A Game Theoretical Approach to Private Tutoring in South Korea*

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Abstract. This paper attempts to develop game theoretical models of parents' decision-making on the consumption of private tutoring (PT). From the individual decision maker's perspective, investment in PT guarantees a high private rate of return, while from the country's viewpoint, PT entails a low social rate of return with substantial opportunity and transaction cost. In this respect, Spence's job market signaling model and Thurow's job queuing model contain similar implications of investment in education, thus these models were introduced and integrated into PT game models. The Nash Equilibriums from the two PT game models were characterized by the following. First, throughout the two non-cooperative PT game models, when the benefits from PT considerably exceeded the costs of PT, games between parents with symmetrical characteristics had suboptimal Nash Equilibriums that are similar to the Prisoner's Dilemma Game. Second, games between parents with asymmetrical characteristics showed a Nash Equilibrium where parents with competitive advantages in income, their child's ability, and preference for education spend all of their income on PT while relatively disadvantaged parents do not spend money on PT. The governmental interventions to shift the equilibriums of the PT game are suggested here.

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Ⅰ. Introduction

In many Asian countries, private tutoring (PT) has long been a matter of educational and social concern, as PT often impedes upon the formal education system. Recent research (i.e., Bray, 1999; 2003; 2005) shows that the PT industry has been on the rise, particularly in Africa, Europe, and North America.[1] Although the scale of PT varies considerably in these regions, PT can be described as a pervasive phenomenon which needs to be studied with academic rigor**.**

There are two potential motivators for participation in PT. First, PT has been described as a component of intensive parenting (Davies, 2004; Bray, 2005). This motivation can be applied to developed countries where parents invest human and social capital in their children that can generate long-term rates of return. Second, in developing countries such as Cambodia, Vietnam, and India, formal school teachers provide PT as a supplement to standard course curriculum. Students are often obligated to participate in this supplemental PT so as not to be held back (Bray, 2003). While these two incentives for PT are quite different, the common thread is that parents contemplate the costs and benefits for their children when making the decision to consume PT or not.

In South Korean society, negative effects of PT are seen in terms of equity and social cohesion in that PT potentially aggravates educational disparities across different income brackets by giving partial access to extra resources of education and information. In particular, the 1st income quintile of Korean households spends, on average, $903[2] per month on PT while the 5th income quintile spends only $106 per month. In 2001, the upper income bracket spent 7.6 times more on PT than the lower income bracket and increased to 8.6 times more by 2004 (Yang, 2006). This shows a clear exacerbation of the polarization of the consumption of PT.

Until now, several research studies on PT have focused on the empirical analysis of the

[1] In Cyprus, 85% of secondary school students received PT in 2003 (Bray, 2005). In Kenya, 68.6% of students among 3,233 6th grade students received PT (Bray, 2005). In Zimbawe, a survey of 2,697 6th graders in all nine regions reported that 61% received PT in 1997 (Bray, 1999). A recent study of 3,000 primary and secondary school students in England found 27% had a private tutor (Ireson and Rushforth, 2004). 24% of parents with school-aged children in Ontario, Canada have recently hired tutors (Livingstone et al., 2003). In a survey of nearly 90,000 university students in Eastern Europe and Mongolia, the majority of students (69%) reported having received some type of supplementary tutoring during their last year in secondary school (Silova and Bray, 2005).

[2] Exchange rate is $1=₩927 (Bank of Korea, 2007, 4, 10).

determinants of expenditure or participation in PT. However, the theoretical basis of PT has yet to draw the attention of the academic community. Among existing literature, Biswal's (1999) research is the sole study that explains that PT in developing countries is considered as a form of corruption where public school teachers have monopolistic power to force consumption of PT in order to compensate for their low salaries. The study used a game theoretical framework with three stages and three players--the government, teachers, and students--in which PT was characterized as a club good and focused on the social and structural problem of suppliers' inducements of demands for PT in developing countries. Yet, while Biswal (1999) proposed a theoretical framework for developing countries, there has been no definitive theoretical model to explain the motivation of PT from the standpoint of East Asian countries.

In general, economists explain the demand for education using two approaches--Human Capital Theory and Signaling. The main difference between these two approaches centers on whether or not education increases productivity. Based on insufficient evidence to explain the positive effects of PT on productivity[3], the function of PT[4] as discussed in the present paper is assumed to be close to that of education as a signal. In this respect, PT is confined to short term return, especially PT for achieving higher scores on the College Scholastic Ability Test (CSAT) and not in increasing the productivity of students in the labor market. If one assumes that some kinds of PT do not enhance student productivity, there is similarity between parents' motivation to choose PT for their child and Spence's signaling hypothesis. In addition, the signaling model has comparable assumptions with Thurow's job competition model in that higher education is not considered to improve students' productivity in the labor market.

[3] There is no formally documented or accepted evidence that shows causality between PT and productivity in the labor market. However, some research conducted in Korea shows that PT emphasizes rote-learning, memorization, and repeated drills while excluding high-level mental processes such as critical reasoning, creative thinking, interactive communication, and self directed learning, which are considered important components in the future labor market (Kim and Kim, 2002; Lee et al., 2004).

