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STUDENT ACADEMIC PERFORMANCE: DOES A STUDENT-SPECIFIC STARTING LINE MATTER?

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Abstract

This study investigates the effects of student time allocation on the academic performance of undergraduate students in Hong Kong by using data envelopment analysis approach. To determine the factors affecting students' educational productive efficiency, we analyze whether a student-specific starting line (qipaoxian, in Chinese pinyin) matters. The pre-university student-specific attributes are identified as a starting line that comprises pre-university study ability, motivation, and parents' educational background. Results suggest that most starting line components have insignificant effects on university students' education efficiency, except students' self-motivation in terms of ambition to earn more money and students' pre-university English language proficiency.

Research findings generate policy implications to the educational institutions on developmental perspectives. For example, universities in Hong Kong can consider offering more intense English language courses to students with relatively lower English language proficiency. In doing so, students' education efficiency can be enhanced.

Keywords

Academic Performance, Student-Specific, Starting Line, Data Envelopment Analysis, Educational Productive Efficiency

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1. Introduction

Numerous studies have been made on the effects of educational institution-specific characteristics and students' academic performance as well as on the educational production function (Eberts & Stone, 1988; Hanushek, 1997, 2003; Levacic & Vignoles, 2002). Studies on students' time allocation and educational productive efficiency and student-specific attributes affecting education efficiency are scarce, except Bratti and Satffolani (2013) and Grave (2011). Therefore, closely investigating the relationship between student time allocation and academic performance is necessary. For the academic study at primary and secondary schools, the question surrounding whether educational opportunities are all equal is a common controversy. Woessmann (2004) used the terminology of family-background characteristics. In this study, we employ the terminology of a starting line (*qipaoxian*, in Chinese *pinyin*) (of a race). As commonly perceived, students with a superior starting line would have obvious advantages in their academic study. The meaning of a starting line in study at primary and secondary schools mainly refers to parents' support to students' extra-curricular activities and outside-classroom private tutorials. Students from a financially well-off family and higher parental guidance usually have advantages in their academic study at schools. In this paper, we define a starting line that comprises pre-university study ability, motivation, and parents' educational background. This study aims to address a research question surrounding whether a heterogeneous starting line affects students' academic performance at a university.

The educational production function is a common approach to model the educational process of examination performance. This study examines the educational production function employing grade point average (GPA) as the output and various time uses as the inputs. We first use the data envelopment analysis (DEA) approach to estimate individual students' educational productive efficiency. In doing so, the potential rather than average educational production functions, that is, the extent of the probable education efficiency, can be estimated. Next, we consider that the pre-university student-specific attributes may affect student education efficiency at a university. Thus, the study on the extent a student-specific starting line affects students' attainment gains of university study is important. Such an approach allows us to generate policy implications to educational institutions through determining the relationship between starting line components and students' education efficiency.

The rest of this paper is organized as follows. Section 2 outlines the literature review. In Section 3, we discuss the methodology, data collection, and sampling. Section 4 presents the econometric results, the interpretation of the results, and a group-wise analysis between (i) the education efficiency gap and starting line components; and (ii) GPA and time uses. Policy implications and conclusions are elaborated in Section 5.

2. Literature Review

Education is a production process in which students allocate their time between various types of study-related activities and non-study-related activities to attain output that is usually measured by academic performance. Becker (1965) raised his concerns over the theoretical analysis of the problem of individual time allocation. In his introduction section, Becker spotted the significant issue of the time of students as one of the inputs into the educational process. In considerable literature, the educational process of academic performance is specified as an educational production function (Dolton, Marcenaro & Navarro, 2003; Graves, 2011; Levin & Tsang, 1987). Students are decision-making units (DMUs) in a sense that students themselves would allocate their time resources in attending classes, in self-study, other study-related activities, as well as non-study-related activities. Different combinations of time allocation may have different effects on student academic performance. The student time allocation problem is an issue of output maximization by choosing the optimal time input in different study activities. Closely investigating how efficient students are in their time allocation in the educational process is necessary.

