.3, we discuss the data and results. Section 4.4 concludes.

4.2 Machado and Mata Deomposition Method

Machado and Mata (2005) method can be used to decompose the changes in the distribution function of the individual outcome across two countries, time periods or subgroups of population in several factors contributing to those changes. Autor et al. (2005) argue that Machado and Mata (2005) decomposition provides a precise link between the 'full variance accounting' technique for analyzing inequality introduced by Juhn et al. (1993) and the kernel re-weighting proposed by DiNardo et al. (1996). To decompose the changes in wage distribution function, Machado and Mata (2005) estimate a counterfactual wage distribution ($F(w)$), which is of the form,

$$F(w) = \int G(w|x)dH(x).$$

Here $G(\cdot)$ is the conditional Cumulative Distribution Function (CDF) of wage (w) given the covariates (X) in period $t = 0$ and H is the unconditional CDF of X in period $t = 1$. Machado and Mata (2005) estimate the inverse of G through a linear quantile regression model and estimate the integral through a simulation method.

Alternative methodologies such as the unconditional quantile regression by Firpo et al. (2009), distributional regression by Chernozhukov et al. (2013), partial distributional policy effects by Rothe (2012) can also be used to construct the counterfactual distribution function. However, the asymptotic properties of the counterfactual distribution function from all these approaches are supposed to give similar results as long as the underlying assumptions of those models are valid. In practice, one of the advantages of the Machado and Mata (2005) method over others is that it is intuitively very elegant and easy to implement. Machado and Mata (2005) decomposition method is based on the fundamental assumption that the conditional quantile function ($Q_\tau(y|x)$) is linear in parameters. Recently, Ghosh (2014) use Chamberlain's two stage Box-Cox quantile regression model when this linearity assumption does not hold in a very skewed wage distribution function.

Let α denotes any distribution statistics such as quantile, skewness, gini coefficients etc. The changes in the wage distribution functions between the period $t = 0$ to period $t = 1$ is as follows:

$$F_\alpha(w_{t=1}) - F_\alpha(w_{t=0}) = \underbrace{[F_\alpha(w_{t=1}) - F_\alpha(w_{t=1}; x_{t=0})]}_{\text{Composition Effect}} + \underbrace{[F_\alpha(w_{t=1}; x_{t=0}) - F_\alpha(w_{t=0})]}_{\text{Wage Structure Effect}} + \textit{Residual}$$

The residual effect is defined as the unexplained part of the total changes in the wage distribution function. Similarly, Machado and Mata (2005) method measures the impact of individual covariates ($\tilde{x}_t$) by considering the following equation,

$$\textit{Impact of } \tilde{x}_t \equiv F_\alpha(w_{t=1}) - F_\alpha\left(w_{t=1}; \tilde{x}_{t=0}, x^\star_{t=1}\right),$$

where $x_t = [\tilde{x}_t \;\; x^\star_t]$ and $x^\star_t$ are all the other covariates except $\tilde{x}_t$. The counterfactual distribution function $F_\alpha\left(w_{t=1}; \tilde{x}_{t=0}, x^\star_{t=1}\right)$ can be recovered from $F_\alpha(w_{t=1}; x_{t=0})$ by assuming that $x^\star_t$ follows independent distribution.

4.3 Decomposition Method Results

The data are drawn from Korean Labor and Income Panel Survey for the years 1998 and 2007. The sample sizes are 4,106 and 5,563 respectively. The wage measured is a monthly earnings in 'Korean Won'. The regressor consists of years of schooling, union status and other basic controls. Annual income is expressed in 2000 Korean Won using the consumer price index. As shown in the summary statistics, women labor force participation rate has increased from 33 to 40%, a trend that can be observed elsewhere in the world. The unionization rate has decreased from 9 to 6.5 percent which is much lower compared to the developed nations.

The top left panel of Figure 4.2 shows how the wage density function changes from 1998 to 2007. As the economy recovers from the financial crisis of 1997, the density function starts to have a longer right tail, shorter left tail and a mass shifting out from the center. The shift in concentration away from the middle in both the direction implies bi-polarization of the Korean wage distribution function. Nahm (2008) finds that the decrease in middle class has been accompanied by the increase in the lower and upper classes. Although the income share of the medium skilled workers is stable over time but the steep increase in the high skilled workers income share causes the bi-polarization of Korean wage distribution.

The top right panel of Figure 4.2 represents the difference between the wage density functions for the years 2007 and 1998. As shown the difference is positive in the upper half and negative in the lower half of the distribution. These results imply that employment opportunities for the high skilled workers have increased and for the low skilled workers have decreased during the period 1998 to 2007. Lee et al. (2013) show that during the period 2003 to 2008, a large fraction of new jobs created in the small firms which consist of less than 5 employees and the average wage of these firms is 46.7% compared to the big firms which have more than 300 employees and argue that this sectorial wage gap can explain the recent changes in wage inequality.

Machado and Mata (2005) decomposition method decomposes the changes in the wage distribution into three parts, namely composition effect (changes in workers' characteristics), wage structure effect (market return of those attributes) and residual effect. To construct the unconditional wage distribution function we take 3,000 quantiles. The third row of each horizontal block in Table 4.2 indicates the percentage of the total change explained by the indicator factor and the numbers in the parenthesis represent the 95% confidence interval which has been generated through 500 bootstrap replications.

Table 4.2 shows that both the composition and wage structure effects have positive contribution to the changes in wage distribution function because their effects are significantly different from zeros especially in the upper-tail of the distribution. The left bottom panel of Figure 4.2 shows that wage structure effects are quantitatively more important in the lower half of the distribution and composition effects explain a major fraction of the total changes in wages in the upper-tail of the distribution. The residual effects of the aggregate contributions account for a relatively small proportion of the total changes in wages in all the estimated quantiles. This implies that the estimated model works reasonably well to explain the recent changes in Korean wage distribution.

The final four columns of Table 4.2 measure the contribution of workers' characteristics such as education, union status, age and sex. As shown in the literature, the number of years of schooling and union status are clearly correlated with individual's unobserved skills. This makes the marginal effects from quantile regression biased and inconsistent. The Oaxaca decomposition method deals with workers unobserved heterogeneity under the assumption that workers unobserved skills remain the same over the two time period we consider. By taking the difference of the wages for similar types of workers in two time periods gives consistent estimates of the impact of covariates as long as the above assumption holds.

As shown the estimated effects of education are positive and monotonic throughout the wage distribution function. The difference between the impact of education for the 90th and 50th quantile implies that had the distribution of education remained the same as in 1998, the 90/50 wage gap would have increased by 5.8%. As shown the 90/50 wage gap has actually increased about 57.2% during the period 1998-2007. Thus, observed increase in education level contributes about 10% of the increase in wage inequality. Similarly, the difference between the impact of education for the middle and lower tail of the distribution shows that the increase in the level of schooling can not explain why the 50/10 wage gap has increased about 9% during the same time period.

There exists an extensive literature on the impact of declining unionization on Korean wage inequality. By using the fixed effect estimators, Cho (2008) shows that during the period 1998-2006 union wage premium is about 2.1% and argues that in Korea union wage premium is relatively small compared to the other developed nations because only 20% of the total small size firms which consist of less than 100 employees have union workers. Moreover, the unionization rate also changes relatively less compared to the other developed countries.

Kim (2008) shows that during the period 1988-1997 union wage premium was about 1.7%, however it increases to 5.1 % during the period 1998-2009.

An important caveat to interpret the marginal effects of union status in the previous studies is that union and nonunion workers differ in terms of their unobserved heterogeneity. Table 4.2 decomposition results can be interpreted as had the unionization rate remained the same in 1998, the 90/50 wage gap would have decreased by 2.3% and the 50/10 wage gap would have increased by 0.6%. Thus declining unionization can explain about 5% of the increase in 90/50 wage gap and has almost no impact to the changes in the 50/10 wage gap. Yoo (1998) finds that declining unionization increases wage inequality approximately 3% during the period 1988-1993.

Kim (2008) and Kim et al. (2004) argue that declining unionization has higher impact on Korean wage distribution in post financial crisis because in the bargain process, unions had to accept easier termination of employment for higher wages due to the revision of labor law. As shown in Table 4.1, the unionization rate falls by 2.5% during the period 1998-2007 and 2.4% of those union workers are from the middle and low skilled occupations. As a result, the decline in unionization rate mainly affects the medium and low skilled workers and that leads to a small increase in the 90/50 wage gap and has almost no impact on the 50/10 wage gap during the period 1998-2007.

