Discussion Paper Series

RIEB

Kobe University

DP2013-19

# Trade Liberalization and Skill Premium in Chile *

Yoshimichi MURAKAMI

June 3, 2013



Research Institute for Economics and Business Administration

Kobe University

2-1 Rokkodai, Nada, Kobe 657-8501 JAPAN

# Trade Liberalization and Skill Premium in Chile[#]

Yoshimichi MURAKAMI[*]

**Abstract**

This study empirically analyzes whether trade liberalization increases wage inequality between skilled and unskilled workers in Chile during 1974–2007. The findings show that tariff reductions contributed to increases in wage inequality by causing price reductions of unskilled labor-intensive goods protected with the highest tariffs prior to trade liberalization. In contrast, we found no evidence that new technologies embodied in capital and intermediate goods caused skill-biased technological change. In addition, this study shows that an increase in the relative supply of college equivalents did not contribute to wage equalization, while an increase in the minimum wages contributed to wage equalization during the period of the democratic governments.

*JEL classifications*: F16, O15

*Key words*: Trade liberalization, Skill-biased technological change, Wage inequality, Chile

[#] I am most grateful to the Microdata Center, Department of Economics, the University of Chile, for providing me with the data from *Encuesta de Ocupación y desocupación en el Gran Santiago*. I am also deeply grateful to the late Prof. Shoji Nishijima, Prof. Nobuaki Hamaguchi, Prof. Takahiro Sato, Prof. Tomokazu Nomura, and Prof. Tsuyoshi Yasuhara for their insightful comments and suggestions. Needless to say, I hold sole responsibility for any errors and misinterpretations present in this paper.

[*] Part-time Research Associate, RIEB (Research Institute for Economics and Business Administration)
Kobe University, 2-1, Rokkodai, Nada-ku, Kobe 657-8501, Japan. Email: y-murakami@rieb.kobe-u.ac.jp

## 1. Introduction

Does trade liberalization increase wage inequality between skilled and unskilled workers? If so, through which channel would trade liberalization affect wage inequality? In spite of traditional theorem inherent in the Heckscher–Ohlin–Samuelson (henceforth, HOS) theory, many empirical studies have shown that trade liberalization has increased wage inequality in Latin American and Caribbean countries (henceforth, LACs) during the last three decades. In this regard, Goldberg and Pavcnik (2007) provide two important explanations based on an abundant body of empirical research. The first line of explanation for these findings focuses on the inconsistency with the assumptions of the HOS theory. Previous research notes that contrary to expectations, the unskilled labor-intensive sectors were in fact the ones most protected, prior to trade liberalization, and that they experienced the largest tariff reductions during the trade liberalization period. Therefore, a rise in wage inequality is exactly what Stolper–Samuelson would predict. In contrast, the second line of explanation focuses on within-industry changes. According to past works, one of the main determinants of increases in wage inequality is the increase in demand for more skilled workers within all industries; that is, a skill-biased technological change (henceforth, SBTC). This increase is attributable to "defensive innovation" (Wood, 1995), which indicates that intensified competition from abroad induces firms to take advantage of the existing new technologies that were unavailable prior to trade liberalization. SBTCs also arise from the incorporation of new technologies embodied in cheaper imported capital goods, such as machines and office equipment, or intermediate goods that are complementary to skilled workers.

With regard to the evolution of wage inequality between skilled and unskilled workers in Chile, the first of the LACs to introduce far-reaching trade liberalization, there seems to be little room for argument; that is, there is, in general, a common agreement that wage inequality increased significantly since the mid-1970s, reached its peak in 1987, then decreased substantially up to the first half of the 1990s, once again increased in the mid- or late 1990s, and decreased afterward over the past decade (that is, during 1998–2007). However, the impacts of trade liberalization on the evolution of wage inequality still remain controversial. Beyer *et al.* (1999) and Gallego (2012), in a more recent study, try to answer the aforementioned questions using exactly the same employment survey over the same period while employing a similar methodology. However, the findings are quite different. The former study finds that trade liberalization, measured as the volume of trade over GDP (the ratio of exports plus imports to GDP), and the price reductions of unskilled labor-intensive goods widen the wage premium gap between skilled and unskilled workers during 1960–1996. Therefore, they conclude that the evolution of wage premiums during this period can be understood within the context of the aforementioned inconsistencies in the assumptions of the HOS theory. In contrast, Gallego (2012) finds that the wage premium in the United States, which is assumed to be a proxy for SBTC in developed countries, increased the relative demand for skilled workers in Chile, while he finds no statistical significance of the volume of trade over GDP and the prices of unskilled labor-intensive goods during 1960–2000. Therefore, he concludes that SBTC caused by technology transfers from developed countries through imported capital is the crucial determinant of the evolution of relative demand for skilled workers.

Furthermore, the impacts of an increase in the supply of skilled workers on wage inequality are also controversial among previous studies. Theoretically, an increase in the supply of skilled workers should push the wages of skilled workers down relative to that of unskilled workers, thereby contributing to wage equalization. Beyer *et al.* (1999) find that an increase in the proportion of the labor force comprising university graduates reduces wage inequality. However, Robbins (1994) finds that an increase in the relative supply of university graduates does not explain the observed wage inequality during 1975–1992. Gindling and Robbins (2001) also find that education-price effects, that is, wage premiums for more educated workers, dominate the effects of an increase in the supply of education during 1974–1990.

In addition to considering the changes in labor supply, we must take into account other possible explanations, such as labor market conditions, when analyzing the evolution of wage inequality between skilled and unskilled workers (Gindling and Robbins, 2001). Among the labor market conditions, minimum wages, unemployment, and union bargaining should be considered the relevant factors for the Chilean case.[1] However, the findings of previous studies are also ambiguous. Gindling and Robbins (2001) find a negative relationship between minimum wages and wage premiums: an increase in the minimum wages contributes to wage equalization, but the correlations are not statistically significant at 10%. Gallego (2012) too finds a negative relationship between minimum wages and the relative demand for skilled workers but these correlations are not statistically significant at 10%. Gindling and Robbins (2001) find a positive relationship between unemployment and wage premiums: a decrease in unemployment contributes to wage equalization; however, the correlations are not statistically significant at 10%. Thus, these previous studies find that the evolution of wage inequality cannot be explained by changes in labor market conditions, although they do recognize the potential role that they play. In contrast, Reinecke and Valenzuela (2011) argue that the weaknesses of unionization and collective bargaining are the key determinants of the limited improvement found in wage inequality after 1990.