Several studies have been conducted on the effects of institutional characteristics on student academic performance. The characteristics are often identified as student/teacher ratio, class size, and expenditure per student. Comparison of student performance between public and private institutions has also been commonly studied (Hanushek, 1997, 2003). Studies on the influence of student time allocation on student performance are scarce. Grave (2011) examined the effects of different types of student time allocation on student academic performance in a group of students in Germany. Grave (2011) found that the time allocated on attending classes and on self-study are positively linked to academic performance. A similar positive relationship is revealed by Schmidt (1983) who found that class attendance has a higher influence on academic performance than self-study. However, some other considerable research such as those by Kember, Jamieson, Pomfret & Wong (1995) and Schuman, Walsh, Olson & Etheridge (1985) found insignificant or no relationship between study time and student academic performance. Dolton et al. (2003) found that, in a group of students in Spain, private tuition has a negative effect on academic performance. The above studies focus on students in the United States or in Europe. Similar study on students in Hong Kong is limited.

In the above literature review, most of the academic studies employ either the method of regression or the method of correlation analysis. Nearly none of them employ the concept of productive efficiency and the pertinent measurement of efficiency level of individual students. For the input–output relationship, each student is a DMU in the allocation of time use in the educational production process. We estimate the educational productive efficiency (education efficiency hereinafter) of students using the DEA approach, which will be explained in the next section. The measurement of individual student's education efficiency is scarce in literature. Some studies on the educational performance employ the DEA approach to measure the efficiency of educational institutions, but most of them do not focus on individual student as a DMU (Colbert et. Al., 2000; Lovell, Walters & Wood, 1994).

3. Methodology

3.1 DEA Approach

In our study, the measurement of students' education efficiency in the educational process is proxied by technical efficiency. When compared with other productivity measures, using technical efficiency scores is more advantageous because this measure allows investigators to compare the performance of an individual student relative to the best-performing students in his or her cohort. The methods of efficiency estimation can be conducted using two common approaches: non-parametric DEA and parametric stochastic frontier analysis (Coelli, Rao, O'Donnel & Battese, 2005). As one of its major advantages, DEA does not require prior specification of functional forms for the production function. However, DEA is not totally free from any deficiencies. First, the presence of the measurement error and statistical noise may influence the shape and position of the frontier. The DEA cannot cope with this problem. Second, conventional hypothesis tests are not allowed in the DEA approach but are allowed in the econometric approach.

For the DEA approach, we assume that *n* DMUs (i.e., students) use *m* types of input (x) to produce *s* types of output (y):

DMU j (for $j = 1, \ldots, n$),
x_{ij} = input i (for $i = 1, \ldots, m$),
y_{rj} = output r (for $r = 1, \ldots, s$), and
a_j = non-negative weights attached to the input and output of DMU j

We use $F_0(x_{j,}y_j) = \text{maximun } \phi$ to represent the output-oriented Farrell efficiency score. The possible expansion of output for DMU j at a maximum level can be referred by such a score. The following output-oriented DEA model with the maximization of ϕ subject is presented as follows:

$$\sum_{j=1}^{n} a_j y_{rj} \geq \phi y_{rj},\ r = 1, \ldots, s \qquad (1)$$

$$\sum_{j=1}^{n} a_j x_{ij} \leq x_{ij},\ \mathrm{i} = 1, \ldots, m \qquad (2)$$

$$a_j \geq 0,\ j = 1, \ldots, n \qquad (3)$$

Charnes, Cooper & Rhodes (1978) explained that the model assumes constant returns to scale (CRS). However, such an assumption is strong and appropriate only when all DMUs are producing at an optimal scale. The assumption is slightly restrictive. To allow a flexible specification, the CRS DEA model was revised to cater for variable returns to scale (VRS) (Banker, Charnes & Cooper, 1984). Mathematically, if the condition of $\sum_{j=1}^{n} a_j = 1$ is added, then VRS is imposed. The VRS is assumed in our proposed study such that efficiency estimation would be possible. The DEA model is a linear programming technique. In our empirical analysis, DMUs (i.e., students) are treated in the estimates as independent when DMUs handle their own decision on study time allocation in their study. The DEA model is devised to solve the relative performance of every DMU in the sample. The efficiency measure is compiled as the inverse of the maximum proportional output that can be achieved with input quantities held constant. This method to estimate the efficiency measure defines a technical efficiency score ranging between zero and one.