4.4 Conclusion

By applying the Machado and Mata (2005) decomposition method on the Korean labor market data for the period 1998-2007, we find that both the composition and wage structure effects contribute in the same direction to the changes in the upper and lower-tail wage inequality. Observed increase in education level can explain about 10% of the increase in upper-tail wage inequality because returns from education have increased about 7 to 10% in the upper-tail while staying roughly same in the lower half of the distribution. Declining unionization can explain about 5% of the increase in 90/50 wage gap and does not have much impact on the 50/10 wage gap because unionization rate declines marginally in Korea during the period 1998-2007.

Currently this income (wage) inequality issue is a topic of hot debate among policy-makers in Korea. Korean government has adopted some policies for redistribution, such as consumption tax, income tax, and transfer income; however, the effectiveness of these policies remains controversial. By providing a better understanding of previous wage inequality that incorporates the role of various individual characteristics at various quartiles, this study can serve as a meaningful base study for the sustainable welfare or redistribution policies that Korean policy-makers are currently seeking.

APPENDICES

APPENDIX A

Chapter III : Appendix

A.0.1 Condition for the marginal surviving firm to neither export nor offshore

For the marginal firm to not export, it must be the case that

$$\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_n}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{\tau^{1-\sigma}A}{\sigma}\right) < f_x$$

That is, even if the firm gets the lowest possible draw of exporting variable cost t_{xv} which is 1, it still cannot cover the fixed cost of exporting, and hence it doesn't export.

What about offshoring? In order for this firm to not offshore it must be the case that

$$\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_o(\psi)|_{t_o=1}}{\widehat{\varphi}}\right)^{1-\sigma}\frac{P^{\sigma-\eta}\mathbb{L}}{\sigma} < f + f_o.$$

That is, even if the firm gets the most favorable draw of t_o which is 1, it still doesn't find it worthwhile to offshore. Since (3.9) is satisfied for this firm, the above can be written as

$$\left(\frac{c_n}{c_o(\psi)|_{t_o=1}}\right)^{\sigma-1} f < f + f_o. \tag{A.1}$$

So, if the above condition is satisfied, then the marginal existing firm doesn't offshore.

Can this firm do both if either of them alone is not possible? This will not be possible if

$$\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_o(\psi)|_{t_o=1}}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{P^{\sigma-\eta}\mathbb{L}+\tau^{1-\sigma}A}{\sigma}\right)-f-f_o-f_x<0$$

Substituting out $P^{\sigma-\eta}$ using (3.9) the above can be written as

$$\left(\frac{c_n}{c_o(\psi)|_{t_o=1}}\right)^{\sigma-1}f-f-f_o+\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_o(\psi)|_{t_o=1}}{\widehat{\varphi}}\right)^{1-\sigma}\frac{\tau^{1-\sigma}A}{\sigma}-f_x<0$$

In light of (A.1) a sufficient condition for the above is that

$$\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_o(\psi)|_{t_o=1}}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{\tau^{1-\sigma}A}{\sigma}\right)-f_x<0$$

We know that the firm cannot export when it is not offshoring: $\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_n}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{\tau^{1-\sigma}A}{\sigma}\right)<f_x$. In order for this firm to not export when offshoring a sufficient condition is $\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_o(\psi)|_{t_o=1}}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{\tau^{1-\sigma}A}{\sigma}\right)<f_x$. Since if this condition is satisfied, the condition $\left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_n}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{\tau^{1-\sigma}A}{\sigma}\right)<f_x$ is satisfied as well. Therefore, the condition needed for the marginal firm to neither export nor offshore is

$$\begin{aligned}\left(\frac{c_n}{c_o(\psi)|_{t_o=1}}\right)^{\sigma-1}f &< f+f_o;\\ \left(\left(\frac{\sigma}{\sigma-1}\right)\frac{c_o(\psi)|_{t_o=1}}{\widehat{\varphi}}\right)^{1-\sigma}\left(\frac{\tau^{1-\sigma}A}{\sigma}\right) &< f_x.\end{aligned}$$

Suppose A is proportional to the domestic market size: $A=\mu P^{\sigma-\eta}\mathbb{L}$, where μ is the proportionality factor. Now, the second condition above becomes

$$\left(\frac{c_n}{c_o(\psi)|_{t_o=1}}\right)^{\sigma-1}\mu\tau^{1-\sigma}f<f_x$$

That is, the common exporting costs (τ and f_x) should be sufficiently large so that even if the firm gets the best possible draw of firm specific trading cost, it still doesn't want to export.

A.0.2 Existence proof

We show that $\frac{d\Pi}{d\widehat{\varphi}} < 0$. Taking the derivative of (3.11) with respect to $\widehat{\varphi}$ obtain

$$\frac{d\Pi}{d\widehat{\varphi}} = -\int_{t_o}\int_{t_x} \pi(\psi|_{\widehat{\varphi}}, \widehat{\varphi}; \tau, \lambda) g(\psi) dt_x dt_o + \int_{\widehat{\varphi}}^{\infty}\int_{t_o}\int_{t_x} \frac{\partial \pi(\psi, \widehat{\varphi}; \tau, \lambda)}{\partial \widehat{\varphi}} g(\psi) dt_x dt_o d\varphi, \qquad \text{(A.2)}$$

where $\psi|_{\widehat{\varphi}} = (\widehat{\varphi}, t_x, t_o)$. Next, note that $\pi(\psi|_{\widehat{\varphi}}, \widehat{\varphi}; \tau, \lambda) = 0$ for all t_x, t_o because a firm with productivity $\widehat{\varphi}$ neither offshores nor exports and the net profits are zero for this firm by construction. Moreover $\frac{\partial \pi(\psi, \widehat{\varphi}; \tau, \lambda)}{\partial \widehat{\varphi}} < 0$ as can be easily verified from (3.10). Therefore, $\frac{d\Pi}{d\widehat{\varphi}} < 0$, and hence the equilibrium exists if the initial conditions are correct. We need $\Pi > f_e$ when $\widehat{\varphi} \to \varphi_{\min}$ and $\Pi < f_e$ when $\widehat{\varphi} \to \infty$.

A.0.3 Impact of changes in τ and λ on $\widehat{\varphi}$

The free entry condition (3.11) implies

$$\frac{d\Pi}{d\tau} \equiv \frac{\partial \Pi}{\partial \widehat{\varphi}} \frac{d\widehat{\varphi}}{d\tau} + \frac{\partial \Pi}{\partial \tau} = 0$$

From the expression for Π in (3.11)

$$\frac{\partial \Pi}{\partial \tau} \equiv \int_{\widehat{\varphi}}^{\infty}\int_{t_o}\int_{t_x} \frac{\partial \pi(\psi, \widehat{\varphi}; \tau, \lambda)}{\partial \tau} g(\psi) dt_x dt_o d\varphi < 0$$

The inequality above follows from the fact that $\frac{\partial \pi(\psi, \widehat{\varphi}; \tau, \lambda)}{\partial \tau} \leq 0$ (easily verified from (3.10)) for any ψ. Since (A.2) yields $\frac{\partial \Pi}{\partial \widehat{\varphi}} < 0$, we get

$$\frac{d\widehat{\varphi}}{d\tau} = -\frac{\partial \Pi}{\partial \tau} / \frac{\partial \Pi}{\partial \widehat{\varphi}} < 0$$

Similarly,

$$\frac{d\Pi}{d\lambda} \equiv \frac{\partial \Pi}{\partial \widehat{\varphi}} \frac{d\widehat{\varphi}}{d\lambda} + \frac{\partial \Pi}{\partial \lambda} = 0$$

Again, from the expression for Π in (3.11)

$$\frac{\partial \Pi}{\partial \lambda} \equiv \int_{\widehat{\varphi}}^{\infty} \int_{t_o} \int_{t_x} \frac{\partial \pi(\psi, \widehat{\varphi}; \tau, \lambda)}{\partial \lambda} g(\psi) dt_x dt_o d\varphi < 0$$

Once again, the inequality above follows from the fact that $\frac{\partial \pi(\psi,\widehat{\varphi};\tau,\lambda)}{\partial \lambda} \leq 0$ for any ψ as is easily verified from (3.10). Therefore,

$$\frac{d\widehat{\varphi}}{d\lambda} = -\frac{\partial \Pi}{\partial \lambda} / \frac{\partial \Pi}{\partial \widehat{\varphi}} < 0$$

