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Does the College Tuition Regulation in Korea Improve Social Welfare?*

Dhongkyu Yoon** · Kyung-woo Lee***

Since 2009, Korea's college tuition regulation has reduced tuition by more than 20% in real terms. This paper examines the welfare effects of tuition regulation using a model of education choices depending on ability and wealth. College is costly but improves productivity and job prospects, whereas high school is free but has no benefits. If firms can observe workers' abilities, tuition regulation can benefit most people because it makes college more affordable. However, if only workers can observe their ability, the welfare gain can be counteracted by the reduction in wages due to changes in education choices. In the simulated model, a 20% tuition reduction hurts approximately 90% of the population if only workers know their abilities. In contrast, it benefits more than 80% of the population if firms can also observe workers' abilities. These findings suggest that tuition regulation may require complementary policies to facilitate the evaluation of workers' abilities.

JEL Classification: H52, I22, I23, I28
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I. Introduction

Since 2009, the government has strictly controlled college tuition in Korea. Despite the rising costs of providing higher education, the government has effectively prohibited universities and colleges from raising tuition through various efforts. Consequently, real college tuition has declined by more than 20% because of inflation since 2009, and tuition regulation has made tertiary education significantly more affordable.

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** First Author, Graduate Student, Department of Economics, University of Washington, Savery Hall, Box 353330, Seattle WA 98195-3330, United States, Email: dhongkyu@uw.edu
*** Corresponding Author, Associate Professor, School of Economics, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea, Email: kwlee76@yonsei.ac.kr

Tuition regulation is intended mainly to lower the financial barriers to higher education. Through this policy, people can obtain better education and become more productive because a college education is important for human capital accumulation. Tuition regulation can be particularly beneficial for low-income families because they can now afford a college education. It may also improve intergenerational mobility because children of low-income parents can now go to college and earn a high income. The policy may also reduce income inequality because poor people can benefit from the significant skills premium of a college education.

Despite such benefits, tuition regulation does not necessarily improve social welfare. As more people attend college, the probability of landing decent jobs after graduation can decrease because of the intensified competition. Hence, college graduates may see their expected utility decline. Wages may also fall because of the change in the composition of workers' productivity. For example, if lower tuition induces less productive people to go to college, the average productivity of the college-educated (CE) labor force may decline. Considering this effect, firms may offer lower wages for the group. Thus, some CE workers can be worse off despite the decrease in tuition.

With this background, we investigate the welfare effects of strict regulation on college tuition. To this end, we build an education-choice model that generalizes the Spence (1973) model in that agents are heterogeneous in both ability and wealth. They can choose between high school and college. The former is free, whereas the latter involves a monetary cost (e.g., tuition, fees, living expenses, etc.) and study efforts, which are decreasing in ability. However, only a college education can improve the agents' labor productivity and make them eligible for high-skill jobs that require advanced knowledge. We further assume that such job opportunities are fewer than the number of college graduates. Hence, after the competition for high-skill jobs, some college graduates, along with all high school graduates, end up in low-skill jobs that do not require knowledge from a college education.[1]

This model is relatively parsimonious but still able to capture essential channels through which tuition regulation affects social welfare. When tuition drops because of government regulation, poor people can go to college and improve their productivity. However, this behavior intensifies the competition for high-skill jobs and changes the ability composition and wages of CE and high-school-educated (HSE) workers. This result may lead to another wave of education changes as people reevaluate their expected utility from college and high school. In this way, tuition regulation affects educational attainment, wages, social welfare, and income distribution through multiple channels in this model.

[1] Throughout this paper, "high school graduates" refer to those who only go to high school but not to college for simplicity of terminology.

With the model, we conduct theoretical and simulation analyses with realistic parameter values drawn from various data sources in Korea. As expected, we found that tuition regulation will likely attract more people to college. However, the welfare effects of the policy depend crucially on whether workers' ability is public or private information. If workers' ability is publicly observed, tuition cuts through government regulation tend to improve social welfare. Our simulation reveals that the policy can almost be a Pareto improvement because it makes more than 80% of the population better off and hurts only 1% or less of the population. By contrast, if workers' ability is only privately observed, tuition regulation may not improve social welfare as much as it would otherwise. This is confirmed in the simulation, as approximately 90% of the population takes utility loss from tuition cuts.

To interpret the findings, let us suppose that the ability is publicly observed. In this case, firms can set workers' wages proportional to their productivity. Therefore, even if low tuition induces some people to go to college, wages remain unchanged for other workers unless their education levels or job types change. Consequently, most people can benefit from tuition regulation because they can save on the cost of a college education without any income loss. The utility may decrease only for some CE workers who lose high-skill jobs because of the intensified competition. However, their population share tends to be insignificant, given the relative scarcity of high-skill jobs. Hence, nearly everyone can benefit from tuition regulation when workers' ability is publicly observed.

Even if the ability is privately observed, tuition regulation still reduces the cost of college and may generate welfare gain. However, the policy also affects social welfare through the wage channel. When workers' ability is unavailable, firms set wages based solely on education and job types of workers, and the average productivity of relevant education-job groups determines such wages. For example, all HSE workers receive the same wage, and all CE workers earn either the wage for low-skill or high-skill jobs. In this environment, a change in education choices between high school and college affects all education-job groups' average productivity and wages. Through this process, tuition regulation can change the equilibrium wages, producing additional welfare effects.

Because of the wage channel, the effects of tuition regulation are theoretically ambiguous when the ability is private information. If the policy reduces college tuition, some people will change their highest education achievement from high school to college as the latter becomes inexpensive. However, these initial responses change the ability composition and wages of all education-job groups. Then, people reevaluate the expected utility from each education level, and some of them switch their education choices. This movement causes wages to change again, and the process will continue until a new equilibrium arises. Because of these general-equilibrium effects, whether more people choose college or if wages are higher is theoretically unclear in the new equilibrium.[2]

Given the ambiguity in the theoretical results, we conduct a model simulation with rigorous parameterization to quantify the effects of tuition regulation when the ability is private information. In the simulated model, if college tuition decreases by 20%, the CE population increases by approximately 10% to 20%. However, those who change their education to college tend to be less able than existing CE workers but more able than existing HSE workers. Therefore, their movements reduce wages for all education-job groups. Moreover, the wages for CE workers decline, regardless of job type, by more than the saved amount of tuition. Therefore, the decrease in wages hurts most people who maintain their education choices and job types. Consequently, approximately 90% of the population experience utility loss in the simulated model despite the reduction in college tuition if the ability is private information.

These results have an interesting policy implication for "blind hiring." It prevents governments, public enterprises, and major companies from discriminating against applicants based on irrelevant factors, such as gender, appearance, and family background. However, blind hiring also restricts employers from gathering information on applicants' educational backgrounds (university names, grade point average, etc.) in the hiring process. In this sense, the ability of workers tends to be private information. Then, based on our findings, blind hiring can reduce (exacerbate) the welfare gain (loss) from tuition regulation. To resolve this potential problem, the government may require additional policies to facilitate employers collecting information on workers' abilities.

This paper builds on the literature on education choices and wage determination following the seminal contribution of Spence (1973). However, following Hendel, Shapiro, Willen (2005), and Balart (2016), we also consider heterogeneity in wealth. With dual heterogeneity in ability and wealth, the former shows that the greater affordability of college education may increase income inequality. In contrast, the latter accounts for the increase in college premiums and the decline in low-skill wages. However, our paper is more general than those papers because workers' ability is binary in their models but is continuously distributed in this model.

Moreover, competition exists for high-income jobs among workers with a college education. Thus, a certain proportion may end up working in low-income jobs along with workers with only a high school education. With these features, we can characterize the education choices and job allocation more realistically than in the previous papers. In particular, the job heterogeneity in CE workers is the key to analyzing Korean labor markets in which many attend college, but only a few are employed in good jobs.

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[2] Despite the ambiguity, we can still describe a set of the qualitative changes in wages and the share of CE workers that can occur simultaneously. See Proposition 3 and Corollary 1 in Section 4 for details.

More broadly, this paper is also related to the previous papers on the impact of education on the economy. Galor and Zeira (1993) examined the role of wealth distribution in the macroeconomy through investment in human capital. Their approach is different because they analyze a dynamic macroeconomic model, whereas we consider a static one. The current paper is also associated with papers that study the effects of college tuition and the policies to reduce the economic burden of college education in Korea. For example, Choi, Chun, and Kim (2016) examined the effects of enhancing public education and education subsidy in a model that features heterogeneity in wealth and ability across households. However, they focused on the competition for prestigious universities, whereas we are interested in the competition for good jobs after a college education. Other papers evaluate the effects of tuition regulation in Korea on university finance (e.g., Kim, 2018). The current paper contributes as it provides a comprehensive theoretical and quantitative analysis regarding the effects of tuition regulation in Korea on labor market outcomes and social welfare.

The remainder of the paper is organized as follows. Section 2 introduces the model, and Section 3 characterizes the model's equilibrium. Then, Section 4 provides a theoretical analysis of the effects of the changes in the cost of college education on various equilibrium outcomes. Section 5 simulates the model to quantify the effects of tuition regulation in Korea. Finally, Section 6 concludes.

II. Model

Consider an economy with a continuum of agents with population 1. Agents are heterogeneous in ability $\theta > 0$ and wealth $a \geq 0$. The joint distribution of θ and a is represented by the density and distribution functions $g(a)$, $G(a)$, $f(\theta \mid a)$, and $F(\theta \mid a)$. Information on the joint distribution is publicly available to all agents. In this model, a represents the economic resources that can finance a college education and consumption. Therefore, parental income and wealth are key determinants of a. Parental income and wealth correlate positively with children's abilities because of the intergenerational transmission of genetic traits and parents' educational investment in children. Consequently, the average ability tends to be high for wealthy agents. Therefore, we assume that the average ability is non-decreasing in wealth.[3]

Assumption 1 $\mathbb{E}(\theta \mid a) \equiv \int_0^\infty \theta f(\theta \mid a) d\theta$ *is non-decreasing in* a.

In this economy, agents make education-related choices. Agents first observe

[3] Note that Assumption 1 also includes the case where θ and a are independent.

their types (θ, a) and choose between high school and college education levels. High school is free but has no positive effect on ability. By contrast, college is costly but improves agents' ability from θ to $\kappa\theta$ with $\kappa \geq 1$.[4] For the costs, college education entails monetary $p > 0$ and utility costs $h(\theta) > 0$. The former captures the financial costs of college, such as tuition, expenses, and opportunity costs, whereas the latter represents the disutility of studying in college. We assume $h' < 0 < h''$ because college education is tougher for less able agents with low θ, and the marginal disutility decreases with θ.

As for the ability to pay tuition, we assume that taking out loans for a college education is impossible. As a result, only agents with $a \geq p$ can afford to go to college whereas those with $a < p$ can only go to high school regardless of ability θ. This borrowing constraint reflects the fact that some low-income people cannot afford to go to college despite various types of financial aid. For example, according to the Youth Socio-Economic Reality Survey in 2016–2021, 5.8–22.6% of HSE respondents gave up college education, despite wanting it because of economic hardship.[5] Similarly, a survey on education opportunities in 2020 reveals that 25% of respondents aged 30–39 did not have sufficient education opportunities and 52.2% of them attributed it to their inability to finance the cost of education.[6] This result can be another evidence of financial barriers to college because almost everyone in that generation received at least high school education. Considering these survey results, the assumption $a \geq p$ for college education appears reasonable.

After completing education, agents have either low-skill or high-skill jobs. The latter requires advanced skills or knowledge at the college level, and thus, high-school graduates are qualified only for low-skill jobs with wage w^0.[7] Therefore, the consumption of a high-school graduate, denoted by c^0, is determined as

$$c^0 = w^0 + a.$$

By contrast, college graduates are qualified for both high-skill and low-skill jobs. If they have low-skill jobs, their productivity is simply their ability $\kappa\theta$. However, if they take high-skill jobs, their productivity increases to $b\kappa\theta$ with $b > 1$. Constant b represents the productivity gain when a college graduate is matched with a high-skill job. To understand why $b > 1$, consider a person with a college degree in

[4] κ is constant in the main model. However, we also consider an alternative model with κ affected by college tuition in the simulation analysis in Section 5 because tuition revenue can be used to improve or maintain the quality of education of college.

[5] This annual survey has been conducted from 2016 for young people aged 15–39 by the National Youth Policy Institute (NYPI) of Korea.

[6] The result is drawn from the Survey of Sufficiency of Education Opportunity and Reasons for Insufficiency, which is part of the Social Survey by Statistics Korea and is available on KOSIS.

[7] We will discuss how wages are determined later.

mechanical engineering as an example. If she becomes a cashier in a supermarket, her intrinsic ability ($\kappa\theta$ in this model) is more relevant for her productivity than her advanced skills and knowledge. By contrast, if she becomes a researcher in an automobile manufacturing company, her knowledge on mechanical engineering can improve her productivity significantly. In this way, college education is more beneficial to workers with high-skill jobs.

To describe the budget constraints for college graduates, let w_H^1 and w_L^1 denote the wages for high-skill and low-skill jobs. Then, we can write their budget constraints as follows:

$$c_j^1 = w_j^1 + a - p \,, \quad j \in \{H, L\} \,,$$

where c_j^1 stands for consumption for a college graduate with a job type $j \in \{H, L\}$.

All agents have an identical utility function as follows:

$$V = u(c) - h(\theta)e \,,$$

where e is an indicator variable for college education (1 for college and 0 for high school). $u(c)$ measures utility from consumption c with standard assumptions $u' > 0 > u''$.

In this model, we adopt the utilitarian social welfare function. Let $V(\theta, a)$ denote the indirect utility for an agent with (θ, a). Then, we can write the social welfare function as follows.

$$SW = \int_0^\infty \int_0^\infty V(\theta, a) f(\theta \mid a) g(a) d\theta da \quad . \tag{1}$$

Throughout this paper, we evaluate social welfare using this function.