3.2 Conceptual Investigation, Regression, and Student-specific Starting Line

Many factors affect student academic performance, such as student effort (Borg, Mason & Shapiro, 1989; Krohn & O'Connor, 2005), teacher characteristics (Kukla-Acevedo, 2009), peer ability (Hanushek, Kain, Markman & Rivkin, 2003; McEwan, 2003), teachers' grading (Bonesronning, 2004), and class size (Borland, Howsen & Trawick, 2005). In this study, we focus on determining whether the academic performance of a university student proxied by education efficiency can be explained by pre-university student-specific attributes. We also determine the extent of the effects. We identify several pre-university student-specific attributes by a collective terminology, that is, student-specific starting line, to cater for the heterogeneity of students in our study. These variables are students' pre-university study ability, motivation, and parents' educational background. In doing so, the pre-university student-specific attributes can be endogenously allowed into our regression model.

Determining the reasons why starting line components would affect student education efficiency is important. Pre-university study ability is heterogeneous among university students. High school leavers with better background in sciences, mathematics, and language would be expected to have higher education efficiency in the study process at universities. However, within the same cohort of students, pre-university academic study would considerably vary among students (Parker, 2006). For the freshmen at universities in Hong Kong, their secondary school background can be categorized into four groups. The first group is from Hong Kong secondary schools with English as the working language in teaching (labeled as SchEng). The second group is from schools with Chinese as the teaching medium language (SchChi). The third group is from the Chinese Mainland (SchPRC). The fourth group comprises all sources other than the first three groups such as vocational training councils, community colleges, and high school leavers from economies other than Hong Kong and the Chinese Mainland. The number of students in the fourth group is very small. We combine this group with the second group because the academic performance of the fourth group is usually comparable with that of the second group.

Students with higher degree of motivation are expected to perform better. Two variables are related to the motivations of students. The first one is a dummy variable "choice" that equals 1 if students were admitted into their first preference degree program at the university. The second variable is ambition that measures a student's degree of intention to study at the university to earn more money and to obtain a better job upon graduation (Boissiere, Knight & Sabot, 1985; Bishop, 1989, 1992; Grave, 2011).

Parents' educational background is often regarded as a starting line component in their children's study. Parents with higher educational background may provide better advice and support to their children in education (Dolton et al., 2003; Grave, 2011; Woessmann, 2004). Woessmann (2004) noted that the parents' background effects exhibit joint impact by nature and nurture. However, our data set does not contain the appropriate information to determine the relative importance of the joint impact.

As the education efficiency ranges between zero and one, the distribution of education efficiency is truncated above from unity. If we use the ordinary least square method for estimation, then the parameter estimates will be biased. To handle this problem, we employ the Tobit model for estimation. The underlying assumption of the Tobit model is that, in terms of the population, education efficiency follows a normal distribution. On the contrary, the distribution of efficiency estimates of our sample students obtained by DEA is a mixture of continuous and discrete distribution. The Tobit model is more appropriate to use when accounting for truncated efficiency scores that range between zero and one. We regress the education efficiency (*EF*) on the components of a student-specific starting line and the equation is specified as follows:

$$EF = \alpha_0 + \alpha_1 High School\_HK\_English + \alpha_2 High School\_PRC + \alpha_3 Father Education + \alpha_4 Mother Education + \alpha_5 Choice + \alpha_6 Motivation \quad (4)$$

Before proceeding to discuss the empirical results, the data profile of this research is described briefly.

3.3 Data Collection, Sampling, and Questionnaire Survey

Several major types of time are used by a student. Dolton et al. (2003, p. 549) categorized eight types of time use: formal education, self-study, private tuition, IT/language, travel/domestic, leisure, paid work, and sleep. In this study, we use five major types of time use as inputs, including class attendance, revision, paid part-time work, extra-curricular activities, and sleep. The measure of output is student academic performance proxied by students' GPA. Input and output measures will be used to construct education efficiency scores.