A.0.4 Expressions for Employment

Given the unit cost for Y in (3.5), Shephard's lemma implies that the requirement of L per unit of output for a firm with productivity φ_v and offshoring status s is given by $\alpha^\rho c_s(\psi)^\rho / \varphi_v$, for $s \in \{n, o\}$. Therefore, $L_s(\psi) = (\alpha^\rho c_s(\psi)^\rho / \varphi)\, z(\psi_v)$. Next, we use (3.2) for $z(\psi)$ to get $L_s(\psi) = (\alpha^\rho c_s(\psi)^\rho / \varphi)\, p(\psi)^{-\sigma} P^{\sigma-\eta} \mathbb{L}$ as the labor requirement to meet domestic demand. Lastly, substitute out $p(\psi)$ and P using equation (3.6) to obtain

$$L_s^d(\psi) = \alpha^\rho \left(\sigma - 1\right) \left(c_s(\psi)^{\rho-\sigma}\right) \left(\frac{\varphi c_n}{\widehat{\varphi}}\right)^{\sigma-1} f \text{ for } s \in \{n, o\}$$

For exporting firms, the export demand is $z^f(\psi) = p(\psi)^{-\sigma} A = \left(\left(\frac{\sigma}{\sigma-1}\right) \frac{\tau t_x c_s(\psi)}{\varphi}\right)^{-\sigma} A$, therefore, they need to ship $\tau t_x z^f(\psi)$, and hence we get the following labor requirement for exports

$$L_s^x(\psi) = \alpha^\rho \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} c_s(\psi)^{\rho-\sigma} \left(\tau t_x\right)^{1-\sigma} \varphi^{\sigma-1} A$$

Combining the above, we obtain the expression for employment presented in the text.

APPENDIX B

Figures and Tables

Figure 2.1: Firm Boundary by Sourcing Mode

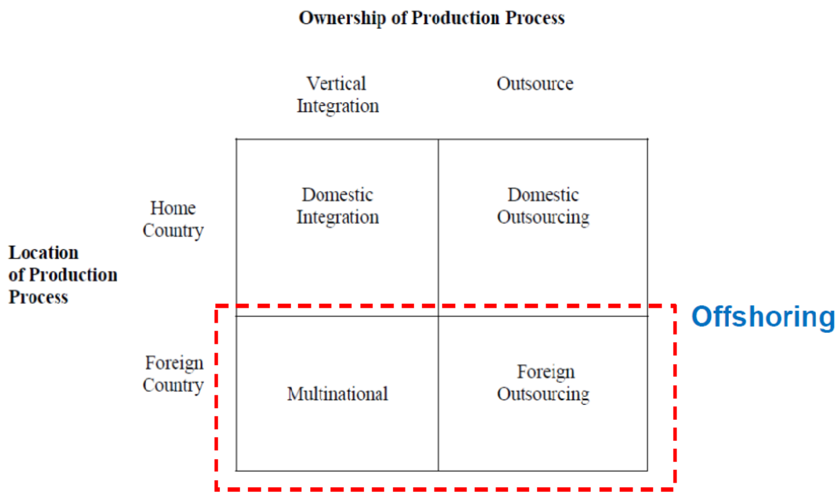


Figure 2.2: Model prediction : Antràs & Helpman (2004)

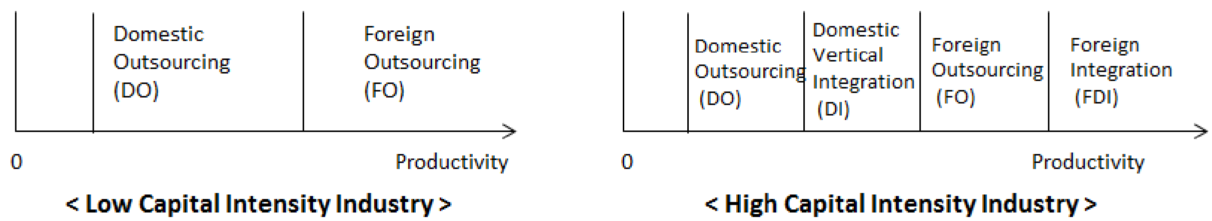
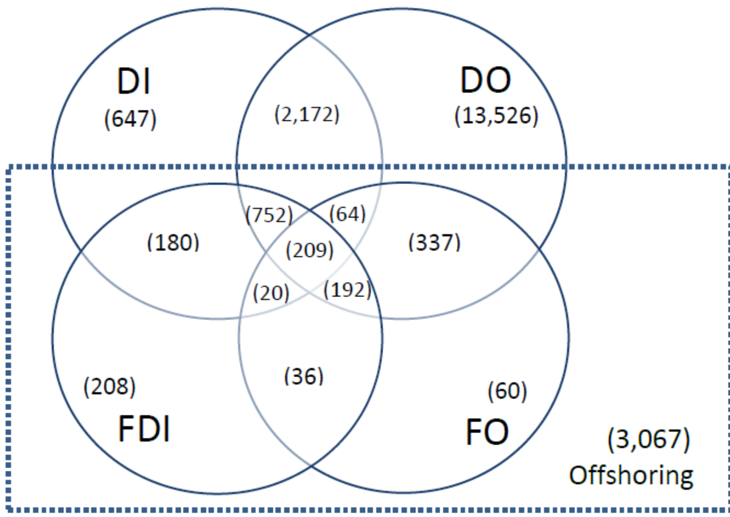


Figure 2.3: Multiple Sourcing in Korean Manufacturing Industry from 2006-2010



Two cases are not shown in this diagram. Intersection only between domestic insourcing (DI) and foreign outsourcing (FO) counts 11 observations. Likewise 998 observations correspond to the intersection only between domestic outsourcing (DO) and foreign direct investment (FDI).

Figure 2.4: Results of Binary Dependent Variable Construction

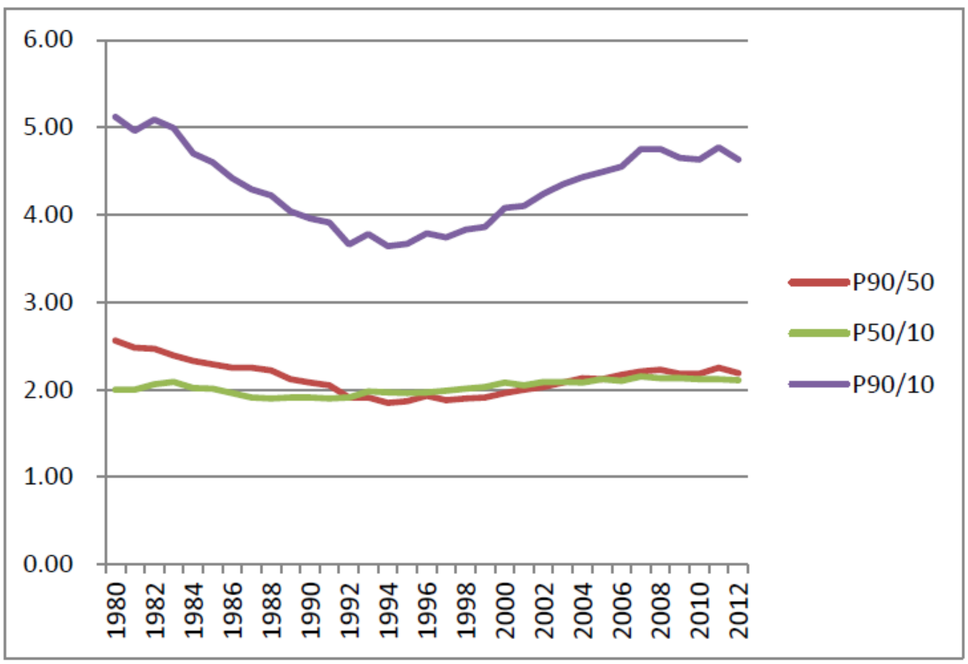
< Main Choice >

DI ($y_i = 1$) 2,280 obs.	DO ($y_i = 1$) 15,667 obs.
FDI ($y_i = 1$) 1,176 obs.	FO ($y_i = 1$) 255 obs.

