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Private Tutoring, Studying Alone, and Labor Market Performance*

Seik Kim**

This paper investigates the effects of supplementary education during high school years, such as private tutoring and studying alone, on post-school labor market performance. Using a representative longitudinal sample of Korean high school seniors in 2004, we find that studying alone has a positive effect on wages after controlling for college entrance exam scores, but private tutoring does not. This implies that private tutoring does not directly affect earning potential, although it may do so indirectly by raising test scores. We also find that both self-directed learning and self-study directed by others are effective for enhancing post-school labor market productivity.

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** Professor, Department of Economics, Korea University, 145 Anam-Ro, Seongbuk-Gu, Seoul 02841, Korea. E-mail: seikkim@korea.ac.kr

1. INTRODUCTION

In many countries, private tutoring is a popular means of supplementing the education delivered by schooling. Extra lessons may help to raise test scores and perhaps enhance earning potential.[1] Previous studies, however, report mixed evidence regarding the effectiveness of private education, or additional instruction beyond regular school hours. In addition, their focus has been limited to academic outcomes. For example, evidence from India in Banerjee *et al*. (2007), from Israel in Lavy and Schlosser (2005), from Japan in Ono (2007), and from Vietnam in Dang (2007) supports a positive effect on exam scores, matriculation rates, or college admissions. In contrast, the studies from the United States in Briggs (2001) and Jacob and Lefgren (2004), from Turkey in Gurun and Millimet (2008), from China in Zhang (2013), and from Korea in Kang (2009) and Ryu and Kang (2013) find mixed or little evidence of private lessons improving academic performance.

This paper explores the effect of supplementary education during high school years on labor market performance after high school graduation using a representative longitudinal sample of Korean high school students.[2] Specifically, we investigate how post-school wages are affected by the quality and quantity of supplementary education while in high school. Supplementary education in this paper includes private tutoring and studying alone, probably the most influential sources of extra human capital other than schooling.[3] The causal relationship between past human capital investments and future labor market outcomes can be explained by the theory of human capital. Consider individuals who possess the same amount of human capital at the time of high school graduation. They are expected to be equally productive when first entering the labor market. In the following

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[1] Bray (1999) and Dang (2013) provide a detailed overview of the shadow education system.
[2] Few papers focus on the labor market outcomes. For example, Park (2015) investigates the effect of private tutoring in the eleventh grade on the duration of job search for the first job after one's completing education.
[3] Go (2013) investigates whether private tutoring substitutes for self-motivated study.

years, however, they may exhibit different earning paths depending on how efficiently they subsequently accumulate human capital. This efficiency is represented by the marginal product of the human capital production function. This paper analyzes whether the efficiency of human capital accumulation after high school graduation can be explained by the quality and quantity of supplementary education carried out before high school graduation.

Supplementary education can affect labor market outcomes through two possible channels. One affects wages indirectly by influencing college entrance exam scores. The other affects wages directly after controlling for college entrance exam scores. Both effects of supplementary education on post-school wages can be estimated by adjusting a standard log wage equation. The wage equation in this paper takes college entrance exam scores as a proxy for the stock of human capital at the time of high school graduation. Labor market experience is measured by years since high school graduation. Controlling for exam scores enables us to determine whether tutoring and self-study have long-term effects on post-school productivity. These long-term effects are direct effects since the effect of the stock of human capital at the time of high school graduation is accounted for by controlling for college entrance exam scores. This direct effect is interpreted as the *improved productivity effect* as it suggests an efficiency gain in the human capital production process. The direct and indirect effects combined can be estimated by specifying a college entrance exam equation and substituting it into the wage equation. If only the indirect effect exists, supplementary education raises human capital by placing an additional input into the human capital production function. In this sense, the indirect effect is interpreted as the *extra input effect*.

For our analyses the Korean educational environment provides an excellent research opportunity for the following reasons. First, most Korean high school students take a common national level college entrance exam and decide which colleges to apply for based on their exam scores. Second, private tutoring is prevalent in Korea. For example, as we find in the descriptive statistics, a high school student on average spends approximately

one tenth of household income on private education. Third, representative panel data of high school seniors allows us to address several other questions regarding the roles of private tutoring and self-study. These questions include whether tutoring quality should be prioritized over tutoring quantity, whether self-directed learning is more effective than self-study directed by others, and whether workplace productivity depends more on studying alone than on private education.

The paper proceeds as follows. Section 2 introduces the data and discusses descriptive statistics to provide a better understanding of the Korean educational environment and labor market systems. Section 3 lays out the theoretical foundation of our hypotheses and proposes empirical specifications accordingly. Section 4 presents the estimation results and analyzes the main findings of this paper. Section 5 concludes.

