Skill Substitutability, Trade with China, and College Wage Premium in Korea[+]

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Abstract

This study explores the major driving forces behind the dynamic pattern of the college wage premium in Korea since the 1980s, using the demand and supply framework. We find that movements in the college wage premium are mainly explained by expansion of the relative supply of college graduates and an increase in the relative demand for high-skilled labor due to trade with China. We also find that the substitutability in Korea between college and non-college-educated workers is higher, with an elasticity of approximately 3.5–4.1, than that in advanced economies. The counterfactual analyses demonstrate that with a lower substitution elasticity or smaller trade volume with China, Korea might have witnessed a sharp decline in the college wage premium.

JEL classification: F16, J24, J31

Keywords: China, college wage premium, education, Korea, substitutability, trade, wage

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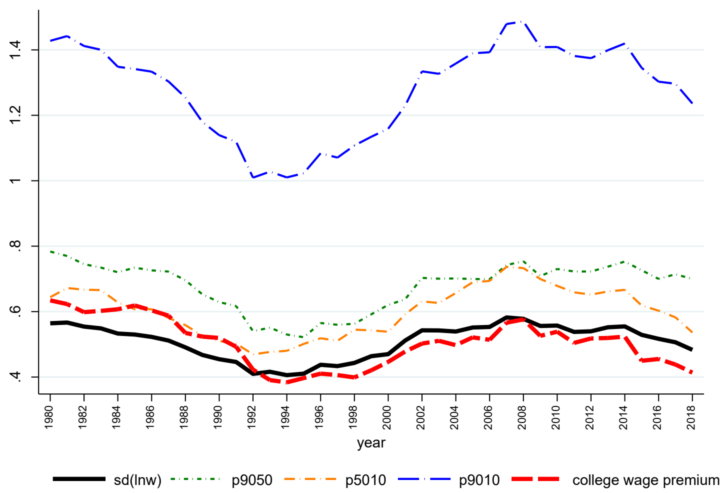
1. Introduction

Korea is well known for its dramatic improvement in educational and economic performance over the past half century (Han & Lee, 2020; Noland, 2012). The rapid expansion of high-educated and high-skilled labor, combined with strong economic growth and transformation, has had a significant impact on returns to college education and wage inequality. Figure 1 presents how wage inequality indices and college wage premium, which is defined as the ratio of the wage of college-educated workers to that of non-college-educated workers, have changed in Korea since 1980.[1] The wage inequality, such as standard deviation of log wage and the p90/p10 gap, declined significantly between 1980–1994, while the trend reversed in 1994 and increased until its peak in 2007–2008 before showing a gradual decline once more. College wage premium, which is depicted as a red line, shows a similar pattern. Hence, the movements in college wage premium have had significant implications for wage inequality since 1980.

Figure 1 Wage Inequality Indices and College Wage Premium Since 1980



[1] Please note that we use college wage premium and skill premium interchangeably.

Notes: Wage inequality indices are constructed using the Basic Survey on Wage Structure (BSWS) and the Survey on Work Status by Employment Type (WSET). sd(lnw) refers to standard deviation of log wage, while p90, p50, and p10 refer to the 90th, 50th, and 10th percentiles, respectively. College wage premium refers to the composition-adjusted college wage premium where we first classify workers into 32 education–age groups (4 education groups×8 age groups) and use the average share of each cell over the whole sample period.

Source: Authors' calculation using data sourced from the BSWS and WSET.

This study aims to investigate the major driving forces behind the dynamic pattern of the college wage premium in Korea since the 1980s, as shown in Figure 1. The literature has analyzed the changes in the supply of high-skilled workers and their consequences in the labor markets of major developed countries such as the United States. These studies reported that despite the increase in the supply of highly educated labor, skill premium as measured by, for example, the relative wages of college graduate workers to high-school graduates, has shown a tendency to increase over the past several decades (Acemoglu and Autor, 2011). This suggests that as the supply of college graduates increased, the relative demand for skills also increased. A popular explanation for the demand increase is the accelerating skill-biased technological change (SBTC) induced by information and communication technology (ICT) and computer revolutions (Acemoglu, 2003; Autor et al., 1998; Goldin & Katz, 2009; Katz & Murphy, 1992). Some researchers have also pointed out how the expansion of international trade and outsourcing, especially caused by the rise of China, raised the relative demand for skilled labor and, thus, the skill premium in advanced countries (David, Dorn, & Hanson, 2013; Feenstra & Hanson, 2011).

In Korea, the college wage premium has gone through dramatic changes through three distinctive phases over the last four decades, as shown in Figure 1. It had declined until the mid-1990s, sharply increased between the mid-1990s and late 2000s, and thereafter declined. Several studies attributed the steady decline in the skill premium in the 1980s to the increase in the labor supply of college graduates due to demographic changes and in the college entrance rate (Choi & Jeong, 2005; Koh, 2018). Some studies also analyzed the causes of the reversal of its trend in the mid-1990s and suggested skill-biased technological progress and trade expansion as possible explanations, similar to other advanced countries.

Most studies on Korean skill premium focused on the 1990s and identified SBTC as a major source of the increasing wage differential between college and non-college-educated workers. Choi and Jeong (2005) opined that wage differentials across education groups widened over 1993–2000, as the effect of relative demand for skilled labor exceeded that of relative supply. By adopting the within and between industry decomposition methodology, they highlighted the SBTC demand for highly skilled workers as a major cause of wage differentials. Adopting the decomposition analysis, Shin (2007) also emphasized that SBTC possibly induced by ICT investment played a major role in wage differentials. However, Koh (2018) argued that SBTC cannot explain some important aspects of the wage inequality development over the longer period of 1980–2016, including the increase in the relative demand for some groups of low-skilled workers such as female and elderly workers. He suggested that the increased supply of a particular group induces directed technological change that necessitates increased use of that group.

In addition, there are empirical studies highlighting the contribution of international trade to the increasing college wage premium in the 1990s. Kim and Son (2013) assessed to what extent global outsourcing and technological change contributed to the increasing college wage premium in Korea over 1990–2007, and showed that global outsourcing can explain 30–40%

of the increase in college wage premium since the Asian financial crisis in 1997. Hahn and Choi (2016), using firm-level data in the Korean manufacturing sector, empirically examined the role of trade liberalization in wage inequality between skilled and unskilled workers and highlighted the role of trade and R&D activities as a mechanism through which trade affects wage skill premium.

The empirical studies on Korea discussed above are based on reduced-form regression focusing on specific demand factors in which the authors were interested. In contrast to these studies, we empirically investigate the sources of college wage premium dynamics by adopting the production function approach developed in Katz and Murphy (1992) and Card and Lemieux (2001). The constant elasticity of substitution (CES) production function incorporating college and non-college-educated workers allows us to structurally obtain the determinants of the college wage premium, which are relative supply and relative demand for skills. This approach also allows us to estimate the substitution elasticity between incorporating college and non-college-educated workers, which was not done in previous skill premium studies on Korea. In several counterfactual (CF) analyses, we show that the size of the substitution elasticity as well as evolution of trade with China are critical to generating the observed college wage premium dynamics in Korea.