We assume that there are at least two important reasons for the aforementioned unsettle debate on the distributional effects of trade liberalization. First, the two studies mentioned above, Beyer *et al.* (1999) and Gallego (2012), cover not only the post-1974 trade liberalization period but

[1] For more details on the role of labor market conditions, see Bussolo *et al.* (2002) and Reinecke and Valenzuela (2011). The minimum wage law was established in the immediate aftermath of the military *coup d'état*, in October, 1973.

also the pre-1973 import substitution industrialization period. The problem with including this period is that Chile had experienced political and economic turmoil during this period, especially from 1970 to 1973; that is, Chile passed through the “socialist-populist Chilean experience” (Larraín and Meller, 1991) era. While various previous studies show that wage inequality was at its lowest level during this period, the determinants of wage equalization comprise the temporal results of distributional policies typically inherent in “economic populism” (Dornbusch and Edwards, 1991); thus, wage equalization should be interpreted as in a separate mechanism from the trade liberalization perspective. This problem is also applicable in the case of labor market condition variables. For example, a decrease in wage inequality chronologically coincides with temporary increases in real minimum wages; this is one of the typical “economic populism” policies. Thus, the aforementioned negative relationship between minimum wages and wage premiums could disappear if we exclude this period from our study. Therefore, we should only cover the post-1974 period when analyzing the impact of trade liberalization on wage inequality; this study extends the analysis to 2007.

Further, we argue that all the trade-related variables used by Beyer *et al.* (1999) and Gallego (2012) are not necessarily appropriate measures of trade liberalization. First, the volume of trade over GDP has flaws as a measure of trade liberalization, as pointed out by Rodriguez and Rodrik (2001). In particular, when one considers the specific Chilean context, trade volumes have crucial flaws as a measure of trade liberalization. This is because exports from Chile still depend heavily on a limited number of commodities, including copper; thus, trade volumes can be approximately determined from the price of copper and the real exchange rate, neither of which is related to trade liberalization by itself.[2] Second, changes in the prices of unskilled labor-intensive goods occur not only because of trade liberalization, that is, tariff reductions or elimination of non-tariff barriers, but also because of other factors, such as decreases in domestic demand. Therefore, we cannot deny the fact that the prices of unskilled labor-intensive goods are endogenous variables with respect to wage inequality. Third, the channel through which wage premiums in the United States would contribute to SBTC in Chile is ambiguous, although wage premiums in the United States are certainly exogenous variables with respect to wage inequality in Chile. In this regard, Gallego (2012) argues that the imported capital from developed countries plays a crucial role in technological transfer. However, he does not show any direct evidence linking technological transfers and imported capital. Therefore, we are rather skeptical of the findings of the two studies

[2] In fact, during 1974–1996, the correlation coefficient between the volume of trade over GDP and the real effective exchange rate was very high: 0.89. The data on the ratio of exports plus imports to GDP are from the International Financial Statistics (IFS) 2009 CD-ROM. The data on the real effective exchange rate are from the calculations developed by the author on the basis of Ffrench-Davis, Leiva and Madrid (1992: 44) during 1974–1976, Banco Central de Chile (2002: 345-349) during 1977–1985, and the bank’ s web page (http://www.bcentral.cl/) during 1986–2007.

and therefore, argue that we should use tariffs, which are the most direct measures of trade liberalization (Rodriguez and Rodrik, 2001). Moreover, tariffs have been not only appropriate proxies for trade liberalization but also exogenously determined with respect to wage inequality in the case of Chile, because Chile applied flat tariffs to most goods since 1979.[3]

Therefore, the objective of this study is to empirically analyze whether trade liberalization increases wage inequality between skilled and unskilled workers and identify the channel through which it would affect wage inequality by using tariffs that are the most direct measure of trade liberalization, and covering only the post-1974 Chilean trade liberalization period. In addition, this paper tries to identify the impacts of the labor supply of skilled workers and labor market conditions on wage inequality, which vary in previous studies. With regard to the analytical methodology, this paper takes advantage of the methodology developed by the relevant labor economics literature, as will be discussed in greater detail in the following section.

This paper is organized as follows. Section 2 describes a stylized theoretical model to analyze wage inequality between skilled and unskilled workers and explains how to apply the model to the Chilean context. Section 3 describes the data and method of estimation. Section 4 provides the findings of econometric analysis. The conclusions are summarized in Section 5.

## 2. Model

In this section, we describe a stylized theoretical model to analyze wage inequality between skilled and unskilled workers and explain how to apply this model to the Chilean context. This model was presented by Katz and Murphy (1992) and then developed by Card and Lemieux (2001) and many other previous studies. This model assumes that wage inequality between skilled and unskilled workers is attributable to the evolution of the relative supply and relative demand for skilled workers. While Card and Lemieux (2001) developed a model incorporating imperfect substitutability between not only different skill groups but also different age groups, this study uses the simplest model presented by Katz and Murphy (1992),[4] because this study uses not wages in themselves but "pure" skill premiums estimated by controlling for observable workers' characteristics, as will be discussed in greater detail in the next section.

Therefore, we assume the following CES production function for aggregate output *Y* with two production factors, skilled workers and unskilled workers:

[3] Although the tariffs levied in each industrial sector varied widely, from 0% to 750%, and the average tariff was 94% at the end of Allende's administration, the military government not only completely eliminated NTBs but also applied a uniform 10% tariff on most goods by 1979. The center-left coalition government, which took office in 1990, implemented further uniform tariff reductions (see Figure 1).

[4] We also owe our specification to Acemoglu and Autor (2011), a recent labor economics textbook.

(1) $$Y_t = [(a_t Ls_t)^{\frac{\sigma-1}{\sigma}} + (b_t Lu_t)^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}},$$

where $Ls_t$ and $Lu_t$ are the total quantities of skilled and unskilled workers used in production during period *t*; $a_t$ and $b_t$ are the factor-augmenting technological parameters in period *t*, meaning that technological changes cause an increase in the productivity of skilled and unskilled workers; and $\sigma \in [0, \infty)$ is the time-invariant elasticity of substitution between skilled and unskilled workers.

If we assume that the wage rate of unskilled workers is equal to the marginal product of unskilled workers and that the wage rate of skilled workers is equal to the marginal product of skilled workers, we obtain the following wage inequality function as the natural log of the ratio of the wage rate of skilled workers to that of unskilled workers:

(2) $$\ln(\frac{Ws_t}{Wu_t}) = (\frac{\sigma-1}{\sigma})\ln(\frac{a_t}{b_t}) - \frac{1}{\sigma}\ln(\frac{Ls_t}{Lu_t}),$$

where $Ws_t$ and $Wu_t$ stand for the wage rate of skilled and unskilled workers, respectively, in period *t*. This equation decomposes the evolution of wage inequality between skilled and unskilled workers into the first term, which represents the relative demand for skilled workers, $\ln(\frac{a_t}{b_t})$, and the second term, which represents the relative supply of skilled workers, $\ln(\frac{Ls_t}{Lu_t})$. What is relevant from the theoretical assumption regarding the impacts of an increase in the supply of skilled workers on wage inequality can be given as follows:

(3) $$\frac{\partial \ln(\frac{Ws_t}{Wu_t})}{\partial \ln(\frac{Ls_t}{Lu_t})} = -\frac{1}{\sigma} < 0 \cdot$$

Therefore, this model shows that an increase in the relative supply of skilled workers reduces the wage inequality between skilled and unskilled workers.

