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The Wage Premium and Market Structure:
The Case of South Korea and Taiwan

Abstacts:

We seek to understand why the difference between wages earned by skilled and unskilled labor, the so-called "wage premium", varies across developing countries, using South Korea and Taiwan as empirical case studies. South Korea and Taiwan are both small developing countries with export-led economies that enjoy relatively high incomes compared to their Asian counterparts (excluding Japan). Between 1990 and 2000, Taiwan experienced a decrease in the wage premium, while South Korea remained the same wage premium. In particular, during that period, the wage premium fell from 67% to 25% in Taiwan, but remains around 44% in South Korea (Helms et al, 1999; Choi and Jeong, 2005); the trend continued through 2012 according statistics published by South Korean and Taiwanese Ministries of Labor.

The existing academic literature offers several theories of how wage premia are determined. One strand of the literature attributes cross-country variation in the wage premium to differences in relative human capital factor endowments; another strand attributes it to differences in rates of skilled biased technical change; and a third strand attributes it to differences in the degrees of competition at the sectoral level (Leamer 1996; Feenstra and Hanson, 1997; and Krugman, 2001). However, none of these theories adequately explain differences in the wage premium observed between South Korea and Taiwan. Both countries have comparable relative human capital endowments (Guo, 2005), have traded heavily with the U.S. (U.S. census data), and have experienced substantial skill-based technical change over the past decade (Chan, 2005; Choi and Jeong 2005).

The puzzling question is then: why is the wage premium in South Korea much higher than in Taiwan? In an effort to resolve the puzzle, we theorize that cross-country variation in the wage premium arises from differences in the degree of competition in markets for differentiated goods. Taiwanese firms are small and operate in a monopolistic competitive environment, whereas South Korean firms are larger and enjoy more government support (Feenstra and Hanson, 1993; Rodrik, 1994). In our paper, we explore whether these differences in market structure can account for the observed differences in the wage premium between the two countries.

To understand the impact of competition on the wage premium, we build and analyze a general equilibrium model of two trading partners, one a small developing country with a relatively low skilled labor endowment and the other a large developed country with a relatively high skilled labor requirement. The trading partners produce and trade two types of goods, a homogenous good and a differentiated good, both of which are produced using two types of labor, skilled and unskilled. We analyze the model under different assumptions regarding the competitiveness of the differentiated good market and find that the wage premium in the developing country will be higher if the market for the differentiated good is characterized by oligopolistic competition rather than monopolistic competition.

We then test the predictions of our theoretical model empirically. Specifically, we test the hypothesis that that wage premium is positively related to concentration measure. Due to the limitation of two different forms of data available to us — individual- and industry-level data — we employ the two stage regression method developed by Goldberg and Pavcnik (2003). In the first stage, we regress the wage premium on individual characteristics, industry dummies, an education variable and an interaction variable of education level and industry dummies; in the second stage, we regress the parameter estimated in the first stage against a measure of product market competition (i.e., the concentration ratio) and other control variables. To our knowledge, a cross-country level comparison on the influence of product market structure on the wage premium has not been undertaken for developing countries.

We employ data from several sources. We use a panel of individual-level and industry-level observations over three distinct years drawn from several sources: the Taiwan Manpower Utilization Survey (TMUS), Academia Sinica (Taiwan), the Korean Labor & Income Panel Study (KLIPS), the OECD Structural Analysis database (STAN), and the U.S. Economic Census. Import and export data are taken from United Nations Commodity Trade Statistics Database and the International Economic Data Bank (IDEB). Data obtained from TMUS and KLPS are at the individual level and the data obtained from sources are at the industry level. We restrict our attention to trade between the Taiwan and the U.S. and between South Korea and the U.S. because for both countries, the U.S. is each country's most important trade partner.

Our analysis departs from the well-established factor endowment and skilled-based technical change literatures, providing a novel explanation that wage premium differences across developing countries differ due to market structure and market power under trade. Our study should provide ample fuel for thought for development economists and policy makers in developing countries who are interested in the impact of trade on economic growth and on the distribution of income among those living in developing countries.

1. Introduction

In my dissertation, I seek to understand why the difference between wages earned by skilled and unskilled labor, the so-called "wage premium", varies across developing countries, using South Korea and Taiwan as empirical case studies.

South Korea and Taiwan are both small developing countries with export-led economies that enjoy relatively high incomes compared to their Asian counterparts (excluding Japan). Between 1990 and 1999, Taiwan experienced an increase and then a decrease in the wage premium, while South Korea experienced a dramatic increase. In particular, during that period, the wage premium fell from 67% to 49% in Taiwan, but rose from 20% to 80% in South Korea (Helms et al, 1999; Choi and Jeong, 2005); the trend continues through 2012 according statistics published by South Korean and Taiwanese Ministries of Labor.

The existing academic literature offers several theories of how wage premia are determined. One strand of the literature attributes cross-country variation in the wage premium to differences in relative human capital factor endowments; another strand attributes it to differences in rates of skilled biased technical change; and a third strand attributes it to differences in the degrees of competition at the sectoral level (Leamer 1996; Feenstra and Hanson, 1997; and Krugman, 2001). However, none of these theories adequately explain differences in the wage premium observed between South Korea and Taiwan. Both countries have comparable relative human capital endowments (Guo, 2005), have traded heavily with the U.S. (U.S. census data), and have experienced substantial skill-based technical change over the past decade (Chan, 2005; Choi and Jeong 2005).

The puzzling question is then: why is the wage premium in South Korea much higher than in Taiwan? In an effort to resolve the puzzle, I theorize that the cross-county variation in the wage premium arises from differences in the degree of competition in markets for differentiated goods. Taiwanese firms are small and operate in a monopolistic competitive environment, whereas South Korean firms are larger and enjoy more government support (Feenstra and Hanson, 1993; Rodrik, 1994). In my dissertation, I explore whether these differences in market structure can account for the observed differences in the wage premium between the two countries.

In Part 1 of my dissertation, I build and analyze a general equilibrium model of two trading partners, one a small developing country with a relatively low skilled labor endowment and the other a large developed country with a relatively high skilled labor requirement. The trading partners produce and trade two types of goods, a homogenous good and a differentiated good, both of which are produced using two types of labor, skilled and unskilled. I analyze the model under different assumptions regarding the competitiveness of the differentiated good market and find that the wage premium in the developing country will be higher if the market for the differentiated good is characterized by oligopolistic competition rather than monopolistic competition.

In Part 2 of my dissertation, I test the predictions of my theoretical model empirically. Specifically, I test whether differences in the wage premium between Taiwan and South

Korea are attributable to differences in the competitiveness of the markets for differentiated goods that they trade with the U.S. I employ a two-stage regression technique developed by Goldberg and Pavcnik (2003), which calls for regressing the wage premium against individual characteristics in the first stage and then regressing the resulting coefficients on a measure of product market competition in the second stage. I employ data from several sources, including labor and income surveys from Taiwan and South Korea, and economic census and trade data from the U.S.