Building on the literature, this study explores the evolution of skill premium in Korea since 1980, by adopting the frameworks developed by Katz and Murphy (1992) and Card and Lemieux (2001). We identify the major supply and demand factors that have contributed to the evolution of skill premium in Korea. To be specific, we estimate the CES production function with college-educated (or high-skilled) and non-college-educated (or low-skilled) workers and examine the extent to which the changes in relative supply of high-skilled workers, technological progress, and international trade, especially with China, can explain the dynamic pattern of the college wage premium. To the best of our knowledge, this study is the first that not only estimates the elasticity of substitution across skill groups but assesses the role of demand and supply factors at the same time for the Korean economy.

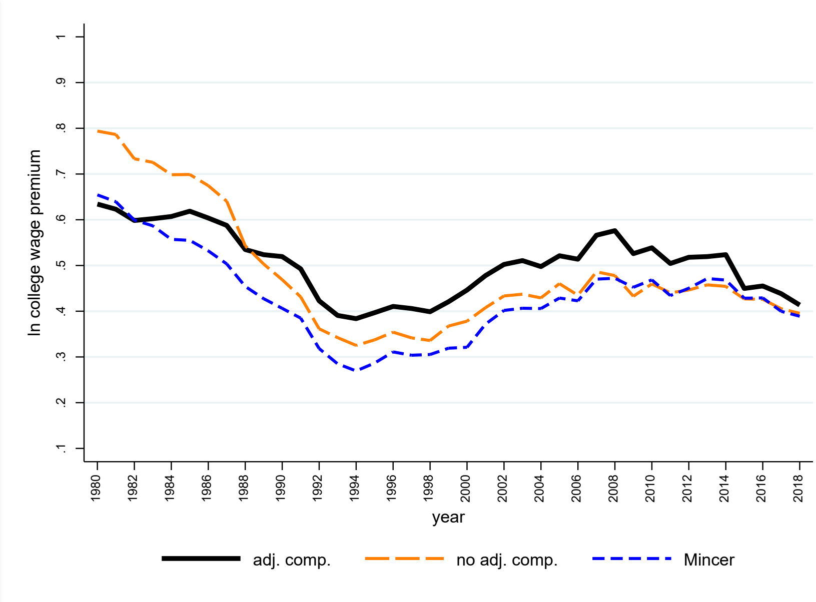
The remainder of this paper is organized as follows. Section 2 documents the evolution of the college wage premium in Korea over 1980–2018; Section 3 describes a model and its empirical specification to assess determinants for the college wage premium; Section 4 describes the data; Section 5 discusses the estimation results; Section 6 performs counterfactual analyses; and Section 7 concludes this work.

2. Changes in college wage premium

We overview the evolution of the college wage premium and relative labor supply between college and non-college-educated workers in Korea since 1980. To do so, we combine two micro datasets: the Basic Survey on Wage Structure (BSWS) from 1980 to 2007 and the Survey on Work Status by Employment Type (WSET) from 2008 to 2018. See Section 4 for details of the datasets.

Figure 2 presents the college wage premium in the Korean labor market over 1980–2018 for full-time, male workers aged between 20 and 59. It shows three different measures of skill premium: the composition-adjusted premium, composition-unadjusted premium, and premium derived by the Mincer wage equation. To construct the composition-adjusted college wage premium, we classify workers into 32 education–age groups (8 education groups X 4 age groups) and use the average share of each cell over the whole sample period. The composition-adjusted college wage premium is our measure for the empirical analyses.

Figure 2 College Wage Premium: Aggregate



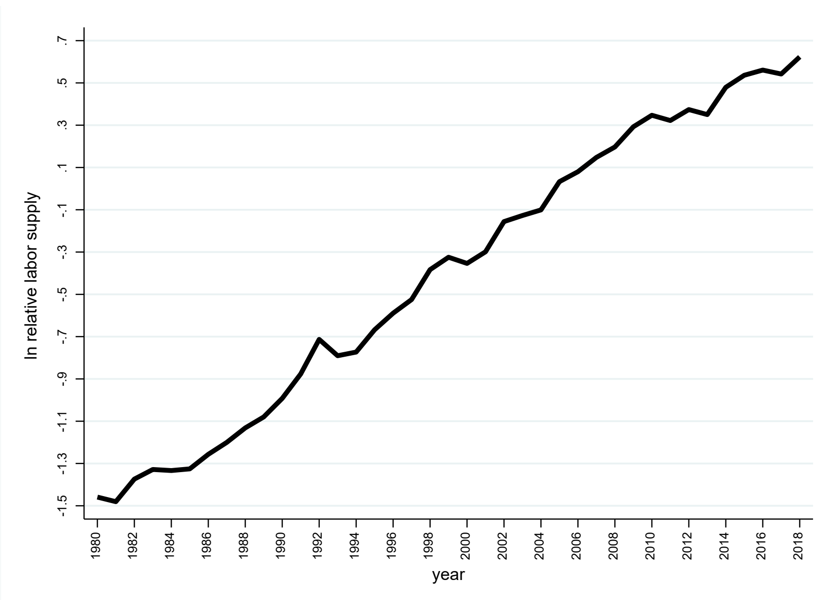
Notes: There are three measures for college wage premium. To construct the composition-adjusted college wage premium, we classify workers into 32 education–age groups (8 education groups X 4 age groups) and use the average share of each cell over the whole sample period. Using the Mincer wage equation, where we control for individuals' age and industry, we can also estimate the relative wage differential between college-educated and non-college-educated workers, that is, the college wage premium.

Source: Authors' calculation using data sourced from the BSWS and WSET.

As shown in Figure 2, the college wage premium in Korea shows a dynamic pattern. It had declined steadily from 1980 to the early 1990s, but it reversed course in 1994. In 1994, the college wage premium was at 0.384 points, which implies that earnings of the average college graduate in 1993 exceeded those of the average non-college groups by 46.8 percent (i.e., $\exp(0.384) - 1 \simeq 0.468$). It then increased gradually until 2008, from which time it reversed course once more, showing a gradual decline in the 2010s. The skill premium in 2018 was at 0.414 points. This pattern can also be observed in the other two measures of the college wage premium. There have been two reversals of the trend in skill premium in Korea since 1980 unlike those in advanced economies such as the United States where the skill premia have increased steadily.

As mentioned in previous studies, relative labor supply is one of the major contributing factors to the dynamic pattern of the college wage premium in Korea. Figure 3 demonstrates the evolution of the relative supply of college-educated versus non-college-educated workers in the Korean labor market since 1980. We refer to college-educated workers as high-skilled workers and non-college-educated workers as low-skilled workers.[2] We measure college/non-college-educated workers' relative supply in average monthly worked hours. Despite the dynamic pattern of the college wage premium in Figure 2, the relative supply between college-educated and non-college-educated workers showed an increasing trend since 1980 that was attributable to demographic changes and expansion of college education.

Figure 3 Relative Labor Supply: Aggregate



Notes: College/non-college-educated workers' relative supply is measured in average monthly worked hours.

[2] Please note that we also use education and skills interchangeably.