Data were collected through a questionnaire survey to students in the second semester (2015–2016) at the Hong Kong Polytechnic University (PolyU). Students involved in the survey had a semester record of their study in the first immediate past academic semester at PolyU. Adopting such a sampling method is bound to several measurement problems, which were discussed by Dolton et al. (2003), Grave (2011), and Juster & Stafford (1991). One common measurement bias of conducting questionnaire survey to students attending classes is the selection bias. Dolton et al. (2003, p. 550) noted that, "*there is the potential for some (selection) bias since the respondents were those who had attended university classes when the survey was carried out, since absent students were not included in the sample.*" To alleviate this potential bias, we conducted the class survey in the first three weeks of the second semester. The benefit of doing so was that PolyU students very often would attend the first few lecture classes, based on our experience and observations. Hence, the problem of selection bias could be considerably mitigated. One way to check this potential bias is to diagnose the correlation between respondents' high school public examination and their class attendance rates (Dolton et al., 2003, p.550). We compile the correlation between the public examination results of English and mathematics of the Diploma of Secondary Education (DSE) and attendance in our sample. The correlation coefficients are very low, at -0.11 and -0.01 respectively. The results suggest that, when public examination scores are a measure of study ability, the association between attendance and study ability is relatively little. These evidences imply that the potential selection bias generated by our sampling students attending classes may be small.

Another measurement problem is potential bias because of a systematic error stemming from unobservable characteristics. We suspect that some under-performed students might base on their self-justification by deliberately under-reporting their study time as an excuse for their poor academic performance. The reason is that these under-performed students may not want to admit their low ability in academic study. However, handling this type of potential measurement error could be difficult.

For the survey on the study time allocation, Juster & Stafford (1991) suggested that questions such as "How much time did you spend on average for activity X last week?" would be appropriate. The reporting error would be negligible if student activities more or less follow a regular schedule. In our questionnaire, we included a disclaimer in the questionnaire that reads, "*This survey does NOT collect any personally identifiable information and all information collected is to be used for academic research purposes only. Respondents are reminded NOT to provide any personal identity information, such as name, student ID, and HKID, in this survey.*" By this type of procedure, we assume that students would provide their information honestly.

The original sample contains 619 observations collected from students. Observations with missing relevant input or output data were excluded from the data analysis. The final sample comprises 508 observations. Table 1 presents the summary statistics.

Table 1: *Description and Summary Statistics of the Variables*

Variable	**Description of variable**	
GPA	GPA of the previous semester, 0 to 4	
Attendance	Class attendance (%)	
Revision	Self-study time per academic credit (min)	
Extra-curricular activities	Number of hours per week	
Part time work	Number of hours per week	
Sleep	Number of hours per week	
High School_HK_English	A dummy = 1 for students attending a high school in Hong Kong with English being the working language; otherwise = 0	
High School_PRC	A dummy = 1 for students attending a high school in the Chinese Mainland; otherwise = 0	
Choice	A dummy = 1 for students studying the bachelor's degree program as his or her first choice when applying for admission into the Hong Kong Polytechnic University; otherwise = 0	
Ambition	The Likert scale = 5 if students' main reason to study at the university is the highest ambition to find a job and to earn more money after graduation; 1 = least ambition	
Father's education	A dummy = 1 for a father with a university degree or higher; otherwise = 0	
Mother's education	A dummy = 1 for a mother with a university degree or higher; otherwise = 0	
Age	In years	
Variable	Mean	Standard deviation
GPA	3.035	0.530
Attendance	0.863	0.179
Revision	26.671	21.359
Extra-curricular activities	5.888	6.951
Part time work	6.138	8.262

Sleep	48.587	10.488
High School_HK_English	0.551	0.498
High School_PRC	0.134	0.341
Choice	0.937	0.732
Ambition	3.764	1.034
Father's education	0.252	0.435
Mother's education	0.183	0.387
Age	20.118	1.719

Note: total number of observation = 508

To assist the interpretation of the empirical results, we conducted seven semi-structured interviews with a total of 10 students in April 2016. We invited students with high, medium, and low performance in the coursework or mid-term tests in the courses delivered by the authors to collect supplementary information. Each interview lasted for about 30 to 60 minutes, and the questions were focused on the student-specific starting line components and the education efficiency at PolyU.