1. 1 background information

Two studies provide evidence that Taiwanese firms tend to be smaller and earn lower profit margins than their South Korean counterparts. Rodrik (1994) finds that South Korean industry is dominated by large conglomerates with branded products (e.g., Hyundai, Samsung, and LG), whereas Taiwanese industry is less concentrated and characterized by less-recognized brand names. Rodrik also finds that South Korean goods are of higher quality and sell for about 20 percent more than their Taiwanese counterparts. He attributes the quality and price differences to differences in brand recognition, arguing that branding gives firms incentives to improve quality in order to protect the value of their brand. He provides the following example: suppose that two competing firms sell similar versions of a product, but only one firm's product has a brand name. If the brand is well established, consumers will know the quality of the branded good, but not that of the unbranded good. Since shoppers do not know the quality of the unbranded good, the producer has no incentive to improve quality. In contrast, the seller of the branded good has an incentive to improve its quality, so long as the increased price associated with a higher-quality good exceeds the cost of quality enhancement (Zeckhauser and Marks, 1996).

Feenstra et al. (1993) find that the Taiwanese market is characterized by many small firms with greater product variety, whereas the South Korean market is characterized by few large firms with lesser product variety. Feenstra et al. chose to study these two economies for their sharply contrasting market structures. In their study, they argue that an economy with vertically integrated business groups (referring to South Korea) will produce a smaller variety of products than a non-integrated economy. Feenstra et al. test their theory empirically, developing a product mix index using U.S. disaggregate import data. They find that Taiwan exports greater product variety to the U.S. than South Korea, especially in downstream industries. Their model also predicts that intermediate-sized vertically integrated groups would be most susceptible to large shocks than smaller disintegrated groups.

1.2. Literature Review

The scholarly economic literature contains three major strands of research that aim to explain inter-country variation in the wage premium. These strands posit different determinants of the wage premium: relative factor endowments and trade, skilled biased technical change, and rent sharing/market structure.

1.1.1 Differences in Factor endowments.

The earliest attempts to explain differences in the wage premium across countries are based on the Heckscher-Ohlin trade model. The Heckscher-Ohlin model posits two countries, two goods, and two factors of production. The model assumes that factors of production are mobile within countries, but immobile across countries; that producers in both countries employ the same constant returns to scale technologies; that consumers in both countries possess identical homothetic preferences; that competition in the product and factor markets is perfect; that trade in goods is free; and that factor endowments differ across countries. Two important theorems may be derived from the Heckscher-Ohlin model. The Heckscher-Ohlin Theorem asserts that a country will export the good that uses its relatively abundant factor intensively. The Stolper–Samuelson Theorem asserts that an increase in the relative price of a good will raise the wage of the factor used intensively in its production and will reduce the wage of the other factor.

The Heckscher-Ohlin model has been used to explain patterns of trade between developed and developing countries. Developed and developing countries differ in their relative endowments of skilled and unskilled labor: developed countries are skilled labor abundant and developing countries are unskilled labor abundant. According to the Heckscher-Ohlin Theorem, the developed country will export the skilled-labor intensive good, while the developing country will export the unskilled-labor intensive good. According to the Stolper–Samuelson Theorem, trade causes the difference in the wage earned by skilled and unskilled workers to widen in the developed country and to narrow in the developing country.

Variants of the Heckscher-Ohlin Model focus on the role of trade in intermediate goods (Feenstra and Hanson, 1996 and 1997; Berman et al, 1994; Berman et al, 1998; Wood, 1995; Goldberg and Pavcnik, 2004). These theories assume that trade is no longer exclusively in the form of final goods but also in the form of intermediate goods that vary in skilled and unskilled labor input requirements. In these models, developed countries retain production of the skilled labor intensive intermediate goods and outsource production of unskilled labor intensive intermediate goods to developing countries. However, what the developing country regards to be unskilled labor is regarded to be skilled labor in the developing country. Thus, outsourcing and trade in intermediate goods causes the wage premium to rise in both the developed and developing country.

Theories that attribute differences in the wage premium to differences in factor endowments, however, have not received much empirical support (Feenstra and Hanson, 1996 and 1997; Katz and Murphy, 1992; Head and Ries, 2002). When empirically testing for the wage premium in U.S., Feenstra and Hanson find that the percentage change of skilled labor share of total wages in Mexico can be a function of both percentage changes of U.S. skilled labor wage and U.S. unskilled labor wage, holding other things being equal. Moreover, these models cannot adequately explain observed differences in the wage

premium between South Korea and Taiwan. Both countries trade heavily with U.S. and possess similar factor endowments (Guo, 2005), yet possess very different wage premia.

1.1.2 Skilled Biased Technical Change

An alternate theory of the determinants of wage premia is based on skilled-biased technical change (SBTC). SBTC theory argues that advancements in technology favor skilled labor, leading to a higher wage premia in the economies in which SBTC takes place (Kats & Murphy, 1992; Krugman, 2000). Once SBTC occurs, whether in a developed or a developing country, the demand for skilled labor rises, causing the wage premium to rise (Wood, 1995; Acemoglu, 2003).

Traditionally, technical change is viewed as factor-neutral. However, the observed rapid rise in the wage premium of skilled workers and an upward trend in their relative supply mean that recent technological change has been skill-biased. This phenomenon is not particular to developed economies, as many developing countries have also experienced SBTC (Galiani and Sanguinetti, 2003; Conte and Vivarelli, 2007). When SBTC takes place, it will result in a heightening of skill intensity in all sectors, not only in the skill intensive sector.

A sub-strand of the SBTC literature argues that SBTC may be induced by trade (Goldberg and Pavcnik, 2004). Wood (1995) proposes "defensive innovation", claiming that firms that trade are forced to adopt new technology and to engage in greater research and development due to the heightened competition that accompanies trade. Acemoglu (2003) argues that international trade induces skill biased technical change, and therefore, has played more important role in determining wage premia than what is generally believed. This position is supported by Krugman (2000), who argues that importation of machinery by developing countries is skill labor augmenting, and thus represents a form of SBTC. Acemoglu (2003) argument is in line with Wood's 1994 defensive innovation. If trade takes place, the relative price of machinery will decrease, raising demand for machinery, which, in turn, raises demand for skilled labor because machinery is skill labor complementary.

SBTC theory, however, also cannot account for the observed differences in wage premia between Taiwan and South Korea (Chan, 2005; Choi and Jeong 2005). Both countries have experiences similar SBTC in recent years.

1.1.3 Rent Sharing/Market Structure Models

The third strand in the wage premium literature, proposed by labor economists, argues that the wage premium is determined by labor union bargaining and product market competition. Nickell et al. (1994) argue that, when firms have market power, they extract rents from the product market and share it with their employees. Using an unbalanced

panel of manufacturing firms in the United Kingdom over the period 1972-86, they found a positive relationship between firm's market power and wage. In a later study, Nickell (1999) identifies three mechanisms through which product market competition affect the labor market: first, greater product competition reduces price margins and leads to greater labor demand; second, labor supply becomes more inelastic when product competition increases, leading to a reduction in the wage; third, reduction of the labor demand elasticity leads to a higher share of rents for those already in the labor market. Endogeneity and robustness, however, are major problems associated with the Nickells' models; he addresses these issues by using two lags of market power as instruments.

Guadalupe (2007) applies a difference in difference method to a panel of U.K. male manufacturing workers employment and wage data. Controlling for technical change and unionization, she finds that the wage premium enjoyed by skilled labor is positively correlated with competition. She finds little evidence that the wage premium depends on technology and unionization.