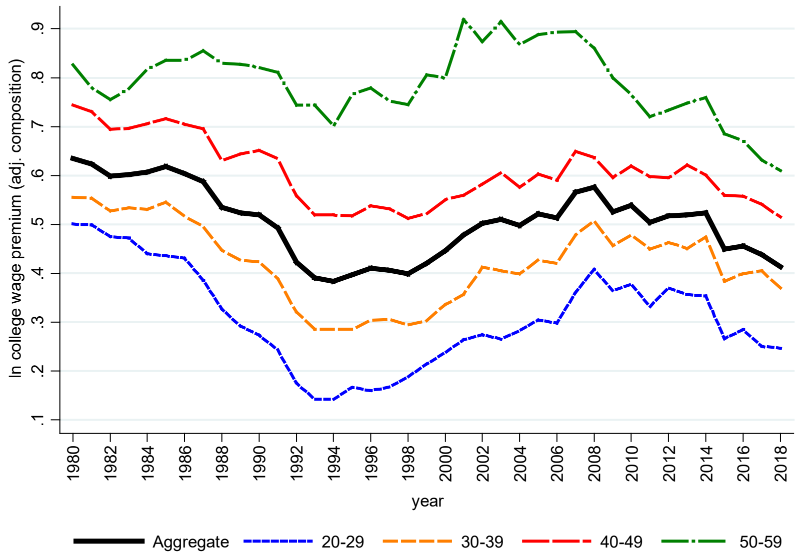
College-educated workers includes those who attained college degrees and higher, whereas non-college-educated workers refer to high-school graduates and those who attained less than high school.

Source: Authors' calculation using data sourced from the BSWS and WSET.

As also pointed out by previous studies, the increasing college/non-college relative labor supply cannot fully explain the dynamic pattern of the skill premium, particularly since 1992. SBTC and trade openness are possible candidates for causing the increase in demand for skilled labor, thereby contributing to the upward trend in skill premium in the early 1990s and 2000s.

Given Korea's rapid expansion of educational opportunities, we explore changes in the college wage premium and its relative supply by age group. Figure 4 depicts the college wage premium by four age groups, over the sample period 1980–2018. Most of the college wage premia showed similar trends by age group, except for the group of older workers aged between 50–59 years old. The premia for the more experienced group are much higher than those for young workers. This is different from advanced economies such as the US, UK, and Canada as observed in Card and Lemieux (2001). In these countries, the college/high-school wage gap for younger men has increased, while the gap for older men has remained stable or declined.

Figure 4 College Wage Premium by Age Group

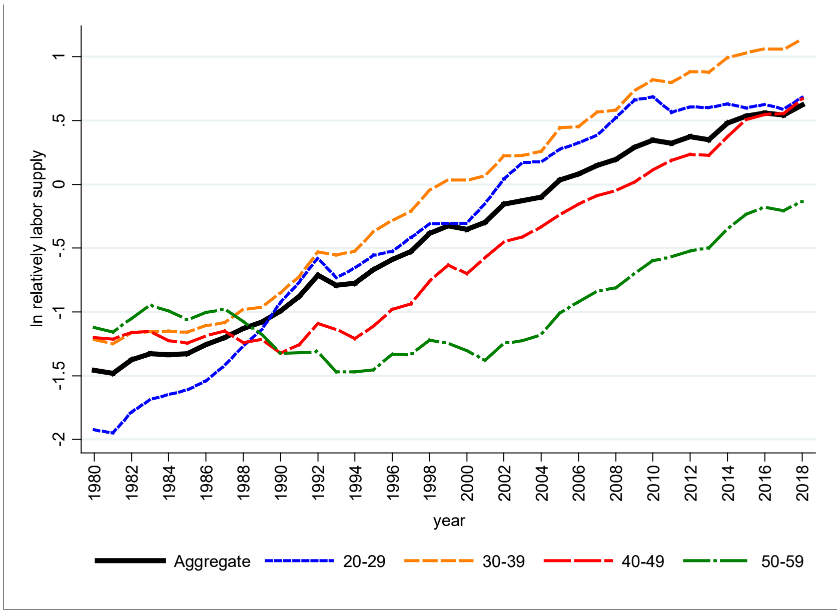


Notes: This figure presents composition-adjusted college wage premium by four age groups. See note to Figure 2 for the construction of the composition-adjusted college wage premium.

Source: Authors' calculation using data sourced from the BSWS and WSET.

Figure 5 demonstrates the relative supply of college to non-college-educated workers by four age groups over the sample period. Different trends across the age groups are easily observable. There has been a rapid increase in the relative supply of young workers, such as those aged less than 49 years, reflecting an increase in the college entrance rate in Korea. This contrasts to minor changes in the group of workers aged 50–59 in the 1990s and 2000s, which may reflect a longer time lag after college graduation.

Figure 5 Relative Supply by Age Group



Note: See note to Figure 3 for the construction of relative supply of college to non-college-educated workers.

Source: Authors' calculation using data sourced from the BSWS and WSET.

3. Model and Empirical Specification

We estimate the relative wage equation under the CES production function based on Katz and Murphy's (1992) and Card and Lemieux's (2001) equations. Before introducing an empirical specification for determination of the college wage premium, we first consider a model for the CES production function.

3.1. Model

We consider the CES production function with two different skills, high and low (Acemoglu & Autor, 2011), as follows:

$$Y_t = \left[A_t^H {H_t}^{\frac{\sigma_E - 1}{\sigma_E}} + A_t^L {L_t}^{\frac{\sigma_E - 1}{\sigma_E}} \right]^{\frac{\sigma_E}{\sigma_E - 1}} \quad (1)$$

where σ_E is the elasticity of substitution between high- and low-skilled workers. A_t^H and A_t^L indicate high-skilled and low-skilled labor augmenting technological progress, respectively. As mentioned earlier, we identify high-skilled workers with college graduates and above, and low-skilled workers with high-school graduates and below. Under this specification, high- and low-skilled workers are imperfect substitutes and different age groups are perfect substitutes, where η in Specification (4) is equal to one.

Given the assumption that the labor market is perfectly competitive, and the wages are equal to the marginal products, the wages for high-skilled and low-skilled workers are set as follows:

$$\mathrm{w_t^H} = \frac{\partial \mathrm{Y_t}}{\partial \mathrm{H_t}} = \mathrm{A_t^H}^{\frac{\sigma_E-1}{\sigma_E}} \mathrm{H_t}^{-\frac{1}{\sigma_E}} \left[\mathrm{A_t^H H_t}^{\frac{\sigma_E-1}{\sigma_E}} + \mathrm{A_t^L L_t}^{\frac{\sigma_E-1}{\sigma_E}}\right]^{\frac{1}{\sigma_E-1}}$$

$$\mathrm{w_t^L} = \frac{\partial \mathrm{Y_t}}{\partial \mathrm{L_t}} = \mathrm{A_t^L}^{\frac{\sigma_E-1}{\sigma_E}} \mathrm{L_t}^{-\frac{1}{\sigma_E}} \left[\mathrm{A_t^H H_t}^{\frac{\sigma_E-1}{\sigma_E}} + \mathrm{A_t^L L_t}^{\frac{\sigma_E-1}{\sigma_E}}\right]^{\frac{1}{\sigma_E-1}}$$

(2)

We can then define the relative wages of high- versus low-skilled workers, that is, skill premium (or college wage premium), as follows:

$$\ln \omega_t \equiv \ln \frac{w_t^H}{w_t^L} = \frac{\sigma_E - 1}{\sigma_E} \ln\left(\frac{A_t^H}{A_t^L}\right) - \frac{1}{\sigma} \ln\left(\frac{H_t}{L_t}\right) \qquad (3)$$

Specification (3) demonstrates that the skill premium is determined by the supply factor, that is, the relative size of H_t/L_t, while the relative technology term is A_H/A_L. When the relative supply of high-skilled workers to low-skilled workers, that is, the relative size of H_t/L_t increases, the skill premium falls. The relative technology term, A_H/A_L, which implies high-skilled-labor augmenting technology progress relative to low-skilled-labor augmenting technology progress, changes the skill premium depending on the size of elasticity of substitution (σ_E). If the elasticity of substitution exceeds one, the increase in the relative technology term (that is, greater high-skilled labor augmenting technology progress) indicates SBTC (Acemoglu, 2009), so that an increase in $\ln(\frac{A_t^H}{A_t^L})$ raises relative demand for skilled labor and thus, skill premium. We also consider international trade as a major factor shifting the relative demand for high-skilled workers. We will discuss the demand factor in detail in Section 3.2.