[4] Generally, PT is classified in two ways according to its purpose. First, PT for long-term return is to improve skills in areas such as art, music, English, and gym for kindergarteners and elementary school students as an accumulated human capital. Second, PT for short term return is to prepare primary and secondary school students for the entrance examination. These kinds of PT are composed of cramming and memorization of simple facts, where their consumption is to gain a higher score on the College Scholastic Achievement Test. The definition of PT in prior studies (Bray, 1999, 2003) focuses on PT to obtain high scores in entrance examination and explains three characteristics of PT. First, PT is concerned with academic subjects (e.g. languages and mathematics) taught in mainstream schools. Second, PT is motivated by private tutors and companies that employ tutors for profit. Finally, PT is supplemental to mainstream schooling and is supplied during extra school hours.

By observing parents' consumption behavior for PT, differences in the characteristics of demand for PT compared to formal education emerge. In reality, parents do not have objective and empirical information on the effectiveness of PT (Yang, 2004). Instead, as economic agents, they construct the cost-benefit of the outcomes of PT by obtaining purchasing guidelines through their own experience or by using information from other parents' decision making to govern their decisions. In this respect, parents' demand for PT cannot be explained by traditional economic decision making theory.

Neoclassical consumer theory has not accepted the assumption that economic agents take into account other consumers' behaviors (Gintis, 1974; Manski, 2000). However, parents' demand for PT contains characteristics of inter-dependent demand influenced not only by their own preferences for university education and PT, but also by those of other parents. To further analyze parents' demand for PT, a non-cooperative game theoretical approach is warranted because in non-cooperative games, two or more players simultaneously decide on a strategy among the players' own strategy set, and the utility of each player is determined by the strategies and actions chosen by the other players.

The purpose of this study is to better understand the demand for PT through a non-cooperative game framework to explain the demand side of parents' motivation to consume PT. It also attempts to describe the characteristics and implications of PT game models. In effect, this paper is an initial effort towards a theoretical understanding of parents' decision making on participation in and expenditures on PT.

The remainder of this paper is organized into three sections. Section 2 describes two well-known economic models, Spence's market signaling model and Thurow's job competition model, which can be incorporated into PT game models, and introduces the relationship between the scoring system and PT in South Korea. Section 3 presents two theoretical PT game models. Finally, Section 4 offers suggestions for policies and further research.

Ⅱ. Prior Models and Private Tutoring in South Korea

1. Prior Models: Spence's market signaling and Thurow's job competition

From the perspective of Human Capital Theory, education increases the productivity of the person and the payoff in the future labor market. However, it is in contradiction to Spence's market signaling model and Thurow's job competition model, where education functions as a market signal which distinguishes the person with a particular credential from others with lower or higher credentials in the labor market. As mentioned above, PT follows the same assumption with the purpose of education as in these two models. Moreover, these models demonstrate the rationale of why some parents have a strong propensity for investing more in their children's education than others. Additionally, similarities between these two models clarify parents' desires to obtain more education for their children as a market signal.

According to Spence's signaling model, the underlying cause of signaling is asymmetric information between potential employers and employees. Usually, employers are not able to observe potential employees' skills and productivity, so education level is used as a means to estimate ability and potential. The key presumption is that education does not improve employees' productivity, but that the cost of the signal is negatively correlated with the productivity that is valuable to employers (Spence, 1974). More distinctive signals increase the probability of acquiring competitive advantages in the job market. Consequently, overeducation arises when there is a signaling equilibrium under which it is optimal for individuals to invest in more education than is exactly required to perform their career-related tasks (Spence, 1974). This model infers that there is a Pareto inferior signaling equilibrium where systematic overeducation occurs when the cost of education is low or when employees' or employers' anticipations about degree of education are escalated.

Thurow's job competition model is consistent with Spence's model where labor queue is a key item in the model. An individual's background characteristics, such as education and experience, are used to place one in a labor queue and that individual's relative position becomes more important than his or her absolute positional status. Based upon one's relative

position in this queue, he or she will be selected for a different job or training opportunity. In the labor queue, workers are ranked by their potential training cost for the firm. It is presumed that formal education and job training supplement employer's cost of training, that is, the employer is economically rational. Increases in the number of individuals with more favored background distinctions can lead to corrosion in the expected earnings of less preferred groups (Thurow, 1975). Therefore, education functions as self-protection of one's market position. However, the private reasonableness of such defensive expenditures can undoubtedly entail excessive expenditures on education from the viewpoint of society as a whole.

2. Private Tutoring in South Korea

The conventional view among economists is that education adds to an individual's productivity and, therefore, increases the market value of his or her labor (Arrow, 1973). In regard to PT, there is no empirical research to substantiate the direct relationship between PT and productivity in the labor market. Despite this, the principle reason parents choose PT for their children is the belief that it will increase the probability of their children achieving high scores on the College Scholastic Ability Test (CSAT), thereby successfully gaining entrance into prestigious universities which, in turn, guarantees a greater return in the future (Jang, 2002; Lee and Kim, 2007).

Moreover, there is a strong tendency for competitive position in the decisions of South Korean parents in providing PT for their children (Yang, 2004). For example, parents whose child is preparing for the university entrance examination make their decision regarding PT by taking into consideration not only their limited budget and the priority PT has over other necessities, but also the impact of other parents' PT decisions regarding their children.