1.4 .Contributions

Current theories of trade and market structure cannot adequately explain the variation of wage premiums observed across some developing countries. My dissertation is devoted to providing a new theory based differences in product market competition under free trade, using South Korea and Taiwan as a case study. My analysis departs from the factor endowment and STBC literatures, explaining wage premium differences in terms of differences in market structure and market power under trade. To this end, I devise a model that allows for monopolistic competition and oligopolistic competition. Developed and undeveloped countries are distinguished by their relative endowments of skilled and unskilled labor.

2. Model

In neoclassical economic theory, when competition is imperfect, firms vary with respect to market power. Monopolistic competition is characterized by a very large number of small firms with each firm having a small market share as a result of producing a slightly differentiated product. Oligopolistic competition is characterized by a small number of larger firms that interact strategically in the market. The two types of competition affect the price markups and the wages offered. Firms with more market power are more willing to distribute their rents to workers.

To explain how market structure affects the wage premium under trade, I draw on the traditional Dixit-Stiglitz model of monopolistic competition, adapting it to accommodate consumer preference as conceived by Krugman (1979). Specifically, in the Krugman model of preferences, consumers prefer greater product variety. When this is the case, trade is welfare enhancing because it offers consumers greater variety. My model assumes two goods, a differentiated good and an undifferentiated good. Production of the differentiated

good is skill intensive, whereas only unskilled labor is required to produce the undifferentiated good. To ensure a closed form solution, I posit a Cobb-Douglas production technology for the differentiated good, and a linear production technology for the undifferentiated good.

I use the model to examine two distinct scenarios, one in which a differentiated good market is characterized by oligopolistic competition and one in which the differentiated good market is characterized by monopolistic competition. The major difference between oligopolistic and monopolistic competition is that under monopolistic competition firms charge the same price, a constant markup over marginal cost. Under oligopolistic competition, on the other hand, mark-ups may vary across firms. I construct a general equilibrium model that endogenously determines the wage premium under both market structure scenarios.

2.1. Closed Economy

I begin by examining a closed economy. In my model, there are two final goods, X and Y. Good X is a differentiated good produced by imperfectly competitive firms using a Cobb-Douglas technology and employing both skilled and unskilled labor. Good Y is a homogeneous good produced by perfectly competitive firms using linear technology and employing only unskilled labor. The production of X also involves fixed costs from advertisement, research and development, headquarter activities, etc.

I denote the unit cost of producing good X by $C^x(W, R)$ and unit cost of producing good Y by $C^y(W, R)$. I denote the wage of unskilled labor by w, the wage of skilled labor by R, and the wage premium by $\omega = \frac{R}{W}$. The price for X denoted by P_x and the price of Y denoted by P_y. The endowments of skilled and unskilled labor are denoted H and L, respectively. The fixed cost required to produce X is denoted by fR, indicating that activities associated with fixed costs employ skilled labor, making fixed costs proportional to the wage of skilled labor. I also assume that there is no strategic interaction among firms under oligopolistic competition. I denote monopolistic competition by the index m, oligopolistic competition by the index o, autarky by the index a, and the rest of the world by the index r.

2.1.1 Monopolistic Competition

Consumers exhibit preferences over the two goods, a heterogeneous good X and a homogenous good Y. The CES sub-utility function is nested in the utility function for the consumption of a continuum of n differentiated varieties of good X. Let σ denote the constant elasticity of substitution between verities and let v denotes variety. I refer to the price of good X by p_i in the demand and utility function to simplify the notation and restore

the original notation the price of good X, p^x, after I impose symmetry across on firms:

$$U = (\int_{v \in V} x(v)^{\frac{\sigma-1}{\sigma}} dv)^{\frac{\gamma\sigma}{\sigma-1}} y^{1-\gamma}, \qquad 0 < \mu < 1 < \sigma \tag{1}$$

Denoting national income by I, I then derive the market demand facing a firm being

$$x(v) = \gamma I \Big/ (p_i^\sigma z^{1-\sigma}) \tag{2}$$

where $z = (\int_0^n p_i^{1-\sigma})^{1/1-\sigma}$ is industry adjusted price index

$$y = (1 - \gamma)I \tag{3}$$

Production of X requires both skilled and unskilled labor; production of Y requires only unskilled labor. In autarky, the fixed cost of producing good X is denoted by $R_a f$, where R_a is skilled labor wage in autarky. This fixed cost does not vary with the quantity of X produced, but increases with the wage for skilled labor. I further assume that the variable cost of producing good X is $C_a^x(W, R) = R_a^\mu w_a^{1-\mu}$ and the total cost of producing good Y is $C_a^y(W, R) = w_a$. Given the factor requirement, I derive the total cost function in closed economy as

$$TC = R_a f + C_a^x(W, R)x = R_a f + R_a^\mu w_a^{1-\mu} x. \tag{4}$$

The optimal quantity and quality in each market is derived from the first order conditions

$$\pi_i(v) = (p_i(v) - mc_i(v))x_i - R_a f \tag{5}$$

The optimal pricing rule for monopolistic competitive firms is thus

$$p_i(1 - 1/\sigma) = mc_i(\varphi) = C_a^x = R_a^\mu w_a^{1-\mu} \tag{6}$$

This derivation is standard in models of monopolistic competition in which price is assumed to reflect a constant mark-up over unit production costs.

To simplify the algebra, I impose symmetry by assuming that firm in the industry are identical. The following systems of equations describe the closed economy under monopolistic competition; I simplify the notation by introducing an index for autarky, a, for the skilled labor and unskilled wage since the center of our discussion is wage premium.

$$p^x(1 - 1/\sigma) = R_a^\mu w_a^{1-\mu} \tag{7}$$

$$(p^x - C_a^x(R_a, W_a)) = R_a f \tag{8}$$

$$p^y = C_a^y \tag{9}$$

$$n\left[f + \mu\frac{C_a^x}{R_a}x\right] = H \tag{10}$$

$$n\left[(1-\mu)\frac{C_a^x}{w_a}x\right] + y = L \tag{11}$$

$$npx = \gamma(w_a L_a + R_a H_a) \tag{12}$$

$$np_y y = (1-r)(w_a L_a + R_a H_a) \tag{13}$$

Equation (7) is standard in models of monopolistic competition. Equation (8) stipulates that under imperfect competition, firms that produce X will enter the market until all rents are extracted, and equilibrium profits equal zero for the marginal entrant. Equation (9) stipulates that under perfect competition, the price of Y equals the marginal cost of producing Y. Equations (10) and (11) are full employment conditions, which are discussed below. Equations (12) and (13) are market clearing conditions for goods X and Y.

Applying Shephard's lemma, I differentiate the cost functions with respect to wages to derive the demands for skilled and unskilled labor, respectively. I thus derive the demand for skilled labor in the production of good X:

$$\frac{\partial C_a^x}{\partial R_a} = \mu\,C_a^x/R_a$$

Similarly, the demands for unskilled labor in producing goods X and Y, respectively, are

$$\frac{\partial C_a^x}{\partial w_a} = (1-\mu)\,C_a^x/w_N$$

$$\frac{\partial C_a^y}{\partial w_a} = C_a^y/w_N = 1$$

I again apply Shepard's Lemma to the full employment conditions (12) and (13) to get

$$n\left[f + \mu\frac{C_a^x}{R_a}x\right] = H \tag{10}$$

$$n\left[(1-\mu)\frac{C_a^x}{w_a}x\right] + y = L \tag{11}$$

Market clearing for good X requires total spending equals total income. We can write it as

$$\mu I = npx \quad \text{where} \quad I = (w_a L_a + R_a H_a)$$

Here, L_N and H_N denote the supply of unskilled and skilled labor in the developed country, respectively, and n is the number of monopolistic competitive firms.