We also consider an extended version following Card and Lemieux (2001), which adopts a more flexible assumption on high-skilled and low-skilled workers by assuming that age groups are imperfect substitutes as follows:

$$\mathrm{H_t} = \left(\sum_j \alpha_j H_{jt}^{\eta}\right)^{1/\eta} \; and \; \mathrm{L_t} = \left(\sum_j \beta_j L_{jt}^{\eta}\right)^{1/\eta} \tag{4}$$

where $\sigma_A = 1 - 1/\eta$ is the elasticity of substitution across different age groups j. α_j and β_j are efficiency parameters that do not vary across cohorts or over time. H_{jt} and L_{jt} are age-group specific supply of high-skilled and low-skilled workers in period t, respectively.

We can then rewrite the CES production function where the aggregate $\mathrm{H_t}$ and $\mathrm{L_t}$ are themselves CES sub-aggregates of high-skilled and low-skilled workers by potential age groups (Card & Lemieux, 2001), and we can also derive the relative wages between high-skilled and low-skilled workers in the same age group as in Specification (5):

$$\ln \omega_{jt} \equiv \ln\left(\frac{w_{jt}^H}{w_{jt}^L}\right) = \ln\left(\frac{A_t^H}{A_t^L}\right) + \ln\left(\frac{\alpha_j}{\beta_j}\right) - \frac{1}{\sigma_E}\ln\left(\frac{H_t}{L_t}\right) - \frac{1}{\sigma_A}\left[\ln\left(\frac{H_{jt}}{L_{jt}}\right) - \ln\left(\frac{H_t}{L_t}\right)\right] + e_{jt} \tag{5}$$

Hence, given this specification, college wage premium, that is, our measure for skill premium, is determined by the aggregate relative supply and age-group specific relative supply and the relative technological change. We also add international trade as a demand shift factor.

3.2. Empirical specification for college wage premium

For the analysis, we will estimate the following empirical specification for the college wage premium based on Katz and Murphy (1992):

$$\ln \omega_t = \beta_0 + \beta_1 \cdot \boldsymbol{T}(t) + \beta_2 \cdot trade_t + \gamma \cdot \ln\left(\frac{H_t}{L_t}\right) + \epsilon_t \qquad (6)$$

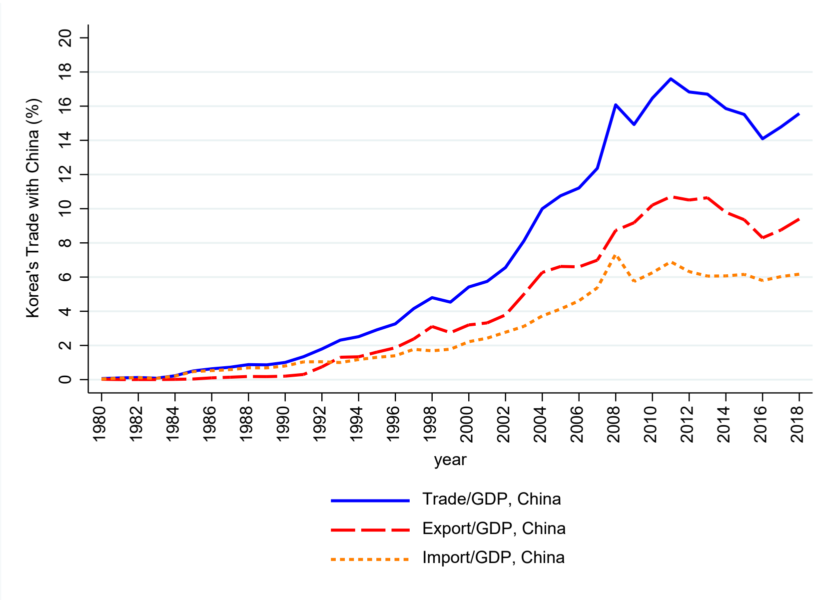
This is the key equation to explore the college wage premium under the framework of supply and demand factors. As in the literature, including Katz and Murphy (1992) and Acemoglu and Autor (2011), we identify the relative supply between high-skilled and low-skilled workers, $\ln\left(\frac{\mathrm{H_t}}{\mathrm{L_t}}\right)$, as a supply factor and its parameter, γ, capture the supply effect. $-\frac{1}{\gamma}$ provides an estimate of σ_E, the elasticity of substitution between high- and low-skilled workers.

As for the demand factors, we consider technological change and trade. First, we consider that $\mathrm{A_H}/\mathrm{A_L}$ captures technological progress, and this term cannot be observed. We assume a cubic time trend $(\boldsymbol{T}(t))$, instead of linear trend or quadratic time trend, which turns out to explain better the two distinctive revisions in the trends in skill premium. The estimate for β_1 reflects a pattern of technological change over time,

Based on traditional international trade theories such as the Heckscher-Ohlin and Stolpher-Samuelson models, we consider trade a possible demand factor that drives changes in skill premium. According to these theories, international trade and outsourcing would drive advanced economies to specialize in skill-intensive goods and developing economies to produce unskilled-intensive goods, given their respective comparative advantages (Krugman, 2008). This would lead to an increase in the relative demand for high-skilled labor in advanced economies, thereby widening the skill premium. Based on these theories, we examine the role of trade in explaining the college wage premium since the 1980s in Korea.

We are particularly interested in the extent to which the expansion of Korea's trade with China can account for the college wage premium, so we include this trade (measured by the share of trade volume in GDP, %) as a regressor in our equation for skill premium as in Specification (6).[3] β_2 measures the extent to which the expansion of Korea's trade with China can account for the dynamics in the skill premium over the sample period. As shown in Figure 6, which illustrates the pattern of Korea's trade engagement with China, the trade share in GDP increased from a mere 0.1% in 1980 to 18% in 2011 and then decreased slightly to 14–15%. The changing pattern since the mid-1990s seems very similar to that of the skill premium in Figure 2. This may imply that the expansion of trade with China since the mid-1990s increased its relative demand for skill-intensive goods, and thereby, the relative demand for high-skilled labor.

Figure 6 Korea's Trade with China over its GDP (%)



[3] Previous studies on developing countries such as Mexico attempted to examine the role of international trade in skill premium based on Heckscher-Ohlin theory by adopting the implementation of NAFTA (North American Free Trade Agreement) as an exogenous event. Likewise, we decide to adopt Korea's trade with China, instead of its total trade, as an exogenous event for international trade.

