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Sustainable Education: Analyzing the Determinants of University Student Dropout by Nonlinear Panel Data Models

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Abstract: University dropout is a serious problem. It affects not only the individual who drops out but also the university and society. However, most previous studies have focused only on the subjective/individual level. University dropout is a very important issue in South Korea, but it has not received much research attention so far. This study examined the possible causes of university dropout in South Korea at the aggregate level, focusing on four fundamental categories: students, resources, faculty, and university characteristics. Three-year balanced panel data from 2013 to 2015 were constructed and estimated by using nonlinear panel data models. The findings show that cost and burden for students, financial resources, qualitative and quantitative features of faculty, and type/size of the university have significant effects on university dropout.

Keywords: sustainable education; dropout; university student; determinants of dropout; withdrawal

1. Introduction

Education has played an essential role in achieving rapid economic growth in South Korea. Higher education institutes such as colleges or universities have been the main source of good-quality human capital and have boosted social mobility. It can easily be proven both historically and statistically that there exists a very close positive correlation between economic growth and higher education attainment; South Korea is no exception. According to the OECD [1], Korea is ranked fourth (45%) for 25–64-year-olds and first (69%) for 25–35-year-olds in tertiary education among 35 OECD countries. Moreover, it has seen a rapid increase in education attainment, from 51% in 2010 to 69% in 2015. The high level and rapid growth of educational attainment seem to be necessary conditions for accumulating human capital at the society level.

However, the high level of participation in tertiary education does not tell us the whole story. Not all freshmen graduate from university and earn their bachelor's degree. There are many reasons outside of the inability to catch up that prevent students from graduating; these can be dichotomized into reasons from the students' side and those from the universities' side. The former includes a lack of full information on and satisfaction with university education or a lack of hope for a bright future. The latter includes poor-quality faculties, lower facility levels, and rickety financial status, which usually induce dissatisfaction in students. No matter how a reason originates, it can push students to drop out.

Table 1 shows the increasing dropout rates of the top 19 universities among all 214 four-year universities in South Korea. The average dropout rate increased from 1.17% in 2010 to 2.099% in 2015. It has almost doubled. This new phenomenon could be partly explained by a simple cost–benefit analysis. During the same time period, the GDP growth rate moved in exactly the opposite direction; it was 6.5% in 2010 and 2.6% in 2015. The average GDP growth rate was 4.14% from 2006 to 2010

and 2.96% from 2011 to 2015. If the cost of finishing one's university education exceeds the expected benefit of earning a degree, there would be little reason to stay in school, even at a top-level university. Until very recently, entering a top-level university was regarded as walking on a royal road to social success, including getting a good job and gaining higher social status in South Korea, which would be one reason why the country maintains such a high education attainment rate. However, this optimistic viewpoint was shattered as South Korea began to suffer from low economic growth and a high unemployed rate. As explored later in Section 3, the average employment rate of university graduates has consistently decreased, from 62.72% in 2013 to 53.08% in 2015. As Table 1 shows, all universities except for UNIST show an upward trend in dropouts.

Table 1. Main university dropout rates.