Since we assume that $\sigma$ is a time-invariant production parameter, technological change is skill neutral as long as the productivity of skilled and that of unskilled workers increase at the same rate. However, this model usually assumes the existence of SBTC, that is, $\frac{a_t}{b_t} > 1$. Since $a_t$ and $b_t$ are not directly observable parameters, the literature assumes that there is a log linear increase in the relative demand for skilled workers over time coming from technology; that is, the evolution of the relative demand for skilled workers can be captured by a linear time trend (Acemoglu and Autor, 2011). Therefore, we make the following assumption on the first term, which represents the relative demand for skilled workers:

$$\ln(\frac{a_t}{b_t}) = \gamma_0 + \gamma_1 t , \quad (4)$$

where *t* is a linear time trend. If we substitute equation (4) into equation (2), we obtain

$$\ln(\frac{Ws_t}{Wu_t}) = (\frac{\sigma - 1}{\sigma})\gamma_0 + (\frac{\sigma - 1}{\sigma})\gamma_1 t - \frac{1}{\sigma}\ln(\frac{Ls_t}{Lu_t}) . \quad (5)$$

Apparently, this model assumes that SBTC takes place at a constant rate. However, there is no special reason for SBTC to always take place at a constant rate; therefore, we do not have to necessarily abide by the aforementioned assumption. In fact, Autor *et al.* (2008) allow the term representing the relative demand for skilled workers to have more flexible specifications; they include not only a linear time trend but also a quadric time trend and a cubic time trend. Moreover, it is natural to assume that SBTC takes place in Chile at a varying rate, because trade liberalization in Chile is very rapid and comprehensive as compared to other developing countries, including the LACs. Therefore, we assume that a linear time trend can capture a SBTC that is not necessarily related to trade liberalization as mentioned in the usual labor economics literature; thus, we include trade-related variables that can capture the SBTC inherent in trade liberalization instead of a quadric or a cubic time trend. Under this assumption, the term representing the relative demand for skilled workers can be described as follows:

(6) $$\ln(\frac{a_t}{b_t}) = \gamma_0 + \gamma_1 t + \gamma_2 trade_t ,$$

where *trade* stands for the trade-related variables in period *t*. We include the average nominal tariff rates of each year as the measure of trade liberalization, as discussed in the introduction. We also separately include the ratio of imports of consumption goods, capital goods, and intermediate goods to each year's GDP (*Consumption M/GDP*, *Capital M/GDP*, and *Intermediate M/GDP*) to identify the channel through which trade liberalization would affect SBTC. This is because SBTC is attributable to both import competition in final goods and the incorporation of new technologies embodied in capital and intermediate goods, as discussed in the introduction; thus, we need to identify which channel is relevant to the case of Chile. Therefore, this is the estimation strategy in which we apply this model to the Chilean context. If we again introduce equation (6) into equation (2), we obtain

(7) $$\ln(\frac{Ws_t}{Wu_t}) = (\frac{\sigma - 1}{\sigma})\gamma_0 + (\frac{\sigma - 1}{\sigma})\gamma_1 t + (\frac{\sigma - 1}{\sigma})\gamma_2 trade_t - \frac{1}{\sigma}\ln(\frac{Ls_t}{Lu_t}) .$$

In addition, we add possible control variables that could have different effects on skilled and unskilled workers. First, we need to control for labor market conditions, such as minimum wages and unemployment, as discussed in the introduction. Theoretically, if the wages of unskilled workers are affected by the minimum wages while the wages of skilled workers are not, an increase in minimum wages can be expected to increase the wages of unskilled workers; thus, it contributes to a reduction in wage inequality (Gindling and Robbins, 2001). Concerning unemployment, if unemployment requires some additional qualification, an increase in unemployment would be expected to lead to an increase in the wages of skilled workers, thus contributing to an increase in wage inequality (Larrañaga, 2001). Second, we consider the export impacts predicted by the HOS theory: if the non-traditional natural resource-based exports, e.g., fish, fruit, and forestry products, expanding after trade liberalization comprises unskilled labor-intensive goods, these changes would favor unskilled labor, thus contributing to a reduction in wage inequality.[5] In our empirical analyses, we estimate equations (5) and (7) without and with control variables, as will be discussed in greater detail in the next section.

[5] For example, Scott (1996) and Schurman (2002) point out that those non-traditional natural resource-based export sectors, especially the fruit sector, were successful in creating relatively unskilled labor-intensive jobs as compared to copper, which is a traditional export sector in Chile.

## 3. Data and estimation method

In this section, we describe the data used in this study and the method of estimation. In the estimation of equations (5) and (7) mentioned above, the evolution of wage inequality between skilled and unskilled workers, $\ln(\frac{Ws_t}{Wu_t})$, and that of the relative supply of skilled workers, $\ln(\frac{Ls_t}{Lu_t})$, are observable variables. Therefore, the most relevant issue in the estimation method is how to calculate the aforementioned two variables.

The data used for calculating the variables come from the Employment and Unemployment Survey for Greater Santiago (*Encuesta de Ocupación y desocupación en el Gran Santiago*), conducted by the University of Chile. This survey covers the Greater Santiago area, which includes roughly 40% of total Chilean population, and is conducted in June every year. Each survey covers fixed 3600 households,[6] and approximately 10000 and 14000 individuals during 1974–2007. The data are repeated cross-section, and the sample is fully representative of the Greater Santiago area.

We define "wages" as the remuneration from one's principal occupation; thus, wages does not include the income from self-employment, assets, pensions, or other sources. The samples used in this study comprise the working age (14–65 years) population who report positive income and positive work hours. The sample includes only salaried workers—that is, white-collar ("empleados") and blue-collar ("obreros") workers—who work on a full-time basis (more than 30 hours a week). Therefore, self-employed workers—that is, employers and independent workers—are not included. Domestic servants, unpaid family workers, and military personnel are also excluded from the sample because their wages are not likely to be determined by market forces. The samples whose variables are not answered in at least one survey question are also eliminated in advance.