Notes: We collect Korea's nominal trade volume with China over the period 1980–2008, from the Korea Trade Statistics compiled by the Korea International Trade Association and Bank of Korea.

We now assume that different age groups with the same educational attainment are imperfect substitutes as in Specification (7):

$$\ln \omega_{j,t} = \beta_0 + \beta_1 \cdot T(t) + \beta_2 \cdot Trade_t + \gamma_1 \ln\left(\frac{H_t}{L_t}\right) + \gamma_2 \left[\ln\left(\frac{H_{j,t}}{L_{j,t}}\right) - \ln\left(\frac{H_t}{L_t}\right)\right] + \delta_j + \eta_{j,t} \quad (7)$$

where j indicates age group, and δ_j is a set of age-group main effects. We include a cubic time trend. $-1/\gamma_1$ provides an estimate of σ_E, the aggregate elasticity of substitution, and $-1/\gamma_2$ provides an estimate of σ_j, the partial elasticity of substitution between different age groups within the same education group. The estimate for cubic time trend β_1 reflects a pattern of technological change over time, while β_2 measures the role of expansion of Korea's trade with China in explaining the college wage premium.

4. Data

To assess the role of supply and demand factors in explaining college wage premium, the study uses three datasets for 1980–2018: the BSWS, WSET, and Korea Trade Statistics. We combine two micro datasets, the BSWS from 1980 to 2007 and the WSET from 2008 and 2018, to obtain a longer wage and labor supply series. To construct a measure for trade, we use data from Korea Trade Statistics released by the Korea International Trade Association (KITA).

We use the BSWS and WSET datasets to construct college wage premium and (relative) labor supply data in the Korean labor market over 1980–2018. The advantage of these datasets is that the wage rates are directly collected from establishments and are therefore less prone to measurement error than self-reported household survey data (Han & Lee, 2020). For the analysis, our sample contains only male survey respondents aged between 20 and 59.[4] We restrict our sample to full-time workers who worked more than 140 hours per month.

We construct a measure for labor supply using men aged 20–59 who worked more than 140 hours per month. We sort the data into four education groups (less than high school, high-school graduates, college graduates, and greater than college) and eight age groups (20–24, 25–29, …, 55–59 years old). The labor supply is calculated by multiplying individuals' weight in the survey by monthly hours worked. We then obtain the labor supply for college/non-college groups by dividing the labor supply of the college group (college graduates, and greater than college) by that of the non-college group (high-school graduates and less than high school).

To construct a college wage premium, we first calculate average hourly wages for the individuals in our sample, by dividing monthly wages by hours worked during the month of the individuals. We then construct the composition-adjusted college wage premium. We first classify workers into 32 education–age groups (4 education groups X 8 age groups), and we use the average share of each cell over the whole sample period.

Additionally, we use the Korea Trade Statistics compiled by the KITA to construct a measure for Korea's trade over 1980–2018. We collect data on Korea's nominal trade volume with China in US dollars. We then construct the measure by dividing Korea's nominal trade volume with China by its nominal GDP. We also calculate annual shares of Korea's export to China and of its import from over its GDP. Table 1 provides descriptive statistics of the variables in

[4] We restrict our sample to men because female labor supply decisions are sensitive to institutional and other external factors such as childbearing. An M-shaped lifecycle employment rate pattern for females is well-known in Korea.

the sample.

Table 1 Descriptive Statistics of Our Sample, 1980–2018

	Mean	Standard Deviation	Min	Max
Log College Wage Premium, $\ln(w_H/w_L)$	0.505	0.074	0.383	0.634
By age group				
20–24	0.210	0.105	0.073	0.484
25–29	0.263	0.098	0.095	0.431
30–34	0.364	0.085	0.213	0.506
35–39	0.487	0.083	0.358	0.634
40–44	0.573	0.072	0.464	0.711
45–49	0.655	0.064	0.557	0.793
50–54	0.744	0.062	0.593	0.841
55–59	0.871	0.114	0.636	1.129
Log Relative Labor Supply, Ln(H/L)	-0.404	0.685	-1.480	0.623
Share of Trade over GDP, China (%)	7.114	6.422	0.063	17.60
Share of Export over GDP, China (%)	4.198	3.982	0.006	10.71
Share of Import over GDP, China (%)	2.918	2.464	0.039	7.349
No. of Observations	39			

Source: To construct log college wage premium and log relative labor supply, data sourced from the BSWS and WSET are used. Three trade variables are constructed using the data from Korea Trade Statistics compiled by the KITA and Bank of Korea.

5. Estimation results

We begin by estimating the model based on Katz and Murphy (1992), that is, Equation (6). Equation (6) assesses the effects of supply and demand factors—log relative supply, our measure for Korea's trade with China, and a cubic time trend—on the composition-adjusted college wage premium, over the sample period.

Table 2 Katz-Murphy Estimation Results: Aggregate Relative Supply

	(1)	(2)	(3)	(4)	(5)
Aggregate relative supply	-0.043***	-0.284**	-0.287***	-0.245**	-0.279**
	(0.014)	(0.137)	(0.032)	(0.114)	(0.103)
Time		-0.039***		-0.025**	-0.030***
		(0.010)		(0.010)	(0.010)
$Time^2/100$		0.029***		0.016***	0.020***
		(0.004)		(0.005)	(0.005)
$Time^3/1000$		-0.004***		-0.002***	-0.003***
		(0.001)		(0.001)	(0.001)
Trade/GDP, China			0.027***	0.016***	
			(0.004)	(0.005)	
Export/GDP, China					-0.009
					(0.010)
Import/GDP, China					0.050***
					(0.015)
Constant	0.487***	0.324	0.194***	0.341*	0.297*
	(0.011)	(0.217)	(0.043)	(0.182)	(0.166)
R-squared	0.159	0.675	0.675	0.750	0.786
Observations	39	39	39	39	39

Notes: The dependent variable is the log of skill premium. Robust Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Column (1) presents the estimation results of the Katz and Murphy (1992) model without considering possible demand factors. It reports that the relative supply of college graduates is highly significant and has a negative effect. The estimate, -0.04, implies that an increase in the relative supply of skills by 1% reduces the college wage premium by 0.04%. In this specification, the elasticity of substitution between college and non-college-educated workers turns out to be very high, at approximately 23. The estimation result reports a low R-squared value of 0.159.

Column (2) adds a cubic time trend to Column (1) and reports the estimates for the relative supply of college/non-college-educated workers and a cubic time trend. The estimate for the aggregate relative supply (-0.284) remains negative and statistically significant, but larger than that in Column (1). An increase in the relative supply of skills reduces the college wage premium with an elasticity of substitution of 3.5, which is much closer to the estimates in the literature, such as 1.63 in Autor et al. (2006) and Acemoglu and Autor (2011). Although the estimated elasticity of substitution in Korea is twice as high as US estimates, it is much lower than Taiwan's 7.41 (Keng et al., 2017). The estimates for a cubic time trend suggest the dynamic pattern that the college wage premium shows in Figure 2. This implies an accelerating SBTC, especially in the 1990s and 2000s. These are consistent with our prediction.

