

The Wage Premium and Market Structure

Ruohan Wu
Department of Economics & Finance
University of North Georgia
Dahlonega, GA 30597 USA
Ruohan.Wu@ung.edu

Meng-Fen Yen
Center for Research in Econometric Theory & Applications
National Taiwan University
Taipei 106, Taiwan, Republic of China
mengfyen@ntu.edu.tw

Mario J. Miranda
Department of Agricultural, Environmental & Development Economics
The Ohio State University
Columbus, OH 43220 USA
miranda.4@osu.edu

April 14, 2020

Abstract

In this paper, we seek to understand why the “wage premium”, the percentage by which wages earned by skilled workers exceed those of unskilled workers, varies among industries featuring different market competitiveness. We construct a theoretical model with CES utility function and constant return to scale production function that allows us to examine the effects of different imperfect market structures (monopolistic competition and oligopoly) on the wage premium. We find that the wage premium is higher under oligopoly than under monopolistic competition. Our findings are supported by empirical evidence from Chilean manufacturers.

Key words: Market structure; oligopoly; monopolistic competition; relative factor endowment; wage premium.

1. Introduction

In this paper, we seek to understand why the “wage premium”, defined as the percentage by which wages earned by skilled workers exceed those of unskilled workers, varies among industries with different competitiveness. The existing literature offers abundant explanations of how wage premiums are determined. The earliest efforts to explain differences in the wage premium stem from the Heckscher-Ohlin two-good bilateral trade model. According to the Heckscher-Ohlin Theorem, the skilled labor abundant country will export the skilled-labor intensive good, while the unskilled labor abundant country will export the unskilled-labor intensive good. And the Stolper–Samuelson Theorem (Goldberg and Pavcnik, 2007) argues that trade causes the gap between the wages earned by skilled and unskilled workers to widen in the skilled labor abundant country and to narrow in the unskilled labor abundant country.

Following Heckscher-Olin, a vast international trade literature has examined the relationship between the wage premium and relative factor endowments. Yeaple (2005) studied how a falling trade costs could induce productivity differences between exporters and non-exporters and increase the wage premium. Unel (2010) found that if firms in skill-intensive sectors are more productive and more exposed to international trade than firms in labor-intensive sectors, trade would boost the wage premium received by skilled workers. Harris and Robertson (2013) found that in emerging economies such as India and China, trade liberalization promotes investment and human capital accumulation, causing the wage premium to rise sharply in the short run. By incorporating micro-level skill intensity differences and national-level skill abundance differences into a Ricardian model, Burstein and Vogel (2017) found that trade liberalization could reallocate factors towards more productive and skill-intensive firms, causing the wage premium to increase. Numerous other studies (Brambilla et al., 2011; Mehta and Hasan, 2012; Klein et al., 2010, 2013; Ge and Yang, 2014; Bhattacharya and Nguyen, 2019) have ascertained that trade liberalization, exports, or foreign ownership can all increase the wage premium received by

skilled workers, and exacerbate wage inequality. However, Dinopoulos et al. (2011) found that if firms' skill intensity responds negatively to output, trade can reduce the wage premium; they supported this finding empirically using Mexican plant-level data from 1993 to 2003. Amiti and Cameron (2012) found tariff reduction could exert no or even negative influences on wage premium in Indonesia. Dix-Carneiro and Kovak (2015) found small but significant declines of skilled workers' wage premium during Brazil's post-1990 trade liberalization period.

An alternate theory of the determinants of wage premiums is based on skilled-biased technical change (SBTC). SBTC theory argues that technological advancements favor skilled labor, leading to a higher wage premium in countries in which SBTC takes place (Krugman, 2000; Galiani and Sanguinetti, 2003; Conte and Vivarelli, 2011; Violante, 2008). Once SBTC occurs, the demand for skilled labor rises, causing the wage premium to rise (Acemoglu, 2003; Weiss and Garloff, 2011; Mallick and Sousa, 2017). Centeno and Novo (2014) combined SBTC with a shortage of skilled labor to explain the surging wage inequality in Portugal. Other studies have found that trade induces skill biased technical change and, therefore, plays a more important role in determining wage premiums than generally believed (Acemoglu, 2003; Goldberg and Pavcnik, 2004; Harrigan and Reshef, 2015).

Departing from the established trade literature, economists have also examined how market structure affects wage premiums. Nickell et al. (1994) argue that firms with market power 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 find a positive relationship between a firm's market power and wages. In a later study, Nickell (1999) identifies three mechanisms through which product market competition affects 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; and, third, reduction of the labor demand elasticity leads to a higher share of rents for those already in

the labor market. Following Nickel, Guadalupe (2007) applies a difference in difference method to a panel of United Kingdom 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.