To calculate the evolution of wage inequality between skilled and unskilled workers and the relative supply of skilled workers, we define skilled workers as college equivalents and unskilled workers as high-school equivalents, because there is a notable wage gap between people who completed university education and those who completed only high school in Chile (Ffrench-Davis, 2010). Therefore, the evolution of wage inequality between skilled and unskilled workers and that of relative supply of skilled workers are calculated as the skill premiums between college equivalents

---

[6] Although the number of households fluctuated during 1957–1979, the number has stayed fixed since 1980.

and high-school equivalents (*wp*) and that of the relative supply of college equivalents (*relative supply*). Then, we apply the methodology of Autor *et al.* (2008) to our study to calculate the evolution of wage inequality college equivalents and high-school equivalents. The methodology is as follows. First, we construct six education categories (workers with up to primary school education, high-school dropouts, high-school graduates, vocational high-school dropouts and graduates, some college,[7] and university graduates) up to 1997, five education categories (workers with up to primary school education, high-school dropout, high-school graduate, some college, and university graduates) after 1998,[8] and four potential experience categories[9] (0–9, 10–19, 20–29, and 30+ years), and then construct 24 or 20 education × experience groups. Second, we estimate the skill premiums for high-school graduates and university graduates from the following wage equation, limiting the sample to males:[10]

(8) $$\ln(W_i) = cons + educateg_i'\alpha + \beta_1 \exp_i + \beta_2 \exp_i{}^2 + X_i'\delta \,,$$

where *i* indexes an individual; *W* stands for hourly wages obtained by dividing monthly wages by four weeks of working hours and are then deflated by the national consumer price index (December 1998 = 1); vector *educateg* represents the aforementioned education categories;[11] *exp* is years of potential experience;[12] and vector *X* contains a head of household dummy that is 1 for workers with a head position, a public sector dummy that is 1 for workers employed in the public sector, and 8 industry indicators.[13] Third, using the results of the aforementioned regression, we calculate the predicted log wages for high-school graduates and university graduates evaluated at the relevant experience level (5, 15, 25, or 35 years, depending on the aforementioned experience groups) and at

---

7 "Some college" comprises workers who had not completed *Centro de Formación Técnica* (CFT)- or *Instituto Profesional* (IP)-based education (which are non-university post-high-school education programs), CFT- or IP-based education graduates, or university dropouts.

8 The classification of education categories has changed since the 1998 survey.

9 The years of potential labor experience is calculated by (age – years of schooling – 6).

10 Following Card and Lemieux (2001), we consider only males when calculating the evolution of wage inequality between college equivalents and high-school equivalents to avoid potential sample selection biases, but we consider both males and females when calculating the evolution of the relative supply of college equivalents.

11 Workers with up to primary school education are chosen as the base category.

12 Although Autor *et al.* (2008) include the interactions of the quadric and Gallego (2012) includes the interactions of cubic for experience with education categories, we do not include the interaction terms with education categories because we cannot reject the jointly conducted *F* test for the insignificance of the interaction terms at the 10% level for most of the analysis period.

13 The industry indicators are classified as follows: agriculture, mining, construction, manufacturing, commerce, financial services, personal services, community services, and transportation. The manufacturing sector is chosen as the base category because it holds the largest employment share among all the industrial sectors.

the base categories with regard to all variables in vector *X*. Finally, we calculate the difference between the predicted log wage for the group of university graduates, $\ln(\hat{W}s_t)$, and high-school graduates, $\ln(\hat{W}u_t)$, using the average share of total monthly hours worked by education × experience groups in each year as weights.

To calculate the evolution of the relative supply of college equivalents, we apply the methodology followed by Card and Lemieux (2001). The model assumes that there are only two kinds of production factors, skilled workers and unskilled workers. Therefore, we need to classify all male and female workers into two groups—that is, college equivalents and high-school equivalents. In this regard, we calculate the quantities of high-school equivalents, $Lu_t$, in period *t* as follows:

$$(9) \qquad Lu_t \equiv L_t^{PS}\left(\frac{\overline{w}_t^{PS}}{\overline{w}_t^{HSG}}\right) + L_t^{HSD}\left(\frac{\overline{w}_t^{HSD}}{\overline{w}_t^{HSG}}\right) + L_t^{HSG} + L_t^{SC}\left(\frac{\left(\frac{\overline{w}_t^{UG}}{\overline{w}_t^{SC}} - 1\right)}{\left(\frac{\overline{w}_t^{SC}}{\overline{w}_t^{HSG}} - 1\right) + \left(\frac{\overline{w}_t^{UG}}{\overline{w}_t^{SC}} - 1\right)}\right),$$

where $L_t^{PS}$, $L_t^{HSD}$, $L_t^{HSG}$, and $L_t^{SC}$ are the total monthly working hours of workers who have completed up to primary school education, are high-school dropouts, are high-school graduates, and have attended some college, respectively; $\overline{w}_t^{PS}$, $\overline{w}_t^{HSD}$, $\overline{w}_t^{HSG}$, $\overline{w}_t^{SC}$ and $\overline{w}_t^{UG}$ are the average wages of each year for workers who have completed up to primary school education, are high-school dropouts, are high-school graduates, have attended some college, and are university graduates, respectively. Therefore, we assume perfect substitution between the less educated workers up to high-school graduates, and precisely weigh their working hours according to the ratio of their actual hourly average wages to those of high-school graduates. We distribute the working hours of the workers with some college education, which are "split" between college equivalents and high-school equivalents on the basis of their relative wages, as shown in equation (9). The quantities of college equivalents, $Ls_t$, in period *t* are calculated in exactly the same way:

(10) $$Lu_t \equiv L_t^{UG} + L_t^{SC} \left( \frac{(\frac{\overline{w}_{jt}^{SC}}{\overline{w}_t^{HSG}} - 1)}{(\frac{\overline{w}_t^{SC}}{\overline{w}_t^{HSG}} - 1) + (\frac{\overline{w}_t^{UG}}{\overline{w}_t^{SC}} - 1)} \right).$$

Although Gallego (2012) also weighs the working hours of workers according to their education level, he applies fixed weights to all years: for example, the working hours of high-school dropouts are half of those of high-school graduates. However, the relative wages substantially fluctuated during his analysis period, rendering his assumption unrealistic and his calculations of the relative supply of skilled workers biased.

Regarding the trade-related variables, the data of average nominal tariff rates (*Tariff*) are from Ffrench-Davis, Leiva and Madrid (1992) for 1974–1989, and Ffrench-Davis (2002) and World Integrated Trade Solution (WITS) for 1990–2007 (shown in percentage terms). We do not consider preferential tariffs given the enforcement of numerous preferential free trade agreements that Chile has actively pursued since the 1990s. The data of the imports of consumption goods, capital goods, and intermediate goods are from Banco Central de Chile (2002) for 1974–1999 and its web page for 2000–2007 (shown in percentage terms). As for the control variables stated earlier, we use the unemployment rate of males (*Unemployment*) from our own calculations based on data from the aforementioned employment survey (shown in percentage terms), real minimum wages (*Real minwage*) from Banco Central de Chile (2002), and the web page of *Biblioteca del Congreso Nacional de Chile*[14] deflated by the national consumer price index (December 1998 = 100). As a proxy for non-traditional natural resource-based exports, we use the ratio of non-copper exports to GDP (*Non-copper EX /GDP*) from Banco Central de Chile (2002) for 1974–1999 and its web page for 2000–2007 (shown in percentage terms).