Column (3) reports the estimates for the relative college/non-college workers and Korea's trade to China/GDP. With the addition of the term Trade/GDP, the estimate for the aggregate relative supply increases, but remains negative and statistically significant. The elasticity of substitution is now estimated at approximately 3.5. The coefficient for Trade/GDP is approximately 0.027, which is positive and statistically significant. This suggests that Korea's trade expansion with China contributed to increasing the skill premium over the sample period. The coefficient indicates that a 1% increase in Trade/GDP would lead to a 0.027% increase in the college wage premium. This result is consistent with previous studies, implying that the expansion of Korea's trade with China created an upward pressure on the college wage premium.

Column (4) estimates the full regression model of the log college wage premium on its log relative supply—our measure for Korea's trade expansion with China—and a cubic time trend, over 1980–2018, that is, Specification (6). The estimation results are consistent with our prediction. The estimate for the aggregate relative supply, -0.244, remains negative and statistically significant. This implies that the increase in relative supply between college and non-college-educated workers over the sample period serves as a downward force on the college wage premium with an elasticity of substitution of 4.1. The estimates for cubic time trends confirm the dynamic pattern of the college wage premium. The coefficient for Trade/GDP, 0.016, is positive and statistically significant and is consistent with our prediction. The regression also reports an R-squared of 0.749.

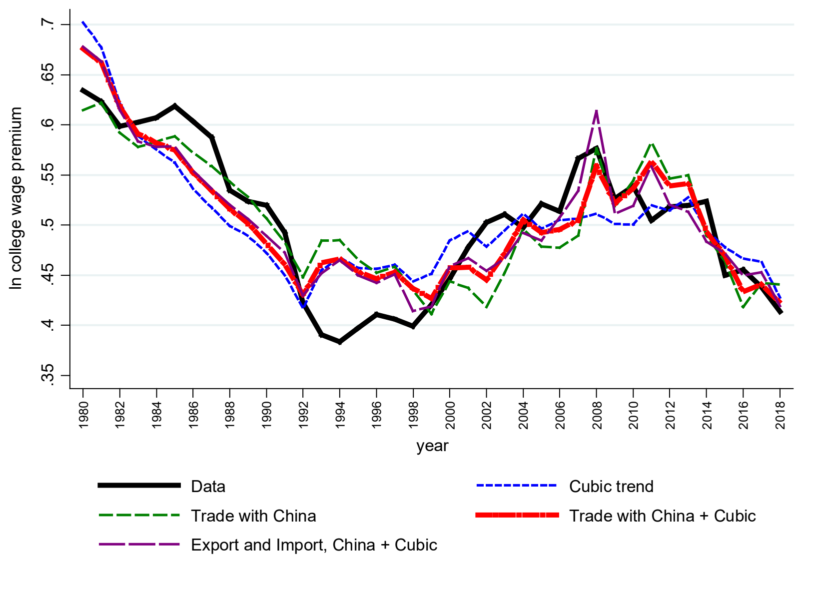
Column (5) additionally estimates Specification (6) with different measures for Korea's trade with China. Instead of Trade/GDP in Column (4), we use Korea's export to China, Export/GDP, China, and its import from China, Import/GDP, China to assess whether Korea's export to and imports from China have a different impact on wage premium. The results in Column (5) report that the coefficient for Import/GDP is positive and statistically significant, while for Export/GDP, it is negative and statistically insignificant. Given the trade structure between Korea and China, importing low- and medium-skill intensity goods from China, these results are consistent with the Heckscher-Ohlin model.[5]

Figure 7 assesses whether the models perform well in capturing the broad features of the

[5] According to the UN Comtrade Database, Korea has imported low- and medium-skill intensity goods from China, whereas it has exported high-skill intensity goods to China. For instance, in the 1990s and early 2000s, Korea's top imports from China were electrical machinery and equipment and parts thereof (HS-85), Mineral fuels, mineral oils and products of their distillation (HS-27), Iron and steel (HS-72) and Cereals (HS-10), and Apparel and clothing accessories (HS 62). Meanwhile, Korea's top exported goods to China were Electrical machinery and equipment and parts thereof (HS-85), Nuclear reactors, boilers, machinery and mechanical appliances (HS-84), Plastics and articles thereof (HS-39), and Organic chemicals (HS-29).

evolving college wage premium between 1980 and 2018, across Columns (2)–(5) in Table 2.[6] It shows that the specification of Column (4) including relative supply, cubic trend, and trade factors performs better in capturing the broad features of the evolving college wage premium, such as its significant decline in 1980–1992 and its sharp reversal in the 2010s.

Figure 7 Katz-Murphy Model for the College Wage Premium



Note: The figure compares actual data for skill premium with its fitted values drawn from Columns (2)–(5) of Table 2.

Source: Authors' calculation using data sourced from the BSWS and WSET.

Then, regarding robustness check, we estimate Specification (7) where we assume imperfect substitutability among age groups. Table 3 reports the estimates for elasticity of substitution

[6]The predicted values for the college wage premium for the period between 1992 and 1996 are slightly higher than the actual data. This discrepancy may come from a substantial increase in female college graduates starting from the early 1990s (Koh, 2018; Han & Lee, 2020). As noted in Footnote 4, due to specific features of female workers and their wages in Korea, this study does not include female workers in its sample.

across different age groups (own minus aggregate supply), the estimates of substitution between college and non-college-educated labor (aggregate relative supply), a cubic time trend, and Korea's trade with China. We find considerably high substitutability across age groups; the estimated elasticities are 16–17. The high elasticity supports the perfect substitution among age groups. Hence, ignoring the assumption of the imperfect substitution among age groups does not matter for the substitutability between college and non-college-educated labor. Moreover, the estimates for aggregate relative supply are similar to the estimates provided in Table 2.

To be specific, Column (4) of Table 3 reports regression pooled across four age groups (those with 20–29, 30–39, 40–49, and 50–59 years old), allowing for group-specific intercepts. The estimates indicate a substantial negative effect of both own-group and aggregate supply on the evolution of the college wage premium by age group. The estimate of the aggregate elasticity of substitution is 3.86, which is similar to the aggregate models in Table 2, whereas the estimate of the elasticities of substitution across age groups is approximately 15.8. These estimates are very high compared to the US, UK, and Canada estimated by Card and Lemieux (2001), which were 4.95, 4.29, and 6.02, respectively. Compared to these numbers, the Korean estimate is 3 to 8 times larger. However, high elasticity of substitution across age groups is observed in the Taiwan case (Keng et al., 2017). The coefficients for Trade/GDP and cubic time trend are consistent with our expectation.