Two types of firms exists on the production side. Low-skill firms with measure 1 offer low-skill jobs to workers regardless of their education. Meanwhile, high-skill firms with measure $\Phi < 1$ offer high-skill jobs exclusively to CE workers. Because there are more jobs than people $(1 + \Phi > 1)$, all agents will be employed but some firms may not hire workers. In this case, they will exit from the labor market.[8] For example, if all high-skill firms can successfully hire CE workers, fraction Φ of low-skill firms fail to hire workers and exit from the labor market. Alternatively, if part of high-skill firms fail to hire CE workers (because of a shortage of CE workers), they exit from the labor market together with some low-skill firms. We assume that Φ is fixed because jobs that require advanced skills and technology

[8] We make this assumption to avoid the issue of unemployment.

and provide high income may not increase as quickly as the number of CE workers.

Firms set wages based on workers' education levels and ability. Firms know that an agent with ability θ can produce the following: (i) θ units of output in a low-skill job after completing high school, (ii) $\kappa\theta$ units of output in a low-skill job after graduating college, and (iii) $b\kappa\theta$ units of output in a high-skill job after graduating college. Then, through firms' competition for hiring workers, wages are equal to workers' ability or expected ability. More specifically, if firms can observe workers' ability, their wages are exactly equal to their production in the job.[9]

$$w^0 = \theta, \ \ w_L^1 = \kappa\theta, \ \ w_H^1 = b\kappa\theta .$$

By contrast, if firms cannot observe workers' ability, all workers in an education-job group receive the same wage, which equals the average production of the group.[10]

$$w^0 = \mathbb{E}(\theta \,|\, \text{high school}), \ \ w_L^1 = \kappa\mathbb{E}(\theta \,|\, \text{college, low skill}),$$
$$w_H^1 = b\kappa\mathbb{E}(\theta \,|\, \text{college, high skill})$$

Finally, we assume that wages cannot be conditioned on wealth because doing so could be illegal or wealth is only privately observed.

We discuss how jobs are allocated to college graduates. If their population share does not exceed Φ, all of them have high-skill jobs. By contrast, if their population share is larger than Φ, only some have high-skill jobs while the remaining have low-skill jobs. Then, to whom are high-skill jobs allocated? The answer depends crucially on whether ability θ is observed publicly or privately. When θ is publicly observable, high-skill jobs are given to the college graduates with high θ. By contrast, when θ is only privately observed, high-skill jobs have to be assigned randomly regardless of ability, as long as agents have college degrees. As such, the observability of θ is the key to characterizing the equilibrium in this economy. Therefore, in what follows, we analyze two types of models depending on the observability of agents' ability.

III. Equilibrium of the Model

3.1. Public-information Model

In the public-information model (hereafter PubM), ability θ is observed

[9] This case is relevant if θ is public information or if wages are determined after production.

[10] This case is relevant if θ is private information and the wage is determined before production.

publicly. This model is relevant when firms can determine the ability of individuals easily. For example, high-income jobs are sometimes allocated based on test results. If such tests are not costly and effective in assessing the ability of agents, θ can be interpreted as public information.

3.1.1. Education Choices and Job Allocation

In the PubM, high-skill jobs are offered to the most productive workers. More specifically, firms set an ability threshold θ^* and offer high-skill jobs to CE workers with $\theta \geq \theta^*$.[11] Firms offer low-skill jobs to all other workers.

Given θ^*, each agent chooses the education level that yields the highest utility, considering the job prospect. First, agents with $a < p$ should go to high school regardless of θ, because they cannot afford college. Consequently, they will have low-skill jobs and receive wage $w^0 = \theta$, which yields the following utility:

$$V^0(\theta, a) \equiv u(c^0) = u(w^0 + a) = u(\theta + a).$$

By contrast, agents with $a \geq p$ can afford college. Among them, agents with $\theta \geq \theta^*$ know that if they go to college, they can have high-skill jobs with wage $w_H^1 = b\kappa\theta$ and utility:

$$V_H^1(\theta, a) \equiv u(c_H^1) - h(\theta) = u(w_H^1 + a - p) - h(\theta) = u(b\kappa\theta + a - p) - h(\theta).$$

However, if they only complete high school, their utility will be V^0 given earlier. Consequently, agents with $\theta \geq \theta^*$ and $a \geq p$ go to college if and only if

$$\Gamma_H(\theta, a) \equiv V_H^1 - V^0 = u(b\kappa\theta + a - p) - u(\theta + a) - h(\theta) \geq 0.$$

The other group, that is, the agents with $\theta < \theta^*$ and $a \geq p$, can also pay for college education but will have low-skill jobs with wage $w_L^1 = \kappa\theta$ after graduating college. In that case, their utility will be

$$V_L^1(\theta, a) \equiv u(c_L^1) - h(\theta) = u(w_L^1 + a - p) - h(\theta) = u(\kappa\theta + a - p) - h(\theta).$$

The utility associated with high school is V^0; thus, agents with $\theta < \theta^*$ and $a \geq p$, go to college if and only if

$$\Gamma_L(\theta, a) \equiv V_L^1 - V^0 = u(\kappa\theta + a - p) - u(\theta + a) - h(\theta) \geq 0.$$

[11] Some workers with $\theta \geq \theta^*$ may decline the offer for high-skill jobs, as will be discussed later.

With Γ_H and Γ_L, we can characterize the education choices of agents with $a \geq p$. We make the following assumption to ensure that agents with high θ choose college, whereas those with low θ choose high school.

Assumption 2 *For any a and θ,*

$$\frac{\partial \Gamma_H}{\partial \theta} = b\kappa u'(b\kappa\theta + a - p) - u'(\theta + a) - h'(\theta) > 0 .$$
$$\frac{\partial \Gamma_L}{\partial \theta} = \kappa u'(\kappa\theta + a - p) - u'(\theta + a) - h'(\theta) > 0 .$$

To analyze the education choices, we define θ_a^j for job type j as ability θ that satisfies[12]

$$\Gamma_j(\theta_a^j, a) = 0 \quad \text{for} \quad j \in \{H, L\} . \tag{2}$$

Then, by Assumption 2, $\Gamma_j < 0$ if $\theta < \theta_a^j$ and $\Gamma_j \geq 0$ if $\theta \geq \theta_a^j$. In other words, agents with $\theta \geq \theta^*$ and $a \geq p$ choose college if $\theta \geq \theta_a^H$ or high school if $\theta < \theta_a^H$. Similarly, agents with $\theta < \theta^*$ and $a \geq p$ choose college if $\theta \geq \theta_a^L$ or high school if $\theta < \theta_a^L$. Thus, we can summarize the education choices and job allocation as follows:

1. College and high-skill jobs if $a \geq p$ and $\theta \geq \max(\theta^*, \theta_a^H)$
2. College and low-skill jobs if $a \geq p$ and $\theta_a^L \leq \theta < \theta^*$
3. High school and low-skill jobs in all other cases.

Thus far, the discussion suggests that θ_a^H and θ_a^L, and their relationship with θ^* is the key to characterizing the education choices. Hence, we present properties of the ability thresholds in the following lemma.

Lemma 1 *Under Assumption 2, θ_a^H and θ_a^L have the following properties for any $a \geq p$.*

1. $\theta_a^H < \theta_a^L$
2. $(b\kappa - 1)\theta_a^H > p$ *and* $(\kappa - 1)\theta_a^L > p$
3. $\partial\theta_a^j / da > 0$ *for* $j = H, L$

Proof. See Appendix A.1. ■

[12] If $\Gamma_j \leq 0$ for any θ, we set $\theta_a^j = \infty$ and if $\Gamma_j \geq 0$ for any θ, we set $\theta_a^j = 0$.

The first result of Lemma 1, $\theta_a^H < \theta_a^L$, suggests that agents are more willing to go to college when high-skill jobs are expected because high-skill jobs are more profitable than low-skill jobs. To interpret the second results, notice that $(b\kappa-1)\theta - p$ and $(\kappa-1)\theta - p$ represent the net income gain from college education for agents with ability θ. It is positive for $\theta = \theta_a^j$ based on the second results of Lemma 1; therefore, the net income gain should be positive for all CE workers because $\theta \geq \theta_a^j$ for them. Finally, the third result of Lemma 1 suggests college education is less attractive to wealthy agents with large a because the productivity gain from college, $(b\kappa-1)\theta$ or $(\kappa-1)\theta$, is less important for the utility when a is large.

To discuss how θ^* is determined, we define LS^H as the population share of agents with $a \geq p$ and $\theta \geq \theta_a^H$:

$$LS^H \equiv \int_p^\infty [1 - F(\theta_a^H \mid a)] g(a) da \,. \tag{3}$$

Intuitively, LS^H represents the number of agents willing to go to college if high-skill jobs are guaranteed. In this sense, we can interpret LS^H as labor supply for high-skill jobs.

Suppose that $LS^H \leq \Phi$. In this case, high-skill jobs have no competition because the number of available high-skill jobs is greater than the number of agents willing to take such jobs. Thus, any θ below the minimum of θ_a^H can be θ^*. All agents with $a \geq p$ and $\theta \geq \theta_a^H$ also go to college and have high-skill jobs, whereas everyone else chooses high school and have low-skill jobs. However, this case appears unrealistic considering the fierce competition for well-paid jobs in Korea and other countries.

As a more realistic case, consider $LS^H > \Phi$. In this case, high-skill jobs are relatively scarce and some agents with relatively low θ may not have high-skill jobs even if they are willing. Given the competition for high-skill jobs, firms should set θ^* above the minimum of θ_a^H to select the most productive workers, and θ^* should satisfy

$$\int_p^\infty [1 - F(\max(\theta^*, \theta_a^H) \mid a)] g(a) da = \Phi \,. \tag{4}$$

The agents included in the integration in the left-hand side (LHS) satisfy three conditions: (i) wealthy enough to afford college $(a \geq p)$; (ii) able enough to qualify for high-skill jobs $(\theta \geq \theta^*)$; and (iii) willing to take such jobs $(\theta \geq \theta_a^H)$. Therefore, they will go to college and have high-skill jobs. In this sense, (4) can be interpreted as a market-clearing condition for high-skill jobs in the economy.

3.1.2. Characterization of the Equilibrium

With the discussion so far, we describe the equilibrium in the PubM as follows.

Definition 1 *In the PubM, ability thresholds* $\{\theta_a^H, \theta_a^L\}$ *for each* $a \geq p$, *and* θ^* *constitute an equilibrium if the following conditions are satisfied.*

1. θ_a^H *and* θ_a^L *satisfy (2).*
2. *The education choices and job types are determined as follows.*
   (a) *If* $a \geq p$ *and* $\theta \geq \max(\theta^*, \theta_a^H)$, *college and high-skill jobs with wage* $w_H^1(\theta) = b\kappa\theta$.
   (b) *If* $a \geq p$ *and* $\theta_a^L \leq \theta < \theta^*$, *college and low-skill jobs with wage* $w_L^1(\theta) = \kappa\theta$.
   (c) *In all other cases, high school and low-skill jobs with wage* $w^0(\theta) = \theta$.
3. *If* $LS^H > \Phi$, θ^* *satisfies (4), but if* $LS^H \leq \Phi$, $\theta^* \leq \min_{a \geq p} \theta_a^H$.

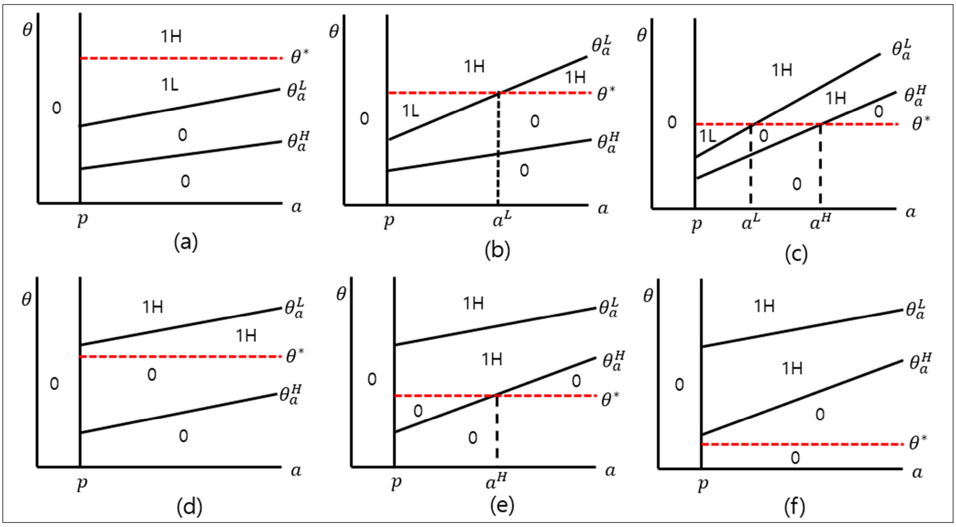
Figure 1 presents various types of equilibria in the PubM. In the figure, education-job indices 0, 1L, and 1H denote high school, college with low-skill jobs, and college with high-skill jobs, respectively. The education choices and job types are assigned based on Definition 1. Notice that in all panels, $\theta_a^H < \theta_a^L$, and both θ_a^H and θ_a^L are increasing in a for $a \geq p$, as shown in Lemma 1.

The lower panels of Figure 1 shows the cases in which all CE workers have high-skill jobs. This type of equilibria can arise if college is costly (high p or $h(\theta)$) and unprofitable (small b or κ) or if high-skill jobs are not scarce (large Φ). This is particularly true in panel (f) of Figure 1 in which $LS^H < \Phi$ because $\theta^* < \theta_a^H$. Hence, vacancies can be found in high-skill jobs because CE workers are fewer than high-skill jobs. Similarly, in panels (d) and (e) of Figure 1, all workers with college education have high-skill jobs. Unlike in panel (f), a competition exists for high-skill jobs in panels (d) and (e) as some agents with $\theta \geq \theta_a^H$ may not qualify for high-skill jobs, and they give up going to college.

In the upper panels of Figure 1, the competition for high-skill jobs is more intense as agents with $\theta \geq \theta_a^H$ can be selected only if $\theta \geq \theta^*$. However, some agents with $\theta < \theta^*$ still go to college even though they do not expect to have high-skill jobs after graduating from college. Consequently, we can observe all three types of workers: (i) high school, (ii) college with low-skill jobs, and (iii) college with high-skill jobs. This type of equilibria can emerge if college is relatively cheap (low p or $h(\theta)$) and profitable (large b or κ) or if high-skill jobs are scarce (small Φ).