In this paper, we further investigate the relationship among wage premiums, relative factor endowments, and market structure. To this end, we develop and analyze a novel general equilibrium model of an economy that produces 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, given with the same relative factor endowment, the wage premium will be higher if the differentiated good market is characterized by oligopoly rather than monopolistic competition.

We then test this proposition empirically using a firm-level dataset on Chilean manufacturers from 2008 to 2016. Chile provides a particularly interesting case study because it is a small yet industrialized economy that has experienced a significant change in its economic structures during the past five decades. Chile has been a subject of study by various researchers. Gindling and Robbins (2001) used sectoral composition of the demand for skilled labor to explain the increasing wage premium in Chile. Gallego (2012) used Chilean data from 1960 to 2000 and found a significant increase of skill upgrading, which had a significantly positive relationship with the wage premium in United States. Harrigan and Reshef (2015) used Chilean firm-level data from 1995, and studied how falling trade costs could lead to greater trade volumes and rising relative demand for skilled labor, therefore broadening wage inequality. Employing data from seven Latin American countries, including Chile, Brambilla et al. (2011) attributed the increasing wage premium to sectoral exports. We update the literature by using the most recent data from Chile, and find that wage premiums are significantly higher for oligopolistic than in monopolistic

competitive industries. Exports, however, are found to exert no significant impacts upon wage premiums of the observed firms.

2. Model

In neoclassical economic theory, when competition is imperfect, firms vary with respect to market power. Monopolistic competition is characterized by a large number of small firms, each possessing a small degree of market power because it produces 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. In the past, either monopolistic competition (Yeaple, 2005; Unel, 2010; Burstein and Vogel, 2011; Dinopoulos et al, 2011; David et al., 2013; Kovak, 2013; Harrigan and Reshef, 2015) or oligopolistic competition (Bastos and Straume, 2012) has been assumed. In our paper, we model them both in order to analyze and compare the effects of market competition on the wage premium.

To explain how market structure affects the wage premium, we draw on the traditional Dixit-Stiglitz model of monopolistic competition, adapting it to accommodate consumer preferences as conceived by Krugman (1979). Specifically, in the Krugman model of preferences, consumers prefer greater product variety. Our 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, we posit a Cobb-Douglas production technology for the differentiated good, and a linear production technology for the undifferentiated good.

We use the model to examine two distinct scenarios, one in which a differentiated good industry is characterized by oligopolistic competition and one in which it 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, mark-ups may vary

across firms. Our general equilibrium model endogenously determines the wage premium under both market structures.

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

We denote the unit cost of producing good X by $C^x(W, R)$ and the unit cost of producing good Y by $C^y(W, R)$. We denote the wage of unskilled labor by W , the wage of skilled labor by R , and the wage premium by $\omega = R/W$. We denote the price for X by P_x and the price of Y by P_y . The endowments of skilled and unskilled labor are denoted H and L, respectively. The fixed cost required to produce X, fR , is assumed to be proportional to the wage of skilled labor. We denote monopolistic competition by the index m , and oligopolistic competition by the index o .

2.1 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 varieties and let v denotes variety. We 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 we impose symmetry across on firms:

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

Denoting national income by I, market demand facing a firm is given by

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

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

$$y = (1 - \gamma)I$$

Production of X requires both skilled and unskilled labor; production of Y requires only unskilled labor. The fixed cost of producing good X is denoted by Rf , where R is skilled labor wage. This fixed cost does not vary with the quantity of X produced, but increases with the wage for skilled labor. We further assume that the variable cost of producing good X is $C^x(W, R) = R^\mu W^{1-\mu}$ and the total cost of producing good Y is $C^y(W, R) = W$. Given the factor requirement, the total cost function is

$$TC = Rf + C^x(W, R)x = Rf + R^\mu W^{1-\mu}x$$

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

$$\pi_i(v) = (p_i(v) - mc_i(v))x_i - Rf.$$

The optimal pricing rule for monopolistic competitive firms is thus

$$p_i(1 - 1/\sigma) = mc_i(\varphi) = C^x = R^\mu W^{1-\mu}.$$

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, we impose symmetry by assuming identical firms.

$$p^x(1 - 1/\sigma) = R^\mu W^{1-\mu} \tag{1}$$

$$(p^x - C^x(W, R))x = Rf \tag{2}$$

$$p^y = C^y \tag{3}$$

$$n \left[f + \mu \frac{C^x}{R} x \right] = H \tag{4}$$

$$n \left[(1 - \mu) \frac{C^x}{W} \right] + y = L \quad (5)$$

$$np_x = \gamma(WL + RH) \quad (6)$$

$$np_y = (1 - r)(wL + RH) \quad (7)$$

Equation (1) is standard in models of monopolistic competition. Equation (2) 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 (3) stipulates that under perfect competition, the price of Y equals the marginal cost of producing Y. Equations (4) and (5) are full employment conditions, which are discussed below. Equations (6) and (7) are market-clearing conditions for goods X and Y.