No.	University	2015			2010			2009		
		Enrollment	Dropout	Dropout Rate	Enrollment	Dropout	Dropout Rate	Enrollment	Dropout	Dropout Rate
1	Ewha	18,623	384	2.06%	17,909	276	1.54%	17,964	181	1.01%
2	Sookmyung	13,084	301	2.30%	13,063	269	2.06%	12,596	216	1.71%
3	Sogang	11,516	234	2.03%	11,917	231	1.94%	11,678	155	1.33%
4	KonKuk	22,963	607	2.64%	23,188	362	1.56%	22,252	331	1.49%
5	GIST	496	12	2.42%	99	1	1.01%			
6	UNIST	3790	66	1.74%	1224	17	1.39%	497	14	2.82%
7	Sungkyungwan	26,596	525	1.97%	28,087	345	1.23%	27,884	266	0.95%
8	Chung-ang	21,882	506	2.31%	20,048	260	1.30%	19,833	237	1.19%
9	Hongik	16,942	383	2.26%	16,790	240	1.43%	16,490	231	1.40%
10	Hanyang	21,631	434	2.01%	22,802	253	1.11%	22,927	183	0.80%
11	Dongguk	19,354	516	2.67%	20,546	233	1.13%	19,550	218	1.12%
12	Univ. of Seoul	13,454	317	2.36%	12,793	175	1.37%	12,456	177	1.42%
13	HUFS	23,325	613	2.63%	12,228	128	1.05%	12,061	147	1.22%
14	Kyunghee	34,224	780	2.28%	17,922	141	0.79%	17,598	125	0.71%
15	KAIST	4679	67	1.43%	4690	54	1.15%	4463	62	1.39%
16	Korea	27,304	512	1.88%	28,293	205	0.72%	28,082	207	0.74%
17	S.N.U.	21,155	215	1.02%	21,776	138	0.63%	22,087	103	0.47%
18	Yongsei	26,073	418	1.60%	26,555	202	0.76%	26,490	127	0.48%
19	POSTECH	1658	9	0.54%	1639	10	0.61%	1672	8	0.48%
Total or Mean		328,749	6899	2.10%	301,569	3540	1.17%	296,580	2988	1.01%

Rapidly growing dropout rates can also be found in other countries. Based on the National Educational Longitudinal Study of 1988 (NELS: 88), Bound et al. [2] found that among the classes of 1972 and 1992 high school cohorts, eight-year college completion rates decreased nationally by 4.6 percentage points, from 50.5% to 45.9%. The snapshot report from the National Student Clearinghouse issued on 27 June 2016, says that "for the 2009–2010 academic years, 536,351 were earned by students with no previous degrees or certificates. Within the next six academic years, over 64% of these students enrolled at a four-year institution and 41% earned a bachelor's degree." Based upon this report, overall more than 30% were not enrolled and can be regarded as college dropouts.

So, why is the dropout rate of university students so important? Larsen et al. [3] describe the significant consequences of university dropout at the individual, university, and societal levels.

At the individual level, university dropout entails both psychological and physical costs. Students may suffer from depression arising from feelings of inadequacy and self-doubt, all of which are related to dropping out. Moreover, they will be aware of wasting personal resources, effort, time, and money.

At the university level, dropouts have economic and academic consequences. From the academic point of view, university dropouts not only represent a failure to adapt to the college life and system but also signify a red light to the education system in regard to providing appropriate services for students. From the economic point of view, the more dropouts, the worse the financial state of the university.

At the societal level, the socioeconomic impact of university dropout can never be ignored because the supply of university graduates significantly influences both the returns to education and overall economic growth [2]. Gitto et al. [4] comment that weak university-level education may have negative effects not only on students but also on economic growth and society as a whole.

Therefore, it is important to analyze the causes of university dropout. Although there have been large, extensive studies of university dropout rates, relatively few analyzed dropout at the aggregated

level. The main novelty of the present research is that we tested a more integrated model that included four factors from not only the demand-side but also the supply-side determinants of dropout. Few previous studies have compared four factors (student, faculty, resource, and structural factors) in one model. Such an approach would allow us to pursue a systematic and thorough understanding of university dropout. In particular, there have been few systematic studies on university dropout in South Korea. Our study, mainly focusing on objective/supply side (more than demand side) variables, aims to implement an empirical study to analyze possible factors related to university dropout with aggregate-level three-year panel data on universities in South Korea.

The remainder of the paper is organized as follows: in Section 2, previous studies are summarized and the theoretical background for university dropout is provided. In Section 3, an econometric model for examining important variables affecting university dropout is introduced. In Section 4, the data are described and the empirical findings are reported. Section 5 summarizes the empirical findings. Finally, Section 6 contains concluding remarks and policy implications.