Two important determinants of successful university admission are high school achievement, based on a standardized ranking system with 15 levels[5] and the standardized score on the

[5] In South Korea, high school students are graded on a curve by a 15 ranking system. The ranks are composed of 1st rank (0.00~3.00%), 2nd rank (3.01~6.95%), 3rd rank (6.96~11.85%), 4th rank (11.86~17.74%), 5th rank (17.75~24.63%), 6th rank (24.64~32.53%), 7th rank (32.54~42.42%), 8th rank (42.43~56.31%), 9th rank (56.32~66.21%), 10th rank (66.22~74.10%), 11th rank (74.11~80.99%), 12th rank (81.00~86.89%), 13th rank (86.90~91.78%), 14th rank (91.79~95.67%), and 15th rank (95.68~100.00%).

CSAT.[6] The relationship among PT, the test score, and admission to prestigious universities can be expressed as follows:

$$P(PA) = f(SAT), \qquad f(SAT) = g(A, PT) \tag{1}$$

where 'P(PA)' is the probability to gain admission into prestigious universities, 'SAT' is the CSAT score, 'A' is the ability of the student and 'PT' is the amount of PT that the student receives before the examination.

In South Korea, the most prestigious universities are all private with the exception of Seoul National University.[7] The difference in tuition between public and private universities is shown in Table 1, where the mean yearly tuition fee for private universities is about 1.5 times more than that of national and public universities. However, despite this difference, this higher tuition does not significantly affect parents' preference for top ranking private universities.

It is well known that there is a gap in the return between high school graduates and college graduates. Additionally, wages differ between graduates from prestigious universities and those from less prestigious universities (Han and Han, 2006). Compared to the monthly wages of middle school graduates, monthly wages of high school graduates are 20% higher, those of college graduates are 30% higher, and those of university graduates are 60% higher. Additionally, graduates from local public and private universities earn 60% higher wages, those from the private universities in Seoul earn 70% more wages, and those from the top prestigious universities earn 130% higher wages when compared to those of middle school graduates. These results reveal that the higher compensation for graduates from top universities creates an environment of "winner takes all."[8] This wage differential may reflect the difference of

[6] The College Scholastic Ability Test (CSAT) is composed of language, math, social science (society), science, and foreign language areas. Each area is worth 200 points, with a total score of 800. The College Scholastic Achievement Test score and the high school record are the most important determinants for university admission.

[7] Among the 175 universities in South Korea, 150 are private universities and 25 are public or national universities. In Seoul, where all of the prestigious universities are located, there are three national or public universities and 35 private universities.

[8] Similarly, Brewer et al. (1999) found that, even after controlling the selection effects, there was an indication of a large labor market premium to attending an elite private institution and a smaller premium to attending a middle-rated private institution, relative to a lower-rated public school. Further, the return of those from elite private colleges increased significantly for the 1980 cohort as compared to the 1972 cohort. However, a study by Dale and Krueger (1999) showed that students who attended more selective colleges do not earn more than other students who were

accumulated human capital among graduates from these two different levels of universities.

However, it is plausible that between two graduates from two different universities, but with the same amount of human capital, H, the student from the more prestigious university will receive higher rewards than the other student from the less prestigious university. This implies that the wage function contains not only the individual's human capital level, i.e., his or her productivity, but also another determinant, R, that is, the title of the university attended. The wage function is represented as follows.

$$W = W(H, R), \quad W_H > 0, \; W_R > 0 \tag{2}$$

In reality, the variable R shows statistical significance and the sign of coefficient of W_R is positive. R includes the title of the socially prominent top university students graduated from. The rationale of why many parents are preoccupied with preference to top-class universities may be in the subsistence of social rent, that is, the fact that $\partial W / \partial R > 0$. This occurrence is viewed as a serious divergence from the principle of "performance-based reward" illustrated as $\partial W / \partial R = 0$. Generally, this wage function governs South Koean society and engenders parents' ardor for a first-class university. In this regard, relationships between the high school scoring system, wages in the future labor market, and PT in South Korea can be compared to Thurow's job queuing model (1975). This is because students are in the score queue and are waiting for the position queue which is assigned by the prestige and popularity of their major, which guarantees better job prospects and higher economic and social rents after graduation.

To get ahead in the scoring queue, students need to score higher than others, and consequently, receive PT to identify themselves with higher signals. In other words, PT that other children receive can influence a child's relative position in the score queue and his/her high school record calculated by a percent scale which, in turn, will affect the relative ranking of the child and impact whether or not the child will successfully be granted admission into a prestigious university.

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accepted and rejected by comparable schools but attended less selective colleges. These two studies showed reverse results of labor market return by college type and Brewer et al. (1999) found similar results with Han and Han's (2006) study of Korean graduates**.**

Ⅲ. Theoretical Models of PT

In this section, two game models are presented. The first model is similar to the Prisoner Dilemma Game[9] in that it is based on strong assumptions, the symmetrical characteristics of the players, and the same payoffs to the players. The second model is more generalized by allowing the asymmetric characteristics of the players, such as different children's achievements, parents' incomes, and desires to enroll their child into a university.