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

$$\frac{\partial C^x}{\partial R} = \mu \frac{C^x}{R}$$

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

$$\frac{\partial C^x}{\partial W} = (1 - \mu) \frac{C^x}{W}$$

$$\frac{\partial C^y}{\partial W} = \frac{C^y}{W} = 1$$

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

$$\mu I = np_x \quad \text{where} \quad I = (WL + RH).$$

Here, L and H denote the supply of unskilled and skilled labor, respectively, and n is the number of monopolistic competitive firms.

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

$$\begin{aligned}
p^x(1 - 1/\sigma) &= C^x(\omega) = \omega^\mu \\
(p^x - C^x(\omega))x &= Rf \\
p^y = C^y &= 1 \\
n^m \left[f + \mu \frac{C^x}{R} x \right] &= H \\
n^m p^x x &= \gamma(L + \omega H)
\end{aligned} \tag{8}$$

Notice that we introduce the m index here to denote monopolistic competitive. Our model thus consist of four equations (we can ignore (8)) in four unknowns: y, n, W . This is a just-identified system. To solve for unknowns, we start by solving for x . From (14)-(15), we get:

$$x = \frac{\omega f(\sigma-1)}{C^x(\omega)}$$

Substituting (14) into (17) and (18) yields

$$n^m f[1 + \mu(\sigma - 1)] = H \tag{9}$$

$$n^m \omega f \sigma = \gamma(L + \omega H) \tag{10}$$

Equations (9) and (10) indicate the relationship between the number of firms n and the wage premium ω . Dividing (10) by (9), we eliminate the unit cost function C^x and obtain:

$$\frac{\sigma}{1+\mu(\sigma-1)} = \gamma \frac{(\omega H+L)}{\omega H} = \gamma \left(1 + \frac{L}{\omega H} \right). \tag{11}$$

Equation (11) describes the relationship between the wage premium ω and the relative factor endowment, which is hereafter defined as the ratio between skilled and unskilled labor input H/L . The wage premium is affected by the relative factor endowment, 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 negatively related to the relative factor endowment. We solve for the number of firms n from equation (10):

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

More importantly, it is evident from (11) that the wage premium is a constant markup over relative factor endowment H/L . More specifically,

$$\omega = \frac{H\{\gamma[1+\mu(\sigma-1)]\}}{L\{\sigma-\gamma(1+\mu(\sigma-1))\}} \quad (12)$$

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.

2.2 Oligopolistic Competition

If we 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. We start by deriving the demand of the heterogeneous good X . We 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:

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

$$y_i = (1 - \gamma)I$$

$$\frac{\partial x_i}{\partial p_i} = - \frac{x_i \sigma z^{-(\sigma-1)} p_i^{1-\sigma}}{p_i z}$$

Total costs are the same as before:

$$TC = Rf + C^x(W, R)x.$$

The notation o stands for oligopolistic case, and we simplify our notation again by adding o on the unknown n only. After imposing symmetry across firms, the equations that describe equilibrium under oligopolistic competition are:

$$\left(1 - \frac{C^x(R,W)}{p^x}\right) \left(\sigma - \frac{\sigma-1}{n}\right) = 1 \quad (13)$$

$$p^y = C^y \quad (14)$$

$$(p^x - C^x(R,W))x = Rf \quad (15)$$

$$n^o \left[f + \mu \frac{C^x}{R} x \right] = H \quad (16)$$

$$n^o \left[(1 - \mu) \frac{C^x}{W} x \right] + y = L \quad (17)$$

$$n^o p^x x = \gamma(WL + RH) \quad (18)$$

$$n^o p^y y = (1 - r)(WL + RH) \quad (19)$$

We derive the equilibrium price by solving the first order condition (13). Unlike under monopolistic competition, 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 (13), characterizes the equilibrium price. Equations (14) and (15) are zero profit conditions for good X and good Y, respectively. Equations (16) and (17) are the full employment conditions derived from Shepard's Lemma. Equations (18) and (19) are the market clearing conditions for good X and good Y.

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

$$\left(1 - \frac{C^x(\omega^o)}{p^x}\right) \left(\sigma - \frac{\sigma-1}{n^o}\right) = 1 \quad (20)$$

$$(p^x - C^x(\omega^o))x = Rf \quad (21)$$

$$n^o \left[f + \mu \frac{C^x(\omega^o)}{\omega^o} x \right] = H$$

$$n^o p^x = \gamma(L + \omega^o H)$$

Thus, we are left with four equations in four unknowns x, p^x, n, ω . Substituting (20) into (21), we obtain the optimal pricing for oligopoly (o stands for oligopoly, and x stands for good X):

$$p^x = C^x(\omega^o) \left[\frac{n^o + (\sigma - 1)(n^o - 1)}{(\sigma - 1)(n^o - 1)} \right]$$