Table 3 Card-Lemieux Regression Models for College Wage Premium

	(1)	(2)	(3)	(4)	(5)
Own minus aggregate supply	-0.023	-0.059**	-0.061**	-0.063**	-0.063**
	(0.019)	(0.019)	(0.017)	(0.018)	(0.018)
Aggregate relative supply	-0.041**	-0.293**	-0.283**	-0.259**	-0.292**
	(0.009)	(0.099)	(0.024)	(0.095)	(0.092)
Dummy, 30–39	0.119**	0.129**	0.129**	0.130**	0.130**
	(0.021)	(0.014)	(0.014)	(0.013)	(0.012)
Dummy, 40–49	0.292**	0.285**	0.285**	0.284**	0.284**
	(0.019)	(0.012)	(0.012)	(0.011)	(0.010)
Dummy, 50–59	0.468**	0.446**	0.445**	0.444**	0.444**
	(0.021)	(0.019)	(0.014)	(0.017)	(0.017)
Time		-0.394**		-0.271**	-0.315**
		(0.061)		(0.062)	(0.063)
$Time^2/100$		0.301**		0.178**	0.223**
		(0.032)		(0.043)	(0.045)
$Time^3/1000$		-0.046**		-0.028**	-0.035**
		(0.005)		(0.007)	(0.007)
Trade/GDP, China			0.027**	0.015**	
			(0.003)	(0.004)	
Export/GDP, China					-0.010
					(0.008)
Import/GDP, China					0.048**
					(0.010)
Constant	0.293**	0.119	0.007	0.134	0.091
	(0.015)	(0.153)	(0.032)	(0.146)	(0.142)
R-squared	0.854	0.920	0.916	0.928	0.933
Observations no.	156	156	156	156	156

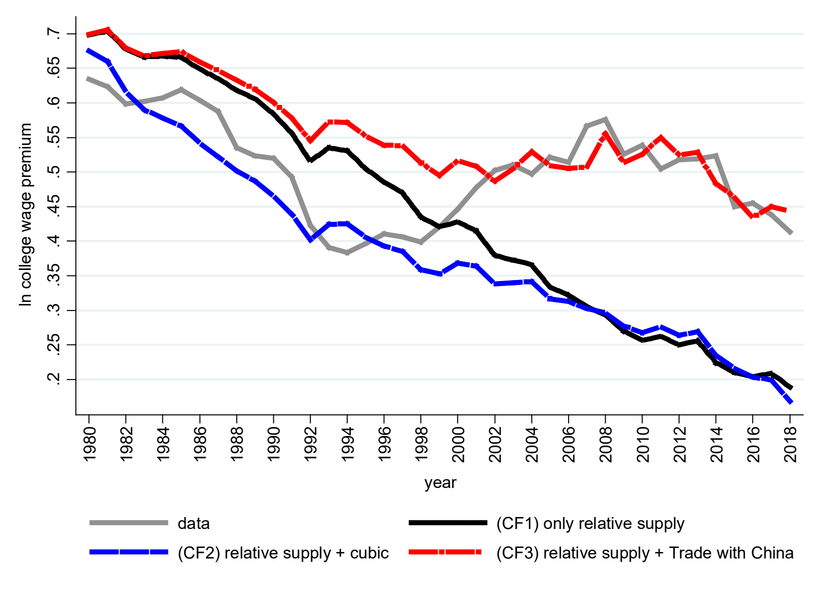
Notes: The dependent variable is the log of skill premium. Robust Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6. Counterfactual analyses

Using the estimates of Column (4) of Table 2, we perform several counterfactual analyses by making four different assumptions to identify the extent to which the role of relative supply of college-educated workers, Korea's trade with China, and elasticity of substitution between college and non-college-educated workers can explain the movements in the college wage premium in Korea since 1980. We demonstrate how college wage premia are constructed based on the counterfactuals.

In the first counterfactual set, we use the estimates of Column (4) of Table 2 and demonstrate the college wage premium time series with the assumption that there is only a relative supply of college to non-college-educated workers as an explanatory variable in the model (CF1). We then include cubic trend and trade with China as additional explanatory variables to CF1. Figure 8 demonstrates the critical role of expansion of Korea's trade with China in explaining the movements in the college wage premium, especially in the 2000s. As CF1 in Figure 8 shows, relative supply of college to non-college-educated workers alone cannot drive the increasing pattern of the college wage premium.

Figure 8. Counterfactuals (1): College Wage Premium only with Relative Supply

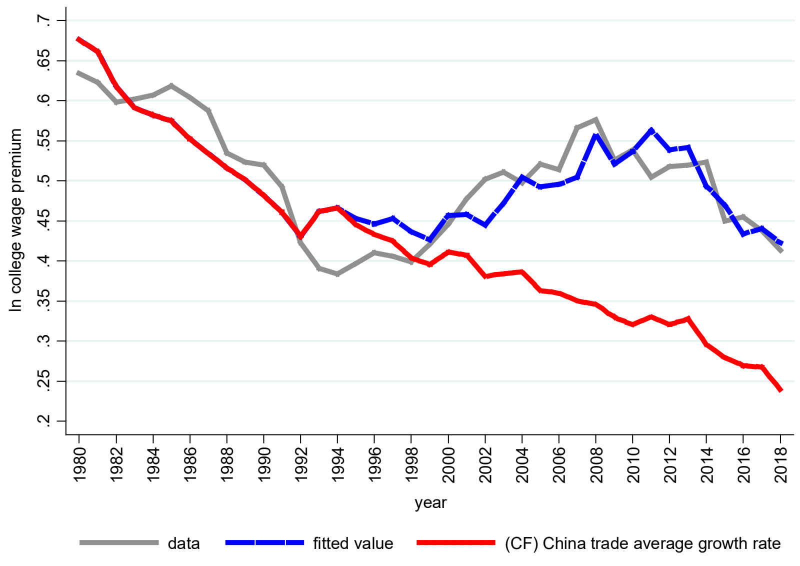


Note: CF refers to counterfactual. To perform counterfactual models from CF1 to CF3, the estimates of Column (4) of Table 2 are used. CF1 demonstrates the college wage premium time series with the assumption that there is only a relative supply of college to non-college-educated workers as an explanatory variable in the model. CF2 and CF3 adds cubic trend and trade with China as additional explanatory variables to CF1.

Source: Authors' calculation using data sourced from the BSWS and WSET.

In the second counterfactual set, we assume that Korea expands its trade with China with a growth rate that is equal to its total trade growth since 1995 (Figure 9). According to the data, average annual growth rate in total trade is approximately 7% over 1980–2018. Using the estimates of Column (4) of Table 2 and the counterfactual trade/GDP with China, we construct the college wage premium as in Figure 9. Under the counterfactual, the college wage premium fell rapidly in the 2000s, due to the increasing relative supply. Figure 9 also highlights the important role that the considerable expansion of Korea's trade with China plays in driving the dramatic increase in the skill premium.

Figure 9. Counterfactual (2): College Wage Premium with Counterfactual Trade with China



Notes: CF refers to counterfactual. The second counterfactual set assumes that Korea expand its trade with Chin with an average annual growth rate of 7% since 1995. Using the estimates of Column (4) of Table 2, the fitter value for college wage premium, which is depicted as a blue dotted line, is constructed. The counterfactual college wage premium (CF), which is depicted as a red dotted line, is constructed by using the estimates of Column (4) of Table 2 and the counterfactual trade/GDP with China.

Source: Authors' calculation using data sourced from the BSWS and WSET.