2. THEORETICAL FRAMEWORK

2.1. Supplementary Education and Human Capital

Supplementary education during high school is expected to affect post-school wages indirectly through influencing college entrance exam scores. Whether supplementary education has a direct effect on future wages is a more complicated problem. The question of whether a direct effect exists or not is related to the question of whether private tutoring or studying alone can influence the shape of the post-school human capital production function. To verify that there is a direct effect, we must compare two students who have the same stock of human capital at the time of high school graduation, but have different experiences in terms of supplementary education while in high school. Suppose that a high school student receives private tutoring or studies alone for extra hours to reach a certain level of human capital stock. One can think of at least two channels to reach that level. The first uses additional supplementary education as an extra input to the human capital production function. The target level can be achieved as the production

function is usually an increasing function. This is what we call the *extra input effect*. The second channel reshapes the production function by making it steeper so that the marginal product is increased. With a more efficient production function, an individual can acquire a larger amount of human capital from the same amount of input. This is what we call the *improved productivity effect*. Although both channels result in additional human capital, only the second one has a long-term influence on an individual's labor market productivity. The long-term influence can be interpreted as the direct effect of supplementary education on labor market productivity since the influence continues to exist after conditioning on the stock of human capital at the time of high school graduation. This property is the key to distinguishing the improved productivity effect from the extra input effect.

It is an empirical question whether private tutoring or studying alone can improve the production function itself rather than simply increasing the inputs to it. Moreover, depending on which of the two effects, the extra input effect or the improved productivity effect, dominates, the causal link between supplementary education and post-school labor market outcomes will be interpreted differently. These two effects can be separately analyzed by exploiting the possible heterogeneity in the production function. Suppose that the human capital production function and the amount of input to it are both homogeneous across individuals when regular schooling is the only way of human capital accumulation. Supplementary education is a source of heterogeneity in the human capital production function. Individuals' use of supplementary education is based on their learning ability or preference and on their parents' economic conditions. As a result, the human capital accumulation path is heterogeneous even among individuals who have the same amount of human capital at a certain point in time. To be more specific, consider individuals who graduate from high school possessing the same stock of human capital. They are expected to be equally productive at the time of high school graduation. In subsequent years, however, they may exhibit different earning potential paths depending

on how efficiently they continue to accumulate human capital. This is possible because while they enter the labor market possessing the same level of human capital, their production functions may have different slopes. The efficiency of human capital production depends on the slope of the production function at the point of evaluation. This slope heterogeneity of the production function is the key that our baseline specification is designed to capture.

2.2. Model Specifications

The baseline empirical specification uses a log wage equation with the following four key variables on the right hand side: private tutoring expenses, private tutoring hours, self-study hours, and college entrance exam scores. The expenses and hours spent on private tutoring are included to respectively represent the quality and quantity measures of private tutoring. The self-study hours reflect a mixture of the quality and quantity measures of studying alone. The effects of supplementary education during high school years on post-school labor market outcomes are identified by additionally controlling for college entrance exam scores. The test scores stand for the amount of human capital acquired by the time of high school graduation. By including these scores in the equation, one can examine whether tutoring and self-study have a direct effect on wages in addition to the indirect effect through raised test scores.

Our baseline specification is based on a standard log wage equation which controls for education and experience. The standard model is modified in two ways. First, the College Scholastic Ability Test (CSAT) score is used instead of the years of schooling completed. Second, years since high school graduation are used as a measure of experience. Since all the respondents graduate high school in the same year, a year dummy variable perfectly controls for the nonlinearity in experience. To account for the potential bias due to neglected ability factors, the model also includes preference and personality measures. Taking these together, the main specification is given by

$$\log wage_{it} = \beta_0 + \beta_1 CSAT_i + \beta'_T Tut_i + \beta'_S Self_i + \beta'_A A_i + \mu_t + \varepsilon_{it}, \quad (1)$$

where $CSAT_i$ is the College Scholastic Ability Test score, Tut_i is a vector of variables on private tutoring, $Self_i$ is a vector of variables associated with studying alone, A_i is a vector of individual specific characteristics including measures of preference and personality, and μ_t is a time dummy. The measures of supplementary education in (1) enable us to verify whether private tutoring and self-study have long-term effects on wages. These effects are the improved productivity effects since the indirect channel of supplementary education raising the CSAT score and that score in turn raising wages is separately estimated. The possible reverse causality due to supplementary education is ignorable in (1) as wages are realized after labor market entry while private tutoring and self-study are realized before. The direct effects of supplementary education on wages are captured by β_T and β_S.