We then solve for x :

$$x = \frac{\omega f (\sigma - 1)(n^o - 1)}{C^x(\omega^o) n^o}$$

Substituting (40) and (41) into (38) and (39), respectively, we obtain:

$$f[n^o + (\sigma - 1)(n^o - 1)] = H \quad (22)$$

$$f[n^o + \mu(\sigma - 1)(n^o - 1)] = \gamma(L + \omega^o H) \quad (23)$$

If we divide (23) by (22), we obtain:

$$\frac{n^o + \mu(\sigma - 1)(n^o - 1)}{n^o + (\sigma - 1)(n^o - 1)} = \frac{\gamma(\omega^o H + L)}{\omega^o H}. \quad (24)$$

We can solve for the number of firms in oligopolistic competition by further simplify equation (23), to get:

$$n^o = \frac{H/f + \mu(\sigma - 1)}{1 + \mu(\sigma - 1)}. \quad (25)$$

Equation (25) shows that the number of firms n is inversely related to the set up cost f . Equation (18) indicates that, unlike the monopolistic competitive case, the wage premium is inversely related to the number of firms and thus positively related to the set-up cost f .

In addition, the wage premium is positively related to the relative factor endowment H/L ; this can be seen by substituting Equation (25) into Equation (24):

$$\frac{H\sigma - f(1-\mu)(\sigma-1)}{H[1+\mu(\sigma-1)]} = \gamma \left(1 + \frac{L}{\omega^o H}\right), \quad \mu < 1 < \sigma$$

We now compare the wage premium between these two market structures. We compare the following two equations (here, m denotes monopolistic competition, and o denotes oligopolistic competition):

$$\omega^m = \frac{H}{L} \frac{\gamma[1+\mu(\sigma-1)]}{\sigma - \gamma[1+\mu(\sigma-1)]} \quad (26)$$

$$\omega^o = \frac{H}{L} \frac{\gamma[1+\mu(\sigma-1)]}{\sigma - \gamma[1+\mu(\sigma-1)] - f(\sigma-1)(1-\mu)/H} \quad (27)$$

Equation (12) is derived earlier and we list it here as equation (26) for ease of comparison. By comparing Equations (26) and (27), we find that given with the same relative factor endowment, 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.

3. Data Description

Our theoretical models predict that the wage premium differs across industries exhibiting different degrees of competition. To test this implication empirically, we employ data from the Encuesta Nacional Industrial Anual, an annual survey of Chilean manufacturers conducted by the National Statistics Institute of Chile (Instituto Nacional de Estadísticas Chile; INE). The data set contains comprehensive cross-sectional firm-level information on manufacturers' production, labor input, and exports. To keep our study current, we limit the scope of our analysis to ENIA data from 2008 to 2016, which includes data for 19,698 manufacturing firms from multiple industries.

Following Al-Muharrami et al. (2006), we classify industry competitiveness using a 4-firm concentration ratio. We calculate the industry concentration ratio as follows. Within each

industry, we sort firms according to production from high to low, sum production for the top four producing firms, and divide by total production generated by all the firms in that industry. If this ratio is less than 40%, that is, if the top four firms produce less than 40% of the entire industry's output, we classify the industry as "monopolistic competitive". If this ratio is greater than 50%, that is, if the top four firms produce more than half of the entire industry's output, we classify the industry as "oligopolistic". If this ratio is between 40% and 50%, we leave the industry's classification "undefined"; it allows us to simultaneously examine and compare the fixed effects of firms belonging to either monopolistic competitive or oligopolistic industries. These "undefined" firms also address the potential sample selection bias from the ENIA survey data. Overall, the majority (75.4%) of the firms in our data set belong to monopolistic competitive industries. The four-firm concentration ratio and competitiveness classifications for the 27 industries represented in our data sample are reported in Table 1.

Table 1. Four-Firm Concentration Ratios and Competitiveness for Chilean Manufacturers in Dataset, 2008-2016, by Industry

Industry	Number of Firms	4-Firm Concentration Ratio	Competitiveness
Basic metals	454	0.37	Monopolistic Competition
Chemical products	841	0.28	Monopolistic Competition
Clothing	682	0.46	Undefined
Coal mining and peat	2,175	0.17	Monopolistic Competition
Crude oil and natural gas	334	0.34	Monopolistic Competition
Electric appliances	432	0.34	Monopolistic Competition
Fabricated metals	1,270	0.42	Undefined
Food and beverage products	3,623	0.11	Monopolistic Competition
Furniture	479	0.27	Monopolistic Competition
Leather products	203	0.57	Oligopoly
Machinery and equipment	761	0.25	Monopolistic Competition
Medical, optical, precision instruments	336	0.52	Oligopoly
Metal minerals mining	271	0.26	Monopolistic Competition
Motor vehicles	117	0.35	Monopolistic Competition
Non-metallic minerals	668	0.66	Oligopoly
Office, accounting, computer machinery	17	0.78	Oligopoly
Other manufacturing	155	0.81	Oligopoly
Other mining, quarrying	374	0.28	Monopolistic Competition