To further simplify the algebra, I use good Y as a numeraire good and normalize its price to 1, denoting the wage premium by $\frac{R}{W} = \omega$. I reduce the numbers of unknowns and equations as follows:

$$p^x \left(1 - 1/\sigma\right) = C_a^x(\omega) = \omega^\mu \tag{7'}$$

$$(p^x - C_a^x(\omega))x = R_a f \tag{8'}$$

$$p^y = C_a^y = 1 \tag{9'}$$

$$n_a^m \left[f + \mu \frac{C_a^x}{R_a} x\right] = H \tag{10'}$$

$$n_a^m p^x x = \gamma(L_a + \omega_a H_a) \tag{11'}$$

Notice that I add the m and a indices here to denote the monopolistic competitive and autarky case. My model thus consist of four equations (we can ignore (6')) in four unknowns: x, y, n, w. This is a just-identified system. To solve for unknowns, I start by solving for x. From (7')-(8'), we get:

$$x = \frac{\omega f(\sigma - 1)}{C_a^x(\omega)} \tag{14}$$

Substituting (14) into (10') and (12'), yields

$$n_a^m f[1 + \mu(\sigma - 1)] = H \tag{15}$$

$$n_a^m \omega_a f\sigma = \gamma(L_a + \omega_a H_a) \tag{16}$$

Equations (15) and (16) indicate the relationship between the number of firms n and the wage premium ω_a. Dividing (16) by (15), we eliminate the unit cost function C_a^x and obtain:

$$\frac{\sigma}{1 + \mu(\sigma - 1)} = \gamma \frac{(\omega_a H + L)}{\omega_a H} = \gamma\left(1 + \frac{L}{\omega_a H}\right) \tag{17}$$

Equation (17) describes the relationship between the inverse of wage premium $\frac{1}{\omega}$ and the relative factor endowment. The wage premium is affected by the factor endowment ratio, but not the absolute size of the factor endowments. The left-hand-side is a constant containing only the preference parameters, elasticity and branding investment. The right-

hand-side shows that wage premium is positively related to the ratio of unskilled to skilled labor, $\frac{L}{H}$. We solve for the number of firms n from equation (16):

$$n_a^m = \frac{H}{f[1 + \mu(\sigma - 1)]} \tag{18}$$

More importantly, it is evident from (17) that the wage premium is a constant markup over relative ratio of skilled labor $\frac{L}{H}$. More specifically,

$$\omega_a = \frac{H\{\gamma[1 + \mu(\sigma - 1)]\}}{L\{\sigma - \gamma(1 + \mu(\sigma - 1)]\}} \tag{19}$$

The wage premium thus increases if the relative skilled labor endowment decreases. In other words, skilled labor abundant countries will have a smaller wage premium than unskilled labor abundant countries.

2.1.2. Oligopolistic Competition

If I assume the market for the heterogeneous good X is characterized by oligopolistic competition, we can infer how the number of firms affects the wage premium. I start by deriving the demand of the heterogeneous good X. I refer to the price of good X, p_i, in the demand and utility function to simplify the notation and restore standard notation for the price of good X, p^x, after imposing symmetry.

In the oligopolistic case, the aggregate price index z is no longer exogenous to the firm and the demand for the heterogeneous good is:

$$x_i(v) = \left.\gamma I \middle/ (p_i^\sigma z^{1-\sigma})\right. \quad \text{where} \quad z = \left(\int_0^n p_i^{1-\sigma} di\right)^{1/1-\sigma} \tag{20}$$

$$y_i = (1 - \gamma)I \tag{21}$$

$$\frac{\partial x_i}{\partial p_i} = -\frac{x_i}{p_i}\frac{\sigma Z - (\sigma - 1)p_i^{1-\sigma}}{Z} \tag{22}$$

Total costs are the same as before: $TC = R_a f + C_a^x(W, R)x$. The notation o, a stands for autarky oligopolistic competitive case, and we simplify our notation again by adding o and a on the unknown n only. After imposing symmetry across firms, the equations that describe equilibrium under oligopolistic competition are:

$$\left(1 - \frac{C_a^x(R_N, W_N)}{p^x}\right)\left(\sigma - \frac{\sigma - 1}{n}\right) = 1 \tag{23}$$

$$p^y = C_a^y \tag{24}$$

$$(p^x - C_a^x(R_a, W_a))x = R_a f \tag{25}$$

$$n_a^o \left[f + \mu \frac{C_a^x}{R_a} x \right] = H \tag{26}$$

$$n_a^o \left[(1 - \mu) \frac{C_a^x}{w_a} x \right] + y = L \tag{27}$$

$$n_a^o p^x x = \gamma (w_a L_a + R_a H_a) \tag{28}$$

$$n_a^o p^y y = (1 - r)(w_a L_a + R_a H_a) \tag{29}$$

I derive the optimal price by solving the first order condition (23). Unlike under monopolistic competition case, the aggregate price index z will be affected by individual firm decisions under oligopolistic competition. The derivative of x with respect to price, as presented in (23), characterizes optimal price. Equations (24) and (25) are zero profit conditions for good X and good Y, respectively. Equations (26) and (27) are the full employment conditions derived from Shepard's Lemma. Equations (28) and (29) are the market clearing conditions for good X and good Y.

As under monopolistic competition, I take Y to be the numeraire good and normalize its price p_y to 1; then, by the zero profit condition for good Y, $w_N = 1$. This allows me to eliminate the market clearing condition and the unskilled labor employment condition for Y. The system of equations is further reduced as follows:

$$\left(1 - \frac{C_a^x(\omega_a^o)}{p^x} \right) \left(\sigma - \frac{\sigma - 1}{n_a^o} \right) = 1 \tag{30}$$

$$(p^x - C_a^x(\omega_a^o))x = R_a f \tag{31}$$

$$n_a^o \left[f + \mu \frac{C_a^x(\omega_a^o)}{\omega_a^O} x \right] = H \tag{32}$$

$$n_a^o p x = \gamma (L_a + \omega_a^O H_a) \tag{33}$$

Thus, I am left with four equations in four unknowns x, p_x, n, ω. Substituting (30) into (31), we obtain the optimal pricing for oligopoly (o stands for oligopolistic case, x stands for good X and a stands for autarky):

$$p_a^{ox} = C_a^x(w) \left[\frac{n_a^o + (\sigma - 1)(n_a^o - 1)}{(\sigma - 1)(n_a^o - 1)} \right] \tag{34}$$

We then solve for x:

$$x = \frac{\omega f(\sigma - 1)(n_a^o - 1)}{C_a^x(w)n_a^o} \qquad (35)$$

Substituting (34) and (35) into (32) and (33), respectively, I obtain:

$$f[n_a^o + (\sigma - 1)(n_a^o - 1)] = H_a \qquad (36)$$

$$f[n_a^o + \mu(\sigma - 1)(n_a^o - 1)] = \gamma(L_a + \omega_a^o H_a) \qquad (37)$$