1. PT Game Model 1: Symmetrical Characteristics of Parents

1.1. Structure

PT game model 1 describes decision making on participation in PT by two parents whose children are third-year high school students planning on taking the CSAT in the hypothetical "Country of PT." "Country of PT" is made up of two families, Parent A and Parent B. In the "Country of PT," there is only one admission slot where the two families believe PT will result in their child's greater success on the exam. In reality, the PT game is a multi-person game. However, this study assumes a two-person game so that the theoretical models can be developed more conveniently with less calculation.

1.2. Symmetry

Parent A and B have the same income levels and both families have a child in the third year of high school with similar academic achievement.

1.3. Full information

Both parents have general knowledge of the other parent's strategy and also have specific knowledge of all possible outcomes caused by choosing a certain strategy. Each parent also knows the other parent's choice as soon as it is made and the other parent behaves rationally in

[9] The prisoner's Dilemma (PD) is a type of non-zero sum game in which two players can "cooperate" with or "defect" the other player. In this game, as in all game theory, the only concern of each individual player ("prisoner") is maximizing his/her own payoff, without any concern for the other player's payoff. The unique equilibrium for this game is a Pareto-suboptimal solution—that is, rational choice leads both players to play defect even though each player's individual reward would be greater if they both played "cooperate" (Kreps, 1997). The Prisoners' Dilemma is a symmetric game where one player's payoffs can be expressed as a transpose of the other player's payoffs.

making his/her decision.[10]

1.4. Strategy Set and Payoff

The parents' strategy set is {PT, No PT}. The payoff of the game is composed of monetary and non-monetary benefits of graduation from universities and the cost of PT. The payoffs of both parents are similar for each strategy, 'PT' or 'NO PT'. Each parent will decide whether or not to consume PT according to the expected payoff calculated by the following method.

$$EW = P \bullet W + (1 - P) \bullet 0 - C \qquad (3)$$

Here, 'EW' is the parents' expected payoff. 'P' is the probability to succeed on the entrance exam. 'W' is the benefit of the parent whose child succeeds on the entrance exam. '0' means the benefit of the parent whose child fails the entrance exam. Finally, 'C' is the cost of PT. Parents can spend 'C' or '0' to finance PT.

In the situation where a parent spends '0' and the other parent spends 'C', the probability that the second parent's child will be accepted into university is '1'. If both spend either 'C' or '0', their children each have the same probability of '0.5'. The payoff matrix constructed by the combination of benefit, cost, and probability mentioned above is shown in Figure 1.

The parameters of 'W' and 'C' are important elements that decide the level of PT expenditures for parents. Based on these values, the following three possible values in Table 2 are derived.

From Table 2, C(A)|C(B) means that Parent A's choice is affected by Parent B's. The Nash Equilibrium derived from the comparison of 'W' and 'C' is as follows:

First, where W > 2C as in [Case 1], PT becomes the dominant strategy for Parent A and Parent B and, therefore, the Nash Equilibrium is achieved when they both spend 'C'. In other words, this Nash Equilibrium is suboptimal, as in the Prisoner's Dilemma Game. In this case, both parents' decision is to purchase PT as long as the benefits of being accepted into a

[10] In Game Theory, an item of information in a game is common knowledge if all of the players know it (it is mutual knowledge) and all of the players know that all other players know it and all other players know that all other players know that all other players know it, and so on. This is much more than simply saying that something is known by all, but also implies the fact that what is known is also known by all, etc. (Dixit and Skeath, 1999).

university exceed twice the cost of PT.

Next, where W=2C as in [Case 2], there is no pure dominant strategy for Parent A and Parent B. In this instance, both parents will choose ‘C’ or ‘0’ regardless of the decision made by the other.

Finally, where W < 2C as in [Case 3], ‘NO PT’ becomes the dominant strategy for Parent A and Parent B and the Nash Equilibrium is formed in a situation where they both spend ‘0’. In other words, the balance is formed in a Pareto-optimal condition. If the benefit from being accepted into a university is smaller than twice the cost of PT, the dominant strategy for both parents is ‘NO PT.’

2. PT Game Model 2: Asymmetrical Characteristics of Parents

The PT game model 1 is based on the strict assumption that both parents' payoffs are the same because of their children’s similar academic achievements and the parents’ similar preferences for education. However, what happens if there are differences in the children's achievements, parents' incomes, and preferences for education? A PT game model with less stringent assumptions is developed below.

2.1. Structure

The basic structure of asymmetrical PT game model is similar to the PT game model 1. Two parents with different desires want their children to enter university. If neither parent purchases PT, under the public education system, a student with more ability will be granted admission to a university. However, there is a possibility that a student with less ability will be able to enter a university by utilizing PT. If parents spend the same amount of money on PT for their children, the child with greater ability will enter university. Parents will expend the cost of PT from their incomes.