For the remainder of this paper, we will focus on the type of equilibria illustrated in the upper panels of Figure 1 because of its greater relevance to Korea and other advanced economies. In Korea, most young people go to college, but only a small portion end up with high-income jobs. Hence, this situation is better represented by

[Figure 1] Equilibrium types in the PubM



Note: θ_a^H and θ_a^L are the lower bounds of ability for going to college, conditional on high-skill and low-skill jobs, respectively. θ^* is the minimum ability to qualify for high-skill jobs. Indices 0, 1H, and 1L refer to high school, college with high-skill jobs, and college with low-skill jobs, respectively. Agents with $a \geq p$ and $\theta \geq \max(\theta_a^H, \theta^*)$ choose college and have high-skill jobs, whereas agents with $a \geq p$ and $\theta_a^L \leq \theta < \theta^*$ choose college and have low-skill jobs. All other agents choose high school. See Section 3 for detail.

the upper panels of Figure 1 because all three types of workers exist. To restrict our attention to such cases, we make the following assumption.

Assumption 3 *In the PubM,* $\theta_a^L < \theta^*$ *for* $a = p$.

Figure 1 clearly shows that if Assumption 3 holds, some (a, θ) always satisfy $a \geq p$ and $\theta_a^L \leq \theta < \theta^*$, that is, the conditions for going to college and having low-skill jobs. In this way, Assumption 3 ensures that CE workers have both high-skill and low-skill jobs.

Finally, we define ϕ as the population share of agents with a college education. Using the criteria for education choices in Definition 1, we can obtain ϕ in the PubM as follows:

$$\phi = \Phi + \int_p^{a^L} [F(\theta^* \mid a) - F(\theta_a^L \mid a)] g(a) da \,, \tag{5}$$

where a^L is the wealth level for which $\theta^* = \theta_a^L$.[13] Then, $\theta^* > \theta_a^L$ for $a < a^L$

[13] $a^L = \infty$ if $\theta^* > \theta_a^L$ for all a, as in panel (a) in Figure 1.

and $\theta^* < \theta_a^L$ for $a > a^L$ because $\theta_a^L < \theta^*$ for $a = p$ by Assumption 3 and θ_a^L is increasing in a by Lemma 1. Thus, the second term on the right-hand side (RHS) can capture the share of the CE workers with low-skill jobs, whereas the first term Φ is the share of the CE workers with high-skill jobs.

3.2. Private-information Model

In the private-information model (hereafter PrvM), ability θ is privately observed.[14] This model is relevant when evaluating agents' ability is difficult or costly. We assume wages are determined before workers produce output to make private information relevant. Otherwise, ability θ would be public information because firms could set wages based on the actual productivity of workers.

With θ being private information, firms cannot set workers' wages based on their productivity. Therefore, firms offer jobs based on workers' education levels and determine wages based on the average ability of the workers. More specifically, all HSE workers have low-skill jobs and receive a common wage w^0, reflecting their average productivity. Similarly, all CE workers with low-skill jobs receive a common wage w_L^1, which is equal to their average productivity. Finally, all CE workers with high-skill jobs receive a common wage w_H^1 which is equal to their average productivity.

In this environment, we analyze the education choices of agents. First, agents with $a < p$ cannot afford college education regardless of ability. Hence, they should go to high school with the following utility

$$V^0 = u(c^0) = u(w^0 + a) .$$

By contrast, agents with $a \geq p$ can go to college if they want. Thus, they compare expected utilities between high school and college to determine their education levels. If agents with θ and $a \geq p$ only graduate high school, their utility will be V^0 in the previous equation. However, if they also go to college, they will have high-skill jobs with a probability π, or in low-skill jobs with a probability $1-\pi$. We assume that π is determined as

$$\pi = \min\left(\frac{\Phi}{\phi}, 1\right). \tag{6}$$

This equation suggests that all college graduates face the same probability for high-skill jobs because π is independent of θ and *a*. More importantly, π

[14] However, the distributions $f(\theta \mid a)$ and $g(a)$ are common knowledge.

depends on ϕ, the population share of the CE individuals.[15] According to (6), if available high-skill jobs are insufficient for college graduates $(\phi > \Phi)$, then $\pi = \Phi / \phi < 1$. In this case, some have low-skill jobs because of the competition among college graduates. However, if $\phi < \Phi$, all agents with a college education can have high-skill jobs. In this way, (6) reflects the job rationing when too many people go to college.

Regarding education choice, agents do not know which jobs they will have after college. Thus, agents choose education levels based on the expected utility. Given w_H^1, w_L^1, and π, we can formulate the expected utility of agents with (θ, a) from college education:

$$V^1 = \pi u(w_H^1 + a - p) + (1-\pi)u(w_L^1 + a - p) - h(\theta).$$

Then, agents with (θ, a) go to college if and only if $V^1 \geq V^0$, or equivalently,

$$\Delta(\theta, a) = \pi u(w_H^1 + a - p) + (1-\pi)u(w_L^1 + a - p) - u(w^0 + a) - h(\theta) \geq 0.$$

In this equation, Δ is the utility gap between college and high school. Notice that wages (w^0, w_L^1, w_H^1) are independent of θ. Therefore, Δ is increasing in θ because

$$\frac{\partial \Delta}{\partial \theta} = -h'(\theta) > 0.$$

Hence, to analyze the education choices of agents, we define θ_a as θ for which agents with (a, θ) are indifferent between college and high school:

$$\Delta(\theta_a, a) = 0. \tag{7}$$

As discussed, Δ is increasing in θ. Hence, agents with $a \geq p$ choose high school if $\theta < \theta_a$, whereas they choose college if $\theta \geq \theta_a$. As such, θ_a fully characterizes the education choices of agents. Moreover, using θ_a, we can determine ϕ in the PrvM as follows:

$$\phi = \int_p^\infty [1 - F(\theta_a \mid a)] g(a) da. \tag{8}$$

We can describe the equilibrium in the PrvM as follows.

[15] We will discuss how ϕ is determined later in this subsection.

Definition 2 *In the PrvM, the ability threshold for college education* θ_a *for each* $a \geq p$, *the population share of college graduates* ϕ, *and wages* (w^0, w_L^1, w_H^1) *constitute an equilibrium if the following conditions are satisfied.*

1. θ_a *satisfies (7) for all* $a \geq p$.
2. ϕ *satisfies (8).*
3. *If* $a < p$ *or if* $a \geq p$ *and* $\theta < \theta_a$, *agents only complete high school and have low-skill jobs with the following wage.*

$$w^0 = \frac{1}{1-\phi}\left[\int_0^p \int_0^\infty \theta f(\theta \mid a) g(a) d\theta da + \int_p^\infty \int_0^{\theta_a} \theta f(\theta \mid a) g(a) d\theta da\right] \tag{9}$$

4. *If* $a \geq p$ *and* $\theta \geq \theta_a$, *agents go to college. With probability* π *in (6), they have high-skill jobs with the following wage.*

$$w_H^1 = \frac{1}{\phi}\left[b\kappa \int_p^\infty \int_{\theta_a}^\infty \theta f(\theta \mid a) g(a) d\theta da\right] \tag{10}$$

With probability $1-\pi$, *they have low-skill jobs with the following wage.*

$$w_L^1 = \frac{1}{\phi}\left[\kappa \int_p^\infty \int_{\theta_a}^\infty \theta f(\theta \mid a) g(a) d\theta da\right] = \frac{1}{b} w_H^1 \tag{11}$$

Notice that w^0, w_L^1, and w_H^1 are equal to the average productivity of the relevant group of workers in (9)–(11). This is because firms make zero profit due to their competition to attract workers while not knowing the ability of workers.

Before we analyze the effects of tuition regulation, we present some properties of θ_a and wages.

Lemma 2 *Under Assumption 1, equilibrium wages satisfy the following equations in the PrvM.*

$$(1-\phi)w^0 + \phi \frac{w_L^1}{\kappa} = \mathbb{E}(\theta) \tag{12}$$

$$\frac{1}{\kappa} w_L^1 > w^0 \tag{13}$$

$$\pi w_H^1 + (1-\pi) w_L^1 - p > w^0 \tag{14}$$

Proof. See Appendix A.2. ■

In Lemma 2, w_L^1/κ and w^0 represent an average θ of CE and HSE workers, respectively. Then, (12) is straightforward because the weighted average of w^0 and w_L^1/κ should be the average θ for the whole population $\mathbb{E}(\theta)$. Moreover, based on such interpretation of w_L^1/κ and w^0, (13) shows that the average θ is higher for CE workers than HSE workers. This result is interesting because individually, some HSE workers, especially those with low wealth $(a<p)$, may have higher θ than some CE workers. Nevertheless, we obtain (13) because the agents with only a high school education are, on average, either less wealthy $(a<p)$ or less productive $(\theta<\theta_a)$ than those with a college education. Given Assumption 1 that agents with low wealth tend to be less able, HSE workers have lower θ on average than the CE workers. Finally, the third result of Lemma 2, (14), suggests that college education always gives agents an income gain on average because the LHS and RHS of (14) represent the average net income from college and high school, respectively. Therefore, even though some people may have higher utility by not attending college, all people will certainly obtain the expected income gain by choosing college instead of high school.

IV. Effects of Changes on College Costs

This section theoretically investigates the effects of a change in college tuition. We analyze how the equilibrium outcomes respond to an exogenous change in p in the two models discussed in the previous section.

4.1. Educational Attainment in the PubM

To examine the effect of p in the PubM, we differentiate the equilibrium conditions (2), (4), and (5). The following proposition summarizes the results.

Proposition 1 *Under Assumptions 2 and 3,* p *affects equilibrium outcomes in the PubM as follows:*

1. $d\theta_a^j/dp>0$ *for any* $a\geq p$ *and* $j=H,L$
2. $d\theta^*/dp<0$
3. $d\phi/dp<0$

Proof. See Appendix A.3. ■

To interpret the first result of Proposition 1, we consider a fall in p from p_h to p_l. This change makes college inexpensive and raises the utility of college education. Consequently, agents with relatively low θ can choose to go to college even though they could only go to high school under p_h. Hence, the thresholds for college education θ_a^H and θ_a^L decline for any $a \ge p_h$ when p decreases. Note that this effect increases the number of college graduates in the economy.

Moreover, the decrease in p makes college newly affordable to agents with $a \in [p_l, p_h)$, and some of them may go to college. Combining these effects, we can see that more people go to college when p falls, which is the third result of Proposition 1. Finally, such an increase in CE workers intensifies the competition for high-skill jobs because the number of those jobs is still fixed at Φ. Therefore, even higher θ is required to qualify for high-skill jobs. Hence, the threshold θ^* increases as p falls, which explains the second result in Proposition 1.

Proposition 1 implies that when agents' ability is publicly observed, government regulation on college tuition induces more people to go to college but makes it tougher for college graduates to be employed in high-skill jobs.

4.2. Utility and Social Welfare in the PubM

To examine the welfare effects of tuition regulation in the PubM, we suppose that p declines from p_h to p_l.[16] Then, we can evaluate the welfare effects by comparing the utility of agents under the two values of p.

Proposition 2 *Let ΔV denote the change in agents' utility when p declines from p_h to p_l. Under Assumptions 2 and 3, ΔV has the following signs depending on the education-job status.*

	Status under p_l		
Status under p_h	*High school*	*College low-skill jobs*	*College high-skill jobs*
High school	*(1A)* $\Delta V = 0$	*(1B)* $\Delta V > 0$	*(1C)* $\Delta V > 0$
College low-skill jobs	*(2A) do not exist*	*(2B)* $\Delta V > 0$	*(2C) do not exist*
College high-skill jobs	*(3A)* $\Delta V < 0$	*(3B)* $\Delta V > 0$ *iff (15) holds.*	*(3C)* $\Delta V > 0$

The condition for a utility improvement in case (3B) is

$$\theta < \frac{p_h - p_l}{(b-1)\kappa}. \tag{15}$$

Proof. See Appendix A.4. ■

To understand (1A)–(1C) in Proposition 2, consider HSE agents under p_h. Their utility is $V^0 = u(\theta + a)$ with p_h irrelevant. Hence, if they only go to high

[16] All results in this subsection can be extended easily to the case of an increase in p. We focus on the reduction in p because we are interested mainly in the effects of tuition control.

school even after the reduction in p, their utility does not change, as in (1A) of Proposition 2. By contrast, their utility must have increased if they go to college instead of taking V^0 from high school education. Hence, the utility increases for agents who move from high school to college after p decreases to p_l, which explains (1B) and (1C) of Proposition 2.

(2A)–(2C) in Proposition 2 are concerned with CE agents with low-skill jobs under p_h. They are characterized by $a \geq p_h$ and $\theta_a^L \leq \theta < \theta^*$. Even under p_l, all of them still choose college and have low-skill jobs because the fall in p reduces θ_a^L for all $a \geq p_h$ but raises θ^* by Proposition 1. Hence, none of them switch to high school or can obtain high-skill jobs, as stated in (2A) and (2C) of Proposition 1. However, they are better off with p_l because they can benefit from the reduction in p.

Finally, consider the CE agents with high-skill jobs under p_h. They satisfy $a \geq p_h$ and $\theta \geq \max(\theta^*, \theta_a^H)$ as specified in Definition 1. However, only part of them can qualify for high-skill jobs when p declines to p_l because θ^* increases by Proposition 1. Their utility should increase due to the decline in p, which explains (3C) in Proposition 2. By contrast, the agents who can no longer qualify for high-skill jobs ($\theta \geq \theta^*$ under p_h but $\theta < \theta^*$ under p_l) choose between only completing high school and going to college for low-skill jobs. If they only go to high school, their utility should decrease. Notice that they could only go to high school for utility V^0 under p_h but they choose to go to college for utility V_H^1. This choice implies that $V_H^1 \geq V^0$. However, V^0 is also the utility they obtain under p_l because the utility from high school is not affected by p. Hence, if agents go to college and have high-skill jobs under p_h but only complete high school under p_l, they should be worse off, as in (3A) in Proposition 2.