If I divide (37) by (36), we obtain:

$$\frac{n_a^o + (\sigma - 1)(n_a^o - 1)}{n_a^o + \mu(\sigma - 1)(n_a^o - 1)} = \frac{\gamma(\omega_a^o H + L)}{\omega_a^o H} \qquad (38)$$

I can solve for the number of firms in oligopolistic competition by further simplify equation (36), to get:

$$n_a^o = \frac{H/f + \mu(\sigma - 1)}{1 + \mu(\sigma - 1)} \qquad (39)$$

Equation (39) shows that the number of firms n is inversely related to the set up cost f. Equation (38) indicates that, unlike the monopolistic case, the wage premium is inversely related to the number of firms and thus positively related to the set up cost f. Also, the wage premium is positively related to the relative factor endowment $\frac{L}{H}$ and the absolute size of skilled factor endowment; this can be seen by substituting Equation (39) into Equation (38):

$$\frac{H_a\sigma - f(1 - \mu)(\sigma - 1)}{H_a[1 + \mu(\sigma - 1)]} = \gamma\left(1 + \frac{L_a}{\omega H_a}\right) \text{, where } \mu < 1 < \sigma \qquad (40)$$

From Equation (40), I evaluate the effect of the skilled factor endowment on the wage premium, holding other things equal. The equilibrium wage premium is determined jointly by the relative skilled factor endowment, the absolute skilled factor endowment and the firm set up cost. Equation (39) indicates a negative relationship between the absolute skilled factor endowment H and the wage premium; it indicates a negative relationship between the relative skilled labor ratio $\frac{L}{H}$ and the wage premium; and it indicates a positive relationship between firm setup cost and the wage premium. Unlike under monopolistic competition, in which the wage premium is determined by the relative skilled labor ratio, wage premium under oligopolistic competition is additionally dependent on the firm setup cost and the absolute skilled factor endowment.

I would like to compare the wage premium between these two market structures in closed economy. From the following equations (here, a denotes autarky, m denotes monopolistic competition, and o denotes oligopolistic competition):

$$\omega_a^m = \frac{H_a}{L_a} \frac{H_a \gamma [1 + \mu(\sigma - 1)]}{H_a \sigma - H_a \gamma (1 + \mu(\sigma - 1))} \tag{19}$$

$$\omega_a^o = \frac{H_a}{L_a} \frac{H_a \gamma [1 + \mu(\sigma - 1)]}{H_a \sigma - H_a \gamma [1 + \mu(\sigma - 1)] - f(\sigma - 1)(1 - \mu)} \tag{41}$$

Equation (19) is derived earlier and we list it here for the purpose of comparison. By comparing Equations (19) and (41), we see that the wage premium is smaller under monopolistic competition than under oligopolistic competition. This is because price is flexible under oligopolistic competition and the price mark-up is redistributed to skilled worker.

2.2 . Open Economy

In this section, I allow for free trade between countries with different factor endowments and discuss the impact of free trade on the wage premium. More specifically, I assume two trading countries, one a developed country, denoted N, and the other a developing country, denoted S. I assume the developed country has higher absolute skilled labor endowment $H_N > H_S$ and a higher skilled to unskilled labor ratio $\frac{L_N}{H_N} < \frac{L_S}{H_S}$. I let R denote the integrated economy.

2.2.1. Monopolistic Competition

When trade opens up between the developed country and the developing country, I consider the integrated economy as a single economy and discuss how the wage premium varies under monopolistically competitive market structure. I again simplify the notation of p^x as p only since price of good Y is ignored here. If we treat the integrated economy as a single closed economy, the systems of equations that describe equilibrium is:

$$p_J(1 - 1/\sigma) = C_t^x(\omega_J) \qquad J = \{N, S\} \tag{42}$$

$$(p_J - C_t^x(\omega_J))x = \omega_J f \tag{43}$$

$$p_y = C_t^y = 1 \tag{44}$$

$$n_J \left[f + \mu \frac{C_t^x(\omega_J)}{\omega_J} x \right] = H_J \tag{45}$$

$$x_N = \frac{\gamma(L_R + \omega_R H_R)}{p_N^\sigma A} \text{ where } A = n_N p_N^{1-\sigma} + n_S p_S^{1-\sigma} \tag{46}$$

$$x_S = \frac{\gamma(L_R + \omega_R H_R)}{p_S^\sigma A} \quad \text{where } A = n_N p_N^{1-\sigma} + n_S p_S^{1-\sigma} \tag{47}$$

When trade opens up, in equilibrium we must have $p_N = p_S = p_R$ and $\omega_N = \omega_S = \omega_R$. By imposing these conditions, we can solve for the wage premium:

$$\frac{\sigma}{1 + \mu(\sigma - 1)} = \gamma\left(1 + \frac{L_R}{\omega_R H_R}\right) \tag{48}$$

$$n_N f\left[1 + \frac{\mu(\sigma - 1)(n_R - 1)}{n_R}\right] = H_N \tag{49}$$

$$n_S f\left[1 + \frac{\mu(\sigma - 1)(n_R - 1)}{n_R}\right] = H_s \tag{50}$$

$$n_R = \frac{H_R}{f[1 + \mu(\sigma - 1)]} \tag{51}$$

I can derive the wage premium for equation (65) as:

$$\omega_R^m = \frac{H_R}{L_R} \frac{\gamma[1 + \mu(\sigma - 1)]}{\sigma - \gamma(1 + \mu(\sigma - 1))} \tag{52}$$

$$\omega_a^m = \frac{H_a}{L_a} \frac{\gamma[1 + \mu(\sigma - 1)]}{\sigma - \gamma(1 + \mu(\sigma - 1))} \tag{19}$$

I list monopolistic competitive autarky results of wage premium derived earlier, equation (19) here for the purpose of comparison determine the direction of wage premium after trade opens up. Notice that a denotes autarky case and R denotes free trade case in these equations.

When free trade is allowed (between the developed and the developing country), by inspecting equation (52), we see that the wage premium in the traded world is determined by relative skilled factor endowments of the integrated economy, $\frac{H_R}{L_R}$. The integrated economy refers to the developed and the developing countries being seen as one economy.

To determine the change of skill premium, we have to consider whether $\omega_R^m > \omega_a^m$ or $\omega_R^m \leq \omega_a^m$. To make a judgment, we need to compare $\frac{H_R}{L_R}$ and $\frac{H_a}{L_a}$ in the right hand side of equation (19) and (52), since our other parameters are assumed to be the same throughout.

As far as the wage premium is concerned, free trade is equivalent to "augmenting a country's factor endowments to the respective world factor endowments". This does not

mean that factor endowments are no longer exogenous and fixed; rather, it means that introducing free trade has the same effect as "increasing" or "decreasing" skilled labor endowments, as equation (52) lays out. For the developed country, because it is relatively and absolutely endowed with more skilled labor, introducing free trade is similar to reducing the relative skilled factor endowment as, $\frac{H_R}{L_R} \leq \frac{H_a}{L_a}$, and thus the wage premium will decrease in the developed economy. By the same argument, for the developing country, introducing free trade is similar to increasing the relative skilled labor endowment, $\frac{H_R}{L_R} \geq \frac{H_a}{L_a}$, and thus the wage premium will increase in the developing country.