The combined effect of the direct and indirect effects of supplementary education on post-school wages is also of interest. To estimate the overall effect, the causal link between supplementary education and the CSAT score needs to be incorporated into (1). We specify the CSAT score as a function of private tutoring and studying alone as well as individual characteristics and the socioeconomic and biological influences of parents:

$$CSAT_i = \delta_0 + \delta'_T Tut_i + \delta'_S Self_i + \delta'_P Fam_i + \delta'_A A_i + v_i, \quad (2)$$

where Fam_i is a vector of variables related to parents or family. Substituting (2) into (1), the reduced form equations are given by

$$\log wage_{it} = \gamma_0 + \gamma'_T Tut_i + \gamma'_S Self_i + \gamma'_P Fam_i + \gamma'_A A_i \mu_t + \nu_t + u_i. \quad (3)$$

The overall effect of tutoring and self-study on wages are reflected in γ_T and γ_S.

3. DATA AND DESCRIPTIVE STATISTICS

3.1. Overview of the Data Set

The Korean Education and Employment Panel (KEEP) is a longitudinal survey of individuals who were middle school, high school, or vocational and technical school seniors in 2004. The sample of high school seniors consists of 2,000 nationally representative individuals; 100 schools were selected from the 1,295 schools across the country that had more than 31 students at grade 11 in 2003, then 4 classes were chosen from each school, and finally 5 students from each class. The students were administered a variety of personal, family, and school-related questions. These students were interviewed every year, with their families, teachers, and school administrators also surveyed in selected years.[4)]

The high school senior sample is linked to administrative data for the 2004 College Scholastic Ability Test (CSAT). The CSAT is the annual national college-entrance examination in Korea and the results of the test are a major determinant of college admission. The test consists of Korean, mathematics, English, and a number of subjects in the natural sciences and social sciences. This paper uses the scores for the Korean, mathematics, and English sections because most students are tested on those subjects. Of the 2,000 high school seniors in the KEEP, 1,752 registered for the 2004 CSAT, with 99.0%, 90.1%, and 98.7% tested on Korean, mathematics, and English, respectively. These rates are consistent with the national average.[5)] Students receive their CSAT scores by subject in three different forms: the raw scores, the percentile scores, and the standardized scores.

The empirical analysis uses a subset of the original high school senior panel sample. First, 156 students do not meet the sampling criteria because

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[4)] For more details about the data set, refer to http://eng.krivet.re.kr/ from the Korea Research Institute for Vocational Education and Training, a government-funded research institute.

[5)] According to the Korea Institute of Curriculum and Evaluation, out of the national total of 574,218 students who took the 2004 CSAT, 98.9% were tested on Korean, 87.8% on mathematics, 99.3% on English, 34.0% on at least one natural science subject, and 59.1% on at least one social science subject.

they specialized in music, fine arts, or athletics, or chose vocational tracks. Excluding these students reduces the sample size to 1,844. Also excluded are 62 students who did not report household information, 206 students who did not apply for the 2004 CSAT, and 114 students who missed any of the three major subject tests. Finally, additional 33 students are removed because their household income or wealth information was missing. The resulting sample size for 2004 is 1,429.

3.2. Background on Private Education in Korea

Private education takes several forms in Korea. The KEEP asked students about their primary source of private education by subject during their second semester of 11th grade. Table 1 reports private education types by subject for the 1,429 students in the 2004 wave sample.[6)]

The most common type of private education is lessons provided by private profit-oriented educational institutes. These lessons are usually taught by professional instructors to a relatively small group of students in a classroom setting. Approximately one-fifth to one-fourth of the respondents listed these as their main source of private education. Another common type of private education is one-to-one or group lessons. These lessons are typically provided by professional instructors or undergraduate/graduate students at the student's home. One-to-one or group lessons were the

Table 1 Types of Private Education

	Korean	Mathematics	English
Private Educational Institutes	21.55%	24.77%	21.34%
One-To-One Lessons	3.01%	21.55%	11.97%
Group Lessons	1.75%	5.84%	3.92%
Home-Study Materials	1.89%	1.12%	1.82%
Internet Lessons	2.24%	1.89%	2.66%
In-School After-Class Lessons	1.05%	1.12%	0.91%
No Private Education	68.51%	43.81%	57.38%
Total	100%	100%	100%

6) For details about Korean public and private education systems, see Kim and Lee (2010).

primary sources of private education in mathematics for more than one-fifth of the responding students. A third form of private education includes home-study materials and internet lessons. For these types of lessons, self-study sheets may be delivered and graded by mail or over the internet. A less common form of private education is in-school after-class lessons. Overall, about 31% of the respondents in the sample engaged in some form of private education for Korean, compared to 56% for mathematics and 43% for English.

3.3. Descriptive Statistics of the First Wave Sample

Table 2 summarizes the descriptive statistics of the 2004 wave. The standardized scores of each subject in the CSAT are centered at 50 with a standard deviation of 10. The average standardized scores are obtained by taking the average of the standardized scores for the three subjects. The average standardized scores are more appropriate than individual subject scores because the data on private tutoring expenses and hours spent studying alone are not broken down by subject. The percentile scores of each subject range from 0 (the lowest) to 100 (the highest). The average percentile scores are the average of the percentile scores for the three subjects. As the sample is representative of the student population, both the standardized scores and the percentile scores have mean values of approximately 50.