4. Results of the Empirical Analysis

The DEA 2.1 Program (Coelli, 1996) was used to calculate students' education efficiency in their educational production process. The average score of the sample students is 79.4%. After computing the education efficiency, we then proceeded to test whether a student-specific starting line affects students' education efficiency by estimating Equation (4) using the Tobit method. The results of the estimation are presented in Table 2. To overcome the possible problem of heteroscedasticity, we conducted a likelihood ratio test against the null hypothesis of homoscedasticity and re-estimated the Tobit model assuming the variance of the error term to be a function of students' ambition. The log likelihood function of the re-estimated model is 126.387, and that of the original Tobit model is 126.326. The likelihood ratio statistic is 0.122, which is smaller than the 95% critical value for the chi-squared distribution with one degree of freedom. Thus, the null hypothesis of homoscedasticity cannot be rejected. The result of the pseudo R^2 suggests that around 5.6% of the variation in education efficiency between the sample students can be explained by variations in students' starting line components and the control variable.

Table 2: *Estimates of the Effects of Student-specific Starting Line Components on Students' Education Efficiency at Hong Kong Polytechnic University (2016)*

	Model (1)	**Model (2)**
Intercept	0.665 (7.293)***	0.434 (2.247)**
High School Background		
High School_HK_English	0.049 (3.129)***	
High School_PRC	0.109 (4.004)***	
DSE_English		0.051

		(4.008)***
DSE_Mathematics		-0.014 (-1.300)
Motivation		
Choice	0.884×10^{-2} (0.932)	0.015 (1.306)
Ambition	0.014 (2.011)**	0.036 (3.722)***
Parents' education		
Father's education	0.018 (0.762)	-0.287×10^{-2} (-0.093)
Mother's education	-0.019 (-0.722)	0.011 (0.273)
Control variable		
Age	0.177×10^{-2} (0.418)	0.440×10^{-2} (0.544)
Log likelihood function	126.326	69.196
Number of observations	508	278
Pseudo R^2	0.056	0.108

Notes:
(1) The t-values are in parentheses.
(2) **, *: significant at the 1% and 5% levels, respectively.

4.1 Pre-university study ability

In the Tobit model, the estimates of the coefficients of English School and PRC School are positively significant. The results suggest that students from the two categories of high schools outperformed their counterparts from the categories of Chinese Schools and others in terms of education efficiency. This finding could result from the sorting process of higher education because students from English high schools in Hong Kong and from the Chinese Mainland have better pre-university public examination results than their counterparts. For example, a considerable amount of Chinese Mainland students studying at PolyU are high-score achievers in the Chinese joint university entrance examination.

4.2 Motivation

4.2.1 Choice

Choice refers to the dummy variable with the value of 1 when a student was admitted to the bachelor's degree program that was his or her first choice in applying for admission to PolyU. The empirical result of the effect of choice variable on student education efficiency is insignificant. In the case of Hong Kong, after the release of the public examination results, applicants are allowed to change their choices of degree programs for admission to universities in Hong Kong. As some degree programs demand higher public examination results, many students would often re-arrange their choice preference to get a higher chance to obtain a university offer disregarding their personal interest. As a result, the degree program currently studied by a student may not be his or her most preferred program (Field survey, April 2016).

4.2.2 Ambition

Ambition is measured by the Likert scale from 1 to 5. The value of 5 implies that the main reason for students to study at a university is to earn more money or to have a better chance to find a job upon graduation. The empirical result finds that the ambition variable has positive significant effects on student education efficiency. Some business students admitted that, "I need a good GPA to qualify for an intern and for a subsequent job search in the Big Four." Some other students expressed that, "The job market in Hong Kong is fairly tough. Firms' sorting processes heavily draw upon students' GPA. I have to work hard to improve my job opportunities" (Field survey, April 2016). Boissiere et al. (1985) and Bishop (1989, 1992) found a positive association between the earning returns and qualitative measures of education (such as cognitive achievement tests). The pressure to obtain a job and to earn more money after graduation spurs student education efficiency. Dolton et al. (2003) found an opposite result.