Other transportation equipment	117	0.74	Oligopoly
Paper products	488	0.56	Oligopoly
Publishing, printing, recording	1,194	0.26	Monopolistic Competition
Communications equipment	82	0.57	Oligopoly
Refined petroleum	542	0.26	Monopolistic Competition
Rubber and plastic products	1,729	0.22	Monopolistic Competition
Textiles	826	0.42	Undefined
Tobacco products	452	0.30	Monopolistic Competition
Wood products	1,076	0.31	Monopolistic Competition

Table 2 presents the means of key firm-level variables for firms in monopolistic competitive and oligopolistic industries and reports the results of a simple t-test for the independence of the means. Generally, firms in monopolistic competitive industries produce significantly less output and employ significantly fewer workers than firms in oligopolistic industries. Even though there is no significant difference in the percentage of firms that export across industry competitiveness, firms in monopolistic competitive industries exhibit a greater degree of foreign ownership and earn a greater proportion of their revenues from exports than firms in oligopolistic industries.

Table 2. Firm-Level Averages for Key Variables,
Chilean Manufacturers, 2008-2016, by Industry Competitiveness

	All Industries	Monopolistic Competitive Industries	Oligopolistic Industries	T-test
Annual Production (million CLP)	10.5	10.1	14.8	*
Number of Workers Employed	101.7	95.9	108.1	***
Export Revenue Ratio	9.2%	8.1%	12.5%	*
Foreign Ownership	5.3%	4.7%	7.2%	***
Ratio of Skilled to Unskilled	5.08	4.75	8.77	**
Relative Factor Endowment	1.41	1.42	1.49	
Number of Observations	19,683	14,844	2,064	
Percent of Firms That Export	24.4%	24.1%	24.5%	

Source: ENIA survey 2008 – 2016.

Most importantly, oligopolistic firms feature a significantly greater wage premium than monopolistic competitive firms, even though there is no apparent difference in their relative factor endowments. This finding is consistent with the theoretical implications of our models, captured by equations (12) and (27), which state that, given with the same relative factor endowment between skilled and unskilled labor inputs, firms in oligopolistic industries exhibit a greater wage premium than those in monopolistic competitive industries.

4. Empirical Test

We now examine the impacts of firms' relative factor endowment upon their wage premiums. The linear regression model is described in equation (28). Specifically, we consider the possibility of an endogeneity problem, as a higher wage premium may attract more skilled workers and raise the relative factor endowment in a business. To address this problem, we introduce an instrumental variable on relative factor endowment. This variable is calculated as the average of the relative factor endowments of all firms located in the same region and industry. This average endowment is closely related to the original firm-level endowment, and is also determined by industry- or location-wise factors such as government policies, technologies, local development status instead of firm-level wage premium. Therefore, this instrumental variable can function properly.

To examine the determinants of wage premium, we also consider several variables beside relative factor endowment, which are captured in X_{it} . In order to keep aligned with the past literature that also attribute the variance of wage premium to trade, we include firms' export status, export revenue ratio, as well as foreign ownership as potential explanatory variables. Meanwhile, we also consider the impacts of the size of firms' total production and employment, and the year fixed effects.

In order to examine the difference between monopolistic competitive and oligopolistic industries, we also add two interactive terms: one between relative factor endowment and a dummy variable which equals to 1 if the firm belongs to an oligopolistic industry, 0

otherwise; the other between relative factor endowment and a dummy variable which equals to 1 if the firm belongs to an monopolistic competitive industry, 0 otherwise. The results are reported in Table 3.

$$\begin{aligned}
 & \log(\text{wage premium}_{it}) && (28) \\
 & = \alpha_1 \log(\text{relative factor endowment}_{it}) \\
 & + \alpha_2 \text{dummy}(\text{oligopolistic industry})_{it} \\
 & + \alpha_3 \text{dummy}(\text{monopolistic competitive industry})_{it} \\
 & + \alpha_4 \log(\text{relative factor endowment}_{it}) \times \text{dummy}(\text{oligopolistic industry})_{it} \\
 & + \alpha_5 \log(\text{relative factor endowment}_{it}) \times \text{dummy}(\text{monopolistic competitive industry})_{it} \\
 & + \beta X_{it} + \xi_{it}
 \end{aligned}$$