< Participation >

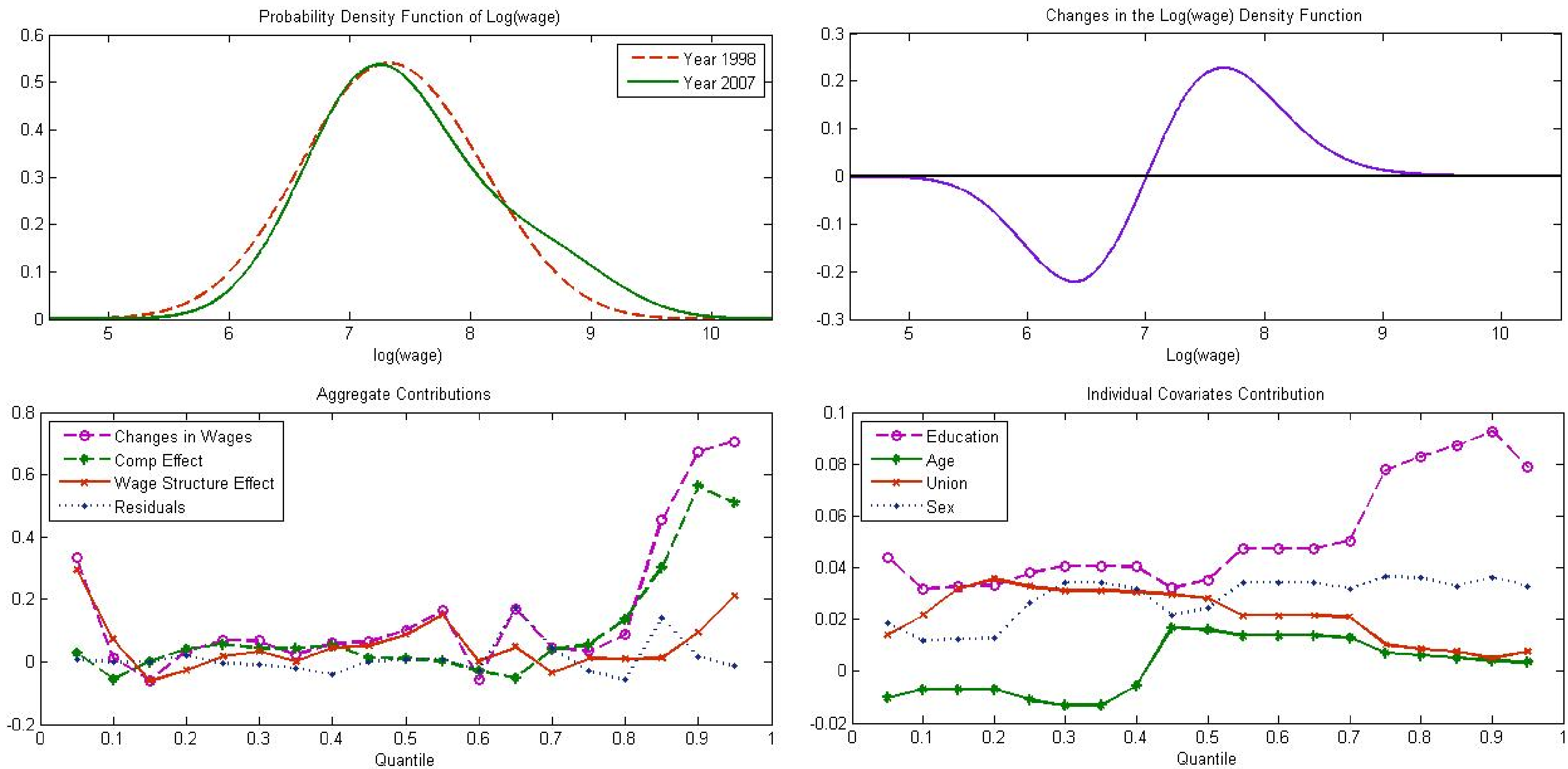
DI ($y_i = 1$) 4,055 obs.	DO ($y_i = 1$) 18,250 obs.
FDI ($y_i = 1$) 2,595 obs.	FO ($y_i = 1$) 929 obs.

Figure 4.1: The Trend of Wage Inequality during 1980-2012



Source : Korean Ministry of Employment and Labor

Figure 4.2: Changes in the Korean Log(wage) Density functions and Machado and Mata (2005) Decomposition Method Results



Gaussian Kernel function is assumed to plot the probability wage distribution function. To estimate the optimal bandwidth, Botev, Grotowski and Kroese (2010) method is used. For aggregate contributions we use Oaxaca Decomposition, $F_\alpha(w_{t=1}) - F_\alpha(w_{t=0}) = \underbrace{[F_\alpha(w_{t=1}) - F_\alpha(w_{t=1}; x_{t=0})]}_{\text{Covariates}} + \underbrace{[F_\alpha(w_{t=1}; x_{t=0}) - F_\alpha(w_{t=0})]}_{\text{Coefficients}} +$ *Residual* and individual covariates contributions are measured as, $F_\alpha(w_{t=1}) - F_\alpha\left(w_{t=1}; x^\star_{t=1}, x_{t=0}\right)$

Table 2.1: Summary Statistics of explanatory variables

	Mean	Standard Deviation			N	n
		Overall	Between	Within		
$\frac{K}{L}$	3.452	1.897	1.787	0.699	27,499	7,298
$\frac{H}{L}$	0.193	0.054	0.044	0.034	27,499	7,298
$\frac{R\&D}{Sales}$	0.017	0.016	0.015	0.007	27,499	7,298
$\frac{Adv.}{Sales}$	0.007	0.011	0.010	0.004	27,499	7,298
TFP	230.52	619.77	588.25	223.89	26,872	7,181
Size	276.16	1712.3	1503.3	148.50	27,499	7,298

[1] K/L indicates industry capital intensity defined as the ratio of total tangible asset to the total wage bill. H/L indicates industry managemenl intensity defined as the ratio of total management workers to the total employment. R&D/Sales indicates industry R&D intensity defined as the ratio of R&D expenditure to the total sales. Adv./Sales indicates advertising intensity defined as the ratio of total advertisement cost over total sales. TFP is total factor productivity obtained by Levinshon-Petrin method, Size is the firm level total number of employment
[2] In the estimation, natural logarithm is taken to all variables.

Table 2.2: Hypothesis 1 : Ownership Choice

	Vertical Integration			Outsourcing		
	Overall	FDI	DI	Overall	FO	DO
$\log(\frac{K}{L})$	0.518^{****}	0.546^{**}	0.311^{*}	-0.235^{*}	0.057	-0.239^{*}
	(0.172)	(0.223)	(0.174)	(0.125)	(0.413)	(0.123)
$\log(\frac{K}{L})$	0.519^{***}	0.550^{**}	0.311^{*}	-0.228^{*}	0.062	-0.232^{*}
with control	(0.172)	(0.225)	(0.174)	(0.125)	(0.414)	(0.123)
Obs.	4826	2161	4238	8323	608	8360
# of Group	1107	501	963	1938	145	1942

[1] Numbers in parenthesis are robust standard errors obatained from boostrapping with 399 replications.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level.
[3] FDI dependent variable is a binary variable indicating the corresponding observation has largest amount of foreign sourcing from related party. DI dependent variable is a binary variable indicating the corresponding observation has largest amount of domestic sourcing from related party. Vertical integration dependent variable is constructed by combining both FDI and DI dependent variable. FO dependent variable is a binary variable indicating the corresponding observation has largest amount of foreign sourcing from unrelated party. DO dependent variable is a binary variable indicating the corresponding observation has largest amount of domestic sourcing from unrelated party. Outsourcing dependent variable is constructed by combining both FO and DO dependent variable.
[4] Firm level control is the firm size.
[4] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.3: Hypothesis 1 : Ownership Choice

	Vertical Integration			Outsourcing		
	Overall	FDI	DI	Overall	FO	DO
$\log(\frac{K}{L})$	0.557***	0.575**	0.352*	-0.229*	0.123	-0.304**
	(0.185)	(0.248)	(0.184)	(0.122)	(0.427)	(0.130)
$\log(\frac{H}{L})$	0.151	0.178	0.065	-0.293**	0.410	-0.258**
	(0.152)	(0.229)	(0.159)	(0.130)	(0.468)	(0.120)
$\log(\frac{R\&D}{Sales})$	0.195**	0.147	0.109	0.054	-0.096	0.055
	(0.093)	(0.128)	(0.097)	(0.071)	(0.298)	(0.069)
$\log(\frac{Adv.}{Sales})$	-0.104*	-0.231***	0.037	-0.014	-0.052	-0.008
	(0.062)	(0.086)	(0.062)	(0.045)	(0.154)	(0.047)
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	4826	2161	4238	8320	608	8357
# of Group	1107	501	963	1938	145	1942