2.2. Asymmetry

Some specific assumptions about expenditures on PT, the ability of children, and preferences to enter a university are:

1) Expenditures on PT: Parents spend some portion of their income on PT, m_i $(i = 1,2)$ and parents' income is $M_i (i = 1,2)$. At this time, a parent knows the other family's income. Parents' expenditure on PT cannot exceed their income. Therefore, strategy set is given as $[0, M_i]$.
2) Ability: The abilities of the children are defined as $a_i (i = 1,2,\ \ 1 < a_i < 2)$. The ability of a child is independent from that of the competing child. A parent is not sure of the ability of the other child; however, it is known that it follows a uniform distribution between 1 and 2.
3) Utility: Utility earned by gaining admission to a university, W_i, differs in proportion to parents' preference to send their child to a university. Additionally, to enter a prestigious institution, '(1+expenditure on PT) × (child's ability)', one parent's value of $'(1 + m_i) \bullet a_i'$ should be greater than that of the other parent's. In this case, the number '1' was added to explain that entrance into college is determined only by the child's ability when the parent does not consume PT. If the children have the same ability, their college entrance probability will be 1/2. Naturally, parents of a child who fails the entrance examination will see no return on their investment.

From the above assumptions, the utility functions of the two parents are as follows.

$$u_1(m_1, m_2) = \begin{cases} -m_1, & (1+m_1)a_1 < (1+m_2)a_2 \\ W_1/2 - m_1, & (1+m_1)a_1 = (1+m_2)a_2 \\ W_1 - m_1, & (1+m_1)a_1 > (1+m_2)a_2 \end{cases} \quad (4)$$

$$u_2(m_1, m_2) = \begin{cases} -m_2, & (1+m_2)a_2 < (1+m_1)a_1 \\ W_2/2 - m_2, & (1+m_2)a_2 = (1+m_1)a_1 \\ W_2 - m_2, & (1+m_2)a_2 > (1+m_1)a_1 \end{cases} \quad (5)$$

The expected utility of Parent 1 is $EU_1(m_1, m_2)$ and that of Parent 2 is $EU_2(m_1, m_2)$.[11]

$$EU_1(m_1, m_2) = \frac{1}{(1+m_2)}\{(W_1 a_1 - 1 - m_2)m_1 + W_1(a_1 - (1+m_2))\} \quad (6)$$

$$EU_2(m_1, m_2) = \frac{1}{(1+m_1)}\{(W_2 a_2 - 1 - m_1)m_1 + W_2(a_2 - (1+m_1))\} \quad (7)$$

2.3. Optimal Strategy of Parent 1, m_1^* and Optimal Strategy of Parent 2, m_2^*

Optimal strategy of Parent 1 is m_1^*. m_1^* is derived by maximizing the equation (6) given m_2^* and optimal strategy of Parent 2, m_2^* is obtained by maximizing the equation (7) given m_1^*.

$$m_1^* = \begin{cases} 0 & if \quad W_1 a_1 < 1 + m_2 \\ m \in [0, M_1] & if \quad W_1 a_1 = 1 + m_2 \\ M_1 & if \quad W_1 a_1 > 1 + m_2 \end{cases} \quad (8)$$

$$m_2^* = \begin{cases} 0 & if \quad W_2 a_2 < 1 + m_1 \\ m \in [0, M_2] & if \quad W_2 a_2 = 1 + m_1 \\ M_2 & if \quad W_2 a_2 > 1 + m_1 \end{cases} \quad (9)$$

Equation (8), which is the optimal strategy of Parent 1, m_1^* can be expressed by Figure 2 and Figure 3. Likewise, m_2^* can be illustrated in the space of m_1 and m_2 shown in Figure 4 and Figure 5.

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[11] $EU_1(m_1, m_2)$

$= (-m_1) \bullet P\{(1+m_1)a_1 < (1+m_2)a_2\} + (W_1/2 - m_1) \bullet P\{(1+m_1)a_1 = (1+m_2)a_2\} + (W_1 - m_1) \bullet P\{(1+m_1)a_1 > (1+m_2)a_2\}$

$= W_1 \bullet P\{(1+m_1)a_1 > (1+m_2)a_2\} - m_1$

$= (\frac{1+m_1}{1+m_2}a_1 - 1)W_1 - m_1$

$= \frac{1}{(1+m_2)}\{(W_1 a_1 - 1 - m_2)m_1 + W_1(a_1 - (1+m_2))\}$

2.4. Nash Equilibriums of the PT Game

By combining Figures 2 through 5, we can derive the following Nash Equilibriums seen in Figures 6 through 9. For example, Figure 6 is derived by associating Figure 2 and Figure 4. Similarly, Figure 7 is obtained from Figure 2 and Figure 5. The Nash equilibrium is formed in the circle, the point where the two players' optimal strategies are met. The interpretation of each Nash equilibrium is as follows:

Under the condition where desires, ability, and income are common knowledge, the Nash Equilibriums of the players' strategies are the points where the optimal correspondence curves meet. For instance, as shown in Figure 6, in [Case1], Nash equilibriums (m_1^*, m_2^*) are formed at three points, $(0, M_2), (W_2 a_2 - 1, W_1 a_1 - 1), (M_1, 0)$.

First, [Case1] is the situation where each parent's level of income is above the threshold. Thus, the Nash equilibrium is at the point where both parents spend some portion of their income on PT or only one parent spends money for PT. For the income of Parent 1, M_1 is higher than $W_2 a_2 - 1$ and for the income of Parent 2, M_2 is higher than $W_1 a_1 - 1$.