As for (3B) in Proposition 2, if some agents still go to college under p_l even though they cannot qualify for high-skill jobs, ΔV can be written as

$$\begin{aligned}\Delta V &= [u(\kappa\theta + a - p_l) - h(\theta)] - [u(b\kappa\theta + a - p_h) - h(\theta)] \\ &= u(\kappa\theta + a - p_l) - u(b\kappa\theta + a - p_h).\end{aligned}$$

Therefore, $\kappa\theta + a - p_l > b\kappa\theta + a - p_h$ is needed for $\Delta V > 0$. We obtain (15) in Proposition 2 by rearranging this inequality. The condition can be satisfied if college tuition becomes significantly cheaper or if productivity gains from college and high-skill jobs are relatively small.

Proposition 2 indicates that if the financial cost of college falls in the PubM, most people tend to see their utility increase or at least remain unchanged. Hence, tuition regulation can improve social welfare provided that agents' ability is publicly observed. Moreover, the only group of agents who can be worse off is those who hold high-skill jobs before the reduction in tuition. In this sense, the policy may also have desirable distributional consequences. Therefore, tuition regulation is suitable when firms can easily determine the workers' ability.

4.3. Educational Attainment in the PrvM

In the PrvM, we can evaluate the effects of p on equilibrium outcomes $(\theta_a, \phi, w^0, w_L^1, w_H^1)$ using the equilibrium conditions (7)–(11). We define S_j as the sum of θ of agents with education $j \in \{0,1\}$. Recall that $j=0$ and $j=1$ refer to high school and college, respectively. Then, we can write S_0 and S_1 as follows:

$$S_0 \equiv \int_0^p \int_0^\infty \theta f(\theta \mid a) g(a) d\theta da + \int_p^\infty \int_0^{\theta_a} \theta f(\theta \mid a) g(a) d\theta da$$
$$S_1 \equiv \int_p^\infty \int_{\theta_a}^\infty \theta f(\theta \mid a) g(a) d\theta da .$$

There are only two education levels and the population is normalized to 1; thus, we have

$$S_0 + S_1 = \mathbb{E}(\theta) .$$

Moreover, w^0 and w_L^1 / κ are equal to the average θ of HSE and CE workers by (9) and (11). Therefore, we can write the relationships between the wages and S_j as follows:

$$(1-\phi) w^0 = S_0 , \quad \phi \frac{w_L^1}{\kappa} = S_1 \quad .$$

Differentiating these equations, we obtain the following equations:

$$(1-\phi) \frac{dw^0}{dp} = w^0 \frac{d\phi}{dp} - \frac{dS_1}{dp} \quad , \tag{16}$$
$$\frac{\phi}{\kappa} \frac{dw_L^1}{dp} = -\frac{w_L^1}{\kappa} \frac{d\phi}{dp} + \frac{dS_1}{dp} \quad . \tag{17}$$

Moreover, once we find dw_L^1 / dp, we can easily obtain dw_H^1 / dp because by (10) and (11),

$$\frac{dw_H^1}{dp} = b \frac{dw_L^1}{dp} .$$

Thus, the effects of p on w_L^1 and w_H^1 are always qualitatively the same.

Equations (16) and (17) suggest that p affects the equilibrium wages through two channels: (i) the net change in the population of CE workers $(d\phi / dp)$ and (ii) the net change in the sum of θ of CE workers (dS_1 / dp). Hence, the effect of p on wages depends crucially on how people adjust their education choices and how the ability composition changes in each education group. However, we cannot specify the signs of $d\phi / dp$ or dS_1 / dp in the PrvM because of general equilibrium effects. For example, more people can go to college when p falls. Moreover, θ_a also declines initially and still more people go to college because it becomes inexpensive. These changes affect ϕ, S_1, and wages. However, these first-order effects influence the expected utility from college and high school. Then, people reevaluate their education choices, thereby changing θ_a, ϕ, S_1, and wages. The signs of $d\phi / dp$, dw^0 / dp, and dw_L^1 / dp cannot be determined clearly in the PrvM because of these general equilibrium effects. However, these derivatives should still satisfy some conditions that we present in the following proposition.[17]

Proposition 3 *Under Assumption 1, the following conditions are satisfied in an equilibrium of the PrvM.*

$$(1-\phi)\frac{dw^0}{dp} + \frac{\phi}{\kappa}\frac{dw_L^1}{dp} + \left(\frac{w_L^1}{\kappa} - w^0\right)\frac{d\phi}{dp} = 0 \tag{18}$$

$$\frac{d\phi}{dp} + v_0 \frac{dw^0}{dp} = -v_p, \quad v_0 > 0, \quad v_p > 0, \tag{19}$$

where v_0 *and* v_p *are composites of the model parameters and equilibrium outcomes.*

Proof. See Appendix A.5. ■

First, (18) is simply the sum of (16) and (17). Notice that all coefficients of $d\phi / dp$, dw^0 / dp, and dw_L^1 / dp in (18) are positive because $0 \le \phi \le 1$ and $w_L^1 / \kappa > w^0$ by Lemma 2. Consequently, the three derivatives cannot have the same sign simultaneously. In other words, at least one of them should be positive and at least one of them should be negative, unless all of them are zero. Second, (19) in Proposition 3 can be derived from the total differentiation of the equilibrium conditions (7)–(11), as shown in Appendix A.5. This equation implies that $d\phi / dp$ and dw^0 / dp cannot be positive at the same time. In other words, at least one of them should be negative. Those restrictions on the signs of $d\phi / dp$, dw^0 / dp, and dw_L^1 / dp can be used to find possible cases regarding the effects of p on the

[17] We do not analyze the qualitative properties of dw_H^1 / dp here because dw_H^1 / dp and dw_L^1 / dp have the same sign.

equilibrium outcomes, as we present in the following corollary.

Corollary 1 *Under Assumption 1, in the PrvM, the effects of p on* ϕ *,* w^0 *, and* w_j^1 *with* $j = H, L$ *are characterized with one of the following cases.*

1. If $d\phi / dp = 0$ *, then* $dw^0 / dp < 0$ *and* $dw_j^1 / dp > 0$ *.*

2. If $d\phi / dp > 0$ *, then* $dw^0 / dp < 0$ *but* dw_j^1 / dp *can take any sign.*

3. If $d\phi / dp < 0$ *and* $dw^0 / dp \le 0$ *, then* $dw_j^1 / dp > 0$ *.*

4. If $d\phi / dp < 0$ *and* $dw^0 / dp > 0$ *, then* dw_j^1 / dp *can take any sign.*

All cases here are direct implications of Proposition 3. Let us interpret the cases in Corollary 1. First, if $d\phi / dp = 0$, we obtain $dw^0 / dp < 0$ by (19) and $dw_j^1 / dp > 0$ by (18). In addition, these results imply $dS_1 / dp > 0$ by (16). In this case, even if p falls, ϕ remains unchanged because even though some people change their education choices from high school to college, many people equally change their education choices from college to high school. However, S_1 has to decrease in this case because $dS_1 / dp > 0$, thereby reducing the average θ of CE workers but raising that of HSE workers. For this reason, w_H^1 and w_L^1 decline, whereas w^0 rises in response to the fall in p.

In case 2 of Corollary 1, $d\phi / dp > 0$. Then, $dw^0 / dp < 0$ by (19) although the signs of dw_H^1 / dp and dw_L^1 / dp are ambiguous. Moreover, $d\phi / dp > 0$ and $dw^0 / dp < 0$ imply $dS_1 / dp > 0$ because by (16),

$$0 < w^0 \frac{d\phi}{dp} < \frac{dS_1}{dp}.$$

To interpret this case, we suppose that p falls and ϕ declines as a result. In other words, after p falls, the number of college-to-high-school movers is greater than that of high-school-to-college movers. Given that more people can afford college because of a fall in p, the reduction in ϕ is possible only if θ_a goes up substantially, and thus, a significant fraction of CE workers no longer go to college after p falls. These education changes reduce S_1, which represents the total θ of CE workers. Moreover, as the agents with relatively high θ choose high school instead of college, w^0, or equivalently, the average θ of HSE workers, goes up.

Cases 3 and 4 of Corollary 1 deal with the situation with $d\phi / dp < 0$. In these cases, the sign of dw^0 / dp is ambiguous. Hence, we consider two cases depending on the sign of dw^0 / dp in the proposition. First, if $dw^0 / dp \le 0$ along with $d\phi / dp < 0$, then both dw_H^1 / dp and dw_L^1 / dp should be positive because of (18) (case 3 of Corollary 1). To interpret this case, we suppose that ϕ increases and w^0 does not decrease after p falls. For this results to occur, S_0 increases or at least does not decrease too much as $w^0 = S_0 / (1 - \phi)$. In other words, even though more people go to college as p falls, the total θ of HSE workers does not decrease much or may even increase, indicating that the high-school-to-college movers have relatively low θ compared with those who choose high school under p_l. Given that $dS_1/dp = -dS_0/dp$, we can conclude that $w_L^1 = \kappa S_1/\phi$ and $w_H^1 = b\kappa S_1/\phi$ decrease because S_1 decreases or does not increase as much as ϕ increases.

Lastly, in case 4 of Corollary 1, $d\phi/dp < 0$ and $dw^0/dp > 0$. In this case, we cannot determine the sign of dw_L^1/dp because any sign can be consistent with (18). To interpret this case, notice that $d\phi/dp < 0$ and $dw^0/dp > 0$ together with (16) imply

$$\frac{dS_1}{dp} < w^0 \frac{d\phi}{dp} < 0 .$$

Therefore, when p falls, both ϕ and S_1 increase (or equivalently, S_0 decreases), but the latter effect is more significant. Such a reduction in S_0 can drive down $w^0 = S_0/(1-\phi)$ because it dominates the fall in $1-\phi$, which represents the share of HSE workers. However, the effect on w_L^1 is ambiguous because it is unclear which of $(w_L^1/\kappa)d\phi/dp$ and dS_1/dp is larger in (17).

Corollary 1 provides useful information on the signs of the derivatives of ϕ and wages. Nevertheless, we cannot predict which case in the corollary prevails. However, we notice that the first-order or partial effects of a change in p are characterized with $d\phi/dp < 0$. For example, when p falls from p_h to p_l, part of the agents with $a \in [p_l, p_h)$ can go to college because they can afford it. Moreover, given ϕ and wages, the college threshold θ_a is initially reduced when p falls because

$$\frac{\partial \theta_a}{\partial p} = -\frac{\partial \Delta / \partial p}{\partial \Delta / \partial \theta_a} = \frac{\pi u'(w_H^1 + a - p) + (1-\pi) u'(w_L^1 + a - p)}{-h'(\theta_a)} > 0 .$$

As θ_a decreases, some agents with $a \geq p_h$ change their education choices from high school to college. As such, the fall in p raises ϕ if we only consider the first-order effects.

For a complete analysis, we should also consider the second-order or general-equilibrium effects. However, we do not know whether ϕ increases or decreases by the second-order effects because how the initial rise in ϕ as the first-order effects influences w^0, w_L^1, w_H^1, expected utility, Δ, and θ_a remains unclear. Therefore, when p falls, ϕ may go up further or go down because of the second-order effects. Given this ambiguity on the direction of the second-order effects, cases 1 and 2 with $d\phi/dp \geq 0$ in Corollary 1 may be relatively improbable because they can occur only if the second-order effects on ϕ are opposite to and stronger than the first-order effects. In this sense, the total effects of a change in p on ϕ may be more likely to be characterized with $d\phi / dp < 0$.

4.4. Utility and Social Welfare in the PrvM

In the PrvM, wages are determined by the average productivity of the workers who have the same education and job types. Therefore, wages are part of the aggregate equilibrium outcomes that respond to p. Hence, when p changes, agents' utility is also affected by wages and education-job types. Thus, the change in an agent's education choice can create an externality to the utility of other agents through the wage channel. This externality brings about additional welfare effects in the PrvM in the case of a reduction in p.

For example, suppose p falls and consider the agents who maintain their original education choices. Their utility is given as $u(w^0 + a)$ or $u(w_j^1 + a - p) - h(\theta)$ with $j = H, L$. Thus, in the PubM, HSE workers are as well off as before and CE workers are better off due to the decrease in p. By contrast, in the PrvM, the utility of HSE workers can decrease if $\Delta w^0 < 0$. The utility of CE workers may also decline if $\Delta w_j^1 < \Delta p$ with relevant job type $j = H, L$. In the context of the fall in p, these conditions can be rewritten as $dw^0 / dp > 0$ and $dw_j^1 / dp > 1$ with $j = H, L$. If these conditions are satisfied, some agents may become worse off even though they maintain their initial education choices and pay less for college. This situation may appear in the PrvM but can never happen in the PubM. In this sense, the PrvM has an additional source of utility loss for the agents who stay with their original education choices.

We can apply similar arguments to the agents who change their education choices. In the PubM, their utility tends to increase after p falls if they choose higher education or have better jobs because they can save the financial cost of college and receive higher wages (Proposition 2). However, in the PrvM, even such agents may experience a utility loss if wages decline significantly. As discussed, Proposition 3 cannot eliminate the possibility of substantial reductions in wages despite the fall in p because $dw^0 / dp > 0$ and $dw_j^1 / dp > 0$ can arise. However, whether the conditions for utility losses are satisfied remains unclear. For example, in case 2 of Corollary 1, both dw^0 / dp and dw_j^1 / dp can be negative. Here, a fall in p raises all wages and tends to make most people better off. By contrast, in case 4 of Corollary 1, $dw^0 / dp > 0$ and $dw_j^1 / dp > 1$ can appear simultaneously. Hence, a reduction in p can make at least part of the population worse off.

Ultimately, whether social welfare improves when tuition regulation reduces p is a quantitative question in PrvM and PubM. In the PrvM, we do not know which case in Corollary 1 is realized and how much wages change. In the PubM, we do not know the share of agents with utility loss (3A in Proposition 2) and the quantitative significance of the utility loss. Thus, we simulate both PubM and PrvM with the parameter values that match key moments in Korea. This simulation analysis shows the differences in the effects of tuition regulation on education attainment, wages, and social welfare between the two types of models.