Column (i) reports the results among all the observed firms, no matter which industry they belong to. We find that the relative factor endowment has significantly positive impact on wage premium; if the firm's relative factor endowment increases by 1, its wage premium will rise significantly. This finding is consistent with much of the existing literature, which predicts that relative factor endowment is the primary determinant of wage premium. The finding also supports our theoretical model, which predicts that relative factor endowment positively affects the wage premium, but need not necessarily be the primary determinant of the wage premium. To be specific, the fact that the firm belongs to a monopolistic competitive industry will significantly decrease its wage premium by 15%, while an oligopolistic firm should expect its wage premium to increase by an insignificant 3%. The interactive term between relative factor endowment and the dummy variable of being in oligopolistic industry features a significantly positive coefficient. This indicates that belonging to an oligopolistic industry can significantly increase the influence of the firm's relative factor endowment on its wage premium. Besides, the interactive term between relative factor endowment and the firm being monopolistic competitive has a significantly negative coefficient. Therefore, belonging to a monopolistic competitive industry reduces

the influence of the firm's relative factor endowment upon its wage premium, as predicted by our theoretical model.¹

Column (ii) presents estimation results for monopolistic competitive industries alone, while column (iii) presents the estimation results for oligopolistic industries alone. Again, the relative factor endowment significantly raises the wage premiums in both types of industries. A unitary increase in a monopolistic competitive firm's relative factor endowment will raise its wage premium by 20.5%, while the same increase and oligopolistic firm's relative factor endowment raises its wage premium by 35.2%. The positive influence of relative factor endowment on wage premium is significantly higher in oligopolistic industries than in monopolistic competitive industries. These findings fit what we have derived previously in equations (12) and (27). Therefore, contradicting Guadalupe (2007), we find that, among Chilean manufacturers, market competition reduces the impact of relative factor endowment on the wage premium.

Regarding other explanatory variables: both the export revenue ratio and the dummy variable representing a firm's export status exhibit no significance on wage premiums. A higher degree of foreign ownership, however, reduces the wage premium. Employment significantly affects the wage premium only in monopolistic competitive industries. Specifically, the smaller the firm, the lower is its wage premium. Furthermore, in both column (ii) and column (iii), the coefficient on the time period dummy variables are monotonically rising over time. This indicates that wage premiums have exhibited long-term growth in both monopolistic competitive and oligopolistic industries in Chile.

¹ A Wald test is also conducted to examine the significance of the dummy variables' coefficients α_2 , α_3 , α_4 , and α_5 . The degree of freedom is 4, and the Wald χ^2 statistic is 583, and the p-value is less than 0.0001. Therefore, the significance of market competitiveness and its interactive relationship with relative factor endowment is confirmed.

Table 3. Wage Premium Model Parameter Estimates

	All Firms	Monopolistic Competitive Industries	Oligopolistic Industries
	(i)	(ii)	(iii)
log (relative factor endowment)	0.234*** (0.026)	0.205** (0.081)	0.352*** (0.093)
Dummy (oligopolistic industry)	0.03 (0.047)	-	-
Dummy (monopolistic competitive industry)	-0.150*** (0.006)	-	-
log (relative factor endowment) × Dummy (oligopolistic industry)	0.123*** (0.027)	-	-
log (relative factor endowment) × Dummy (monopolistic competitive industry)	-0.025* (0.013)	-	-
Dummy (being an exporter)	0.019 (0.032)	0.012 (0.036)	0.15 (0.103)
Export revenue ratio	0.839 (1.496)	0.936 (0.63)	1.04 (1.6)
Foreign ownership %	-0.172*** (0.06)	-0.117* (0.069)	-0.322* (0.172)
Production (million CLP)	0.009 (0.018)	-0.007 (0.223)	-0.346 (0.343)
Size dummy (employment < 50)	-0.808*** (0.376)	-0.866** (0.389)	-0.122 (1.617)
Size dummy (50 ≤ employment < 500)	-0.595* (0.368)	-0.643* (0.387)	0.149 (1.604)
Size dummy (employment ≥ 500)	-0.489 (0.399)	-0.568 (0.395)	0.327 (1.627)
Year dummy (2009–2010)	0.154** (0.062)	0.195*** (0.067)	-0.028 (0.161)
Year dummy (2011–2012)	0.131** (0.065)	0.196** (0.072)	0.177*** (0.016)
Year dummy (2013–2014)	0.240*** (0.064)	0.300*** (0.069)	0.182** (0.084)
Year dummy (2015–2016)	0.379*** (0.056)	0.460*** (0.076)	0.510** (0.218)
Fixed effect (region)	Yes	Yes	Yes
Fixed effect (industry)	-	Yes	Yes
Adjusted R-squared	0.147	0.136	0.108
Number of observations	14,889	11,581	1,366

Note: ***, ** and * represent significance at 1%, 5% and 10%, respectively.

5. Conclusion and Discussion

In this paper, we have shown theoretically and empirically that differences in the degree of competition affect the wage premiums offered by different industries. More specifically, given with the same relative factor endowment, the wage premium is higher under an oligopolistic industry than under a monopolistic competitive industry. Our findings confirm the dominant result in the trade literature that relative skilled factor endowment is a determinant of the wage premium, but further reveals an important role for market structure.