Private tutoring hours are defined as the average weekly hours spent on private education. In the original sample, respondents were asked to choose from a list of time intervals, and the center of each interval is used in this analysis. The average student spent 5.8 hours on private tutoring a week. Private tutoring expenses given are average monthly expenses spent on private education. The overall average was 308,000 Korean won (261 U.S. dollars in 2003) a month.[7] Overall, 65.8% of the 1,429 grade 11 students have taken some form of private education.

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[7] 1,179.59 Korean won was 1 U.S. dollar in 2003. In 2011, 1,108.11 Korean won was 1 U.S. dollar.

Table 2 Descriptive Statistics for the 2004 Wave (Full Sample) vs. Sample of Employed in 2014

	Full Sample		Employed in 2014		Differences
	Mean	SD	Mean	SD	*t*-statistic
2004 Estimates					
Standardized CSAT Score	49.9	7.5	50.2	7.5	−0.90
Percentile CSAT Score	49.5	22.3	50.6	22.4	−0.99
Tutoring Hours (per week)	5.8	6.2	5.7	6.2	0.41
Tutoring Expenses (per month)	0.308	0.354	0.279	0.315	1.68
Received Private Education	0.658	0.475	0.648	0.478	0.42
Self-Study Hours (per week)	12.2	10.3	12.5	10.4	−0.63
Preference for Korean (1-5)	3.3	1.0	3.3	1.0	0.92
Preference for Math (1-5)	3.1	1.3	3.1	1.2	−0.50
Preference for English (1-5)	3.3	1.1	3.3	1.1	0.72
Determination (1-5)	3.2	0.9	3.2	0.9	0.76
Power of Execution (1-5)	3.1	0.8	3.1	0.8	0.95
Female (%)	43.8	49.6	44.8	49.8	−0.38
Science Track (%)	43.2	49.5	45.3	49.8	−0.85
Household Income (per month)	3.258	2.004	3.026	1.790	2.34
Household Wealth	174.3	266.1	162.1	275.8	0.89
Father's Education (years)	11.9	4.6	11.8	4.5	0.76
Mother's Education (years)	11.2	3.6	11.0	3.7	1.16
Father's Education (years)	11.9	4.6	11.8	4.5	0.76
2014 Estimates					
Graduated College			0.787	0.410	
Monthly Regular Salary			1.853	0.540	
Total Monthly Labor Income			2.115	0.690	
Weekly Regular Hours Worked			43.9	7.2	
Weekly Total Hours Worked			47.6	8.8	
Observations	1,429		525		
Male/Humanity	387 (27.1%)		135 (25.7%)		
Male/Science	416 (29.1%)		155 (29.5%)		
Female/Humanity	425 (29.7%)		152 (29.0%)		
Female/Science	201 (14.1%)		83 (15.8%)		

In table 2, self-study hours are the average reported weekly hours spent studying alone. Self-study hours do not include hours spent studying in school or taking private tutoring, but do include time spent on self-directed learning and homework from either school or from private tutoring. Self-study hours are recorded as an interval variable, and the center of each interval is used in this paper. An average student spent 12.2 hours studying alone a week.

Several variables are selected as proxy variables for individual characteristics. Students were asked to report their preference for each

subject on a scale of 1 to 5 with 5 being the highest preference. Students also self-rated their determination and power of execution on a scale of 1 to 5.

The average total household after-tax income in 2003 was 3,258,000 won (2,762 U.S. dollars) per month. Wealth including financial and nonfinancial assets is reported in intervals, but taking the midpoints of the intervals, the average wealth was 174,328,000 won (147,789 U.S. dollars). About 74% of the households had a home of their own and about 85% of the students had a room of their own. The average years of schooling of the fathers and mothers were 11.9 and 11.2 years, respectively.

3.4. Nonresponse in the Subsequent Wave Samples

It is worth investigating the response rates in the later waves of the survey in which post-school variables are collected. The annual rates of nonresponse are relatively high in the panel, but the representativeness of the sample is unaffected. Of the 1,429 individuals in 2004, 54.3% responded to the 2008 survey. The response rates were subsequently 69.0%, 69.1%, 66.9%, 70.5%, 69.3%, and 68.6% in 2009, 2010, 2011, 2012, 2013, and 2014, respectively. The increase in response rates after 2008 is primarily because individuals who had completed military service or international exchange programs had returned to the sample. Most Korean males serve about two years in the military around the age of 20 and are absent from the survey during that time. In addition, a number of Korean college students participate in international exchange programs, and they too are missing from the survey while abroad. It is also possible that some individuals just refuse to respond. There is no data on why a given individual is missing.