4.3 Parents' educational background

Our empirical results show that none of the regressors used in the measurement of father and mother's educational background is significant in explaining student education efficiency. Some students mentioned that parents with higher educational background may have more effects on students' study in the primary schools. These effects would diminish when students enter high schools, and the effects would be insignificant when students enter universities. The reason is that students would have more independent mindset in decision making as they age (Field survey, April 2016). However, Woessmann (2004) found that family background in terms of parents' educational attainment has strong effects on student performance in secondary schools in the United States and many European countries. Dolton et al. (2003) found a different result that, in their samples, university students performed better in education efficiency when their mothers had a university degree qualification.

We now assess the effect of the control variable age on students' education efficiency. The estimated result shows that age variable has insignificant effect on students' education efficiency in the educational process. In literature, the effects of age on students' education efficiency are mixed. Dolton et al. (2003) and Grave (2011) showed a positive significant association between students' age and education efficiency, whereas Bratti & Staffolani (2013) suggested an insignificant effect of age on efficiency.

In summary, our empirical findings suggest that most components of a student-specific starting line do not affect student education efficiency. The exception is the component of high school background and ambition. To determine the effects of high school profile on education efficiency, we diagnose the heterogeneity of students' pre-university profile by considering their study ability measured by students' public examination results in English Language and Mathematics. In this regard, we re-estimated Equation (4) using the sub-sample data from Hong Kong students only. The reason is that we do not have the public examination results of individual subjects from the Chinese Mainland students. The sub-sample includes the Hong Kong students (from both types of high schools with English or Chinese as the teaching medium) that attempted the DSE English Language and Mathematics examinations. The re-estimation results of Model (2) are presented in Table 2. The major conclusion from the Model (2) results is the same to those found in the Model (1) results. From Model (2) results, we found that students with better pre-university English language ability perform better than their counterparts. Some students explained that, "With poor English language proficiency, we have intense difficulty to follow the lectures, revise the lecture notes, and read textbooks because all teaching-related materials are in English" (Field survey, April 2016). Therefore, the English language proficiency significantly matters in student education efficiency. For a cross reference, in a study at a South African university, black students with English as their home language outperformed their cohorts in the study of the subject "Introduction to Economics" who are non-English speakers (Parker, 2006).

We determine whether mathematics knowledge have similar effect on education efficiency. Our empirical finding shows that the result of Mathematics examination for DSE has insignificant effect on education efficiency. The result is unexpected. One major reason may be that few students during our field interviews expressed that, "The DSE mathematics questions are basically the same over the years. After I have repeated working on the past examination papers, I was able to obtain the highest grade in DSE mathematics subject. This situation may not reflect that my mathematical knowledge is solid and strong." In addition, a better pre-university mathematics knowledge background would be important for mathematics subjects whereas mathematics skills are insignificantly important for business subjects such as accounting (Field survey, April 2016). By contrast, Parker (2006) observed a strong positive effect of mathematical ability on student performance in the subject "Introduction to Economics."

4.4 Group-wise Comparison: Starting Line Components and Education Efficiency

To obtain a first indication of the relationship between starting line components and education efficiency illustrated by Tobit model, we extend our empirical study from the base model by performing the following group-wise analysis. We explore the education efficiency gaps of the following two groups, DSE English Language and Mathematics Proficiency

The following group-wise comparisons would only be applicable to students attending a high school in Hong Kong with results of English Language and Mathematics examinations for DSE. The highest grade of a DSE subject is 7 and the lowest is 1.