Here, $(W_2 a_2 - 1, W_1 a_1 - 1)$ is a realistic equilibrium where both parents spend some portion of their income. An interesting fact at this equilibrium is that the expenditure on PT is not determined by one parent's income or the child's ability; instead, it is determined by the other parent's preference and the ability of the child. After all, as one parent has a higher preference for education and has a child with higher ability, the burden of PT expenditure for the other parent increases.

Second, in [Case2], (0, M_2), and in [Case3], (M_1, 0), where the other parent's preference for education and the ability of the other child is higher than that of the first, the Nash equilibrium manifests when one parent gives up consuming PT and the other parent spends all of his or her disposable income on PT. This Nash equilibrium reveals an inequitable resource allocation for PT that results from one parent's unilateral advantages in terms of background characteristics.

Third, [Case4] shows that parents' preference for education and children's abilities are both high. In this situation, the Nash Equilibrium is formed where the two parents spend all of their

income on PT, meaning that parents with high preferences for education and children with high ability spend their earnings for exhaustive and defensive competition.

In [Case1] and [Case4], salient features of these models are that the dominant strategy is to spend money on PT and the Nash Equilibriums finally manifests at (PT, PT) just as in the previous simple PT game models.

The theoretical model presented here suggests that the prevalence of PT in South Korea occurs as the result of four factors. First, as income rises, the demand for PT also rises. Second, the higher the child's ability, the greater the demand for PT. Third, the greater the parents' desire to put their child into a prestigious university, the demand for PT will increase. Fourth, one parent's demands for PT are affected by other parent's desire and, ultimately, by other parent's demand for PT. Based on the above model, parent's expenditures on PT is influenced by other parent's income, the other child's academic achievement, and, ultimately, by other parent's expenditure on PT.

The two PT game models, Spence's Market signaling and Thurow's job competition model, are connected in that signaling in the job market with imperfect information, the structure of the labor queue, and the composition of the university ranking are similar. In these models, limited positions are available for applicants and that they should receive more education (regardless if it is university education or PT) to show their eligibility for the position they desire. In the PT game, students receive a higher score on the CSAT as a result of PT while in the job competition model, people show their credentials as the result of their education. These models predict that excessive education persists, which creates economic costs in the form of excessive investments in PT, inefficiencies in educational resource allocation, and increased income inequalities in the labor market.

Ⅳ. Conclusion

First, from an individual perspective, every South Korean parent and student is able to dedicate restricted time and fiscal resources to PT. However, from the perspective of the South Korean society as a whole, PT can be explained by the problem of "fallacy of composition."

Only a small portion of students are admitted to the prestigious university that they desire; the majority of students end up at their second or third choice, or possibly at none at all. As shown from the two PT game models, as long as the received benefit of PT is greater than parents' economic encumbrance of expenditure on PT, all parents in the PT game have an incentive to invest in PT, forcing all players (i.e., Korean society as a whole) to be caught in a low-welfare, over-investment equilibrium.

Second, given the nature of the non-cooperative game, the PT game should be modified to be a cooperative game in which players can enforce contracts through outside parties. All individuals involved in the PT game play rationally under their respective incentive schemes. In a two-person game, the Prisoner's Dilemma can be avoided when one player who plays the game from a third party's perspective, or the intervention of the third party, can change the pay-off matrix of the game. When a large number of players fully conversant with the rules of the PT game are involved, it becomes more likely that a deficient equilibrium will be evaded. In this respect, the government should correct the public's distorted perception of education and the academic elite through reform in the social system and lowering the economic rent enjoyed by successful graduates of prestigious universities in South Korean society. More concretely, the wage gap between graduates from prestigious universities and those from less prestigious universities, which is attributed to social rent, should be attenuated by using a performance based reward system. Additionally, graduates from the less prestigious university need more opportunities to highlight their productivity by making the firms and public institutions provide more internship programs and intensify the vocational guidance courses in the less prestigious universities.

Finally, as shown in the asymmetrical PT game model, parents and students who come from disadvantaged backgrounds usually end up giving up the PT game**.** In this respect, PT can bring about a great inequality between households with different income levels due to variations in marginal substitution rates between PT and other goods. Therefore, the government should support low income and low achieving students by developing an affordable substitute to PT.

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FIGURES

		Player (Parent B)	
		PT	**NO PT**
Player (Parent A)	**PT**	$(W/2-C,\quad W/2-C)$	$(W-C,\quad 0)$
	NO PT	$(0,\quad W-C)$	$(W/2,\quad W/2)$