The high nonresponse rates are potentially concerning. Moreover, entry into the labor market may further exacerbate the problem because the main analysis is based on a log wage equation. For example, by 2014, 525 individuals had completed schooling and reported being employed. The averages of monthly regular salary and total monthly labor income were 1,853,000 won (1,672 U.S. dollars in 2011) and 2,115,000 won (1,909 U.S. dollars in 2011), respectively. Of the 525 respondents in 2014, 78.7% were

college graduates. A possible concern is that relying on these 525 individuals may result in inconsistent estimation due to nonresponse and selection problems.[8] As table 2 indicates, however, the bias due to nonresponse and sample selection is not substantial. The difference between the summary statistics of the 2004 sample of 1,429 schooled individuals and the 2014 sample of 525 employed individuals is negligible except for parental household income.

4. EMPIRICAL FINDINGS

4.1. Improved Productivity Effects of Supplementary Education

Table 3 presents the estimation results of equation (1) for those individuals who had left school and were employed. The analyses are based on 8-year panel data from the 2007-2014 waves of the high school senior sample linked to the high school variables in the 2004 wave. This is an unbalanced panel because an individual's wage in a given year is observed only if he or she has finished schooling and was employed in that year. As an individual may appear multiple times in the sample, robust standard errors clustered at the individual level are used. The dependent variable is the logarithm of total monthly labor income. Total monthly labor income is obtained by summing the monthly regular salary, average monthly performance pay, and average monthly over time pay. In the Korean labor market, this total monthly labor income figure best reflects an individual's productivity since performance pay and over time work hours are often included in a contract. The independent variables include the standardized CSAT score, private tutoring hours per week, private tutoring expenses per month, and self-study hours per week. The coefficients of supplementary education remain unaffected by replacing the standardized CSAT score with the percentile

[8] Those who are missing include students who have postponed graduation or who have gone on to a graduate school. In addition, individuals who have left school may be out of the sample for various reasons, such as parental leave (Kim, 2018).

Table 3 Log Wage Equation Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Standardized CSAT Score	0.009***	0.008***	0.009***	0.008***	0.008***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Tutoring Hours	0.003*	0.003*	0.003*	0.002	0.002	0.002
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Tutoring Expenses	−0.021	−0.028			−0.030	−0.030
	(0.041)	(0.042)			(0.042)	(0.042)
Tutoring Expenses / Tutoring Hours			−0.069	−0.102		
			(0.209)	(0.204)		
Self-Study Hours	0.004***	0.003***	0.004***	0.003***	0.003*	0.003*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Self-Study Hours x Tutoring Ever					0.001	0.001
					(0.002)	(0.002)
Graduated University						−0.014
						(0.024)
Female	−0.127***	−0.119***	−0.127***	−0.119***	−0.119***	−0.118***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Science Track	0.045**	0.033	0.045**	0.033	0.032	0.033
	(0.020)	(0.022)	(0.020)	(0.022)	(0.022)	(0.023)
Preference for Korean		−0.019*		−0.018*	−0.019*	−0.019*
		(0.010)		(0.010)	(0.010)	(0.010)
Preference for Math		0.008		0.008	0.008	0.008
		(0.009)		(0.008)	(0.009)	(0.009)
Preference for English		0.018*		0.018*	0.018*	0.018*
		(0.010)		(0.010)	(0.010)	(0.010)
Determination		0.030**		0.030**	0.030**	0.029**
		(0.012)		(0.012)	(0.012)	(0.012)
Power of Execution		0.015		0.015	0.015	0.015
		(0.013)		(0.013)	(0.013)	(0.013)
Age	Y	Y	Y	Y	Y	Y
Constant	Y	Y	Y	Y	Y	Y
Observations	1,918	1,918	1,918	1,918	1,918	1,918
R-squared	0.239	0.257	0.239	0.256	0.257	0.257

Notes: Robust standard errors clustered at the individual level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

CSAT score, and so the estimates are not reported.

In column (1), an increase of one standard deviation in the CSAT score (a 10 unit increase in the standardized CSAT score) leads to a 9% increase in wages. Both private tutoring and studying alone effectively increase wages. One additional hour of private tutoring per week raises wages by 0.3%, although the estimate is marginally significant. One additional hour of studying alone per week raises wages by 0.4%. These two estimates are the direct effects of supplementary education on wages as the CSAT scores are controlled for in equation (1). These results suggest that private tutoring

hours and self-study hours are associated with a more efficient post-school human capital production function. Tutoring expenses do not have statistically significant impact on wages. The results in column (1) also show that females earn 12.7% less than males and that individuals who chose the science track in high school earn 4.5% more than those who chose the humanities track.