## 4. Estimation results

Figure 2 shows the evolution of skill premiums between college equivalents and high-school equivalents, and figure 3 shows the evolution of the relative supply of college equivalents during 1974–2007. The evolution of skill premiums basically coincides with that seen in the previous studies: it increased significantly since the mid-1970s, reaching its peak in 1987; it then decreased substantially up to the first half of the 1990s, and once again increased in the mid-1990s; after that, it slightly decreased, although fluctuating year by year. This is as discussed in the introduction. The evolution of the relative supply of college equivalents basically shows an increasing trend, although this too fluctuated year by year.

[14] http://www.bcn.cl/ (accessed on December 8, 2011)

The results of the Augmented Dickey–Fuller (ADF) unit roots tests without and with time trend are presented in table 1. The lag length is determined by the sequential *t* test on the highest-order lag, beginning with higher-order lags and stopping when the coefficient is statistically significant. The results show that we cannot reject the null hypotheses of unit roots at the 5% significance level in without and with time trend, except for the relative supply of college equivalents and the ratio of the imports of intermediate goods to GDP, indicating the existence of unit roots in dependent and all independent variables. Therefore, we perform the Engel–Granger cointegration tests in the estimation equations.

Table 2 reports the results of estimation equations (5) and (7). The coefficients on the relative supply of college equivalents are not statistically significant at all. Moreover, they show positive in some models—that is, they do not show theoretically the "correct" signs. Therefore, we cannot reject the perfect substitution between college equivalents and high-school equivalents; we find that an increase in the relative supply of skilled workers does not contribute to wage equalization during 1974–2007. The findings are quite different from both Gallego (2012), who rejects the perfect substitution between college equivalents and high-school equivalents during 1960–2000,[15] and Beyer *et al.* (1999), who find that an increase in the proportion of labor force with university graduates reduces wage inequality during 1960–1996, but agree with Robbins (1994).

Regarding trade-related variables, the coefficients on tariffs are negatively significant in models without and with control variables (reported in columns [3], [4] and [8]), indicating that tariff reductions contribute to increases in wage inequality between skilled and unskilled workers. The coefficients on the ratio of the imports of consumption goods and capital goods to GDP are positive but not statistically significant (reported in columns [5] and [6]). The coefficients on the ratio of the imports of intermediate goods to GDP are negatively significant at 10% level (reported in column [7]). However, the significance of the ratio of the imports of intermediate goods to GDP disappears after controlling for tariffs, while the significance of tariffs is found to persist (reported in column [8]). Therefore, the results show that tariff reductions in themselves affect wage inequality, while the observed negative relationship between the ratio of the imports of intermediate goods to GDP and wage inequality is lack of robustness; that is, tariffs correlate with both wage inequality and the ratio of the imports of intermediate goods to GDP. In fact, a regression of the ratio of the imports of intermediate goods to GDP on tariffs yields a positive and statistically significant coefficient of 0.074 (with a *T*-statistic of 4.46) during 1974–1989.

The null hypotheses of no cointegration are also rejected, as shown in columns [4] and [8]; thus, the relationship between wage inequality and tariffs is not spurious. Moreover, the impacts of

[15] Gallego (2012) estimates the elasticity of substitution between college equivalents and high-school equivalents from 1.40 to 1.70; that is, the coefficients on relative supply of college equivalents are estimated from –0.714 to –0.588. For more details, see footnote 14 of Gallego (2012).

tariffs on wage inequality are practically large; a coefficient of –0.0090 shows that a 50% tariff reduction would lead to a 0.45-point increase in the log wage difference between college equivalents and high-school equivalents; thus, 67% of the total change of skill premiums from 1974 to 1987 can be explained by tariff reductions.

A logical examination of these findings would directly show what Beyer *et al.* (1999) imply by using the prices of unskilled labor-intensive goods; the unskilled labor-intensive sectors that were protected with the highest tariffs prior to trade liberalization experienced the largest tariff reductions. In fact, Hachette (2000) shows that the two unskilled labor-intensive sectors, textiles, and footwear and apparel, which were protected with the highest effective tariffs among 23 industrial sectors in 1975, experienced the largest tariff reductions from 1975 to 1979.[16] Therefore, tariff reductions contribute to increases in wage inequality through the Stolper–Samuelson effects.

A possible explanation for the insignificance of the ratio of the imports of capital and intermediate goods to GDP is the effect of "imports-de-substitution" (Ffrench-Davis, 2008; 2010) after trade liberalization in Chile. Ffrench-Davis (2008; 2010) point out that the abandonment of the import substitution of final consumption goods reduced the imports of intermediate goods and capital goods, such as machinery and equipment, while it increased the imports of consumption goods (particularly non-food goods), leading to bankruptcy in the remaining import substitution sectors, such as the automotive industry. Therefore, the findings show that SBTC is not attributable to the incorporation of new technologies embodied in capital and intermediate goods in the case of Chile. Moreover, the findings are unique to Chile in that they are in contrast with some other LACs like Mexico, which experienced a growing importance of trade in intermediate goods; thus, the import catalyzed technological change is the main cause for SBTC[17]. Therefore, the findings are quite different from both Gallego (2012) and Gindling and Robbins (2001), who conclude that skill-intensive technologies embodied in imported capital goods caused SBTC in Chile. The findings can be also interpreted as the experience of a country with a weak manufacturing sector and comparative advantage in natural resources after rapid and far-reaching trade liberalization, that is, "premature de-industrialization" (McMillan and Rodrik, 2011).

Another interesting finding is the impact of minimum wages. The coefficients on minimum wages are negatively significant in cointegrated models (reported in columns [2], [4], [5], [6] and [8]). The finding shows that a decrease in minimum wages certainly contributes to increases in wage inequality between skilled and unskilled workers, even if we exclude the "socialist-populist Chilean experience" era from the analysis period; thus, it is quite different from the ambiguous results of the previous studies. This is a reasonable finding, because the minimum wages were

[16] The effective tariffs of the textiles sector decreased from 138% to 16% and those of the footwear and apparel sector decreased from 164% to 14% from 1975 to 1979.
[17] See, for example, Crag and Epelbaum (1996) and Harrison and Hanson (1999).

sufficiently low under the military government; it is just the same as the per capita poverty line income of an urban area in Chile.[18] Thus, the finding coincides with the theoretical assumption that if the wages of unskilled workers are affected by minimum wages while the wages of skilled workers are not, an increase in minimum wages would be expected to decrease wage inequality. Therefore, we conclude that the weak performance of labor markets under the military government is also an important determinant of increasing in wage inequality, while the improvement in labor market performances, especially an increase in the minimum wages, contributed to wage equalization during the period of the democratic governments. On the other hand, the coefficients on unemployment are positive, except for column [7]; that is, they are the expected signs, but not statistically significant.