2.2.2 Oligopolistic Competition

I now discuss how market structure affects the wage premium in two trading countries with different absolute and relative skilled factor endowments. When allowing free trade, we may consider the two countries as forming a single integrated economy. I again simplify notation p^x as p since the price of good Y is ignored. I let N and S denote the developed country and the developing country countries, respectively, and I let R denote the integrated system/the world economy. Equilibrium for the integrated system is described by:

$$\left(1 - \frac{C_t^x(\omega_N)}{p_N}\right)\left(\sigma - \frac{(\sigma-1)p_N^{1-\sigma}}{A}\right) = 1$$

$$\left(1 - \frac{C_t^x(\omega_S)}{p_S}\right)\left(\sigma - \frac{(\sigma-1)p_S^{1-\sigma}}{A}\right) = 1 \tag{53}$$

where $A = n_N p_N^{1-\sigma} + n_S p_S^{1-\sigma}$

$$(p_N - C_t^x(\omega_N))x_N = \omega_N f$$

$$(p_S - C_t^x(\omega_S))\ x_S = \omega_S f \tag{54}$$

$$n_N\left[f + \mu\frac{C_t^x(\omega_N)}{\omega_N}x_N\right] = H_N$$

$$n_S\left[f + \mu\frac{C_t^x(\omega_S)}{\omega_S}x_S\right] = H_S \tag{55}$$

$$x_N = \frac{\gamma(L_R + \omega_R H_R)}{p_N^\sigma A}$$

$$x_S = \frac{\gamma(L_R + \omega_R H_R)}{p_S^\sigma A} \tag{56}$$

If i solve the above equations, I get:

$$p_N = C_t^x(\omega_N)\left[1 + \frac{A}{(\sigma - 1)(A - p_N^{1-\sigma})}\right]$$

$$p_S = C_t^x(\omega_S)\left[1 + \frac{A}{(\sigma - 1)(A - p_S^{1-\sigma})}\right] \tag{57}$$

$$[p_J - C(\omega_J)]\, x_J = \omega_J f \quad J = \{N, S\} \tag{58}$$

$$\omega_J = \frac{\gamma Y_R p_J^{1-\sigma}}{f[(\sigma - 1)(A - p_N^{1-\sigma}) + A]} \quad J = \{N, S\} \tag{59}$$

Note that, under free trade, $p_N = p_S = p_R$ and $\omega_N = \omega_S = \omega_R$. I further reduce these equations to:

$$n_R = \frac{\dfrac{H_R}{f} + \mu(\sigma - 1)}{1 + \mu(\sigma - 1)} \tag{60}$$

where n_R denotes the total number of firms in the developed country and the developing country combined. The number of firms in each country is proportional to the skilled labor endowment, which are given by:

$$n_N f\left[1 + \frac{\mu(\sigma - 1)(n_R - 1)}{n_R}\right] = H_N$$

$$n_S f\left[1 + \frac{\mu(\sigma - 1)(n_R - 1)}{n_R}\right] = H_s \tag{61}$$

If the developed country has a greater absolute skilled labor endowment, it will have more firms than the developing country.

Substituting Equation (60) into Equation (61), I obtain the number of firms in each country:

$$n_J = \frac{H_J}{H_R} \frac{\dfrac{H_R}{f} + \mu(\sigma - 1)}{1 + \mu(\sigma - 1)} \quad J = \{N, S\} \tag{62}$$

Comparing the number of firms before and after trade, I obtain

$$n_N - n_a = \frac{(H_N - H_R)\mu(\sigma - 1)}{H_R[1 + \mu(\sigma - 1)]} < 0 \tag{63}$$

By equation (63), the number of firms in the developed and in the developing country decrease.

If I substitute Equations (60) and (61) into equation (59), I get:

$$\frac{H_R\sigma - f(\sigma-1)(1-\mu)}{H_R[1+\mu(\sigma-1)]} = \gamma\left(1+\frac{L_R}{\omega_R H_R}\right) \tag{64}$$

$$\omega_R^o = \frac{H_R}{L_R}\frac{\gamma H_R[1+\mu(\sigma-1)]}{H_R\sigma - H_R\gamma[1+\mu(\sigma-1)] - f(\sigma-1)(1-\mu)} \tag{65}$$

Here, a denotes autarky and R denotes free trade case, as before. From Equation (63), it follows that the wage premium is positively related to both the absolute and relative skilled labor endowments in the integrated economy; this result is similar to what occurs under autarkic oligopolistic competition, where wage premium is increasing in relative and absolute skilled labor endowment.

$$\omega_a^o = \frac{H_a}{L_a}\frac{H\gamma[1+\mu(\sigma-1)]}{H_a\sigma - H_a\gamma[1+\mu(\sigma-1)] - f(\sigma-1)(1-\mu)} \tag{41}$$

Equation (41) is listed here for the purpose of comparison to determine the increase or decrease of wage premium after trade. We now have to determine whether $\omega_R^o > \omega_a^o$ or $\omega_R^o \le \omega_a^o$. To make a judgment, we need to compare $\frac{H_R}{L_R}H_R$ and $\frac{H_a}{L_a}H_a$ in the right hand side of equation (65) and (41), since our other parameters are assumed to be the same throughout.

The developed country is absolutely and relatively abundant in skilled labor. Moving from autarky to free trade, we may consider the world as an integrated economy in which the developed country experiences a "decrease" in relative skilled labor endowment and an "increase" in absolute skilled labor endowment. In this regard, it is not clear whether $\frac{H_R}{L_R}H_R \ge \frac{H_a}{L_a}H_a$ or $\frac{H_R}{L_R}H_R \le \frac{H_a}{L_a}H_a$. Thus, upon introducing free trade, the developed country may face an increase or decreases in wage premium, depending on the magnitudes of relative skilled labor and absolute skilled labor endowments. A far as the developing country is concerned, we need to compare $\frac{H_R}{L_R}H_R$ and $\frac{H_a}{L_a}H_a$ again. The developing country "faces" a "increase" in relative skilled endowment such that $\frac{H_R}{L_R} > \frac{H_a}{L_a}$; the absolute skilled labor endowment of the integrated economy H_R is also greater than H_a. It is obvious that trade increases the wage premium in the developing country.

$$p_R = \frac{H_R\sigma - f(\sigma-1)(1-\mu)}{(H_R-f)(\sigma-1)} \tag{66}$$

From the partial derivative $\frac{\partial p}{\partial H} = \frac{f[(\sigma-1)(1-\mu)-\sigma]}{(H-f)^2(\sigma-1)} < 0$, we know that both the developed and developing country will experience increase in absolute skilled labor endowment, and therefore a decrease in the price of good X will occur when trading is allowed between the developed and the developing country, which is the benefit of trade.

$$\omega_R^o = \frac{H_R}{L_R} \frac{\gamma H_R [1 + \mu(\sigma - 1)]}{H_R \sigma - H_R \gamma [1 + \mu(\sigma - 1)] - f(\sigma - 1)(1 - \mu)} \qquad (67)$$

$$\omega_R^M = \frac{H_R}{L_R} \frac{H_R \gamma [1 + \mu(\sigma - 1)]}{H_R \sigma - H_R \gamma (1 + \mu(\sigma - 1))} \qquad (68)$$

Clearly, the increase in the wage premium is greater under oligopolistic competition than under monopolistic competition. In particular, under monopolistic competition, the relative skilled labor endowment in the developing country will determine the magnitude of the increase in the wage premium; in the oligopolistic case, the relative and absolute skilled labor endowments will determine the magnitude of the increase in the wage premium.