[1] Numbers in parenthesis are robust standard errors obatained from boostrapping with 399 replications.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level.
[3] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.4: Hypothesis 2 : TFP effects on the FDI choice

	High Captal Intensity Industry					
	Above mean		Above 50th		Above 75th	
log(TFP)	0.518**	0.383^{m}	0.563***	0.408*	0.556**	0.480*
	(0.230)	(0.236)	(0.216)	(0.214)	(0.259)	(0.260)
log(TFP) with control	0.528**	0.406*	0.570***	0.425**	0.573**	0.515**
	(0.231)	(0.239)	(0.217)	(0.216)	(0.256)	(0.260)
log(TFP) with two step	0.786**	1.695*	0.772**	1.856**	0.677*	1.352
	(0.372)	(0.914)	(0.321)	(0.842)	(0.386)	(0.981)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	779(480)	779(480)	994(611)	994(611)	572(349)	572(349)
# of Group	194(139)	194(139)	242(173)	242(173)	147(103)	147(103)

	Low Captal Intensity Industry					
	Below mean		Below 50th		Below 25th	
log(TFP)	0.378**	0.286*	0.349**	0.258	0.427	0.328
	(0.157)	(0.170)	(0.173)	(0.184)	(0.265)	(0.284)
log(TFP) with control	0.361**	0.302*	0.319*	0.264	0.374	0.326
	(0.160)	(0.173)	(0.175)	(0.189)	(0.269)	(0.296)
log(TFP) with two step	0.198	0.288	0.121	-0.040	0.374	-0.785
	(0.290)	(0.767)	(0.322)	(0.939)	(0.269)	(1.364)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	1198(728)	1198(728)	996(603)	996(603)	571(328)	571(328)
# of Group	295(207)	295(207)	248(174)	248(174)	147(96)	147 (96)

[1] Numbers in parenthesis are robust standard errors obatained from boostrap 399 replications.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level. m denotes marginal significance within 10.5%
[3] The first and second row for each side(Top and Bottom) contains estimation results of equation (2). The third row for each side(Top and Bottom) contains second stage estimation results of equation (4).
[4] The numbers of observations and groups in the two stage estimation are reported in the parenthesis.
[5] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.5: Hypothesis 2 : TFP effects on the Foreign outsourcing choice

	High Captal Intensity Industry					
	Above mean		Above 50th		Above 75th	
log(TFP)	-0.134 (0.496)	-0.151 (0.779)	-0.234 (0.571)	-0.222 (0.757)	-0.624 (0.814)	-0.889 (2.620)
log(TFP) with control	-0.176 (0.554)	-0.257 (0.892)	-0.279 (0.619)	-0.310 (0.897)	-0.919 (1.154)	-1.373[a] (1.158)
log(TFP) with control	-1.142 (2.246)	-5.336[a] (4.125)	-1.331[a] (1.431)	-5.881[a] (3.831)	-2.097[a] (1.872)	-18.345[a] (13.596)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	117(50)	117(50)	132(33)	132(33)	72(58)	72(58)
# of Group	30(15)	30(15)	33(10)	33(10)	18(17)	18(17)

	Low Captal Intensity Industry					
	Below mean		Below 50th		Below 25th	
log(TFP)	0.254 (0.303)	0.257 (0.308)	0.282 (0.297)	0.276 (0.303)	0.250 (0.373)	0.111 (0.397)
log(TFP) with control	0.320 (0.305)	0.293 (0.315)	0.355 (0.296)	0.317 (0.304)	0.353 (0.392)	0.138 (0.409)
log(TFP) with control	1.371** (0.617)	2.403 (1.483)	1.403** (0.582)	2.519* (1.421)	1.537** (0.821)	3.197 (2.146)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	416(235)	416(235)	403(228)	403(228)	258(144)	258(144)
# of Group	104(67)	104(67)	101(65)	101(65)	67(43)	67(43)

[1] Numbers in parenthesis are robust standard errors obatained from boostrap 399 replications.
[a] In the corresponding cell, standard error is reported as the failure of boostrapping.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level.
[3] The first and second row for each side(Top and Bottom) contains estimation results of equation (2). The third row for each side(Top and Bottom) contains second stage estimation results of equation (4).
[4] The numbers of observations and groups in the two stage estimation are reported in the parenthesis.
[5] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.6: Hypothesis 2 : TFP effects on the Offshoring choice

	High Captal Intensity Industry					
	Above mean		Above 50th		Above 75th	
log(TFP)	0.504**	0.386*	0.529***	0.387*	0.442*	0.339
	(0.223)	(0.219)	(0.204)	(0.203)	(0.236)	(0.257)
log(TFP)	0.513**	0.400*	0.535***	0.398**	0.457*	0.361
with control	(0.224)	(0.221)	(0.204)	(0.202)	(0.234)	(0.259)
log(TFP)	0.897**	1.373	0.843***	1.480*	0.602	0.806
with two step	(0.379)	(0.864)	(0.323)	(0.789)	(0.404)	(0.917)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	802(489)	802(489)	1028(628)	1028(628)	580(355)	580(355)
# of Group	202(142)	202(142)	252(178)	252(178)	151(105)	151(105)
	Low Captal Intensity Industry					
	Below mean		Below 50th		Below 25th	
log(TFP)	0.427**	0.338*	0.410**	0.322*	0.531*	0.358
	(0.171)	(0.181)	(0.173)	(0.178)	(0.281)	(0.277)
log(TFP)	0.420**	0.360*	0.399**	0.337*	0.526*	0.382
with control	(0.173)	(0.184)	(0.171)	(0.178)	(0.282)	(0.274)
log(TFP)	0.596**	1.240*	0.569**	1.032	0.651	1.055
with two step	(0.260)	(0.652)	(0.289)	(0.698)	(0.451)	(0.996)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	1397(855)	1397(855)	1182(721)	1182(721)	671(404)	671(404)
# of Group	341(243)	341(243)	292(218)	292(218)	171(120)	171(120)

[1] Numbers in parenthesis are robust standard errors obatained from boostrap 399 replications.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level.
[3] The first and second row for each side(Top and Bottom) contains estimation results of equation (2). The third row for each side(Top and Bottom) contains second stage estimation results of equation (4).
[4] The numbers of observations and groups in the two stage estimation are reported in the parenthesis.
[5] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.7: Hypothesis 3 : Discrete Duration Analysis

	Full Sample	High Capital Intensity			Low Capital Intensity		
		Above Avg.	Above 50th	Above 75th	Below Avg.	Below 50th	Below 25th
log(TFP)	0.198**	0.170*	0.254***	0.158	0.224*	0.099	-0.072
	(0.078)	(0.096)	(0.081)	(0.139)	(0.124)	(0.150)	(0.179)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	7880	3020	4726	1708	4860	3154	2008

[1] Numbers in parenthesis are robust standard errors.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level.
[3] The base sample consists of continuing domestic outsourcing firms from 2006 to 2010.
[4] Dependent variable is the year of FDI occurence.
[5] Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.8: Participation Behavior : Ownership Choice

	Vertical Integration			Outsourcing		
	Overall	FDI	DI	Overall	FO	DO
$\log(\frac{K}{L})$	0.538^{***}	0.698^{***}	0.264^{*}	0.030	0.178	0.039
	(0.143)	(0.184)	(0.157)	(0.137)	(0.276)	(0.142)
$\log(\frac{K}{L})$	0.534^{***}	0.698^{***}	0.267^{*}	0.038	0.165	0.049
with control	(0.143)	(0.184)	(0.157)	(0.137)	(0.274)	(0.144)
Obs.	5605	3322	5686	6496	1702	6578
# of Group	1279	754	1296	1528	396	1548

[1] Numbers in parenthesis are robust standard errors obatained from boostrapping with 399 replications.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level.
[3] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.9: TFP effects on the FDI Participation

	High Captal Intensity Industry					
	Above mean		Above 50th		Above 75th	
log(TFP)	0.725^{**}	0.549^{**}	0.695^{***}	0.462^{**}	0.496^{*}	0.382
	(0.284)	(0.276)	(0.224)	(0.218)	(0.255)	(0.264)
log(TFP)	0.759^{**}	0.605^{**}	0.717^{***}	0.502^{**}	0.524^{*}	0.435
with control	(0.300)	(0.297)	(0.235)	(0.233)	(0.273)	(0.290)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	1078	1078	1371	1371	760	760
# of Group	268	268	331	331	193	193