Our empirical findings shed light on various questions. First, based on the observed Chilean manufacturers, the relative factor endowment between high and low skill labor inputs does positively impact the wage premium. During economic development, the reallocation of production factors from unskilled labor-intensive to skilled labor-intensive industries raise the relative compensation received by skilled relative to unskilled workers.

We also find that market competitiveness tends to reduce the wage premiums offered by firms. Among the Chilean manufacturers, firms who operate in monopolistic competitive industries offer a significantly lower wage premium than those who operate in oligopolistic industries. Our interpretation is that market competition may force firms to cut costs, including lowering the extra wage payments made to the skilled workers. In addition, intensive market competition tends to reduce the heterogeneity of firms' production sizes and costs, and therefore reducing wage differentials between skilled and unskilled workers. Thus, firm wage premiums are considerably lower in highly competitive industries. In contrast, in a highly concentrated industry, firms have considerable market power can better control their own prices and production costs; as a result, they are able to sustain their wage premiums and pay significantly more for their skilled labor inputs.

However, we also find that firms' exporting behavior does not exert significant influence on wage premiums. Other things being equal, how much a firm produces for export or earns from exporting does not significantly affect the wage premium. If anything, there is

evidence that foreign ownership reduced wage premiums. This departs from the traditional Heckscher-Ohlin model, which argues that globalization helps to raise the wage premiums across countries. Similarly, Head and Ries (2002) found that the influence of off-shore production on domestic labor skill intensity depended on where the production and foreign direct investment (FDI) occurred. FDI towards low-income countries could significantly raise the skill intensity; however, this positive effect of FDI diminishes as the investment moves towards high-income countries. Therefore, in a typical industrialized country such as Chile, where the market tends to be mature and stabilized, globalization cannot positively influence the wage premium anymore.

Our findings have several policy implications. In a mature and well-industrialized market, globalization cannot support the wage premium received by the skilled workers. Although the wage premium tends to increase as a firm expands, the government should still be actively involved if it desires to raise the wage premium as an incentive for the workers to enhance their skills. Meanwhile, since market competition can lower the extra payment received by the skilled workers, the government should motivate workers to receive advanced educations or training. Public assistance to facilitate the professional training, by reducing the cost of advanced education and training, or subsidizing training of skilled workers can all be helpful. Besides, highly concentrated industries might be more attractive to well-trained workers because of their higher wage premiums. Guaranteeing the welfare of the unskilled workers in such industries, therefore, should be kept in mind by the government in order to prevent the income inequality from escalating.

Our finding suggests areas for further research to gauge the impacts of market structure on the labor market. Although we find that exports do not exert direct influence upon Chilean manufacturers' wage premiums, there can be other indirect influences worth exploring. Under globalization, the market structure and competitiveness of industries can shift over time. As a result, a greater understanding of the dynamic relationship among market competition, wage premium, and globalization is needed.

References

- Acemoglu, D. (2003). Patterns of skill premiums. *The Review of Economic Studies* Vol 70 No. 2 pp. 199-230.
- Al-Muharrami, S., Matthews, K., and Khabari, Y. (2006). Market structure and competitive conditions in the Arab GCC banking system. *Journal of Banking and Finance* Vol 30 No. 12 pp. 3487-3501.
- Amiti, M. and Cameron, L. (2012). Trade liberalization and the wage skill premium: Evidence from Indonesia. *Journal of International Economics* Vol 87 No. 2 pp. 277-287.
- Bastos, P. and Straume, O.R. (2012). Globalization, product differentiation, and wage inequality. *Canadian Journal of Economics/Revue canadienne d'économique* Vol 45 No. 3 pp. 857-878.
- Bhattacharya, M. and Nguyen, K. T. (2019). Trade liberalization and the wage-skill premium: Evidence from Vietnamese manufacturing. *Economics of Transition and Institutional Change* Vol 27 No. 2 pp. 519-540.
- Brambilla, I., Dix-Carneiro, R., Lederman, D., and Porto, G. (2011). Skills, exports, and the wages of seven million Latin American workers. *The World Bank Economic Review* Vol 26 No. 1 pp. 34-60.
- Burstein, A. and Vogel, J. (2011). *Factor prices and international trade: A unifying perspective* No. w16904). National Bureau of Economic Research, Cambridge, MA.
- Burstein, A. and Vogel, J. (2017). International trade, technology, and the skill premium. *Journal of Political Economy* Vol 125 No. 5 pp. 1356-1412.
- Centeno, M. and Novo, Á. A. (2014). When supply meets demand: Wage inequality in Portugal. *IZA Journal of European Labor Studies* Vol 3 No. 1 pp. 23.