4.4.1 DSE English language

The null hypothesis is that the distributions of the education efficiency measures are the same between group (a1) students with DSE English language result of grades 2 and 3 and group (a2) of grades 4–7. Given that assuming the normal distribution of education efficiency is unreasonable, non-parametric Wilcoxon test is performed. From Table 3, the mean rank of education efficiency for group (a1) is 122.54, whereas that of the contrasted group is 153.60. The Wilcoxon statistic is significant at the 1% level. Therefore, the two groups exhibit different levels of education efficiency. Table 3 also shows that the average education efficiency of group (a1) is 0.751 and that of group (a2) is 0.810. Thus, students with DSE English language of grade 4 or above performed better than the contrasted group. The implication is that students with higher English language proficiency exhibit higher educational productive efficiency in the education process. To closely identify the significance of the English language in education efficiency, we extend the group-wise comparison by referring to the median grade of DSE English result, that is, grade 4 in our sample. We examine the education efficiency between group (a3) students with DSE English language result of grade 4 and group (a4) of grade 5. The Wilcoxon test results suggest that the two groups exhibit different levels of education efficiency. From Table 3, students with a higher English language result by one grade from the median grade have obvious efficiency advantage increment of 8.9% in the educational learning process at universities in Hong Kong. This finding signifies the paramount significance of English proficiency in the university education process in Hong Kong.

Table 3: *Group-wise Education Efficiency Comparisons*

Grouping variable	Mean rank	No. of observations	Wilcoxon statistic	Z-statistic	Significance level	Average education efficiency
(a) DSE English Language						
(a1) Grades 2 and 3	122.54	114				0.751
(a2) Grades 4–7	153.60	167				0.810
(a1) vs. (a2) statistics			13970	-3.149	0.002	
(a3) Grade 4	77.05	130				0.790
(a4) Grade 5	101.52	33				0.860
(a3) vs. (a4) statistics			10016	-2.665	0.008	
(b) DSE Mathematics						
(b1) Grades 2 and 3	33.81	21				0.810
(b2) Grades 6 and 7	27.89	38				0.760
(b1) vs. (b2) statistics			1606	-1.267	0.205	

(b3) Grade 5	73.46	113				0.780
(b4) Grade 6	69.02	31				0.770
(b3) vs. (b4) statistics			2140	-0.525	0.599	
(c) High school Background						
(c1) High School_English	167.79	280				0.800
(c2) High School_PRC	202.11	68				0.860
(c1) vs. (c2) statistics			46983	-2.526	0.012	

Notes:
(1) The null hypothesis of the Wilcoxon test is that the education efficiency distributions of the two populations are the same.
(2) The Wilcoxon statistic is the lesser of the two rank sums.

4.4.2 DSE Mathematics

We examine the education efficiency between group (b1) students with DSE Mathematics result of grades 2 and 3 and group (b2) of grades 6 and 7. The Wilcoxon test results suggest that the distribution of education efficiency in the two groups is insignificantly different from each other. Furthermore, we check the education efficiency between group (b3) students with DSE Mathematics result at the median grade 5 (in our sample) and group (b4) with a higher grade 6. The result by the Wilcoxon test suggests that the two groups do not exhibit different levels of education efficiency. The pre-university mathematics knowledge has insignificant effect on education efficiency in our sample.

(c) Hong Kong students from schools with English as the working language (SchEng) versus students from the Mainland (SchPRC)

Examining the student education efficiency between two groups, namely, (c1) Hong Kong students from schools with English as the working language (SchEng) and (c2) students from the Chinese Mainland (SchPRC), is interesting. We set the null hypothesis that the distributions of the education efficiency measures are the same between group (c1) SchEng and group (c2) SchPRC. From Table 3, the Wilcoxon statistic is significant at the 5% level. The average education efficiencies of the SchEng and SchPRC are 0.800 and 0.860, respectively. Therefore, group (c2) students from the Chinese Mainland (SchPRC) exhibit higher education efficiency than group (c1) students from the Hong Kong English schools (SchEng). One solid evidence supporting this empirical finding is the overwhelming number of first class honor achieved by Chinese Mainland students in the last many years at PolyU. For example, the Graduation Ceremony Brochure of the Faculty of Business (2015) shows that approximately 81percent of the first-class honor awardees were students from the Chinese Mainland.