2.3. Summary of the Theoretic Results

In this section, I have shown theoretically how market structure can affect wage premium in a trade setting. Unlike traditional theoretical paper on wage premium, I provide two scenarios of imperfect competition—monopolistic competitive case and oligopolistic case. My result consistently shows that different degree of competition does affect the wage premium, i.e.: wage premium in oligopolistic case are higher than that in monopolistic competitive case. This result departs from traditional trade literature that relative skilled factor endowments and absolute skilled factor endowments are not the two solo factors in determining wage premium. Market structure also plays a critical role. In next section, I would like to turn to the empirical analysis of the relationship between wage premium and market structure and to access its quantitative importance. I will discuss the hypotheses of empirical model, the data and variables I will employ, the identification of critical variables, and potential econometrical problems that may arise in our estimation process.

3. Empirical Testing

I now turn to the empirical testing of my theoretical model, which maintains that inter-country differences in the wage premium can be explained by market structure. I use Taiwan and South Korea in my case study. These two economies exhibit very different wage premiums and market structures, but are alike in many other respects, most notably the relative endowments of skilled and unskilled labor and access to technology. In previous sections, I use the term "market structure" to refer to two polar forms of imperfect competition. For the purposes of econometric estimation, I use more conventional measures of the degree of competition that are continuous.

For my empirical analysis, I use a panel of individual-level and industry-level observations over three distinct years drawn from several sources: the Taiwan Manpower Utilization Survey (TMUS), Academia Sinica (Taiwan), the Korean Labor & Income Panel Study

(KLIPS), the OECD Structural Analysis database (STAN), and the U.S. Economic Census. The import and export data are taken from United Nations Commodity Trade Statistics Database and the International Economic Data Bank (IDEB). Data obtained from TMUS and KLPS are of individual level and that from the rest of the sources are of industry-level. I restrict my attention to trade between the Taiwan and the U.S. and between South Korea and the U.S. because for both countries, the U.S. is each country's most important trade partner.

I test the hypothesis that that wage premium is positively related to concentration measure. Due to the limitation of two different forms of data—individual- and industry-level, I employ a two stage regression method developed by Goldberg and Pavcnik (2003). In the first stage, I regress the wage premium on individual characteristics, industry dummies, an education variable and an interaction variable of education level and industry dummies; in the second stage, I regress the parameter estimated in the first stage against a measure of product market competition (i.e., the concentration ratio) and other control variables. To my knowledge, a cross-country level comparison on the influence of product market structure on wage premium differentials has not been undertaken for developing countries. Given comparable data on the products available across countries, our analysis takes the form of a cross-sectional comparison. My results should shed light in the determinants of the wage premium in export-led developing countries.

3.1 Hypothesis Testing

Our primary hypothesis is that the wage premium should be higher in industries characterized by lower levels of competition. We focus on the following stylized theoretical relationship:

$$\log\left(R_{it}\big/W_{it} \right) = f(competitiveness, other\ control\ variables)$$

In this set up, the wage premium is dependent variable and the critical independent variable is the level of industry competitiveness.

To measure competitiveness, I use a market concentration index. One must be careful when choosing proxies for competitiveness since they are prone to measurement and endogeneity problems. In the next section, I describe in detail the data and variables I use in my empirical analysis.

3.2 Model Variables

3.2.1. Wage Premium

To test my theory empirically, I need to fashion an operational definition of the wage premium. The conventional approach is to divide labor into skill- and unskilled groups by their education level and compute the average wage for each group. For the purposes of estimation, unskilled will refer to employees with secondary education and below; skilled will refer to employees with post-secondary education and above. The wage premium is then simply the ratios of compensation per hour worked for skilled and unskilled workers as: $= \frac{R}{w}$, where ω is the wage premium, $\frac{R}{w}$ is the ratio of skilled labor wage versus unskilled labor wage.

3.2.1. Competitiveness

To test my theory empirically, I also need to fashion an operational definition of the competitiveness. As is standard in the literature, I will employ an industry concentration index as an indicator competition, with a high (low) concentration index being identified with a low (high) degree of competition. Designing an industry concentration index is complicated because there are many possible alternative measures, each with its own merits and drawbacks. As I search for a proper concentration index, I employ the criteria suggested by Hall and Tideman (1967):

   i.   A concentration index should be a number between zero and one.
   ii. A concentration index should be independent of the size of the industry.
   iii. A concentration index should increase if the share of one firm is increased at the expense of a smaller firm.
   iv. If all firms are divided into N equal parts, then the concentration index should be reduced by a proportion 1/N.

Two commonly-used concentration indices are the N-firm concentration ratios (CRN), and the Hirschman-Herfindahl concentration index (HHI), both of which are recorded in the US Economic Census. The N-firm concentration ratio (CRN) is defined as:

$$CRN = \sum_{i=1}^{N} S_i$$

where S_i represents the share of firm ith largest firm. The 4-firm and 8-firm concentration ratios, CR4 and CR8, are commonly used in empirical applications. Market share is usually measured in terms of sales revenue, but others measures are possible as well. The 4-firm ratio is calculated as follows: suppose the largest firm in an industry has 40% of the total market share; second largest firm has 20%, the third largest firm has 10% and the fourth largest firm has 5%; then the 4-firm ratio is 65% of total market share. The concentration ratio is from effectively zero for perfect competition to 100 percent for monopoly. The general rule of thumb is that a concentration ratio that exceeds 40% indicates oligopoly, while a concentration less than 40 percent indicates monopolistic competition.

The Hirschman-Herfindahl Index (HHI) is defined as:

$$HHI = \sum_{i=1}^{N} S_i^2$$

where S_i represents the share of firm ith largest firm and N is the total number of firms in the industry.   The HHI is calculated as the sum of the squared market shares of all firms in the industry. The HHI is calculated as follows: suppose there are three firms in an industry, with 70%, 20% and 10% market shares, respectively; then the HHI= 23.8%. The HHI can range from zero (infinitely many firms) to one (monopoly). Regulators take an HHI less than 0.1 to indicate perfect competition, an HHI between 0.1 and 0.2 to indicate monopolistically competition, an HHI between 0.2 and 0.6 to indicate oligopoly, and an HHI above 0.6 to indicate monopoly.

The CRN and HHI indices both meet the criteria set by Hall and Tideman (1967), but have different merits and drawbacks. First, the threat of entry can make a big difference in the competitiveness of an industry; but both measures only consider existing firms. Second, the degree of product differentiation can make a difference in the competitiveness of an industry; highly differentiated products can shield firms in low-concentration industry from competitive pressures, while homogeneous products can expose firms in a high concentration industry to greater competitive pressures. Third, the two indices can behave very differently. For example, the HHI provides statistical robust results for the U.S. banking industry, but not for the U.S. electricity industry (Muharrami et al., 2006). It is often suggested that both indices should be used in empirical work. Therefore, in our empirical model, we would like to control for the fixed cost (entry of barrier) and will employ both indices.

3.3.1. Control Variables

Labor Characteristics

The most important control variables pertain to the labor employed in each industry. These variables include age, experience and educational level. These variables are of measureable at the individual level and can readily be found in Korean Labor and Income Panel Survey and Taiwan Manpower Utilization Survey.