- Conte, A. and Vivarelli, M. (2011). Globalization and employment: Imported skill biased technological change in developing countries. *Developing Economies* Vol 49 No. 1 pp. 36-65.
- David, H., Dorn, D., and Hanson, G. H. (2013). The China syndrome: Local labor market effects of import competition in the United States. *American Economic Review* Vol 103 No. 6 pp. 2121-68.
- Dinopoulos, E., Syropoulos, C., Xu, B., and Yotov, Y. V. (2011). Intraindustry trade and the skill premium: Theory and evidence. *Journal of International Economics* Vol 84 No. 1 pp. 15-25.
- Dix-Carneiro, R. and Kovak, B. K. (2015). Trade liberalization and the skill premium: A local labor markets approach. *American Economic Review* Vol 105 No. 5 pp. 551-57.
- Galiani, S. and Sanguinetti, P. (2003). The impact of trade liberalization on wage inequality: evidence from Argentina. *Journal of Development Economics* Vol 72 No. 2 pp. 497-513.
- Gallego, F. A. (2012). Skill premium in Chile: studying skill upgrading in the South. *World Development* Vol 40 No. 3 pp. 594-609.
- Ge, S. and Yang, D. T. (2014). Changes in China's wage structure. *Journal of the European Economic Association* Vol 12 No. 2 pp. 300-336.
- Gindling, T. H. and Robbins, D. (2001). Patterns and sources of changing wage inequality in Chile and Costa Rica during structural adjustment. *World Development* Vol 29 No. 4 pp. 725-745.
- Goldberg, P. K. and Pavcnik, N. (2004). *Trade, inequality, and poverty: What do we know? Evidence from recent trade liberalization episodes in developing countries* (No. w10593). National Bureau of Economic Research, Cambridge, MA.
- Goldberg, P. K. and Pavcnik, N. (2007). Distributional effects of globalization in developing countries. *Journal of Economic Literature* Vol 45 No. 1 pp. 39-82.

- Guadalupe, M. (2007). Product market competition, returns to skill, and wage inequality. *Journal of Labor Economics* Vol 25 No. 3 pp. 439-474.
- Harrigan, J. and Reshef, A. (2015). Skill-biased heterogeneous firms, trade liberalization and the skill premium. *Canadian Journal of Economics/Revue canadienne d'économique* Vol 48 No. 3 pp. 1024-1066.
- Harris, R. G. and Robertson, P. E. (2013). Trade, wages and skill accumulation in the emerging giants. *Journal of International Economics* Vol 89 No. 2 pp. 407-421.
- Head, K. and Ries, J. (2002). Offshore production and skill upgrading by Japanese manufacturing firms. *Journal of international economics* Vol 58 No. 1 pp. 81-105.
- Instituto Nacional de Estadísticas Chile (2019). *Encuesta Nacional Industrial Annual*. Santiago, Chile.
- Klein, M. W., Moser, C., and Urban, D. M. (2010). *The contribution of trade to wage inequality: the role of skill, gender, and nationality* No. w15985). National Bureau of Economic Research, Cambridge, MA.
- Klein, M. W., Moser, C., and Urban, D. M. (2013). Exporting, skills and wage inequality. *Labour Economics* Vol 25 pp. 76-85.
- Kovak, B. K. (2013). Regional effects of trade reform: What is the correct measure of liberalization? *American Economic Review* Vol 103 No. 5 pp. 1960-76.
- Krugman, P. R. (2000). Technology, trade and factor prices. *Journal of international Economics* Vol 50 No. 1 pp. 51-71.
- Mallick, S. K. and Sousa, R. M. (2017). The skill premium effect of technological change: New evidence from United States manufacturing. *International Labour Review* Vol 156 No. 1 pp. 113-131.
- Mehta, A. and Hasan, R. (2012). The effects of trade and services liberalization on wage inequality in India. *International Review of Economics and Finance* Vol 23 pp. 75-90.

- Nickell, S. (1999). Product markets and labour markets. *Labour Economics* Vol 6 No. 1 pp. 1-20.
- Nickell, S., Vainiomaki, J., and Wadhvani, S. (1994). Wages and product market power. *Economica* Vol 61 No. 244 pp. 457-473.
- Unel, B. (2010). Firm heterogeneity, trade, and wage inequality. *Journal of Economic Dynamics and Control* Vol 34 No. 8 pp. 1369-1379.
- Violante, G. L. (2008). Skill-biased technical change. *The new Palgrave dictionary of economics*, 2.
- Weiss, M. and Garloff, A. (2011). Skill-biased technological change and endogenous benefits: the dynamics of unemployment and wage inequality. *Applied Economics* Vol 43 No. 7 pp. 811-821.
- Yeaple, S. R. (2005). A simple model of firm heterogeneity, international trade, and wages. *Journal of international Economics* Vol 65 No. 1 pp. 1-20.