2. Theoretical Background

2.1. Research Trends Related to Dropout at the University Level

The term "university dropout" is commonly used to describe situations where a student leaves the university in which (s)he has enrolled before having obtained a formal degree. The terms used to describe university dropout from a student's perspective are many: dropout, departure, withdrawal, academic failure, noncontinuance, and noncompletion. Their positive counterparts include persistence, continuance, completion, etc. [3] (p. 5).

Dropout takes place for various reasons. Spady [5] and Tinto [6] argue that a student's persistence/withdrawal decision is the result of a long series of interactions between the student and the academic and social systems of the institution. Lam [7] points out the various reasons for dropout—student status, residence, financial sources, distance of hometown from the university, goal fulfilment, and satisfaction with the overall university atmosphere—which are useful in making predictions. Also, according to an extensive literature review by Larsen et al. [3], various factors explain dropout from university: the student's sociodemographic background, academic competencies, motivations for studying, social and academic integration at university, and living conditions.

There have been extensive efforts to analyze the determinants of university dropout. Those studies can be divided into four trends.

First, as a conventional approach, a lot of studies on university dropout tended to focus more on the demand (student) side rather than the supply (university) side. According to Gitto et al. [4], dropout studies have heavily focused on demand-side characteristics such as students' prior educational achievements (before entering university), gender, age, motivation, financial constraints, sociodemographic background, and individual circumstances. Using path analysis, Bean [8] finds that college grades, institutional fit, and institutional commitment are important intervening variables in dropout syndrome. He also points out that the supply-side determinants of dropout (e.g., organizational conditions within universities) have only recently started receiving attention. Moreover, he shows that a student's peers are more important agents of socialization than informal faculty contacts and that a student may play a more active role in socializing with his peers than previously perceived. Heublein et al. [9,10] include pre-university factors in explaining university dropout. Those factors comprise the student's financial situation/living conditions, advice/support from friends/family and other opportunities for counseling, as well as the student's own future plans.

Second, previous studies have focused more on subjective or psychological factors at the individual level than on objective variables at the aggregate or university level. For example, Bean [8] focuses on individual-level variables such as college grades, institutional fit, and institutional commitment. He shows that college grades seem more a product of selection than of socialization. Moreover, according to Spady [5], psychological factors such as institutional commitment and

perceived social integration (i.e., a subjective sense of belonging and fitting in) have a stronger influence on the decision to drop out in one's first year.

Third, compared to the numerous studies focusing on the demand/subjective side at the individual level, relatively recent and few studies have been examining the supply/objective side at the aggregate level. However, institutional supply-side factors also have an influence on dropout decisions. Larsen et al. [3] mention causal factors of dropout at the institutional level, which concern the course/subject of study, department, faculty, university, or the entire system of higher education. Gitto et al. [4] demonstrate that some supply-side factors such as the structure of university courses and reorganization of remote branches have a significant impact on the likelihood of dropout occurring. Bound et al. [2] argue that even though the supply-side factors of higher education play an important role in explaining changes in student outcomes, they have often been disregarded.

Lastly, a more recent trend for analyzing university dropout is to adopt a more balanced view to reflect the supply/objective side as well as the demand/subjective one. There exist several previous studies that adopt a more balanced model. Based on the Student Integration Model, Tinto [6] emphasizes the interactions between individual students' attributes and institutional structures within universities. He argues that not only student factors but also university factors influence dropout, as follows: First, students' attributes such as family background, personal characteristics, and prior schooling influence his/her abilities and prerequisites for study at a university. They provide the resources for adaptation to the student lifestyle. Second, university factors consist of academic and social systems. The first is concerned with academic performance and interactions with professors/staff. The latter is about extracurricular activities and social relations. Gitto et al. [4] comment that even though university dropout may be explained by the supply-side characteristics of the university as well as by students' individual characteristics, many studies have focused only on the latter factors [2,7,8]. Based on survey data, Pierrakeas et al. [11] show that not only intrinsic (student-related) factors such as sickness, work/school conflicts, etc., but also extrinsic (institution-related) factors such as study methods and materials, educational approach, and tutors influence dropout at the university level.