	Low Captal Intensity Industry					
	Below mean		Below 50th		Below 25th	
log(TFP)	0.208	0.142	0.221	0.177	0.165	0.122
	(0.135)	(0.140)	(0.151)	(0.154)	(0.234)	(0.235)
log(TFP)	0.192	0.162	0.212	0.210	0.153	0.158
with control	(0.135)	(0.138)	(0.150)	(0.152)	(0.236)	(0.231)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	1920	1920	1632	1632	841	841
# of Group	462	462	399	399	212	212

[1] Numbers in parenthesis are robust standard errors obatained from boostrap 399 replications.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level. m denotes marginal significance within 10.5%
[3] The first and second row for each side(Top and Bottom) contains estimation results of equation (2) with participation dependent variable.
[4] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 2.10: TFP effects on Foreign Outsourcing Participation

	High Captal Intensity Industry					
	Above mean		Above 50th		Above 75th	
log(TFP)	0.665*	0.642*	0.462	0.453	0.427	0.426
	(0.342)	(0.359)	(0.312)	(0.327)	(0.362)	(0.399)
log(TFP) with control	0.635*	0.597	0.440	0.418	0.365	0.351
	(0.362)	(0.374)	(0.316)	(0.329)	(0.373)	(0.405)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	395	395	520	520	282	282
# of Group	99	99	128	128	73	73

	Low Captal Intensity Industry					
	Below mean		Below 50th		Below 25th	
log(TFP)	0.009	0.056	0.053	0.096	0.043	0.083
	(0.185)	(0.185)	(0.202)	(0.203)	(0.248)	(0.254)
log(TFP) with control	0.098	0.149	0.188	0.229	0.278	0.333
	(0.192)	(0.197)	(0.212)	(0.222)	(0.263)	(0.275)
Year FE	No	Yes	No	Yes	No	Yes
Obs.	1096	1096	964	964	591	591
# of Group	265	265	236	236	153	153

[1] Numbers in parenthesis are robust standard errors obatained from boostrap 399 replications.
[2] ***, **, and * denote significance at 1%, 5%, and 10% level.
[3] The first and second row for each side(Top and Bottom) contains estimation results of equation (2) with participation dependent variable.
[4] Fixed Effect Logit estimation is applied. Raw coefficients from the statistical software are reported.

Table 3.1: Summary Statistics

Variable	Mean	Std. Deviation	Min	Max	Obs.
ln(import)	8.280	2.239	0	17.67	14,551
i.import	0.440	0.496	0	1	33,104
ln(export)	8.678	2.259	0	18.37	19,849
i.export	0.600	0.490	0	1	33,104
OTC	9.691	10.994	0.235	152.47	32,113
ITC	9.056	8.892	1.908	81.50	31,953
ITC2	8.784	8.304	2.320	60.30	31,953
ln(market share)$_0$	-7.030	1.584	-16.08	-0.170	33,094

Table 3.2: Impact of Trade Cost on Exports

	Intensive Margin : ln(export)			Extensive Margin : Prob(export>0)		
	(1)	(2)	(3)	(4)	(5)	(6)
ITC	-0.038***			-0.007***		
	(0.004)			(0.001)		
ITC2			-0.020***			-0.004***
			(0.005)			(0.001)
OTC		-0.027***	-0.021***		-0.004***	-0.003***
		(0.004)	(0.005)		(0.0004)	(0.0004)
ln(market share)$_0$	0.542***	0.538***	0.546***	0.055***	0.054***	0.055***
	(0.020)	(0.020)	(0.020)	(0.003)	(0.003)	(0.003)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	19304	19417	19304	31951	32103	31951
# of Firms	5399	5421	5399	7858	7883	7858
R^2	0.198	0.193	0.200	0.044	0.040	0.043

***, **, and * denote significance at the 1%, 5%, and 10% level. Robust standard errors are reported in the parenthesis. ITC (ITC2) is the input trade cost which is a weighted average of output trade cost (OTC) with weights from input-output table including (excluding) the diagonal elements. Random effects estimations are performed on models (1)-(3). LPM with random effects estimations are performed on models (4)-(6)

Table 3.3: Impact of Trade Cost on Imports

	Intensive Margin : ln(import)			Extensive Margin : Prob(import>0)		
	(1)	(2)	(3)	(4)	(5)	(6)
ITC	-0.014***			-0.004***		
	(0.003)			(0.0005)		
ITC2			-0.011***			-0.003***
			(0.003)			(0.001)
OTC		-0.008***	-0.005*		-0.002***	-0.001***
		(0.003)	(0.003)		(0.0004)	(0.0005)
ln(market share)$_0$	0.678***	0.675***	0.680***	0.066***	0.065***	0.066***
	(0.018)	(0.018)	(0.018)	(0.003)	(0.003)	(0.003)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	14226	14318	14226	31951	32103	31951
# of Firms	4499	4517	4499	7858	7883	7858
R^2	0.263	0.263	0.264	0.053	0.052	0.053

***, **, and * denote significance at the 1%, 5%, and 10% level. Robust standard errors are reported in the parenthesis. ITC (ITC2) is the input trade cost which is a weighted average of output trade cost (OTC) with weights from input-output table including (excluding) the diagonal elements. Random effects estimations are performed on models (1)-(3). LPM with random effects estimations are performed on models (4)-(6)

Table 3.4: Impact of Imports on Exports

	ln(export)		ln(export+1)		ln(export)	ln(export+1)
	(1)	(2)	(3)	(4)	(5)	(6)
ln(import)	0.277*** (0.011)	0.231*** (0.011)			0.138*** (0.013)	
ln(import+1)			0.392*** (0.007)	0.374*** (0.007)		0.289*** (0.009)
ln(market share)$_0$		0.376*** (0.022)		0.441*** (0.025)		
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	12797	12794	33098	33094	12797	33098
# of Firms	4068	4067	8094	8093	4068	8094
R^2	0.304	0.311	0.301	0.302	0.260	0.298

***, **, * denote significance at 1%, 5%, and 10%. Robust standard errors are reported in the parenthesis. Random effects estimations are performed on models (1)-(4). Fixed effects estimations are performed on models (5)-(6)

Table 3.5: Impact of Trade Costs on Firm-Level Employment

ln(employment)	(ρ-σ)		ρ		Input Rauch-Output Rauch		Input Rauch	
	Sub. Input	Comp. Input	Sub. Input	Comp. Input	Sub. Input	Comp. Input	Sub. Input	Comp. Input
ITC2	0.002**	-0.022***	0.002***	-0.013***	-0.010***	0.0002	0.004***	-0.012*
	(0.001)	(0.003)	(0.001)	(0.003)	(0.003)	(0.001)	(0.001)	(0.007)
OTC	0.001***	-0.001	0.002***	-0.006***	0.005**	-0.001	0.002***	-0.008***
	(0.0004)	(0.001)	(0.0004)	(0.002)	(0.002)	(0.001)	(0.0004)	(0.002)
ln(market share)$_0$	0.250***	0.309***	0.349***	0.245***	0.283***	0.290***	0.328***	0.305***
	(0.009)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)	(0.009)	(0.012)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
# of Obs.	16409	15542	17227	14724	16822	15129	16526	15425
# of Firms	4262	4245	4395	3982	4365	4065	4212	4058
R^2	0.256	0.384	0.410	0.265	0.309	0.339	0.398	0.350

***, **, * denote significance at 1%, 5%, and 10%. Robust standard errors are reported in the parenthesis. ITC2 is the input trade cost which is a weighted average of output trade cost (OTC) with weights from input-output table excluding the diagonal elements. Random effects estimations are performed.