4.5 Group-wise Comparison: Attendance and GPA

Class attendance is commonly perceived as a significant time use in the educational production function. Many studies suggest that class attendance is an important facilitator of students' success in academic performance or academic competence (Schmidt, 1983). In this subsection, we diagnose the relationship between class attendance rate and GPA between group (d1) students with class attendance rate of 95%–100% and group (d2) with class attendance rate of 80%–90% with the full data set. From Table 4, the Wilcoxon test statistic is significant at the 1% level. Therefore, the distributions of GPA of the two groups are significantly different from each other. This finding implies that the academic performance gap between students with class attendance of 95%–100% and the counter part of 80%–90% are substantially obvious. The average GPA of students with high attendance rate of 95-100% is 3.173 and that of students with relatively lower attendance rate of 90-90% is 3.030. We also determine the effect on academic performance of students with much lower attendance rate of 50%–80% when compared with high attendance rate of 95-100%. We conducted a similar Wilcoxon test, and the results suggest that group (d3) students with class attendance of 50%–80% and group (d4) with 95%–100% attendance displace different distribution of GPA. The academic performance by GPA of students with 95%–100% attendance significantly outperformed the contrasting group with 50%–80% attendance by 14.6%. Despite this finding, Arulampalam, Naylor & Smith (2012) highlighted that, "*the respondents (students) in the present study clearly tended to see lectures as optional and not always a beneficial or important part of their time at college.*"

Table 4: *Group-wise GPA Comparisons*

Grouping variable	**Mean rank**	**No. of observations**	**Wilcoxon statistic**	**Z-statistic**	**Significance level**	**Average GPA**
(c) Class attendance						
(d1) Attendance rate of 80%–90%	136.03	103				3.030
(d2) Attendance rate of 95%–100%	165.89	208				3.173
(d1) vs. (d2) statistics			14012	-2.757	0.006	
(d3) Attendance rate of 50%–80%	108.9	101				2.769
(d4) Attendance rate of 95%–100%	177.38	208				3.173
(d3) vs. (d4) statistics			10999	-6.323	0	

Notes:
(1) The null hypothesis of the Wilcoxon test is that the GPA distributions of the two populations are the same.
(2) The Wilcoxon statistic is the lesser of the two rank sums.

As a cross reference, for the General Certificate of Secondary Education (GCSE) public examination in the United Kingdom, the statistical results suggest that UK students with (i) class attendance rate of 80%–90% performed relatively poor in the GCSE when compared with students with (ii) high attendance rate of 95%–100%. Referring to the band of high performance of GCSE with grades A* to C in five subjects, only 35% of students from group (i) were able to attain this set of good performance, whereas 73% of students from group (ii) were able to obtain the same set of good results (Taylor, 2012). In short, with the significant positive effects of class attendance on academic performance, can we make attendance non-negotiable? The next section will address this policy question.

5. Conclusion

This paper contributes to the literature by an empirical study of the effects of a student-specific starting line on student academic performance. We first estimated the education efficiency of sample students. Then, the results as estimated by Tobit model suggest that many components of a student-specific starting line do not have effects on the university student academic performance except two factors, viz pre-university English proficiency and student ambition. First, we would stress that the mother language of the sample students from Hong Kong and the Mainland is not English though we did not ask for this piece of information directly in our questionnaire survey. While the working language at the universities in Hong Kong is English, the empirical result that sample students with high English proficiency performing better than their other students with lower English proficiency is not unexpected. The implication is that the academic programme management units may have to give due attention how to help students to raise their English proficiency. Along this implication, Laadem (2017) examined how teaching and learning English in tertiary education institutes would well be performed using e-learning. Second, if students' main reason to study at a university is to find a job and to earn more money after graduation, they would then be motivated to work harder in order to attain better academic performance. Better academic performance is expected to be the key to get a better-paid job. Pigden & Moore (2017) explored a similar issue to what extent passion in study and subject choice would affect graduate employment. Finally, we highlight the limitation of this research that the empirical investigation is based on a small sample size.

The scope of future research is suggested to employ on a wider scope of sample data before the empirical results from this paper can be generalized. In particular, data sample is suggested to be collected from different geographical locations with different education systems, where language and cultural background of the students are expected to vary from the sample of this research. The suggested research is expected to provide insights on how much the significance of the factors considered in this study is culture specific.

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