Figure 1: Payoff Matrix of PT Game Model 1

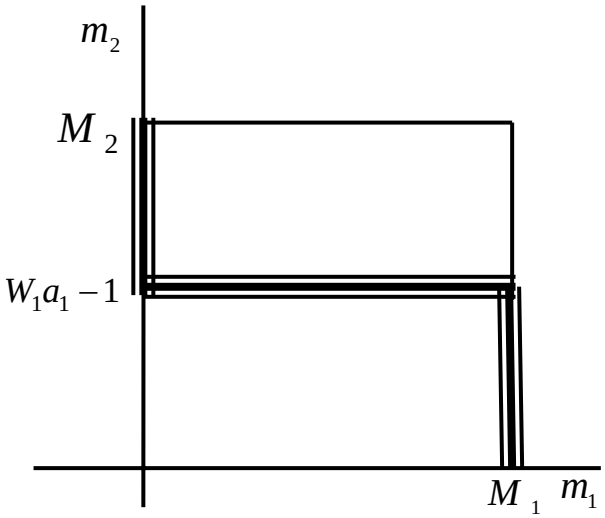

Figure 2: $W_1a_1 - 1 < M_2$

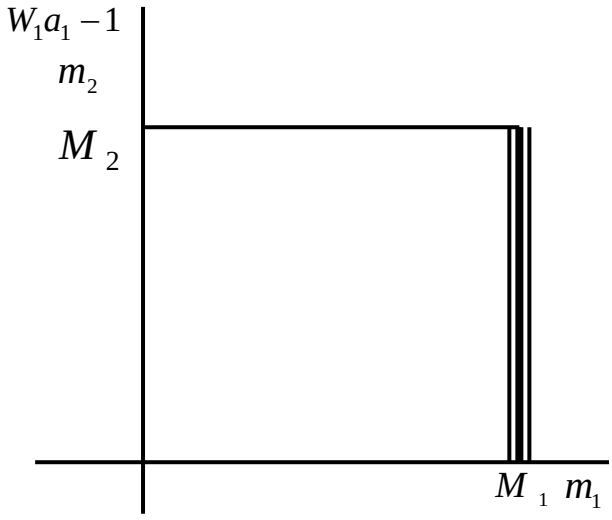

Figure 3: $W_1a_1 - 1 \geq M_2$

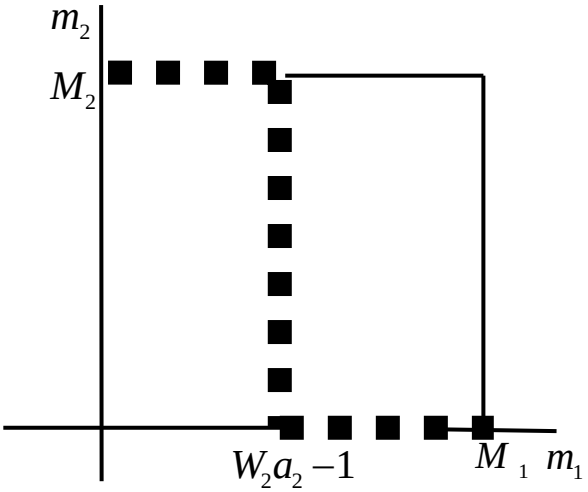

Figure 4: $W_2a_2-1<M_1$

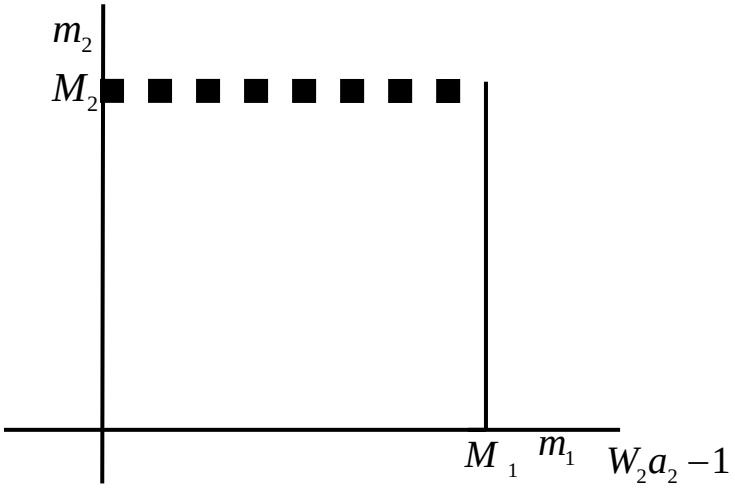

Figure 5: $W_2a_2-1\geq M_1$

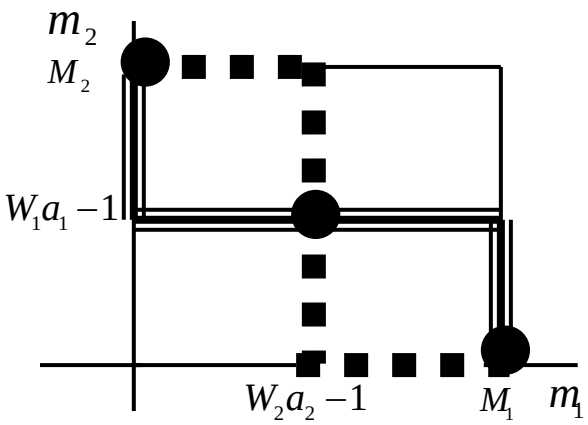

Figure 6: [Case 1] $W_1a_1-1<M_2$, $W_2a_2-1<M_1$

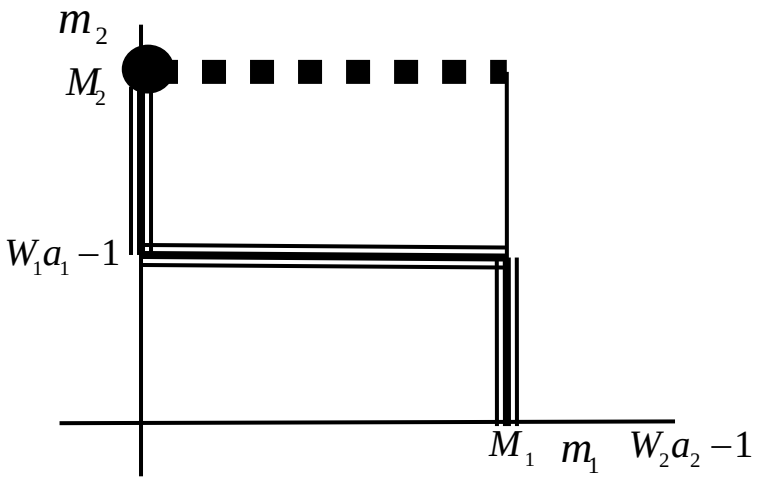

Figure 7: [Case 2] $W_1a_1-1<M_2$, $W_2a_2-1\geq M_1$

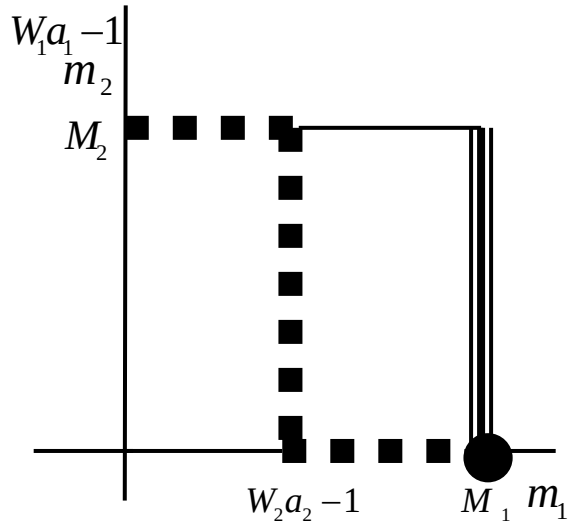

Figure 8: [Case 3] $W_1a_1-1 \geq M_2$, $W_2a_2-1 < M_1$

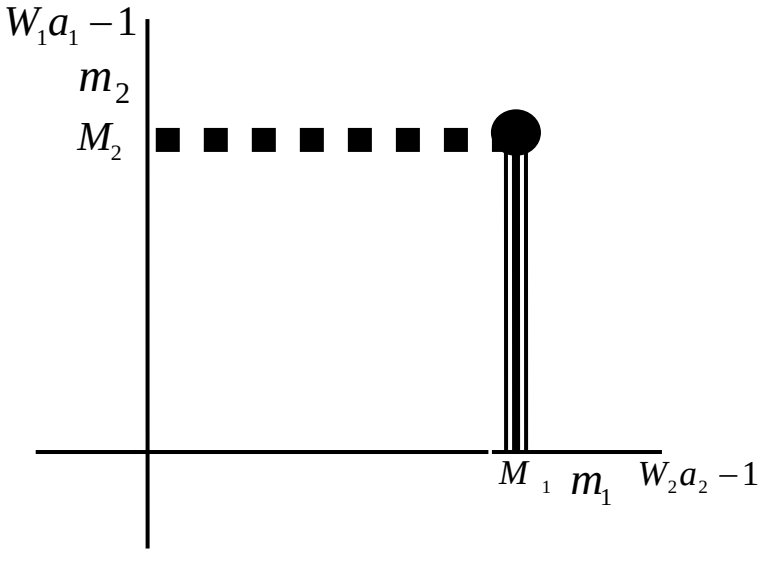

Figure 9: [Case 4] $W_1a_1-1 \geq M_2$, $W_2a_2-1 \geq M_1$

TABLES

Table 1.

Annual Tuition Fees in Universities (per student)

Unit: ₩ / ($)

Major	National & Public Universities	Private Universities
Humanities & Social Sciences	4,415,500 (4,768)	5,082,000 (5,488)
Natural Sciences & Physical Education	5,235,500 (5,654)	6,915,000 (7,468)
Engineering	5,129,500 (5,539)	7094000 (7,661)
Medical	4,739,500 (5,177)	10,033,500 (10,835)
Total	4,893,910 (5,285)	7,281,138 (7,863)

Source. Ministry of Education (2006). Educational Indicators in South Korea
Note1. Number is calculated on the basis of tuition of freshmen.
Note2. Number includes admission fee, tuition fee and supporting fee.

Table 2.

Optimal strategy by the payoff matrix

Case	Conditions	Optimal Strategy
[Case 1]	$W > 2C$	$C(A)\,\|\,[C(B) = C] = C$ $C(A)\,\|\,[C(B) = 0] = C$
[Case 2]	$W = 2C$	$C(A)\,\|\,[C(B) = C] = C$ or 0 $C(A)\,\|\,[C(B) = 0] = C$ or 0
[Case 3]	$W < 2C$	$C(A)\,\|\,[C(B) = C] = 0$ $C(A)\,\|\,[C(B) = 0] = 0$