Table 3.6A: Impact of Imports on Firm-Level Employment

ln(employment)	(1) RE	(2) RE	(3) RE	(4) RE	(5) RE	(6) RE	(7) OLS	(8) OLS	(9) OLS
ln(Import+1)	0.008***	0.005***	0.005***	0.008***	0.004***	0.004***	0.018***	-0.003	-0.003*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
[ln(Import+1)]* (i.export)		0.002*	0.002*		0.003**	0.003**		0.023***	0.024***
		(0.001)	(0.001)		(0.001)	(0.001)		(0.002)	(0.002)
[ln(Import+1)]* (ρ-σ)			-0.0002***			-0.0002***			-0.0004***
			(0.0001)			(0.0001)			(0.0001)
i.export		0.037***	0.038***		0.032***	0.032***		0.009	0.009
		(0.007)	(0.007)		(0.007)	(0.007)		(0.008)	(0.008)
(ρ-σ)	-0.001**	-0.001**	-0.001						
	(0.001)	(0.001)	(0.0005)						
ln(market share)$_0$	0.268***	0.267***	0.267***	0.350***	0.349***	0.349***	0.453***	0.449***	0.448***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.004)	(0.004)	(0.004)
Industry FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	32942	32942	32942	33094	33094	32942	33094	33094	32942
# of Firms	8068	8068	8068	8093	8093	8068			
R^2	0.329	0.334	0.336	0.496	0.499	0.500	0.574	0.576	0.577

***, **, * denote significance at 1%, 5%, and 10%. Robust standard errors are reported in the parenthesis. ρ: input elasticity of substitution, σ : output elasticity of substitution.

Table 3.6B: Impact of Imports on Firm-Level Employment

ln(employment)	(1) RE	(2) RE	(3) RE	(4) RE	(5) RE	(6) RE	(7) OLS	(8) OLS	(9) OLS
ln(Import)	0.031***	0.021***	0.021***	0.031***	0.019***	0.018***	0.053***	0.00005	-0.0003
	(0.002)	(0.005)	(0.005)	(0.002)	(0.005)	(0.005)	(0.003)	(0.008)	(0.008)
[ln(Import)]* (i.export)		0.012**	0.012**		0.014**	0.015***		0.059***	0.060***
		(0.005)	(0.005)		(0.005)	(0.005)		(0.008)	(0.008)
[ln(Import)]* (ρ-σ)			-0.001***			-0.001***			-0.002***
			(0.0002)			(0.0002)			(0.0002)
i.export		-0.030	-0.030		-0.054	-0.058		-0.340***	-0.342***
		(0.045)	(0.045)		(0.045)	(0.045)		(0.062)	(0.061)
(ρ-σ)	-0.002*	-0.002*	0.005***						
	(0.001)	(0.001)	(0.002)						
ln(market share)$_0$	0.318***	0.317***	0.316***	0.405***	0.404***	0.404***	0.494***	0.487***	0.485***
	(0.009)	(0.009)	(0.009)	(0.011)	(0.011)	(0.011)	(0.007)	(0.007)	(0.007)
Industry FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	14456	14456	14456	14548	14548	14456	14548	14548	14456
# of Firms	4563	4563	4563	4581	4581	4563			
R^2	0.426	0.433	0.437	0.590	0.593	0.597	0.658	0.661	0.664

***, **, * denote significance at 1%, 5%, and 10%. Robust standard errors are reported in the parenthesis. ρ: input elasticity of substitution, σ : output elasticity of substitution.

Table 3.7A: Impact of Imports on Firm-Level Employment : IV Estimation

ln(employment)	(1) RE	(2) RE	(3) RE	(4) IV	(5) IV (i.export=0)	(6) IV (i.export=1)	(7) (i.export=0)	(8) (i.export=1)
ln(Import+1)	0.008***	0.008***	0.008***	0.005	0.089	0.028	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.017)	(0.071)	(0.025)	(0.002)	(0.001)
[ln(Import+1)]* (ρ-σ)		-0.0002***	-0.0002***	-0.0005***	-0.001	-0.001***	-0.0002	-0.0001**
		(0.0001)	(0.0001)	(0.0001)	(0.001)	(0.0001)	(0.0002)	(0.0001)
ITC			0.0004					
			(0.001)					
(ρ-σ)		-0.001	-0.001				-0.001*	-0.001
		(0.0004)	(0.0005)				(0.001)	(0.001)
ln(market share)$_0$	0.268***	0.268***	0.268***	0.271***	0.146***	0.314***	0.169***	0.324***
	(0.007)	(0.007)	(0.007)	(0.014)	(0.021)	(0.021)	(0.007)	(0.008)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	33094	32942	31951	31951	12647	19304	13209	19733
# of Firms	8093	8068	7858	7858	4779	5399	4944	5515
R^2	0.328	0.331	0.331	0.321	0.098	0.421	0.145	0.398

***, **, * denote significance at 1%, 5%, and 10%. Robust standard errors are reported in the parenthesis. ρ: input elasticity of substitution, σ : output elasticity of substitution.

Table 3.7B: Impact of Imports on Firm-Level Employment : IV Estimation

ln(employment)	(1) RE	(2) RE	(3) RE	(4) IV	(5) IV (i.export=0)	(6) IV (i.export=1)	(7) (i.export=0)	(8) (i.export=1)
ln(Import)	0.032***	0.032***	0.032***	0.171***	0.057	0.072	0.029***	0.033***
	(0.002)	(0.002)	(0.002)	(0.064)	(0.097)	(0.056)	(0.008)	(0.002)
[ln(Import)]* (ρ-σ)		-0.001***	-0.001***	-0.0004***	-0.001***	-0.0004***	-0.001**	-0.001***
		(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.001)	(0.0002)
ITC			-0.0004					
			(0.001)					
(ρ-σ)		0.005***	0.005***				0.005	0.006***
		(0.002)	(0.002)				(0.004)	(0.002)
ln(market share)$_0$	0.318***	0.317***	0.317***	0.228***	0.191	0.308***	0.202***	0.332***
	(0.009)	(0.009)	(0.009)	(0.042)	(0.051)	(0.038)	(0.015)	(0.009)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	14548	14456	14226	14226	1713	12513	1744	12712
# of Firms	4581	4563	4499	4499	927	3992	945	4051
R^2	0.424	0.430	0.432	0.465	0.263	0.481	0.261	0.451

***, **, * denote significance at 1%, 5%, and 10%. Robust standard errors are reported in the parenthesis. ρ : input elasticity of substitution, σ : output elasticity of substitution.

Table 3.8: Test of Balancing Hypothesis : 2007 Matching Performance

Variable	Sample	Mean		% Bias	t-test	
		Treatment	Control		t	P - value
ln(Employment)	Unmatched	5.397	4.683	79.9	11.81	0.000
	Matched	5.397	5.454	-6.3	-0.36	0.719
Sales/Wage Bill	Unmatched	10.112	7.480	33.7	4.77	0.000
	Matched	10.112	9.961	1.9	0.15	0.884
Export Dummy	Unmatched	0.578	0.289	60.8	6.82	0.000
	Matched	0.578	0.593	-3.1	-0.25	0.806
ln(TFP)	Unmatched	4.846	4.620	25.4	3.12	0.002
	Matched	4.846	4.876	-3.3	-0.25	0.800

Table 3.9A: Difference-in-Difference Estimation

ln(employment)	< OLS >		< Fixed Effects >		< Random Effects >	
$IMP_{i,t-1}$	0.338*** (0.035)	0.388*** (0.038)	0.050*** (0.011)	0.013 (0.014)	0.056*** (0.011)	0.023* (0.014)
Year FE	No	Yes	No	Yes	No	Yes
# of Firms			594	594	594	594
# of Obs.	2,970	2,970	2,970	2,970	2,970	2,970
R^2	0.03	0.03	0.03	0.004	0.03	0.008

*** Significant at 1%, ** significant at 5%, and * significant at 10%. IMP : Import dummy (takes the value 1 if the firm is importing, 0 otherwise)

Table 3.9B: Difference-in-Difference Estimation

ln(export+1)	< OLS >		< Fixed Effects >		< Random Effects >	
$IMP_{i,t-1}$	3.504*** (0.168)	3.853*** (0.185)	1.342*** (0.135)	1.003*** (0.168)	1.720*** (0.131)	1.603*** (0.159)
Year FE	No	Yes	No	Yes	No	Yes
# of Firms			594	594	594	594
# of Obs.	2,970	2,970	2,970	2,970	2,970	2,970
R^2	0.128	0.136	0.128	0.100	0.128	0.123

*** Significant at 1%, ** significant at 5%, and * significant at 10%. IMP : Import dummy (takes the value 1 if the firm is importing, 0 otherwise)

Table 3.10: Difference-in-Difference Estimation

ln(employment)	< OLS >		< Fixed Effects >		< Random Effects >	
$IMP_{i,t-1}$	-0.535***	-0.481***	0.020	-0.010	-0.010	-0.033
	(0.066)	(0.068)	(0.025)	(0.026)	(0.025)	(0.026)
$IMP_{i,t-1}$ *$\ln(\text{export}+1)_{i,t-1}$	0.081***	0.081***	0.002	0.002	0.006**	0.006*
	(0.008)	(0.008)	(0.003)	(0.003)	(0.003)	(0.003)
$IMP_{i,t-1}$ * $(\rho-\sigma)_{i,t-1}$	-0.002	-0.002	-0.001	-0.001	-0.0004	-0.0002
	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
$\ln(\text{export}+1)_{i,t-1}$	0.055***	0.055***	0.004***	0.004**	0.007***	0.007***
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
$(\rho-\sigma)_{i,t-1}$	-0.007***	-0.007***	0.001	0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.009)	(0.001)	(0.001)	(0.001)
Year FE	No	Yes	No	Yes	No	Yes
# of Firms			590	590	590	590
# of Obs.	2,949	2,949	2,949	2,949	2,949	2,949
R^2	0.203	0.207	0.121	0.070	0.186	0.156

*** Significant at 1%, ** significant at 5%, and * significant at 10%. IMP : Import dummy (takes the value 1 if the firm is importing, 0 otherwise). P : input elasticity of substitution, σ : output elasticity of substitution.