Fixed Costs

As indicated in our theoretical model, fixed costs are critical determinants of the wage premium. There are several types of fixed costs that arise from barriers to entry: research and development (R&D) costs, advertising costs, etc. In particular, firms that operate in imperfect competitive environment often use R&D to deter new entrants. The OECD Structural Analysis Database (STAN) provides value added R&D investment at industry level for South Korea. We can use this information to calculate the relative R&D intensity of various manufacturing sectors. We can find comparable R&D investment from series of surveys conducted by Academia Sinica (Taiwan) and calculate relative R&D intensity as well.

Export Intensity

I need to control for export intensity in my estimation model. The variable I will use is percentage of industry sales that are exported for both countries. This information can be found in the UN Commodity Trade Statistics Database.

Industry Dummies

I have to control for idiosyncratic variations across industries that might affect wages. The traditional way is to set up necessary industry dummies (need to set up such that there is no perfect colinearity). Data of an individual working in an industry will be available through Korean Labor and Income Panel Survey and Taiwan Manpower Utilization Survey.

3.4 Data

I focus on manufacturing industries in my empirical analysis. Data come from several databases. Individual worker information is drawn from the Korean Labor and Income Panel Survey (KLIPS), which is collected by the Korea Labor Institute. KLIPS, a longitudinal survey of households and individuals in Korea, was started in 1998; the sample size is approximately several thousand households every year. The survey provides information on socioeconomic characteristics, such as: years of schooling, age, tenure, work experience, industry, region of working place, as well as monthly wage and working hour.

Taiwanese labor data is drawn from the Taiwan Manpower Utilization Survey series, which started in 1998 and is available through 2010. This household level panel survey contains detailed information on earnings, employment and worker characteristics with sample size of several thousand each year. Factors that affect wage can be found in the data, including years of schooling, age, tenure, work experience, industry, region of working place, as well as monthly wage and working hour.

The industry-level data is drawn from several different sources. Industry-level data for Taiwan and South Korea are collected less frequently and in less detail than they are for the U.S. The OECD Structural Analysis (STAN) database contains annual measures of output, labor input, R&D investment and international trade for South Korea; these data may be used to construct indicators of productivity growth, competitiveness and general structural change. Academia Sinica, a Taiwanese economic research institution, collects comparable industry level data for Taiwan, including information on annual output, labor input and R&D investment.

Another source of data is the UN Commodity Trade Statistics Database (UNCOMTRADE), which contains annual imports, exports, and re-exports in U.S. dollars by commodity and by trading partner. Commodities are classified according to the International Trade Classification (SITC: Rev.1 from 1962, Rev.2 from 1976 and Rev.3 from 1988) and the Harmonized System (HS) (from 1988 with revisions in 1996 and 2002). Imports from and exports to South Korea's major trading partners by commodity are classified according to SITC Rev.3 and on the HS system from 1993 to 2003. U.S. Census data will also prove useful for constructing concentration indices.

The US-dollar value of exports and imports by 4-digit International Standard Industrial Categories (ISIC) are from the International Economic Data Bank (IEDB) for both Taiwan and South Korea. IEDB converts UN trade data from Standard International Trade Categories to ISIC using concordance tables based on the structure of trade and production in the two economies. For South Korea, the production data are gross output in US dollars by 3-digit ISIC codes from the UNIDO Industrial Statistics Database.

3.5 Model Specifications

Our theoretical model indicates that wage premiums are determined as follows:

$$\omega_R^o = \frac{H_R}{L_R} \frac{\gamma H_R[1 + \mu(\sigma - 1)]}{H_R\sigma - H_R\gamma[1 + \mu(\sigma - 1)] - f(\sigma - 1)(1 - \mu)} \tag{67}$$

$$\omega_R^m = \frac{H_R}{L_R} \frac{H_R\gamma[1 + \mu(\sigma - 1)]}{H_R\sigma - H_R\gamma(1 + \mu(\sigma - 1))} \tag{68}$$

Here, m represents monopolistic competition (more firms with less rent/ price mark-up); o represents oligopolistic competition (less firms in the industry but with more price mark-up/ more market power); R denotes free trade.

To operationalize our wage premium equation for estimation, I assume that the log wage premium for works in sector j at time t can be written as:

$$\ln(\omega_{jt}) = \alpha + \beta_{CI}CI_{jt} + \gamma X_{jt} + \varepsilon_{jt}$$

Where ω_{jt} is the wage premium, the ratio of skilled labor wage with respect to unskilled labor wage; CI_{jt} is the market concentration index variable in industry j at time t, X_{jt} is a vector of industry aggregated employee characteristics (including variables such as age, experience and education level dummies), and ε_{jt} is a white noise.

In this model specification, the log wage premium is assumed to be a function of industry competitiveness. This parameter β_{CI} captures how market competitiveness affects the wage premium; it is the critical parameter whose significance we would like to test. My theory maintains that β_{CI} is significantly positive, indicating that the higher the market concentration, the lower the competitiveness, the higher the wage premium. Also, γ captures how the wage premium varies across industry-level employee characteristics.

This specification, however, is susceptible to a variety of problems. The first specification problem, the major problem, is heterogeneity, which arises because aggregated labor characteristics may not be the true reflection of individual labor characteristics within an industry.

The second specification problem is endogeneity, which arises from the fact that profits and wages are simultaneously determined. I can correct for endogeneity in one of two ways. One is to assume that the increase in profits in the past is predetermined and estimate model by regressing the wage premium on lagged indicators of profit. The second way is to find a good instrumental variable.

To address heterogeneity in labor characteristics, I employ the two stage procedure developed by Goldberg and Pavcnik (2003). In the first stage, I regress the log of hourly real wage for worker i employed in industry j in a year t on a vector of individual characteristics, a set of industry dummies where this individual is employed, an educational indicator of this individual, and an interaction term of education level and industry dummies of this individual. In particular:
In the first stage I run the following regression:

$$w_{ijt} = \alpha + \beta edu_{ijt} + \gamma X_{ijt} + \mu I_{ijt} + \lambda_{jt}(edu_{ijt} * I_{ijt}) + \varepsilon_{ijt}$$

$$where \ \varepsilon_{ijt} \sim N(\mu_1, \sigma_1^2); 1 \ denotes \ first \ stage \ ;$$

Here, X_{ijt} is a vector of characteristics excluding education across individual I, across time t and across industry j ; edu_{ijt} is a vector of individual education levels; I_{ijt} is industry dummies where this individual is employed at time t. The coefficient λ captures the inter-industry differential in wage premium in industry j at time t for different education levels. The first stage regression is estimated for each year.

In the second stage, I pool the inter-industry differential in wage premium, λ_{jt}, over time and regress them on market concentration index of our choice, export ratio and industry dummies . In particular, I run the following regression:

$$\lambda_{jt} = \beta_{CI}CI_{jt} + \beta_D D_{jt} + \beta_T T_{jt} + u_{jt}$$

$$where \ u_{jt} \sim N(\mu_2, \sigma_2^2); 2 \ denotes \ second \ stage$$

Note here that the observation unit is at industry level, not at individual level. CI_{jt} is competition index variable of our choice in sector j at time t. D is a vector industry and year dummies; T is the export ratio of South Korea and Taiwan over time. The second stage equation regress the parameter estimate we get from the first equation and test how this λ responds to β_{CI}. If we find β_{CI} positive and significant at some % level, we will be able to claim that we do test positively the relationship between wage premium and market concentration, that the more concentrated the market is, the higher the wage premium.

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