Column (2) in table 3 adds preference and personality control variables: determination, power of execution, and preference for each subject. These self-rated variables are reported on a scale of 1 to 5 with 5 being the highest degree of determination, power of execution, or preference. These additional taste variables may help to control for unobserved heterogeneity which can affect decisions about whether to do self-study and how much to do. For example, if students engaging more in supplementary education happen to be those of higher ability, the coefficient estimates of private tutoring hours and self-study hours would overstate the true effect of supplementary education. It is therefore important to include variables that can be used as proxies for ability. In our analysis, the preference and personality variables serve this role.

Of the additional control variables, we find that the coefficients of preference for English and determination are statistically significant. Inclusion of the preference and personality variables leads to a mild decrease in the effects of the CSAT score and self-study hours. An increase of one standard deviation in CSAT score results in a 8% rather than 9% increase in wages. The return from studying alone for an additional hour per week is 0.3% rather than 0.4%. The return from private tutoring for an additional hour per week remains unaffected. The results presented in column (2) suggest that while preference and personality explain a small proportion of the positive effect of supplementary education on wages, supplementary education still has substantial positive long-term effects on productivity after controlling for the preference and personality variables. In column (2) the gender wage gap reduces and the premium for completing a science track disappear, implying that much of the effects of these variables can be

explained by preference and personality.

In columns (1) and (2) the estimated coefficients on tutoring expenses after controlling for tutoring hours are negative, although they are statistically insignificant. As tutoring expenses given tutoring hours is a measure of quality, it may be useful to replace tutoring expenses with tutoring expenses divided by tutoring hours. Columns (3) and (4) present the results. We find that the coefficient estimates on tutoring expenses per unit of time remain negative and statistically insignificant, while the other coefficients are unaffected.

Since studying alone plays a significant role in wage determination, column (5) investigates its mechanism further. Self-study hours are broadly defined in the data set, ranging from undertaking independent study to doing homework set by private tutors. A naturally arising question is whether self-directed learning and self-study directed by others are equally effective. This has an important policy implication because, unlike self-directed learning, self-study directed by others can be imposed against one's will. Simply providing an environment in which students work alone can enhance their future earning potential. As self-study directed by others is also inexpensive to implement, there is no need to pay for more expensive private education.

An ideal data set would distinguish between hours spent in self-directed learning and self-study under external direction. In the absence of that information, column (5) employs a variable which interacts the self-study hours with the dummy indicating whether an individual ever used private tutoring in grade 11. The added explanatory variable helps to identify the difference in the effects of self-study between an average individual for those who had never received tutoring and an average individual for those who had received tutoring at least once. This variable, therefore, is designed to capture any difference between the effect of self-study unrelated to private education and the effect of self-study when possibly directed by others. Since the self-study hours of those students who had experienced private tutoring would also include self-directed study hours, the estimate serves as a

lower bound of the effect of self-study directed by others relative to self-directed study. In column (5), the coefficient estimates of the interaction term is small and statistically insignificant. This result indicates that the distinction between self-directed learning and self-study performed via private tutoring has no differential effect on wages, although the estimate reflects the lower bound of the effect of self-study under external direction. The rate of return for studying alone is not affected by inclusion of the interaction term, but the rate of return for private tutoring hours loses its statistical significance. As the effect of private tutoring expenses is also insignificant, column (5) suggests that private tutoring is not effective at raising wages. There is no evidence that self-directed learning and self-study directed by others function differently on earning potential.

Column (6) adds a dummy variable indicating whether an individual has graduated from a 4-year-college or above. The sample used throughout this paper includes high school graduates as well as college graduates. A justification for having both is that everybody graduates from high school at the same age and has the same number of years to invest in human capital after graduating from high school whether they go to college or not. Whether they start working right after finishing high school or postpone working until college graduation, they will continue investing in human capital and their earning potential will be determined by the amount of human capital they have obtained. We expect that the coefficient would be negative because the high school graduates started work earlier than the college graduates. The resulting coefficient estimate in column (6) confirms our prediction, although the estimate is statistically insignificant, probably due to the small sample size.[9] More importantly we find that all the other coefficients, including those on tutoring hours and self-study hours, remain unaffected.

[9] Including a 2 year college dummy may be also useful in theory, but we do not do so as the number of individuals with a 2 year college degree is practically too small.