The coefficients on the ratio of non-copper exports to GDP are positive except for in columns [4]. However, one possible explanation for the unexpected positive sign is that this employment survey covers only the Greater Santiago area—an urban area that includes part of a metropolitan region; that is, only about 1% of all the workers surveyed there were employed in the agriculture, forestry, or fishing sectors, excluding for the natural resource-based manufacturing sectors. Therefore, it is not appropriate to empirically analyze the impacts of natural resource-based exports on wage inequality using this employment survey.

## 5. Conclusions

This study empirically analyzed whether trade liberalization increases wage inequality between skilled and unskilled workers and identifies the channel through which it would affect wage inequality in Chile. The findings show that tariff reductions contributed to increases in wage inequality by causing price reductions of unskilled labor-intensive goods protected with the highest tariffs prior to trade liberalization. In contrast, we found no evidence that new technologies embodied in capital and intermediate goods caused SBTC. In addition, this study shows that an increase in the relative supply of college equivalents did not contribute to wage equalization. In contrast, the minimum wages did matter—that is, a decrease in minimum wages contributed to increases in wage inequality during the period of the military government, while an increase in the minimum wages contributed to wage equalization during the period of the democratic governments. Therefore, this study found that under the military government, unskilled workers faced two major issues. First, the price reductions of unskilled labor-intensive goods after trade liberalization decreased their relative wages. Second, they were also affected by a squeeze on the real minimum wage due to the government's repressive labor policy. In this regard, this study shows quite different

[18] For example, the monthly minimum wage was only 10120 pesos, while the per capita poverty line of monthly income in urban areas was 10158 pesos in 1987 (Banco Central de Chile, 2002).

findings from previous studies by using tariffs, which are the most direct measures of trade liberalization, and by covering only the post-1974 trade liberalization period in Chile.

Further research needs to be done in this area. First, we have not mentioned the reason why the increase in the relative supply of college equivalents does not contribute to wage equalization. One possible explanation is the quality of education. If new private universities established after 1980 are not compatible with traditional universities, our calculation of the relative supply of college equivalents could be biased, although both Gindling and Robbins (2001) and Gallego (2012) argue using cohort effects analyses that the difference in the quality of education between the new universities and the traditional universities does not influence the skill premiums for college equivalents. Second, if we were to obtain more detailed data on the components of consumption, capital, and intermediate goods, we could identify more precisely the channel through which trade liberalization affects wage equality in Chile. For example, if we were to classify consumption goods into non-food and food goods and capital goods into machinery and equipment and other goods, we could obtain the precise impact of trade liberalization on SBTCs. However, no such empirical analyses regarding these issues were undertaken in this study; this area will be an interesting subject for future research.

**References**


Acemoglu, D. and D. Autor (2011), "Skills, Tasks and Technologies: Implications for Employment and Earnings", in Ashenfelter, O. and D. Card (eds.) in *Handbook of labor economics*, vol. 4B, North-Holland: Elsevier, 1043–1171.

Autor, D., L. Katz, and M. Kearney (2008), "Trends in US wage inequality: Revising the Revisionists", *Review of Economic and Statistics*, Vol. 90 (2), 300-323.

Banco Central de Chile (2002), *Chile Social and Economic Indicators 1960-2000*, Santiago: Banco Central de Chile.

Beyer, H., P. Rojas, and R. Vergara, "Trade liberalization and wage inequality", *Journal of Development Economics*, Vol. 59 (1), 103-123.

Bussolo, M, A. Mizala, and P. Romaguera (2002), "Beyond Heckscher – Ohlin: Trade and Labour Market Interactions in a Case study for Chile", *Journal of Policy Modeling*, Vol. 24 (7-8), 639-666.

Card, D. and T. Lemieux (2001), "Can Falling Supply Explain the Rising Return to College for Younger Men? A Cohort-Based Analysis", *Quarterly Journal of Economics*, Vol. 116 (2), 705-746.

Cragg, M. and M. Epelbaum (1996), "Why Has Wage Dispersion Grown in Mexico? Is it the Incidence of Reforms or the Growing Demand for Skills?", *Journal of Development Economics*, Vol. 51 (1), 99–116.

Ffrench-Davis, R. (2002), *Economic Reforms in Chile: From Dictatorship to Democracy*, Ann Arbor: The University of Michigan Press.

Ffrench-Davis, R., (2008), *Chile entre el neoliberalismo y el crecimiento con equidad: Reformas y políticas económicas desde 1973*, 4a. edición, Santiago: J.C. Sáez Editor.

Ffrench-Davis, R. (2010), *Economic Reforms in Chile: From Dictatorship to Democracy*, 2nd edition, Basingstoke, Hampshire; New York: Palgrave Macmillan.

Ffrench-Davis, R., P. Leiva, and R. Madrid (1992), *Trade Liberalization in Chile: Experiences and Prospects*, New York: United Nations.

Gallego, F. (2012), "Skill Premium in Chile: Studying Skill Upgrading in the South", *World Development*, Vol. 40 (3), 594-609.

Gindling, T. H. and D. Robbins (2001), "Patterns and Sources of Changing Wage Inequality in Chile and Costa Rica During Structural Adjustment", *World Development*, Vol. 29 (4), 725-745.

Goldberg, P. K. and N. Pavcnik (2007), "Distributional Effects of Globalization in Developing Countries", *Journal of Economic Literature*, Vol. 45(1), 39-82.

Hachette, D. (2000), "La reforma comercial", in Larraín, F and R. Vergara (eds.) *La transformación económica de Chile*, Santiago: Centro de Estudios Públicos, 293-338.

Harrison, A. and G. Hanson (1999), “Who Gains from Trade Reform? Some Remaining Puzzles”, *Journal of Development Economics*, Vol. 59 (1), 125–54.

Katz, L. and K. Murphy (1992), “Change in Relative Wages, 1963-1987: Supply and Demand Factors”, *Quarterly Journal of Economics*, Vol. 107 (1), 35-78.

Larraín, F. and P., Meller (1991), “The Socialist-Populist Chilean Experience: 1970-1973”, in Dornbush, R. and S. Edwards (eds.). *The Macroeconomics of Populism in Latin America*, Chicago: University of Chicago Press, 175-221.