The research trend seems to move from a unilateral view considering demand-side/individual level or supply-side/aggregate level to comprehensive or bilateral view such as a balance model. When analyzing university dropout, we will maintain the balanced view and focus on not only demand-side student factors but also supply-side institutional university factors. Furthermore, for more depth study, we divide the supply-side into three fundamental categories (i.e., faculty, resource, and structural factors) and suggest a modified balanced model. Our main research question concerns which factors critically contribute to explaining dropout at the university level. Next, we will review previous findings related to these factors and present the research hypotheses.

2.2. Student Factors

Every year, many students with different backgrounds, characteristics, and cultures go to university. There are many factors that affect dropout decisions. Various types of student characteristic have some influence on these decisions. Among these various student factors, we will concentrate on two: student qualities and costs/benefits. The former concerns the ability, competence, motivation, and performance of a student. The latter relates to the financial cost and the expected or realized benefits that a student carries on or receives after entering university.

First, the quality of students influences how they will be integrated into or drop out of a university's social and academic systems. Titus [12] demonstrates whether or not precollege academic performance has an impact on student persistence in university. He shows that those who have a high SAT score demonstrate more persistence. Also, Astin [13] regards high-achieving students as a useful resource because large numbers of such students enhance the quality of the learning environment for all students. Simpson et al. [14] show that good performance, such as a higher GPA, decreases failing dropouts and transfers, and that higher SAT scores also reduce failing transfers. Gitto et al. [4] corroborate the intuitive proposition that students who do well in high school are more

likely to succeed at university and, as a result, are less likely to drop out. Bound et al. [2] report that preparations for entering college (as measured by math test scores) by a student explain one-third of the observed decline in completion rates. Moreover, Spady [5] shows that those who have academic potential show higher graduation rates. According to a literature review by Larsen et al. [3], 14 out of 22 studies found that higher (upper) secondary school marks significantly lowered the risk of dropout. Pierrakeas et al. [11] report that those who are not qualified enough (i.e., do not have the required knowledge for a specific course) to pursue university-level studies are felt to be dropouts.

Second, the costs and benefits that students face at university influence their dropout decisions. In terms of costs, financial burdens such as tuition, scholarships, and student loans critically influence dropout decisions. Li and Killian [15] examine patterns of attrition at a midwestern research university and report that among the most often proffered reasons for leaving, financial factors are the most important ones in relation to persistence in higher education. If the tuition is high, more students will feel psychological and economic hardships, thereby negatively affecting their dropout decision and participation in higher education. Financial aid from universities is closely related to dropout. According to Ishitani et al. [16], generally those who receive financial aid show lower dropout rates than nonaided students. Moreover, after estimating the effect of financial aid on dropout from and completion of a five-year university degree in Denmark, Arendt [17] shows that an increase in grants decreases the dropout rate but has no overall impact on the completion rate.

In terms of benefits, expected or realized benefits will reduce the dropout rate. Students will not leave university if they can envision the prospective future that awaits after they graduate: for example, getting a good job, entering a better graduate school, and having other chances in their personal life. Simpson et al. [14] show that among students of good standing, those who have high vocational orientation have a lower probability of withdrawing.

2.3. Faculty Factors

A faculty is a buffering resource that makes contributions to reducing student dropout at a university. Spady [5] and Tinto [6] stress that social and academic integration is critical influencing factors on student persistence. Pascarella et al. [18] argue that the faculty–student interaction is the key factor in the academic and social integration of students. Such contacts have a strong impact on student attrition. Based on data collected from students at a private university, they also argue that academic and social contacts with faculty at some institutions, particularly private ones, influence attrition-related content more than those at other institutions. Pascarella and Patrick [19] show that a faculty has two integration functions: academic and social ones. The first relates to faculties' concern for teaching and student development and students' informal contact with faculty for the sake of intellectual discussions. The second is about informal relations with a faculty; for example, helping to resolve a personal problem. Such interactions have a significantly negative impact on college attrition.