4.2. Direct and Indirect Effects of Supplementary Education

Supplementary education can affect wages through influencing the CSAT score. The direct and indirect effects combined are estimated by equation (3). We first investigate whether private tutoring and studying alone affect

Table 4 Standardized CSAT Score Equation Estimates

	(1)	(2)	(3)	(4)	(5)
Tutoring Hours	0.073**	0.111***	0.045	0.012	−0.001
	(0.034)	(0.035)	(0.031)	(0.034)	(0.043)
Tutoring Hours x Female					0.042
					(0.071)
Tutoring Expenses	−0.033	2.218***	−0.213	−0.359	−0.495
	(0.637)	(0.643)	(0.572)	(0.569)	(0.766)
Tutoring Expenses x Female					0.290
					(1.000)
Self-Study Hours	0.185***	0.200***	0.144***	0.102***	0.096**
	(0.018)	(0.018)	(0.018)	(0.027)	(0.038)
Self-Study Hours x Female					0.017
					(0.053)
Self-Study Hours x Tutoring Ever				0.062**	0.078**
				(0.028)	(0.039)
Self-Study Hours x Tutoring Ever x Female					−0.042
					(0.056)
Female	0.698*	0.581	0.381	0.348	0.168
	(0.378)	(0.384)	(0.364)	(0.364)	(0.708)
Science Track	0.203	0.347	−0.589	−0.584	−0.586
	(0.385)	(0.392)	(0.408)	(0.407)	(0.408)
Preference for Korean			0.796***	0.794***	0.801***
			(0.192)	(0.192)	(0.193)
Preference for Math			1.362***	1.358***	1.359***
			(0.154)	(0.154)	(0.154)
Preference for English			1.039***	1.040***	1.034***
			(0.179)	(0.179)	(0.179)
Determination			0.018	0.034	0.038
			(0.227)	(0.226)	(0.227)
Power of Execution			−0.056	−0.078	−0.079
			(0.237)	(0.236)	(0.237)
Father's Education	0.115**		0.103**	0.104**	0.104**
	(0.047)		(0.045)	(0.045)	(0.045)
Mother's Education	0.295***		0.259***	0.255***	0.256***
	(0.059)		(0.056)	(0.057)	(0.057)
Household Income	Y		Y	Y	Y
Household Wealth	Y		Y	Y	Y
Constant	Y	Y	Y	Y	Y
Observations	1,429	1,429	1,429	1,429	1,429
R-squared	0.170	0.113	0.255	0.257	0.258

Notes: Robust standard errors clustered at the individual level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

the CSAT scores by estimating equation (2). The control variables include socioeconomic and biological influences by parents, specifically a quartic function of household income at grade 11, dummies of household wealth at grade 11, and the father's and mother's education.

In column (1), one additional hour of private tutoring per week increases the CSAT score by around 0.073 points, meaning that it increases the score by 0.007 standard deviations. One additional hour of studying alone per week increases the CSAT score by around 0.020 standard deviations. Parents' education levels are positively associated with the CSAT score. Although not reported, most coefficients of income and wealth are statistically insignificant. When parents' variables are excluded from the estimation in column (2), private tutoring expenses seem to have a positive effect on the CSAT score. This result implies that students with more educated parents happen to be those who spend more on private tutoring. In other words, these students do better in the CSAT not because they receive more expensive private tutoring but because their parents have a higher level of human capital. Once parents' education levels are controlled for, the effect of private tutoring expenses disappear.

Column (3) adds preference and personality measures to column (1). The estimates of all three preference variables are positive and statistically significant. None of the personality measures seem to affect the CSAT score. When preference and personality variables are controlled for, the coefficient estimate of tutoring hours becomes statistically insignificant. This result implies that the seemingly positive effect of private tutoring hours on the CSAT score is misleading because students who take more hours of private education are also those who like the subjects. In other words, these students do better in the CSAT exam because they like the subjects rather than because they take more hours of private tutoring.

Column (4) includes the interaction between self-study hours and whether the student has experience of taking private tutoring. It seems that the effect of self-study under external direction is more effective in raising the CSAT score than self-directed study. As the added control variable helps to

identify the difference between an individual who has never received tutoring and an average individual for those who have received tutoring at least once, the statistically significant estimate of 0.062 is a lower bound for self-study directed by others relative to self-directed learning. While self-study in general improves the CSAT score, replacing every one hour of self-study directed by others with one hour of self-directed study increases the CSAT score by at least 0.006 standard deviations. This result does not necessarily contradict the findings of the previous section since it is still possible that self-study directed by others does not exert a long-term effect. Later we investigate whether self-directed study and self-study directed by others differ in their indirect effects on wages. Finally, column (5) reveals that the effects of private tutoring and self-study on the CSAT score are not gender-specific.

Table 5 presents the estimation results of equation (3) for those individuals who had left school and were employed. The dependent variable is the logarithm of total monthly labor income. Column (1) of table 5 corresponds to column (1) of table 4 substituted into column (1) of table 3. The return for one additional hour of self-study per week is a 0.5% wage increase, but private tutoring exerts no effect on wages. These effects are the combined (direct and indirect) effects of supplementary education on wages. Column (1) also shows that the male premium and science track premium are 12.2% and 4.6%, respectively.