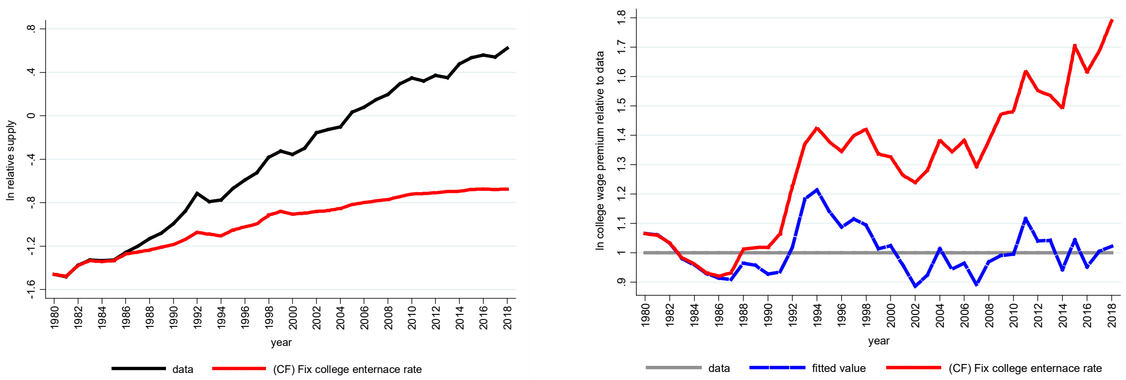
In the third counterfactual set, the college entrance rate is fixed to the cohort, 1960−1964.[7] We can then construct the counterfactual relative supply as in Figure10(a). Assuming that the college entrance rate is fixed to the cohort, 1960−1964, the counterfactual relative supply has always been lower than the actual relative supply, and the gap between the two has widened.

Using the estimates of Column (4) of Table 2 and the counterfactual relative supply in Figure 10(a), we construct the counterfactual college wage premium as in Figure 10(b). Under the counterfactual (CF) where the college entrance was fixed, the college wage premium would have remained higher than the benchmark.

[7] In Korea, due to the university entrance quota, there is no significant difference between the number of college entrants and that of college graduates.

Figure 10. Counterfactual (3): College Wage Premium with Counterfactual Relative Supply

(a) Relative Supply **(b) College Wage Premium**

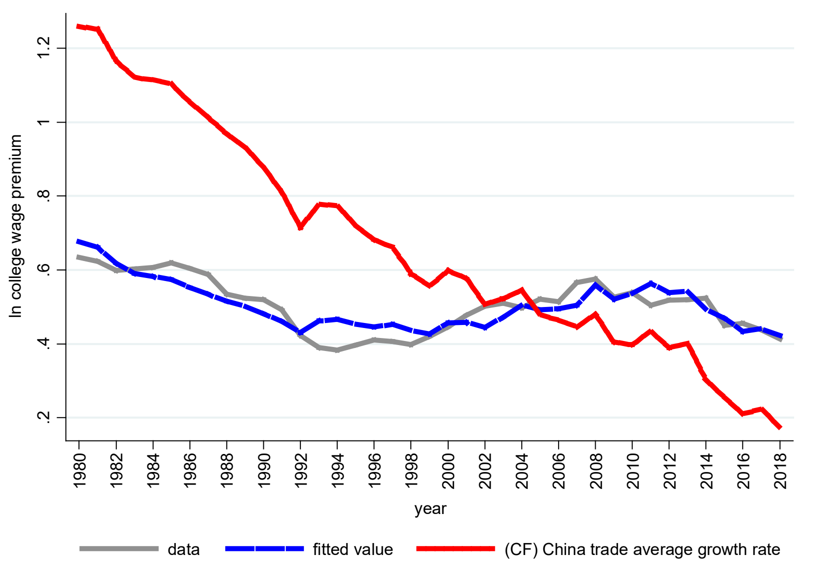


Notes: CF refers to counterfactual. The third counterfactual set assumes fixed college entrance rate to the cohort, 1960–1964. Using the estimates of Column (4) of Table 2, the fitter value for college wage premium, which is depicted as a blue dotted line, is constructed. The counterfactual college wage premium (CF), which is depicted as a red dotted line, is constructed by using the estimates of Column (4) of Table 2 and the counterfactual relative supply of college-educated to non-college educated workers.

Source: Authors' calculation using data sourced from the BSWS and WSET.

The last counterfactual analysis is conducted with a lower elasticity of substitution between college and non-college-educated workers. According to our estimate in Column (4) of Table 2, the elasticity of substitution is approximately 4.08, which is much higher than that in advanced economies. According to Acemoglu and Autor (2011), the substitution elasticity in the US labor market is approximately 1.55. To examine whether the size of elasticity matters for the college wage premium dynamics, we replace the elasticity of substitutability in Korea with the elasticity in the US, which is 1.55. Figure 11 depicts several measures for the college wage premium including the counterfactual college wage premium with the assumption of substitution elasticity of approximately 1.55. It shows that with a lower substitution elasticity, the Korean labor market witnessed a higher level of college wage premium (CF) in the 1980s and early 1990s, and experienced a sharp decline over the sample period. Interestingly, we can observe the decreasing pattern of college wage premium since the mid-1990s when Korea's trade with China began burgeoning. This is because of a lower substitutability. Given the lower substitutability between college and non-college-educated workers, the effect of relative supply on skill premium dominates that of Korea's trade with China, which drives the decreasing skill premium in the mid-1990s and 2000s. This implies that in addition to expansion of Korea's trade with China, the substitutability between college and non-college-educated workers is also critical in explaining the movements in skill premium.

Figure 11. Counterfactual (4): College Wage Premium with a Lower Degree of Elasticity of Substitution



Notes: CF refers to counterfactual. The fourth counterfactual set assumes that the elasticity of substitution is approximately 1.55, which is equivalent to that of the US and much smaller than our estimate, 4.08. Using the estimates of Column (4) of Table 2, the fitter value for college wage premium, which is depicted as a blue dotted line, is constructed. The counterfactual college wage premium (CF), which is depicted as a red dotted line, is constructed by adopting the estimates of Column (4) of Table 2 and the assumption of substitution elasticity of approximately 1.55

Source: Authors' calculation using data sourced from the BSWS and WSET.

7. Conclusion

In this study, we explored the college wage premium in Korea over the period 1980–2018 and assessed the role of demand and supply factors such as trade with China and relative supply of college/non-college-educated workers. The college wage premium in Korea has displayed three distinctive phases: decreasing trend until the mid-1990s, sharp increases between the mid-1990s and late 2000s, and a mild decline after the 2000s.

To scrutinize the sources of college wage premium dynamics, we estimated the CES production function developed by Katz and Murphy (1992), which is widely used in the skill premium literature. Besides the relative supply of college/non-college-educated workers, we incorporated the cubic time trend and Korea's trade with China to incorporate the demand factors for high-skilled workers. The empirical analysis presented considerably high elasticity of substitution between college and non-college-educated workers in Korea compared to advanced countries; the elasticity in Korea is 3.5, whereas the elasticity in the US is 1.63. Moreover, the elasticity of substitution among age groups within the (same) skill groups is also extremely high, indicating almost perfect substitutability across age groups. Our empirical results also suggest that expanding trade with China has accounted for the rising skill premium since the mid-1990s.

To inspect the contribution of supply and demand factors on college wage premium dynamics, we performed counterfactual analyses. The expansion of trade with China yields the college wage premium rise during the mid-1990s and early 2000s. At the same time, the high substitutability between college and non-college workers as well as these supply and demand factors is a crucial ingredient to account for the college wage premium dynamics in Korea.

This study has made several contributions to the skill premium literature by assessing the role of demand and supply factors in college wage premium for the Korean economy while explicitly considering the elasticity of substitution across skill groups. Nonetheless, this study has limitations in that it does not incorporate more detailed data such as wages by gender, employment status, and industry in the analyses and role of institutional factors that may cause wage differentials. We will leave this issue for future studies.

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