V. Simulation

5.1. Parameter Values

In the simulation, we analyze the effects of tuition regulation in Korea on educational attainment, wages, and social welfare. As discussed, tuition regulation has reduced real college tuition by approximately 20%. Therefore, we examine how the various equilibrium outcomes respond when p falls by 20% from p_h to p_l in the simulation. We assume that p_h is 50 million won, which represents all expenditures for college education. Then p_l should be 40 million won because p_l is 20% lower than p_h. In the simulation, we set $p_h = 0.05$ and $p_l = 0.04$ because we set 1 unit in the model equivalent to 1 billion won.

To parameterize Φ, we interpret employment in major firms and public sectors as high-skill jobs. Hence, we set $\Phi = 0.2$ because approximately 17% and 6% of employees work in major firms and governments, respectively.

For the value of κ, we must quantify the improvement in one's ability through college education. Unfortunately, finding reliable estimates of κ for Korea is difficult even though some evidence for the U.S. exists.[18] Hence, we use the Korea Collegiate Essential Skills Assessment (K-CESA), which is a standardized test for college students on various abilities and skills. In 2016–2019, college seniors obtained approximately 25% higher average K-CESA scores than first-year college students (Son et al., 2019). Interpreting this gap as the ability improvement through college education, we set $\kappa = 1.25$.

As for b, we interpret large firms as high-skill jobs and small firms as low-skill jobs. Though imperfect, this approximation can provide useful information on the productivity gain from matching CE workers to high-skill firms. According to the Ministry of Employment and Labor (2020), CE workers in firms with 500 or more employees earned approximately 30% higher wages than those in firms with 100–299 employees. Accordingly, we choose $b = 1.3$.

For the distribution of wealth a and ability θ, we assume that θ is determined by a and the idiosyncratic ability shock ε as follows:

$$\ln(\theta - \theta_{\min}) = r \ln a + \varepsilon, \quad r \geq 0, \quad \theta_{\min} > 0,$$

[18] For example, see Fang (2006).

where r and $\theta_{\min}$ are nonrandom constants, and $\theta_{\min}$ is the lower bound of θ. We assume that a and ε follow log normal distributions to capture the well-known empirical facts that wealth and income distributions have long upper tails. Then, $\theta-\theta_{\min}$ is also distributed log normally. To make education choices interesting for all θ, we set $\theta_{\min}$ so that for any $\theta>\theta_{\min}$, college gives higher consumption, even with a low-skill job, than high school in the PubM with $p=p_h$.

$$\kappa\theta+a-p_h\geq\theta+a\Leftrightarrow\theta\geq\frac{p_h}{\kappa-1}\quad\text{for any}\quad\theta>\theta_{\min}.$$

To ensure that this inequality will hold for any $\theta>\theta_{\min}$, we set $\theta_{\min}=\frac{p_h}{\kappa-1}$.

r in the equation for θ is interpreted as the elasticity of ability with respect to wealth. We consider two values: $r=0$ (independent case) and $r=0.3$ (correlated case). The latter value is based on the literature on intergenerational mobility.[19] Notice that both cases are consistent with Assumption 1.

For wealth distribution, we determine the mean and standard deviation of $\ln a$ such that $\Pr[a<p_h]=6\%$ and $\Pr[a<p_l]=1.5\%$. These conditions are based on the Youth Socio-Economic Reality Survey. In the survey, 20%–30% of respondents only received high school education or less. In 2016, 22.6% said that economic hardship was the main reason for their giving up college education. However, the share of such respondents declined to 6.4% in 2021. These results suggest that college education might have been unaffordable to even more people before tuition regulation was introduced in 2009. Then, the conditions for the wealth distribution are consistent with the survey results because 6% and 1.5% of the whole population correspond to 20%–30% and 5%–7.5% of the HSE population if 20%–30% of the population are only high school educated as in the survey.

The mean and standard deviation of $\ln\varepsilon$ are set such that (i) $\mathbb{E}(\varepsilon)$ is 400 million won and (ii) ε exceeds 1 billion won for the top 1% of the population. Using the properties of a and ε, we can obtain the distribution for θ in the simulation. Figure 2 shows the probability density functions $g(a)$ and $f(\theta\,|\,a)$ with the two values of r.

The consumption utility is assumed to be $u(c)=\ln c$. The utility cost of college education is described as follows:

$$h(\theta)=q[\ln(\theta_{\max}-\theta_{\min})-\ln(\theta-\theta_{\min})],\quad q>0\quad, \tag{20}$$

In this equation, $\theta_{\max}$ is the maximum value of θ in the range considered in the simulation.[20] This function satisfies all conditions required for $h(\theta)$, as $h'<0$

[19] See, for example, Black and Devereux (2011) and Black et al. (2020) for an extensive review.

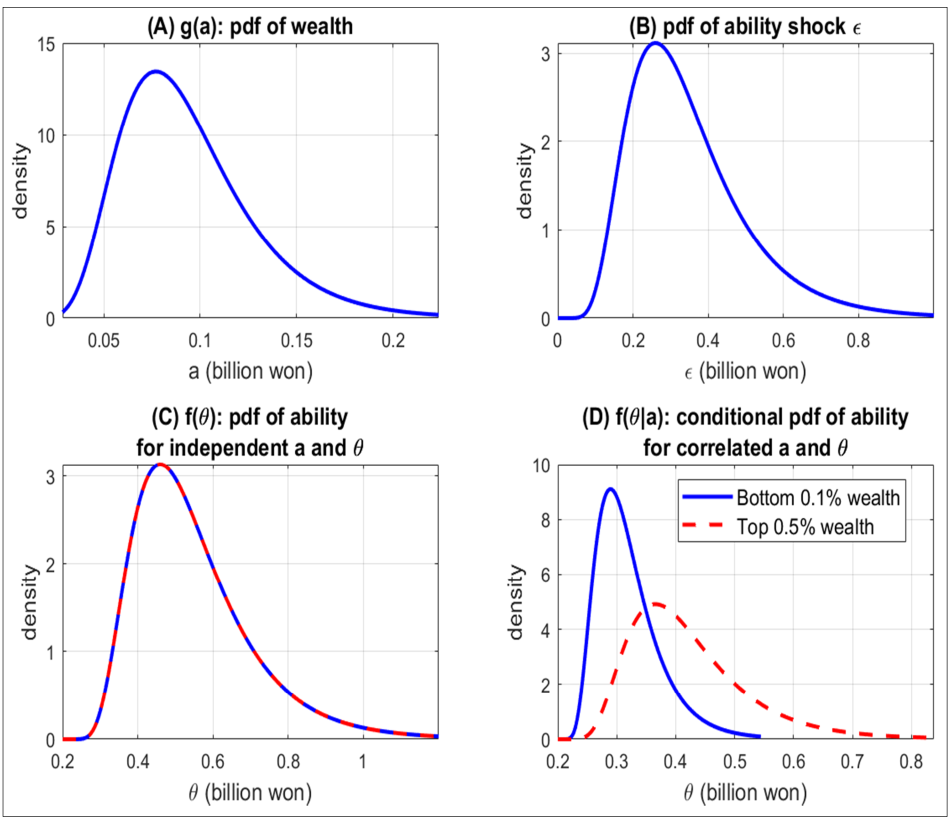
[20] For a trapezoidal approximation of integrals, we truncate the distributions of a and ε.

$< h''$. $u(c)$ and $h(\theta)$ clearly satisfy Assumption 2 in the PubM. Moreover, $h(\theta)$ in (20) allows us to have interior θ_a because

$$\lim_{\theta \to \theta_{\min}} h(\theta) = \infty, \quad \lim_{\theta \to \theta_{\max}} h(\theta) = 0,$$

as long as the consumption utility gap between college and high school is positive. Finally, q in (20) represents the importance of $h(\theta)$ relative to $u(c)$. In each model, we choose q so that $\phi = 0.7$ is in equilibrium with $p = p_h$. In the PubM, $q = 0.0726$ if $r = 0$ and $q = 0.0395$ if $r = 0.3$. In the PrvM, $q = 0.3652$ if $r = 0$ and $q = 0.2341$ if $r = 0.3$. Table 1 summarizes the parameter values explained so far. In what follows, models with parameter values as shown in the table will be referred to as baseline models.

[Figure 2] Probability density functions for wealth (a) ; ability shock (ε), and ability (θ).



Therefore, θ has a maximum value in the simulation.

[Table 1] Parameter values

Parameter	Description	Value	Note
p_h	Monetary cost of college education (high tuition)	0.05	50 million won
p_l	Monetary cost of college education (low tuition)	0.04	40 million won
Φ	Proportion of high-skill jobs	0.2	
κ	Improvement in ability due to college education	1.25	
b	Productivity gain when college graduates have high-skill jobs	1.3	
μ_a	Mean of ln a	-2.432	
σ_a	Standard deviation of ln a	0.363	
μ_ε	Mean of ln ε	-1.149	
σ_ε	Standard deviation of ln ε	0.446	
r	Elasticity of ability θ with respect to wealth a	0 or 0.3	

5.2. Effects of Tuition Regulation in the Baseline PubM

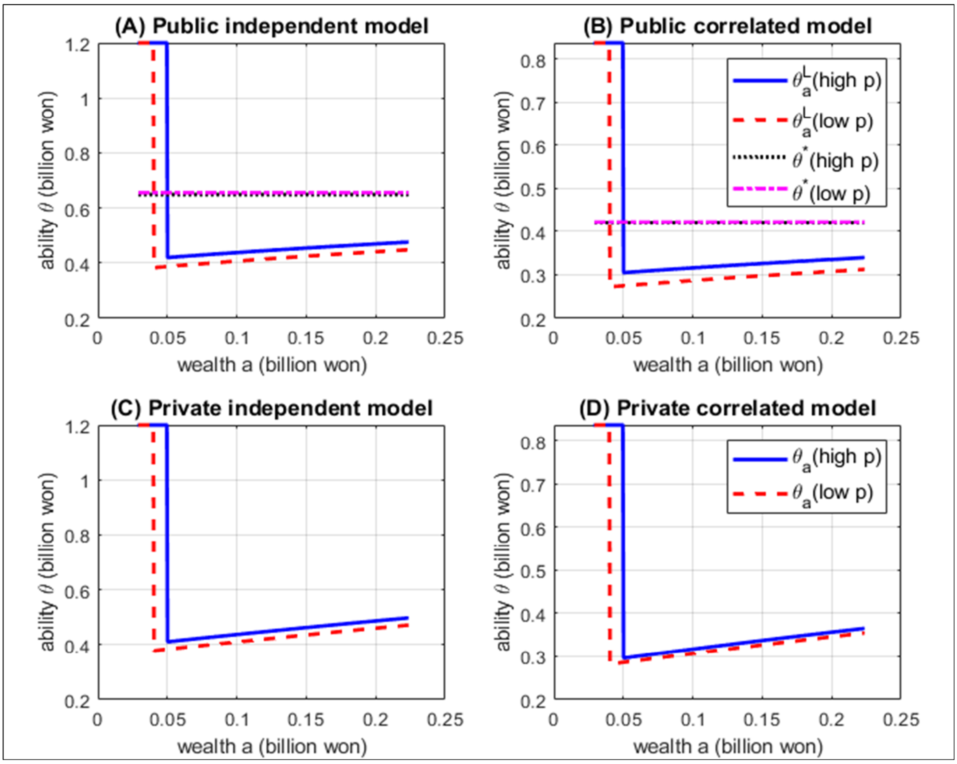
5.2.1. Educational Attainment and Wages

In this subsection, we analyze the effects of the 20% decline in p in the PubM. First, the upper panels of Figure 3 show that $\theta^* > \theta_a^L$ for any $a \geq p$ in the equilibrium. In other words, the equilibrium is characterized as case (a) in Figure 1. Hence, high-skill jobs are given to the CE workers with $\theta \geq \theta^*$ and $a \geq p$, even though more people want to have such jobs. The agents with $\theta_a^L \leq \theta < \theta^*$ and $a \geq p$ also go to college but only have low-skill jobs. All other agents with either (i) $a < p$ or (ii) $a \geq p$ and $\theta < \theta_a^L$ only complete high school and have low-skill jobs. These results capture the characteristics of the Korean labor markets, such as the existence of all three groups of workers and the competition for high-income jobs among the CE workforce. In this sense, our simulation is reasonable, and thus, we can use it to analyze the effects of tuition regulation.

We can also verify all results in Proposition 1 in the simulation. First, Table 2 shows that θ^* increases in the PubM regardless of the correlation between θ and a, as predicted by $d\theta^* / dp < 0$ in Proposition 1. As discussed, qualifying for high-skill jobs becomes harder as the number of people who can afford a college education increases. Second, θ_a^L declines for all $a \geq p_h$ in the upper panels of Figure 3, which confirms $d\theta_a^L / dp > 0$ in Proposition 1.[21] Moreover, the fall in p and the reduction in θ_a^L imply that more people go to college, which is consistent with $d\phi / dp < 0$ in Proposition 1. Indeed, ϕ increases by 12.4%p or 19.2%p in Table 2, depending on the correlation between θ and a.

[21] Although not shown in Figure 3, θ_a^H also declines, thereby confirming $d\theta_a^H / dp > 0$ in Proposition 1.

[Figure 3] Changes in the ability thresholds for college education



Note: This figure shows the changes in θ_a^L (threshold for college and low-skill jobs) and θ^* (threshold for employment in high-skill jobs) in the PubM and θ_a (threshold for college) in the PrvM when p falls from 50 million won to 40 million won. Panel (A): θ is publicly observed, and a and θ are independent. Panel (B): θ is publicly observed, and a and θ are positively correlated. Panel (C): θ is privately observed, and a and θ are independent. Panel (D): θ is privately observed, and a and θ are positively correlated.

The changes in the composition of HSE and CE workers affect the average wages in the PubM in Table 2. First, the average wage for high-school jobs declines regardless of the correlation between θ and a. Moreover, the college threshold θ_a^L decreases for any $a \geq p_h$; therefore, the most productive HSE workers under p_h switch to college under p_l, as clearly shown in the upper panels of Figure 3. This effect lowers the average ability of HSE workers, or equivalently, their average wage. By contrast, the average wage for college high-skill jobs increases regardless of the correlation between θ and a. This is straightforward because the rise in θ^* forces the least productive people in the group to move down to low-skill jobs after the reduction in p. Then, the average productivity (or average wage) of those who retain the high-skill jobs increases.