Preference and personality control variables are additionally included in column (2) of table 5. Similar to the results in column (2) of table 3, the coefficients of preference for English and determination are statistically significant. Studying alone for an additional hour per week raises wages by 0.4%, slightly less than the value in column (1) of table 5. While preference and personality measures are positively associated with self-study hours, supplementary education still has positive long-term effects on productivity.

Column (3) investigates the role of self-directed study. The coefficient estimate of the interaction term is small and statistically insignificant. This indicates that there is no evidence that self-directed learning and self-study

Table 5 Log Wage Equation Estimates (Reduced Form)

	(1)	(2)	(3)	(4)	(5)
Tutoring Hours	0.002	0.002	0.001	0.001	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Tutoring Hours x Female					0.005
					(0.003)
Tutoring Expenses	−0.038	−0.038	−0.039	−0.039	−0.024
	(0.046)	(0.046)	(0.046)	(0.046)	(0.056)
Tutoring Expenses x Female					−0.027
					(0.078)
Self-Study Hours	0.005***	0.004***	0.004***	0.004***	−0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Self-Study Hours x Female					0.010***
					(0.003)
Self-Study Hours x Tutoring Ever			0.001	0.001	0.005**
			(0.002)	(0.002)	(0.002)
Self-Study Hours x Tutoring Ever x Female					−0.007**
					(0.003)
Graduated University				0.014	0.016
				(0.023)	(0.023)
Female	−0.122***	−0.118***	−0.118***	−0.119***	−0.202***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.039)
Science Track	0.046**	0.036	0.036	0.035	0.036
	(0.021)	(0.023)	(0.023)	(0.023)	(0.023)
Preference for Korean		−0.010	−0.010	−0.010	−0.010
		(0.010)	(0.010)	(0.010)	(0.010)
Preference for Math		0.012	0.012	0.011	0.013
		(0.008)	(0.008)	(0.008)	(0.008)
Preference for English		0.027***	0.027***	0.026**	0.024**
		(0.010)	(0.010)	(0.011)	(0.011)
Determination		0.032***	0.032***	0.033***	0.033***
		(0.012)	(0.012)	(0.012)	(0.012)
Power of Execution		0.010	0.010	0.010	0.012
		(0.013)	(0.013)	(0.013)	(0.013)
Father's Education	Y	Y	Y	Y	Y
Mother's Education	Y	Y	Y	Y	Y
Household Income	Y	Y	Y	Y	Y
Household Wealth	Y	Y	Y	Y	Y
Age	Y	Y	Y	Y	Y
Constant	Y	Y	Y	Y	Y
Observations	1,918	1,918	1,918	1,918	1,918
R-squared	0.236	0.259	0.259	0.259	0.269

Notes: Robust standard errors clustered at the individual level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

performed via private tutoring have differential effects on wages. Self-study induced by others may raise the CSAT score more than self-directed study does as suggested in column (3) of table 4, but its overall effect on wages is the same. All the other coefficients remain unaffected.

Column (4) adds a dummy variable indicating whether an individual has graduated from a 4-year-college or above. The estimate is positive, but statistically insignificant. Again, all the other coefficients remain unaffected. Finally, column (5) investigates whether the effects of private tutoring and self-study are gender-specific. An interesting finding is that while self-directed learning is effective for females, self-study directed by others is effective for males. These results suggest that efforts to provide an environment supportive of studying alone for female students or to form an independent study habit for male students can raise future earnings. It is worth noting that the effects of self-study on wages are gender-specific, while the effects of self-study on test scores are not different across genders according to column (5) of table 4. These results imply that studying alone can affect labor market performance through channels other than enhancement of academic performance. As data limitation obstructs full investigation of this issue, we leave it as future research.

5. CONCLUDING REMARKS

Using a representative longitudinal sample of Korean high school seniors in 2004, this paper finds that studying alone has a positive effect on wages after controlling for college entrance exam scores. One additional hour of self-study increases wages by 0.3%-0.4% directly. The estimated returns from studying alone raise wages by additional 0.1% points when the indirect effects are considered. However, neither the expenses of nor time spent on private education influence wages directly, although private education may do so indirectly by facilitating admission to higher quality colleges. These main findings are robust to controlling for preference and personality variables. The distinction between self-directed study and self-study directed by others is not substantial for raising wages after controlling for the CSAT score.

From the view point of the human capital theory, while private education serves as an extra input for the human capital production function, studying

alone makes the production function itself more efficient. In other words, in addition to affecting wages indirectly through raising test scores, studying alone affects wages directly. In sum, hours spent studying alone can explain the heterogeneity in post-school labor market performance after controlling for human capital at the time of high school graduation. Considering that private education is typically unavailable after high school graduation, the role of studying alone while in high school is even more pronounced. Our findings suggest that efforts to provide an environment supportive of studying alone or to form an independent study habit during high school may be helpful in increasing an individual's earning potential.

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