Larrañaga, O. (2001), “Distribución de ingresos: 1958-2001”, in Ffrench-Davis, R. and B. Stallings, *Reformas, crecimiento y políticas sociales en Chile desde 1973*, Santiago: LOM Ediciones/ CEPAL, 295-328.

McMillan, M. and D. Rodrik (2011), “Globalization, Structural Change, and Productivity Growth”, NBER Working Paper No. 17143.

Reinecke, G. and M. E. Valenzuela (2011), “Illustrating the Gap: Collective Bargaining and Income Distribution in Chile”, in: Hayter, S. (ed.), *The Role of Collective Bargaining in the Global Economy: Negotiating for Social Justice*, Cheltenham: Edward Elgar, 187-203.

Robbins, D. (1994), “Worsening Relative Wage Dispersion in Chile during Trade Liberalization: Supply or Demand driven Inequality?”, Working paper series, 122, Center for Institutional Reform and the Informal Sector (IRIS), University of Maryland at College Park.

Rodriguez, F. and D. Rodrik (2001), “Trade Policy and Economic Growth: A Skeptic’s Guide to the Cross-National Evidence”, *NBER Macroeconomics Annual*, Vol. 15, 261-325.

Schurman, R. A. (2001), “Uncertain Gains: Labor in Chile’s New Export Sectors,” *Latin America Research Review*, Vol. 36 (2), 3-29.

Scott, C. (1996), “The Distributive Impact of the New Economic Model in Chile”, in Bulmer-Thomas, V. (ed.), *The new economic model in Latin America and its impact on income distribution and poverty*, London: Macmillan, 147-184.

Wood, A. (1995), “How Trade Hurt Unskilled Workers”, *Journal of Economic Perspectives*, Vol. 9 (3), 57–80.

## Table 1

## Results of the ADF unit root tests

| variable | Test statistics without trend | Number of lags | Number of obs | Test statistics with trend | Number of lags | Number of obs |
|---|---|---|---|---|---|---|
| wp | -2.772 * | 2 | 31 | -1.930 | 2 | 31 |
| Relative supply | -2.433 | 0 | 33 | -4.183 ** | 0 | 33 |
| Real minwage | 0.390 | 5 | 28 | -2.301 | 3 | 30 |
| Unemployment | -2.443 | 0 | 33 | -2.834 | 0 | 33 |
| Tariff | -2.464 | 1 | 32 | -3.127 | 1 | 32 |
| Consumption M/GDP | -2.055 | 0 | 33 | -2.523 | 0 | 33 |
| Capital M/GDP | -2.042 | 0 | 33 | -2.096 | 0 | 33 |
| Intermediate M/GDP | -0.558 | 5 | 28 | -4.226 ** | 0 | 33 |
| Non-copper EX/GDP | -2.213 | 0 | 33 | -3.157 | 4 | 31 |

** and * indicate significance at the 5% and 10% levels, respectively.

## Table 2

## Regression results of estimation equations (5) and (7)

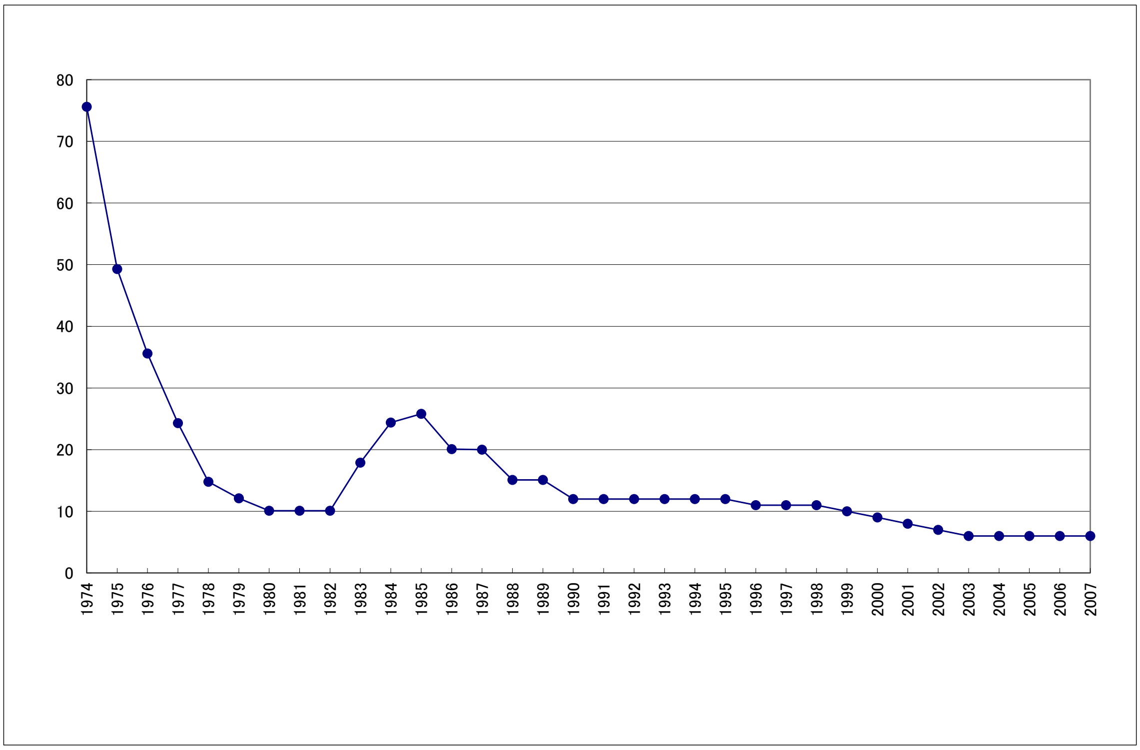
| | equation (5) | | equation (7) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] |
| Relative supply | 0.1221 | 0.1479 | -0.0702 | -0.1889 | 0.0825 | 0.1463 | 0.0142 | -0.1652 |
| | (0.1708) | (0.1707) | (0.1871) | (0.1466) | (0.1370) | (0.1406) | (0.1549) | (0.1404) |
| Trend | 0.0049 | 0.0183 *** | 0.0045 | 0.0237 *** | 0.0143 | 0.0090 | 0.0097 | 0.0202 *** |
| | (0.0043) | (0.0056) | (0.0048) | (0.0085) | (0.0117) | (0.0072) | (0.0080) | (0.0036) |
| Real minwage | | -0.0035 *** | | -0.0045 *** | -0.0036 * | -0.0025 ** | -0.0019 | -0.0046 *** |
| | | (0.0012) | | (0.0009) | (0.0020) | (0.0012) | (0.0012) | (0.0009) |
| Unemployment | | 0.0025 | | 0.0057 * | 0.0038 | 0.0019 | -0.0006 | 0.0061 * |
| | | (0.0031) | | (0.0028) | (0.0055) | (0.0076) | (0.0039) | (0.0034) |
| Tariff | | | -0.0048 * | -0.0081 *** | | | | -0.0090 *** |
| | | | (0.0026) | (0.0021) | | | | (0.0023) |
| Consumption M/GDP | | | | | 0.0275 | | | |
| | | | | | (0.0426) | | | |
| Capital M/GDP | | | | | | 0.0064 | | |
| | | | | | | (0.0323) | | |
| Intermediate M/GDP | | | | | | | -0.0253 * | 0.0121 |
| | | | | | | | (0.0129) | (0.0102) |
| Non-copper EX/GDP | | | | -0.0041 | 0.0142 | 0.0175 | 0.0244 * | |
| | | | | (0.0142) | (0.0140) | (0.0105) | (0.0140) | |
| Constant | 1.3413 *** | 1.5894 *** | 1.1345 *** | 1.2684 *** | 1.2813 *** | 1.3692 *** | 1.3568 *** | 1.1792 *** |
| | (0.3138) | (0.3412) | (0.3334) | (0.2446) | (0.2638) | (0.4208) | (0.3160) | (0.2819) |
| Number of obs | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| R-squared | 0.2287 | 0.4583 | 0.2897 | 0.6058 | 0.4846 | 0.4794 | 0.5181 | 0.6115 |
| ADF-Test | -3.647 | -5.102 *** | -3.693 | -6.947 *** | -5.409 *** | -5.288 *** | -5.977 *** | -6.861 *** |