[Table 2] Simulation results in the baseline models

	(A) PubM				(B) PrvM			
	Independent		Correlated		Independent		Correlated	
	p_h	p_l	p_h	p_l	p_h	p_l	p_h	p_l
ϕ	70.0%	82.4%	70.0%	89.2%	70.0%	81.4%	70.0%	79.4%
θ^*	0.648	0.656	0.421	0.422	N.A.	N.A.	N.A.	N.A.
π	N.A.	N.A.	N.A.	N.A.	28.6%	24.6%	28.6%	25.2%
$\mathbb{E}(w^0)$	0.411	0.373	0.294	0.271	0.408	0.374	0.293	0.281
$\mathbb{E}(w_L^1)$	0.659	0.643	0.450	0432	0.751	0.729	0.496	0.485
$\mathbb{E}(w_H^1)$	1.268	1.277	0.793	0.795	0.976	0.947	0.644	0.631
Social welfare	-0.382	-0.370	-0.714	-0.697	-0.568	-0.596	-0.876	-0.887
Pop. share of utility gain	81.7%		88.9%		11.3%		9.4%	
Pop. share of same utility	17.4%		10.7%		0%		0%	
Pop. share of utility loss	1.0%		0.4%		88.7%		90.6%	

Note: $p_h = 0.05$ and $p_l = 0.04$, which are equivalent to 50 and 40 million won. The PubM and PrvM stand for "public information" and "private information" models. Ability θ is determined by $\theta = a^r\varepsilon + \theta_{\min}$ with $r = 0$ "independent" models and $r = 0.3$ in "correlated" models. ϕ denotes the population share of CE workers. θ^* is minimum θ for high-skill jobs in the PubM. π is the probability of high-skill jobs for CE workers in the PrvM. In the PrvM, average wages presented are wages that all workers in relevant education-job groups receive commonly.

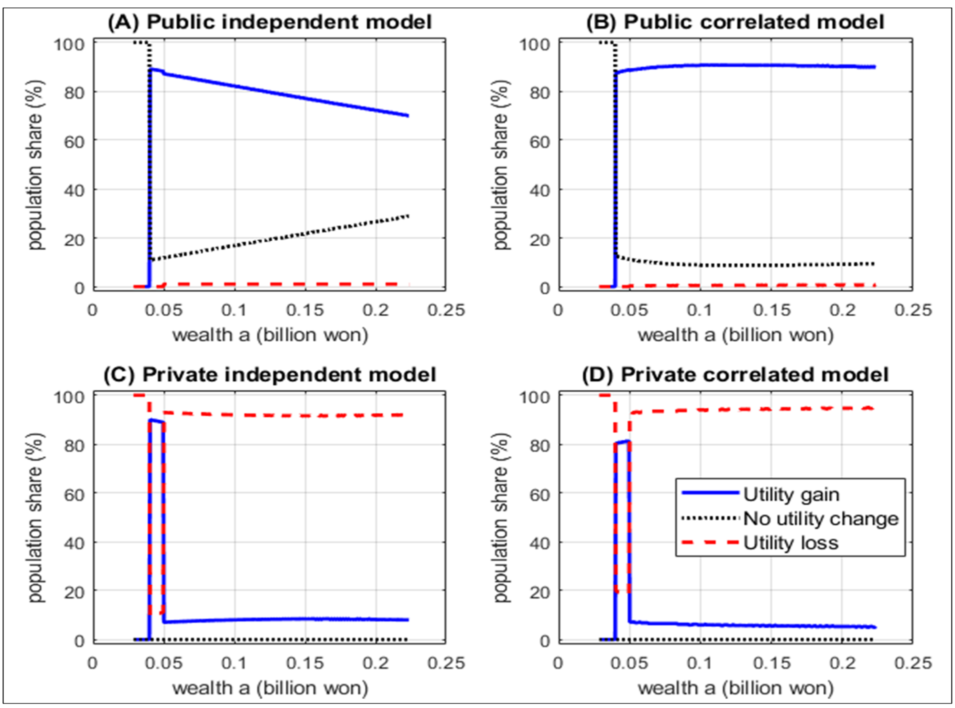
The response of the average wage for college low-skill jobs to the fall in p is theoretically ambiguous. On the one hand, some HSE workers under p_h change their education to college under p_l. However, they are less productive than existing CE workers under p_h. Therefore, this movement can decrease the average ability of CE workers with low-skill jobs. On the other hand, some CE workers with high-skill jobs under p_h are forced to move to low-skill jobs under p_l. They are more productive than the existing CE workers with low-skill jobs under p_h. Therefore, this movement can raise the average ability of CE workers with low-skill jobs. Given the counteracting effects, we do not know how the average wage for college low-skill jobs changes. In the simulation, the average wage falls regardless of the correlation between θ and a in Table 2, indicating that the upward movement from high school to college dominates the downward movement from high-skill to low-skill jobs.

5.2.2. Individual Utility and Social Welfare

In the simulation, we evaluate individual utility and utilitarian social welfare (1). In the simulated PubM, social welfare increases after p decreases by 20%, regardless of the correlation between a and θ (Table 2). This result suggests that if workers' ability determines their own wages, tuition regulation may enhance social welfare.

In light of Proposition 2, this result is hardly surprising because the decrease in p improves the utility of all agents except for two groups. First, the agents who only complete high school regardless of p experience no utility change because p is irrelevant. The upper panels of Figure 4 confirm this view, as the panels show the population shares of those who are better off, worse off, and as well off as before, after the fall in p for each level of a. In those plots, the share of agents whose utility remains unchanged coincides with the share of those who go to high school regardless of p. Therefore, the share is 100% if $a < p_l$ in the upper panels of Figure 4 because all these agents should go to high school. For $a \geq p_l$, the share is increasing in a when θ and a are independent because θ_a^L rises with a in the upper panels of Figure 3. However, when θ and a are positively correlated, the share does not monotonically increase because the average θ is higher for large a. In Table 2, the population share of agents with no utility change is 17.4% if θ and a are independent and 10.7% if they are positively correlated.

[Figure 4] Welfare effects of tuition regulation by wealth



Note: This figure displays the population shares of those whose utility increases, those whose utility remains the same, and those whose utility decreases for each level of a: Panel (A): θ is publicly observed, and a and θ are independent. Panel (B): θ is publicly observed, and a and θ are positively correlated. Panel (C): θ is privately observed, and a and θ are independent. Panel (D): θ is privately observed, and a and θ are positively correlated.

Additionally, some CE agents can be worse off if they are forced to move from high-skill to low-skill jobs and cannot satisfy (15) according to Proposition 2.[22] However, only few people meet these conditions. The upper panels of Figure 3 show that θ^* does not decline much in response to the fall in p, indicating that the population share of such agents may be insignificant. This point is verified in Table 2 because only 1.0% or 0.4% of the population become worse off after p falls.

Other than the two groups of agents, everyone else becomes better off in the PubM when p falls to p_l, as shown in Proposition 2. Indeed, more than 80% of the population see an increase in their utility in the PubM in Table 2. Overall, in the PubM, approximately 99% of people either benefit from or are unaffected by the 20% reduction in college tuition. Only few people who could hold high-skill jobs without tuition regulation become worse off. In this sense, the policy is almost a Pareto improvement and can be supported by almost everyone.

5.3. Effects of Tuition Regulation in the Baseline PrvM

We analyze the effects of the 20% decrease in college tuition in the PrvM. We again consider the change in equilibrium outcomes when p declines from $p_h = 0.05$ to $p_l = 0.04$.

5.3.1. Educational Attainment and Wages

The 20% decline in p makes college more affordable and attractive. These effects are evident in the lower panels of Figure 3, which present θ_a under p_h and p_l in the PrvM. First, after p decreases, agents with $p_l \le a < p_h$ can have access to college. Second, θ_a declines for any $a \ge p_h$ because college education becomes less costly. The reduction in θ_a implies that agents between the solid and the dashed lines in the lower panels of Figure 3 change their education from high school to college.

Clearly, such an upward movement raises ϕ. According to Table 2, ϕ increases by 11.4%p or 9.4%p in the PrvM depending on the correlation between θ and a after p falls by 20%. Moreover, the upward changes in education choices reduce wages for all education-job groups. The lower panels in Figure 3 show that those who change their education are on average more able than those who stay with high school but less able than those who stay with college. The average productivity of both groups decline as these agents leave the group of HSE workers and join the group of CE workers. Consequently, all three wages decrease because

[22] No agents who used to hold high-skill jobs under p_h change their education to high school under p_l in this simulated model. Thus, (3A) of Proposition 2 is irrelevant to the simulation.

they are proportional to the average productivity of relevant education-job groups. Furthermore, the reduction in wages is quantitatively significant. Table 2 reports that in PrvM, all wages decrease by more than $p_h - p_l = 0.01$, that is, the saved financial cost of college. This result indicates that tuition regulation can hurt workers if their ability is not easily observed.

The simulation results are summarized as $\Delta\phi > 0$, $\Delta w^0 < 0$, and $\Delta w_j^1 < 0$ with $j = H, L$ in response to $\Delta p < 0$. These results can be re-expressed as $d\phi / dp < 0$, $dw^0 / dp > 0$, and $dw_j^1 / dp > 0$; therefore, they are consistent with case 4 of Corollary 1. $d\phi / dp < 0$ also suggests that the first-order effects largely determine the total effects of the fall in p. To see this point, recall that the reduction in p initially makes college more affordable and less costly if other variables remain unchanged. Thus, θ_a is reduced for the agents who could afford college even before the fall in p. Moreover, some agents who become able to pay for college because of the fall in p can go to college. Through these channels, ϕ or the share of the CE people increases. As such, the rise in ϕ and the reduction in θ_a characterize the initial first-order effects of the fall in p. The phenomenon is also part of the total effects in the simulated PrvM when p falls (lower panels of Figure 3). Therefore, the simulation results may indicate that the first-order effects in the PrvM mostly explain the total effects.

A comparison of the simulation results between the PubM and PrvM is also interesting. First, when college tuition falls exogenously, ϕ increases significantly in both models in Table 2.[23] However, the effects of the fall in p on wages are different between the two models. In the PubM, agents' wages are unaffected by the fall in p unless they change their education or jobs. By contrast, wages decline in the PrvM because of the negative externality caused by the adjustment of education choices from high school to college in Table 2. Therefore, the key to understanding the effects of tuition regulation on wages is whether workers' ability is close to public information or private information.

5.3.2. Individual Utility and Social Welfare

Table 2 shows that social welfare deteriorates in the PrvM after college education becomes inexpensive, regardless of the correlation between θ and a. This result is in stark contrast to the welfare improvement in the PubM. Moreover, in Table 2, 88.7% or 90.6% of people become worse off after the reduction in p in the PrvM. This result is completely different from the finding from the PubM that approximately 99% of the population see their utility increase or unchanged after

[23] In contrast to this simulation result, college enrollment has been stable or slightly decreased in Korea after tuition regulation. Later in this section, we will discuss the factors that can account for this discrepancy.

p decreases.

Why do so many people experience the utility loss in the PrvM even though college becomes inexpensive? The answer lies in the reductions in all wages because of the fall in p. In particular, w_L^1 and w_H^1 always decline by more than the fall in p, as shown in Table 2. Then, the utility of those who maintain their education choices and jobs should decrease because $u(w^0+a)$ and $u(w_j^1+a-p)-h(\theta)$ with $j=H,L$ are reduced when w^0 and w_j^1-p decline. Moreover, an overwhelming majority of the population stay with their original education choices despite the fall in p because p and θ_a do not change much (lower panels of Figure 3). Combining those results, we can see why so many people experience the utility loss and social welfare deteriorates in the simulated PrvM.

The reduction in π due to the rise in ϕ further exacerbates the welfare loss in Table 2. A smaller π makes it more difficult for agents to obtain high-skill jobs after college in the PrvM. Consequently, social welfare can decrease even further. In summary, most agents are worse off under lower p because of the combined effects of smaller π and lower wages. This result can also be observed in the lower panels of Figure 4. After the fall in p, more than 90% of the population become worse off for a outside the interval $[p_l, p_h)$. Few people become better off under lower p because they can have access to college education due to tuition regulation, or they can upgrade their job statuses from low-skill to high-skill jobs under p_l.[24] Considering the effects on individual utility, we can clearly see why tuition regulation reduces social welfare in the PrvM.

5.4. Modified Models to Explain College Enrollment in Korea

In the simulated models, tuition regulation raises ϕ significantly. By contrast, in Korea, the college enrollment rate has been relatively stable despite tuition regulation. This inconsistency is not surprising because several potential determinants of college enrollments (e.g., κ, b, Φ, etc.) are taken as constant in the simulation whereas, in reality, they may have changed together with p. If such parameters were also allowed to change, the simulated models could match the observed stability in college enrollment. We consider two modified models in this subsection to examine this possibility. First, we allow κ, which represents the ability gain from college education, to decline together with p. Second, we relax the borrowing constraint so that any agent can go to college regardless of a. As discussed below, a declining κ appears to better explain relatively stable college enrollment in Korea.

[24] For agents who choose college under p_h and p_l, the probability for a low-skill job under p_h and a high-skill job under p_l is $(1-\pi_h)\pi_l = 0.185$ in the simulation. Though relatively improbable, it can happen.

5.4.1. Reducing the Ability Gain from College Education

κ is the parameter that represents the ability gain from college education. It may have a significant effect on education choices and labor market outcomes because it affects labor productivity and earnings in many periods over the life cycle. In Korea, κ may have declined because of tuition regulation even though it is treated as a constant in the model. To see why, notice that the policy has reduced tuition revenue, thereby making it more challenging for colleges to finance the costs to maintain or improve their education quality. Consequently, tuition regulation can cause a deterioration in the quality of college education. This effect could also be significant because most colleges in Korea have relied heavily on tuition revenue for their budgets. Therefore, tuition regulation may have reduced κ because the ability gain from college education is affected by the education quality.