Table 3.11: Difference-in-Difference Estimation

ln(employment)	< OLS >		< Fixed Effects >		< Random Effects >	
$IMP_{i,t-1}$	0.073	0.128	0.028	-0.004	0.027	-0.001
	(0.085)	(0.087)	(0.027)	(0.028)	(0.028)	(0.029)
$IMP_{i,t-1}$ *$i.export_{i,t-1}$	0.182*	0.179*	0.015	0.015	0.020	0.020
	(0.094)	(0.094)	(0.030)	(0.030)	(0.030)	(0.030)
$IMP_{i,t-1}$ * $(\rho-\sigma)_{i,t-1}$	-0.007**	-0.007**	-0.0005	-0.0003	-0.001	-0.001
	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
$i.export_{i,t-1}$	0.267***	0.270***	0.028**	0.025*	0.037***	0.034**
	(0.039)	(0.039)	(0.014)	(0.014)	(0.014)	(0.014)
$(\rho-\sigma)_{i,t-1}$	-0.008***	-0.008***			-0.0002	-0.0003
	(0.002)	(0.002)			(0.001)	(0.001)
Year FE	No	Yes	No	Yes	No	Yes
# of Firms			590	590	590	590
# of Obs.	2,949	2,949	2,949	2,949	2,949	2,949
R^2	0.071	0.075	0.055	0.020	0.061	0.035

*** Significant at 1%, ** significant at 5%, and * significant at 10%. IMP : Import dummy (takes the value 1 if the firm is importing, 0 otherwise). ρ : input elasticity of substitution, σ : output elasticity of substitution.

Table 4.1: Summary Statistics (Mean and Standard Deviation) of Korean Labor and Income Panel Survey Data for All and by Male and Female

		All		Male		Female	
Variable	Stats	1998	2007	1998	2007	1998	2007
Log Wage	Mean	7.329	7.493	7.309	7.750	7.368	7.123
(Monthly)	SD	0.484	0.621	0.476	0.642	0.498	0.339
Female	Mean	0.339	0.409				
	SD	0.474	0.492				
Married	Mean	0.811	0.649	0.862	0.793	0.712	0.440
	SD	0.392	0.477	0.345	0.405	0.453	0.497
Household size	Mean	3.687	3.642	3.760	3.688	3.546	3.576
	SD	1.091	0.762	1.031	0.721	1.188	0.813
Education	Mean	11.553	10.860	11.940	10.375	10.801	11.559
	SD	3.172	3.789	2.775	4.140	3.717	3.086
Age	Mean	40.227	45.674	40.990	49.740	38.739	39.811
	SD	10.655	12.153	11.535	10.757	8.496	11.648
Experience	Mean	22.673	28.814	23.051	33.365	21.938	22.252
	SD	13.060	14.220	13.614	12.400	11.878	14.115
Union Workers(%)							
All Occ		8.950	6.455	12.710	10.201	1.662	1.054
Unskilled Occ		8.458	6.041	12.188	9.744	1.228	0.702
Skilled Occ		0.492	0.414	0.522	0.457	0.434	0.351
No of Obs		4,106	5,563	2,713	3,285	1,393	2,278

The skilled occupation category is consists of (i) Legislators, Senior officials and Managers (ii) Professionals (iii) Associate Professionals and Technicians (iv) Service Workers (v) Skilled Agricultural, Forestry and Fishery Workers and the unskilled occupation is the combination of (i) Clerks (ii) Sales Workers (iii) Craft and related Trade Workers (iv) Plant, Machine Operators and Assemblers (v) Elementary Occupations.

Table 4.2: Decomposition of Wage Distribution Function by Using Machado and Mata (2005) Decomposition Method

	Marginals			Aggregate Contributions			Individual Covariates			
	2007	1998	Change	Composition Effect	Wage Structure Effect	Residuals	Education	Age	Union	Sex
10th quant.	6.787	6.773	0.013	-0.057	0.072	-0.002	0.032	-0.007	0.022	0.012
			(-0.003,0.030)	(-0.059,-0.054)	(0.054,0.089)		(0.030,0.033)	(-0.008,-0.009)	(0.020,0.023)	(0.011,0.013)
				-4.277	5.413	-0.135	2.385	-0.528	1.625	0.890
25th quant.	7.053	6.984	0.069	0.056	0.018	-0.005	0.038	-0.011	0.033	0.026
			(0.064,0.073)	(0.053,0.060)	(0.013,0.022)		(0.037,0.039)	(-0.010,-0.012)	(0.031,0.034)	(0.025,0.028)
				0.819	0.255	-0.074	0.551	-0.160	0.475	0.383
50th quant.	7.347	7.245	0.102	0.010	0.086	0.006	0.035	0.016	0.028	0.024
			(0.099,0.105)	(0.006,0.013)	(0.083,0.090)		(0.033,0.037)	(0.015,0.017)	(0.026,0.030)	(0.023,0.026)
				0.096	0.849	0.056	0.346	0.158	0.274	0.239
75th quant.	7.722	7.688	0.034	0.055	0.010	-0.030	0.078	0.007	0.010	0.036
			(0.018,0.050)	(0.046,0.064)	(-0.003,0.022)		(0.075,0.080)	(0.005,0.009)	(0.008,0.012)	(0.034,0.038)
				1.607	0.284	-0.890	2.276	0.209	0.300	1.068
90th quant.	8.619	7.945	0.674	0.564	0.095	0.016	0.093	0.004	0.005	0.036
			(0.671,0.677)	(0.558,0.570)	(0.092,0.098)		(0.090,0.095)	(0.003,0.005)	(0.003,0.007)	(0.035,0.039)
				0.836	0.141	0.023	0.137	0.006	0.007	0.054
Scale	0.091	0.097	-0.006	0.000	-0.002	-0.004	0.004	0.001	-0.003	0.001
			(-0.008,-0.004)	(-0.002,0.001)	(-0.003,-0.001)		(0.003,0.005)	(0.000,0.001)	(-0.004,-0.0002)	(0.000,0.002)
				0.053	0.338	0.609	-0.720	-0.007	5.641	-0.116
Skewness	0.657	-0.054	0.711	0.279	0.540	-0.109	-0.005	-0.005	-0.055	0.000
			(0.697,0.726)	(0.267,0.291)	(0.514,0.568)		(-0.006,-0.004)	(-0.006,-0.004)	(-0.057,-0.052)	(-0.002,0.002)
				0.393	0.760	-0.153	0.085	-0.007	-0.077	0.000
Kurtosis	3.149	2.833	0.316	0.137	-1.410	1.589	-0.044	-0.007	0.089	-0.040
			(0.268,0.365)	(0.090,0.185)	(-1.542,-1.282)		(-0.049,0.040)	(-0.008,-0.007)	(0.083,0.094)	(-0.045,-0.035)
				0.435	-4.467	5.032	-0.141	-0.023	0.282	-0.014
Gini Coeff	0.045	0.037	0.008	0.009	-0.002	0.002	0.001	0.000	-0.001	0.000
			(0.007,0.009)	(0.008,0010)	(-0.003,-0.001)		(0.000,0.002)	(0.000,0.001)	(-0.002,-0.003)	(0.000,0.002)
				1.050	-0.264	0.214	0.141	-0.001	-0.071	0.047

The first row of each block is the point estimated in the change in the attribute of the density, explained by the indicator factor; the second row is the 95% confidence interval for that change and the third row is percentage of the total change explained by the indicator factor.

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