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

*Note*: Numbers in parentheses are Newey–West HAC standard errors.

**Figure 1**

**Evolution of average nominal tariff rates, 1974–2007 (%)**




*Source*: Ffrench-Davis, Leiva and Madrid (1992), Ffrench-Davis (2002), and World Integrated Trade Solution (WITS).

**Figure 2**

**Evolution of skill premiums between college equivalents and high-school equivalents in Greater Santiago, 1974–2007**

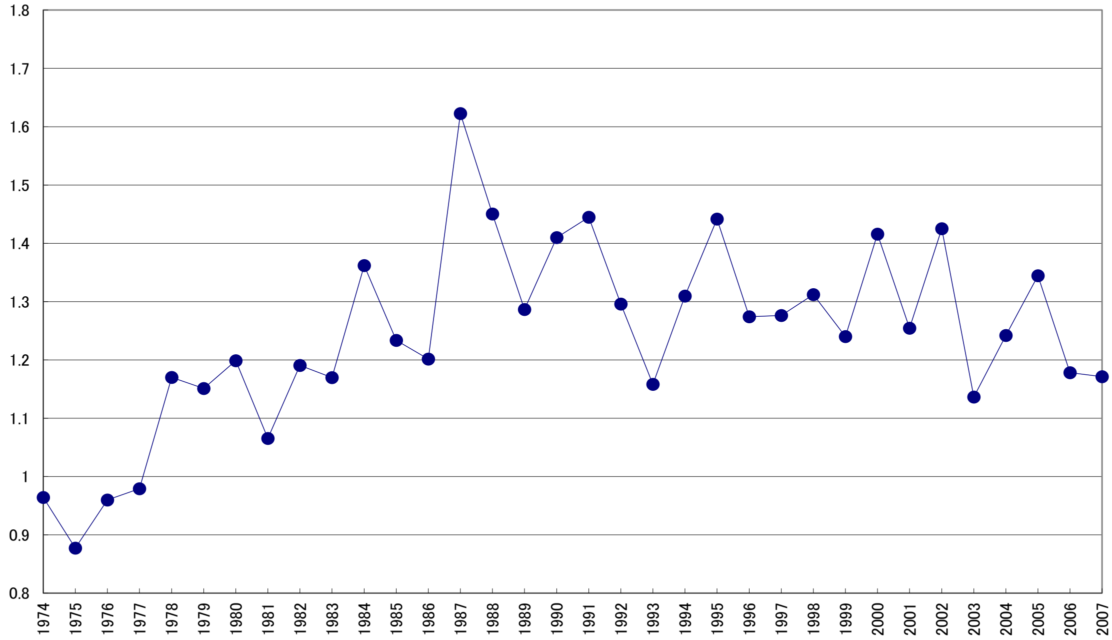
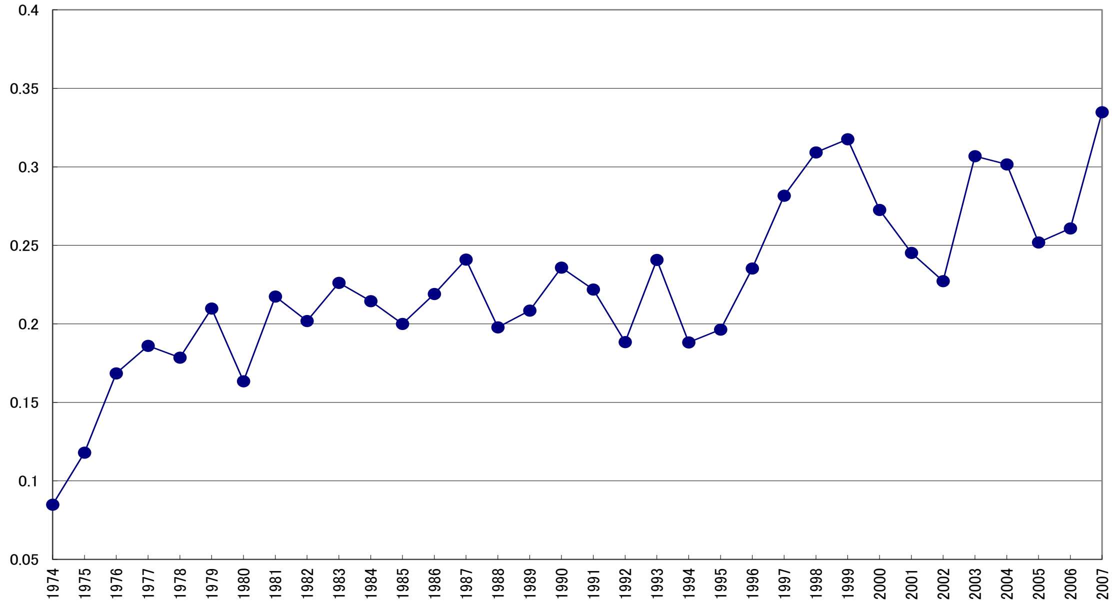



**Figure 3**

**Evolution of the relative supply of college equivalents in Greater Santiago, 1974–2007**




*Source:* Author's calculations based on the data from *Encuesta de Ocupación y desocupación en el Gran Santiago*.