Based on the discussion so far, we conduct an additional simulation analysis with an alternative assumption that tuition regulation causes a 20% reduction in p and $\kappa-1$, that is, the ability gain from college education. In other words, κ also declines from 1.25 to 1.2 because of tuition regulation. Here, we assume $\kappa-1$ and p decline by the same proportion because we do not have reliable empirical evidence on their relationship. In this sense, the simulation should be taken as an illustration of the potential effect of κ on education choices rather than a full-fledged calibration.

In Table 3, we can compare the change in ϕ caused by a 20% reduction in p in various types of models. Row [1] presents the simulation results with κ fixed at 1.25, whereas row [2] reports the simulation results with a change in κ from 1.25 to 1.2. By comparing the results, we can clearly see that a 20% reduction in κ has a strong negative effect on ϕ. In the PubM, ϕ declines by 9.7%p or 10.2%p when κ falls by 20% whereas it rises by 12.4%p or 19.2%p when κ is maintained. This result is intuitive because a smaller κ makes college education less profitable and therefore reduces ϕ. However, the quantitative significance of κ is noticeable because a 20% fall in κ alone makes a 22.1%p or 29.4%p difference in the change in ϕ.

Unlike in the PubM, ϕ increases in the PrvM even if p and κ decline together. Nevertheless, the reduction in κ can also prevent ϕ from rising excessively in the PrvM by making college education less profitable. In Table 3, ϕ increases only by 5.5%p or 0.7%p if κ declines by 20% whereas it increases more significantly by 11.4%p or 9.4%p in the baseline PrvM with constant κ. Therefore, the reduction in κ can correct an excessive hike in college enrollment in the simulated models although its effects are mitigated in the PrvM by the general-equilibrium effects including changes in wages.

Thus far, the analysis suggests that κ may explain the gap in college enrollment between the baseline model and Korea. As discussed, a change in κ

can have a significant quantitative effect on ϕ because it affects life-cycle earnings for several decades. Thus, it is an important channel through which tuition regulation affects college enrollment and social welfare. Although we do not consider it to focus on more direct effects of p, future research on the ability gain channel can be very useful in evaluating the effects of tuition regulation in a more comprehensive manner.

[Table 3] Simulated changes in college enrollment in various models

	(A) PubM		(B) PrvM	
	Independent	Correlated	Independent	Correlated
[1] Baseline	+12.4%p	+19.2%p	+11.4%p	+9.4%p
[2] 20% fall in college ability gain	-9.7%p	-10.2%p	+5.6%p	+0.7%p
[3] No borrowing constraint	+9.3%p	+17.5%p	+2.0%p	+4.2%p

Note: This table presents the changes in ϕ when p declines from $p_h = 0.05$ to $p_l = 0.04$. In each model, q is set to attain $\phi = 70\%$ under p_h. For all other parameters, we use the values in Table 1 in all models. In models in [1], κ is maintained at 1.25 and $a \geq p$ is imposed for college education throughout the change in p. In models in [2], κ changes from 1.25 under p_h to 1.20 under p_l. In models in [3], $a \geq p$ college education is not required throughout the change in p.

5.4.2. Relaxing the Borrowing Constraint

In the baseline model, agents can go to college only if $a \geq p$ because they cannot borrow for college education. As will be discussed later, this assumption may contribute to an excessively strong response of ϕ in the simulation. Therefore, we conduct another simulation analysis with an alternative assumption that agents can go to college regardless of a. However, we maintain all parameter values in Table 1 except q in (20), which is set to obtain $\phi = 70\%$ under $p_h = 0.05$ without the borrowing constraint.[25] We then compare the simulation results in Table 3 between the baseline models and the alternative models without the borrowing constraint.[26]

In the PubM, relaxing the borrowing constraint makes little difference to the response of ϕ to a 20% reduction in p. In row [3] of Table 3, ϕ increases by 9.3%p or 17.5%p without the borrowing constraint. Although this change is slightly smaller than 12.4%p or 19.2%p in the baseline PubM (row [1] of Table 3), it is still quite different from the observed change in the college enrollment rate in Korea. Therefore, relaxing the borrowing constraint would not be helpful in matching

[25] In the PubM, $q = 0.0786$ if $r = 0$ (independent θ and a) and $q = 0.0422$ if $r = 0.3$ (correlated θ and a). In the PrvM, $q = 0.4208$ if $r = 0$ and $q = 0.2500$ if $r = 0.3$.

[26] Even if the borrowing constraint is relaxed, almost all theoretical results are still valid. More specifically, all results in the PrvM hold regardless of the borrowing constraint. In the PubM, part 2 of Proposition 1 and part 3A of Proposition 2 are slightly more generalized if the borrowing constraint is relaxed. All other results in the PubM hold regardless of the borrowing constraint.

college enrollment in Korea. This result indicates that the borrowing constraint may not play a significant role in the effects of p on ϕ in the PubM.

In the PrvM, relaxing the borrowing constraint has a significant quantitative effect on ϕ. In row [3] of Table 3, ϕ increases by only 2.0%p or 4.2%p in the PrvM without the borrowing constraint. This change is more comparable to the relatively stable college enrollment in Korea than the 11.4%p or 9.4%p in the PrvM with the borrowing constraint (row [1] of Table 3). In this sense, relaxing the borrowing constraint can be helpful for the simulated PrvM to match college enrollment in Korea. This result also suggests that the borrowing constraint can be quantitatively important for college enrollment in the PrvM.

Why does the borrowing constraint matter more in the PrvM? To answer this question, we consider the initial flow of workers from high school to college when p falls to p_l from p_h. They can be divided into two groups: (i) agents with $a \in [p_l, p_h)$ but $\theta \geq \theta_a$ under p_l, and (ii) agents with $a \geq p_h$ but $\theta < \theta_a$ under p_h. In other words, the first group cannot afford college under p_h despite high θ whereas the second group gives up college education because of low θ despite relatively large a. In the following discussion, we refer to the first group as high θ movers and the second group as low θ movers. Notice that high θ movers exist because of the borrowing constraint, whereas low θ movers always exist regardless of the borrowing constraint.

ϕ can increase more significantly in the PrvM because with the borrowing constraint because high θ movers tend to widen the wage gap between CE and HSE workers. To see why, notice that high θ movers tend to be much more productive than the remaining HSE workers with $\theta < \theta_a$. Therefore, their movement can significantly reduce the average productivity and wage of HSE workers. By contrast, high θ movers have relatively similar ability to existing CE workers because both groups are above the threshold θ_a. Consequently, the average productivity or wages of CE workers may not change much. Through these differential effects, high θ movers can widen the wage gap between CE and HSE workers, which in turn makes college even more profitable and attract even more HSE workers to college. The presence of high θ movers can lead to a significant increase in ϕ.

High θ movers do not exist without the borrowing constraint. In other words, when p falls, only low θ movers change their education to college. However, their effect on the wage gap between CE and HSE workers tends to be small because they are only slightly more productive than the remaining HSE workers. Then, relatively few HSE workers can be induced to change their educational level to college. Consequently, ϕ may not go up so much if the borrowing constraint is absent.[27] This view is confirmed by the simulated PrvM: ϕ rises only slightly

[27] Our argument here relies on the first-order effects of a fall in p. However, the first-order effects

without the borrowing constraint, as discussed in Table 3.

The discussion so thus far suggests that relaxing the borrowing constraint can be helpful to attaining a reasonable college enrollment rate in the simulation. However, the models without the borrowing constraint may not adequately represent education choices in Korea, especially before tuition regulation because they may ignore the financial barriers that prevent low-income people from receiving a college education. For this reason, we use the model with the borrowing constraint in this paper because it seems to represent the Korean economy better.

5.5. Implications for Blind Hiring in Korea

Tuition regulation can produce desirable outcomes, such as giving people better access to college education and reducing the economic burden. As a result, more people can attend college and improve their productivity. These effects are confirmed in the simulation. Hence, tuition regulation could be beneficial to society as people invest more in higher education and accumulate more human capital.

However, the simulation results also reveal that the overall welfare effects of tuition regulation depend crucially on whether information on agents' abilities is easily available in the labor market. If their ability is publicly observed, the policy can improve social welfare and make most people better off or as well off as before (Table 2). By contrast, if agents' ability is privately observed, the policy can reduce social welfare and worsen the welfare of many people (Table 2). Therefore, tuition regulation is not sufficient to enhance social welfare. Rather, it requires complementary policies to make the economy more like the PubM.

These findings have interesting implications for Korea's "blind hiring" policy, which was introduced in 2017 for jobs in the public sector and major private firms. Under this policy, employers are not allowed to collect information on the characteristics of job applicants unrelated to the jobs. Hence, blind hiring can reduce unjust discrimination of workers based on their traits irrelevant to the jobs, such as gender, race, appearance, and family background. However, the policy may also hinder employers from correctly evaluating the ability of job applicants because some information on academic achievements has also become unavailable. In this sense, blind hiring has made the ability of workers closer to private information. Our analysis suggests that the policy can reduce the utility of many workers and social welfare when combined with tuition regulation.

Moreover, blind hiring can distort the allocation of high-income jobs in the public sector and major companies. Notice that these jobs are precisely the jobs referred to as high-skill jobs throughout this paper. As discussed, high-skill jobs are allocated to the most productive people in the PubM, which appears efficient and

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tend to dominate the general-equilibrium effects in all the simulation.

fair. By contrast, such jobs are randomly given to part of college graduates in the PrvM. In this process, some college graduates with low ability may obtain high-skill jobs, which is inefficient for the economy. In this sense, blind hiring could also reduce the efficiency of the economy.

VI. Concluding Remarks

This paper studies the effects of college tuition regulation on education, wages, and social welfare. We find that the policy can have different effects on social welfare depending on the availability of information on workers' ability. If the information is available to firms and workers themselves, tuition regulation tends to improve social welfare and the utility of many people. By contrast, if the information is only available to the workers, the policy will be much less likely to enhance social welfare because many people can experience wage losses as some people move from high school to college.

This paper concentrates on the effects of college tuition through wages and job allocation. However, the quality of college education can also be important for education attainment and social welfare as suggested by our simulation results. Tuition revenue can be used to recruit top-level professors, provide research grants and scholarships, and invest more in the education environment. Such spending can be helpful in better educating college students better and improving their ability. Then, tuition regulation may have an additional negative effect on education attainment and social welfare by reducing the quality of college education. Therefore, empirical studies on the quantitative significance of this channel can be very useful to better understand the effects of tuition regulation. Results from such studies, together with the findings in this paper, could also be incorporated into more general models with multiple channels through which college tuition influences the economy. With this kind of research, we could evaluate the effects of tuition regulation in a more comprehensive manner.

A. Appendix: Proofs of main theoretical results

A.1 Proof of Lemma 1

Proof of result 1 Notice that $\Gamma_H(\theta_a^L, a) > 0$ because

$$\Gamma_H(\theta_a^L, a) = u(b\kappa\theta_a^L + a - p) - u(\theta_a^L + a) - h(\theta_a^L) > \\ u(\kappa\theta_a^L + a - p) - u(\theta_a^L + a) - h(\theta_a^L) = 0$$

Therefore, $\theta_a^H < \theta_a^L$ to attain $\Gamma_H(\theta_a^H, a)$ because Γ_H is increasing in θ by Assumption 2.

Proof of result 2 We can rewrite (2) as the following:

$$u(b\kappa\theta_a^H + a - p) - u(\theta_a^H + a) = h(\theta_a^H),$$
$$u(\kappa\theta_a^L + a - p) - u(\theta_a^L + a) = h(\theta_a^L).$$

Because $h(\theta) > 0$,

$$u(b\kappa\theta_a^H + a - p) > u(\theta_a^H + a),$$
$$u(\kappa\theta_a^L + a - p) > u(\theta_a^L + a).$$

Because $u' > 0$, these equations imply

$$b\kappa\theta_a^H + a - p > \theta_a^H + a, \tag{21}$$
$$\kappa\theta_a^L + a - p > \theta_a^L + a. \tag{22}$$

Rearranging terms, we obtain $(b\kappa - 1)\theta_a^H > p$ and $(\kappa - 1)\theta_a^L > p$.

Proof of result 3 Notice that

$$\frac{d\theta_a^j}{da} = -\frac{\partial\Gamma_j / \partial a}{\partial\Gamma_j / \partial\theta_a^j} \quad \text{for} \quad j = H, L.$$

Based on Assumption 2, the denominator is positive. Thus, the numerator is written as

$$\frac{\partial \Gamma_H}{\partial a} = u'(b\kappa\theta_a^H + a - p) - u'(\theta_a^H + a),$$
$$\frac{\partial \Gamma_L}{\partial a} = u'(\kappa\theta_a^L + a - p) - u'(\theta_a^L + a).$$

Both expressions are negative because of (21), (22), and $u'' < 0$. Therefore, $d\theta_a^H / da > 0$ and $d\theta_a^L / da > 0$ for any $a \geq p$.

A.2 Proof of Lemma 2

Proof of equation (14) To prove the equation, we rewrite (7) as

$$\Delta(\theta_a, a) = \pi u(w_H^1 + a - p) + (1-\pi)u(w_L^1 + a - p) - u(w^0 + a) - h(\theta_a) = 0. \tag{23}$$

Because $h(\theta) > 0$, this equation implies

$$\pi u(w_H^1 + a - p) + (1-\pi)u(w_L^1 + a - p) > u(w^0 + a).$$

u is strictly concave; thus,

$$u[\pi(w_H^1 + a - p) + (1-\pi)(w_L^1 + a - p)] > \pi u(w_H^1 + a - p) + (1-\pi)u(w_L^1 + a - p).$$

Combining the two inequalities and using $u'(c) > 0$, we obtain

$$\pi(w_H^1 + a - p) + (1-\pi)(w_L^1 + a - p) > w^0 + a, \tag{24}$$

which is rearranged to yield (14).

Proof of equation (13) Using (9) and (11), we can write $w_L^1 / \kappa - w^0$ as follows.

$$\begin{aligned}\frac{w_L^1}{\kappa} - w^0 &= \frac{1}{\phi}\left[\int_p^\infty \left\{\int_{\theta_a}^\infty \theta f(\theta \mid a) d\theta\right\} g(a) da\right] \\ &\quad - \frac{1}{1-\phi}\left[\int_0^p \left\{\int_0^\infty \theta f(\theta \mid a) d\theta\right\} g(a) da + \int_p^\infty \left\{\int_0^{\theta_a} \theta f(\theta \mid a) d\theta\right\} g(a) da\right] \\ &= \mathbb{E}(\theta \mid a \geq p, \theta \geq \theta_a) - P\mathbb{E}(\theta \mid a < p) - (1-P)\mathbb{E}(\theta \mid a \geq p, \theta < \theta_a),\end{aligned}$$

where $P = \frac{\Pr(a<p)}{1-\phi}$ denotes the share of agents who cannot afford college in the high school graduates. $\mathbb{E}(\theta \mid a)$ is non-decreasing in a by Assumption 1; therefore,

$$\mathbb{E}(\theta \mid a \geq p, \theta \geq \theta_a) > \mathbb{E}(\theta \mid a \geq p) \geq \mathbb{E}(\theta \mid a < p).$$

Using this result,

$$\begin{aligned}\frac{w_L^1}{\kappa} - w^0 &= \mathbb{E}(\theta \mid a \geq p, \theta \geq \theta_a) - P\mathbb{E}(\theta \mid a < p) - (1-P)\mathbb{E}(\theta \mid a \geq p, \theta < \theta_a) \\ &> \mathbb{E}(\theta \mid a \geq p, \theta \geq \theta_a) - P\mathbb{E}(\theta \mid a \geq p, \theta \geq \theta_a) - (1-P)\mathbb{E}(\theta \mid a \geq p, \theta < \theta_a) \\ &= (1-P)\left[\mathbb{E}(\theta \mid a \geq p, \theta \geq \theta_a) - \mathbb{E}(\theta \mid a \geq p, \theta < \theta_a)\right] \\ &> 0\end{aligned}$$

Proof of equation (12) Using (9) and (11),

$$\begin{aligned}&\phi\frac{w_L^1}{\kappa} + (1-\phi)w^0 \\ &= \int_p^\infty \left\{\int_{\theta_a}^\infty \theta f(\theta \mid a) d\theta\right\} g(a) da + \int_0^p \left\{\int_0^\infty \theta f(\theta \mid a) d\theta\right\} g(a) da \\ &\quad + \int_p^\infty \left\{\int_0^{\theta_a} \theta f(\theta \mid a) d\theta\right\} g(a) da \\ &= \int_0^\infty \left\{\int_0^\infty \theta f(\theta \mid a) d\theta\right\} g(a) da = \mathbb{E}(\theta)\end{aligned}$$

A.3 Proof of Proposition 1

Proof of result 1 Taking total differentials to the equations in (2) with respect to θ_a^H, θ_a^L, and p, we obtain

$$\begin{aligned}\frac{d\theta_a^H}{dp} &= \frac{u'(b\kappa\theta_a^H + a - p)}{b\kappa u'(b\kappa\theta_a^H + a - p) - u'(\theta_a^H + a) - h'(\theta_a^H)}, \\ \frac{d\theta_a^L}{dp} &= \frac{u'(\kappa\theta_a^L + a - p)}{\kappa u'(\kappa\theta_a^L + a - p) - u'(\theta_a^L + a) - h'(\theta_a^L)}.\end{aligned}$$

The numerators of these equations are positive because $u' > 0$ and the denominators are positive due to Assumption 2. Therefore, $d\theta_a^H / dp > 0$ and $d\theta_a^L / dp > 0$ for any $a \geq p$.

Proof of result 2 θ^* is independent of a whereas θ_a^H is increasing in a by Lemma 1. Also, by Assumption 3, $\theta^* > \theta_a^L > \theta_a^H$ at $a = p$. Hence, there is wealth level a^H such that $\theta_a^H < \theta^*$ for $a \in [p, a^H)$ and $\theta_a^H \geq \theta^*$ for $a \geq a^H$. (If $\theta_a^H < \theta^*$ for any a. then $a^H = \infty$.) Then we can rewrite (4) as

$$\int_p^{a^H}[1-F(\theta^* \mid a)]g(a)da+\int_{a^H}^{H}[1-F(\theta_a^H \mid a)]g(a)da=\Phi .$$

Taking total differential to this equation yields

$$-[\{1-F(\theta^* \mid p)\}g(p)]dp-\left[\int_p^{a^H} f(\theta^* \mid a)g(a)da\right]d\theta^*$$
$$-\left[\int_{a^H}^{\infty} f(\theta_a^H \mid a)d\theta_a^H g(a)da\right]=0 ,$$

which implies

$$-\{1-F(\theta^* \mid p)\}g(p)-\left[\int_{a^H}^{\infty} f(\theta_a^H \mid a)\frac{d\theta_a^H}{dp}g(a)da\right]=\left[\int_p^{a^H} f(\theta^* \mid a)g(a)da\right]\frac{d\theta^*}{dp} .$$

The LHS is negative because $d\theta_a^H / dp>0$ and the coefficient on $d\theta^* / dp$ is positive. Consequently, $d\theta^* / dp<0$.

Proof of result 3 Taking total differential to (5) and dividing the resulting equation by dp, we obtain the following:

$$\frac{d\phi}{dp}=-[F(\theta^* \mid p)-F(\theta_p^L \mid p)]g(p)+\int_p^{a^L}\left[f(\theta^* \mid a)\frac{d\theta^*}{dp}-f(\theta_a^L \mid a)\frac{d\theta_a^L}{dp}\right]g(a)da .$$

Then $d\phi / dp<0$ because $d\theta_a^L / dp>0$, $d\theta^* / dp<0$, and $\theta^*>\theta_a^L$ at $a=p$ by Assumption 3.

A.4 Proof of Proposition 2

For each type of agent, let V_h and V_l denote the utility under p_h and p_l, respectively. Then, $\Delta V=V_l-V_h$ as Proposition 2 is concerned with a fall in p. We prove each result in the proposition as follows.

1A. high school→high school $\Delta V=0$ because $V_h=V_l=u(\theta+a)$.

1B. high school→college low-skill job The education choice under p_l implies

$$V_l=u(\kappa\theta+a-p_l)-h(\theta)\geq u(\theta+a)=V_h .$$

Therefore, $\Delta V > 0$ for this type of agent.

1C. high school→college high-skill job The education choice under p_l implies

$$V_l = u(b\kappa\theta + a - p_l) - h(\theta) \geq u(\theta + a) = V_h.$$

Therefore, $\Delta V > 0$ for this type of agent.

2A. college low-skill job→high school The education choices under p_h and p_l imply the following:

$$V_h = u(\kappa\theta + a - p_h) - h(\theta) > u(\theta + a).$$
$$V_l = u(\theta + a) > u(\kappa\theta + a - p_l) - h(\theta)$$

Combining these inequalities yields

$$u(\kappa\theta + a - p_h) - h(\theta) > u(\theta + a) > u(\kappa\theta + a - p_l) - h(\theta).$$

However, this inequality cannot hold because $p_h > p_l$. Due to this contradiction, no agents move from college low-skill jobs to high school.

2B. college low-skill job→college low-skill job In this case, $\Delta V > 0$ because $p_h < p_l$ implies

$$V_l = u(\kappa\theta + a - p_l) - h(\theta) > u(\kappa\theta + a - p_h) - h(\theta) = V_h.$$

2C. college low-skill job→college high-skill job Note that high-skills jobs yield higher utility than low-skills jobs. Hence, the education choice under p_h implies $\theta < \theta^*$, because otherwise, the agents would have high-skill jobs after completing college. However, θ^* is even higher under p_l based on Proposition 1. Therefore, high-skill jobs after college is impossible for this type of agent. Hence, no agents can move from college low-skill jobs to college high-skill jobs.

3A. college high-skill job→high school $\Delta V < 0$ because $V_h = u(b\kappa\theta + a - p_h) > u(\theta + a) = V_l$.

3B. college high-skill job→college low-skill job The utility changes from $V_h = u(b\kappa\theta + a - p_h) - h(\theta)$ to $V_l = u(\kappa\theta + a - p_l) - h(\theta)$. For $V_l > V_h$, we need

$$b\kappa\theta + a - p_h < \kappa\theta + a - p_l.$$

which is rearranged to yield (15).

3C. college high-skill job→college high-skill job $\Delta V > 0$ because $p_h < p_l$ implies

$$V_l = u(b\kappa\theta + a - p_l) - h(\theta) > u(b\kappa\theta + a - p_h) - h(\theta) = V_h .$$

A.5 Proof of Proposition 3

Proof of equation (18) Equation (18) is simply the sum of (16) and (17).

Proof of equation (19) To prove (19), we take total differentials to equilibrium conditions (6), (7), (8), (9), (10), and (11) with respect to p and the equilibrium outcomes $(\phi, \pi, \theta_a, w^0, w_L^1, w_H^1)$.

To start the proof, notice that (10) and (11) imply $w_H^1 = bw_L^1$, which in turn yields the total differential,

$$dw_H^1 = bdw_L^1 . \tag{25}$$

Taking total differentials to (7) and using (25), we obtain the following equation after some algebra:

$$d\theta_a = m_\phi d\phi - m_1 dw_L^1 + m_0 dw^0 + m_p dp , \tag{26}$$

where

$$m_\phi \equiv \frac{\pi'(\phi)[u(c_H^1) - u(c_L^1)]}{h'(\theta_a)} > 0$$

$$m_1 \equiv -\frac{\pi b u'(c_H^1) + (1-\pi)u'(c_L^1)}{h'(\theta_a)} > 0$$

$$m_0 \equiv -\frac{u'(c^0)}{h'(\theta_a)} > 0$$

$$m_p \equiv \frac{\pi u'(c_H^1) + (1-\pi)u'(c_L^1)}{h'(\theta_a)} > 0$$

In (26), $m_\phi > 0$ because $\pi'(\phi) < 0$ in (6) as we are focused on the case $\phi > \Phi$.

Taking total differentials to (8) gives

$$d\phi = -[1 - F(\theta_p \mid p)]g(p)dp - \int_p^\infty [f(\theta_p \mid a)g(a)d\theta_a]da\,.$$

Substituting (26) into this equation, we have

$$\begin{aligned} d\phi = {} & -[1 - F(\theta_p \mid p)]g(p)dp \\ & -\int_p^\infty [f(\theta_a \mid a)g(a)\{m_\phi d\phi - m_1 dw_L^1 + m_0 dw^0 + m_p dp\}]da\,, \end{aligned}$$

which in turn is rearranged to yield

$$\frac{d\phi}{dp} = -n_p + n_1 \frac{dw_L^1}{dp} - n_0 \frac{dw^0}{dp}\,, \tag{27}$$

where

$$\begin{aligned} n_p &\equiv \frac{[1 - F(\theta_p \mid p)]g(p)dp + \int_p^\infty [f(\theta_a \mid a)g(a)m_p]da}{1 + \int_p^\infty [f(\theta_a \mid a)g(a)m_\phi]da} > 0 \\ n_1 &\equiv \frac{\int_p^\infty [f(\theta_a \mid a)g(a)m_1]da}{1 + \int_p^\infty [f(\theta_a \mid a)g(a)m_\phi]da} > 0 \\ n_0 &\equiv \frac{\int_p^\infty [f(\theta_a \mid a)g(a)m_0]da}{1 + \int_p^\infty [f(\theta_a \mid a)g(a)m_\phi]da} > 0 \end{aligned}$$

Finally, solving (18) for dw_L^1 / dp and plugging it into (27) yields

$$\frac{d\phi}{dp} = -n_p - n_1 \left[\kappa \frac{1-\phi}{\phi} \frac{dw^0}{dp} + \left(\frac{w_L^1 - \kappa w^0}{\phi} \right) \frac{d\phi}{dp} \right] - n_0 \frac{dw^0}{dp}\,.$$

Rearranging terms and dividing by dp, we obtain the following (19):

$$\frac{d\phi}{dp} + v_0 \frac{dw^0}{dp} = -v_p\,,$$

where

$$v_0 \equiv \frac{n_0 + n_1 \kappa \frac{1-\phi}{\phi}}{1 + n_1 \frac{w_L^1 - \kappa w^0}{\phi}} > 0\,, \quad v_p \equiv \frac{n_p}{1 + n_1 \frac{w_L^1 - \kappa w^0}{\phi}} > 0\,.$$

In this equation, the denominator of v_0 or v_p is positive by (13) in Lemma 2. The numerators of v_0 and v_p are also positive. Therefore, both v_0 and v_p are positive.

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등록금 규제는 사회후생을 개선하는가?*

윤 동 규** · 이 경 우***

초 록

2009년 이후 한국의 대학 등록금은 등록금 규제 정책에 의해 실질가치로 20% 이상 하락했다. 본 연구는 능력과 재산에 따른 교육수준 선택 모형을 이용해 등록금 규제의 후생효과를 검토한다. 이 모형에서 대학은 비용이 들지만 생산성과 고용 전망을 향상시키는 반면, 고등학교는 무료이지만 그러한 혜택을 주지 않는다. 본 연구의 주된 결과는 다음과 같다. 기업이 노동자의 능력을 관찰할 수 있는 경우, 등록금 규제 정책은 학비 부담을 낮추어 대부분의 사람에게 이익이 된다. 하지만, 노동자만 본인의 능력을 관찰할 수 있는 경우, 교육수준 변화에 따른 임금 하락 때문에 등록금 규제의 후생이득이 감소할 수 있다. 대학 등록금의 20% 하락 효과를 모형에서 모의실험한 결과, 기업도 노동자의 능력을 관찰할 수 있으면 인구의 80% 이상의 후생이 증가하는 반면, 노동자만 본인의 능력을 관찰할 수 있으면 인구의 90% 정도의 후생이 감소한다. 이러한 결과는 기업이 노동자의 능력을 잘 평가할 수 있도록 돕는 정책이 등록금 규제와 동반되어야 함을 시사한다.

핵심 주제어: 등록금 규제, 교육수준 선택, 노동생산성, 사회후생

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** 제1저자, University of Washington 경제학과 박사과정, e-mail: dhongkyu@uw.edu

*** 교신저자, 연세대학교 경제학부 부교수, e-mail: kwlee76@yonsei.ac.kr