If the quantity and quality of professors are enhanced, there will be better roles for them. The former is about the volume of faculty (e.g., the number of professors, the student–faculty ratio, and how many classes are taught by professors) whereas the latter is about the faculty's research competences (i.e., the number of publications and research funding).

Related to the quantity of faculties, Astin [13] explains that the lower the student–faculty ratio becomes, the greater the learning and personal development, because reduced teaching load encourages professors to spend more time and energy supporting students. Gitto et al. [4] find that the ratio of the number of lecturers to newly enrolled students is negatively correlated to dropout. This implies that the quality of teaching has some obvious influences on dropout decisions. According to Bound et al. [2], an increase in the student–faculty ratio explains a large portion of the total observed completion rate reduction.

Education is affected not only by quantitative aspects but also by qualitative ones: Educational environments can be improved by bringing in better or higher-quality professors. Our research assumes that higher-quality professors with many good publications and significant research funds

help to boost the quality of education to a more desirable level, leading to a decrease in the dropout rate. However, previous studies have not explicitly examined such qualitative aspects of faculties.

2.4. Resource Factors

Plentiful resources that universities can utilize provide the fundamental structure for better education. Gitto et al. [4] and Bound et al. [2] argue that even though the supply side of higher education plays an important role in explaining changes in students' outcomes, its importance has been overlooked. Bound et al. [2] show that resources that are available within these institutions are key factors in influencing college completion in the United States. They demonstrate that a decrease in institutional resources explains about one quarter of the observed completion rate decline. According to Astin [13] (p. 520), these resources include a wide range of ingredients believed to enhance student learning, such as fiscal resources (financial aid, endowments, and extramural research funds) and physical facilities (laboratories, libraries, and audiovisual aids).

Our study focuses on two resource factors: financial resources and facility level. The former includes the amount of revenue and expenditure mainly based on tuition, funding from donations, and grants from the government, whereas the latter concerns building a space for education.

If universities have enough resources from revenues, higher education will afford more qualitative services. Titus [12] analyzes the effect of revenue and expenditure patterns. He shows that an increased percentage of resources from tuition, not from state appropriations or grants, will increase student persistence. On the contrary, a higher percentage spent on administration (not on instruction, student services, grants and scholarships, or research) decreases it. Moreover, if there is a higher percentage of revenues based on government subsidies, then participation in higher education will be higher. Government grants or subsidies play some role in expanding access through lowering tuition levels. Gross et al. [20] examine the effects of institutional financial aid on the persistence of university undergraduate and graduate students. They find that institutional financial aid from public universities has a positive but modest effect on persistence. Interestingly, the effects of aid are greater for men than for women, all else being equal.

The physical conditions at a university, such as the age and size of facilities and the quality of the classrooms, have an influence on dropout. According to Sewasew [21], a lack of facilities is one of the major challenging factors in the university environment and has been identified as one reason for dropout. Bowers and Burkett [22] compare schools in terms of age and find that students at a modern school have higher attendance rates than those at an older facility. However, McGowen [23] shows that school facilities influence discipline and behavior but not achievement, attendance, or completion rate.

2.5. Structural Characteristics of Universities: Type, Size, and Location

Much like how sociodemographic variables at the individual level such as gender, residence, age, and social status affect university dropout, characteristics at the university level such as type, size, and location also have some effects on it.

First, Titus [13] shows that the type (private versus public), location (rural versus urban), and size (number of enrollments) of a university do not influence students' persistence. Bound et al. [3] mention the critical role of institution type: collegiate characteristics have more of an influence on dropout. Bound et al. [3] demonstrate that the kind of college that students attend is an important factor in the changes in college completion in the United States. Also, Gitto et al. [4] show that the dropout rates at public universities appear higher than private ones.

Second, the size of the university influences the quality of the education as well. In the education field, the principle "small is beautiful" is generally and empirically validated. The smaller the school, the more efficient its educational outcomes. Pittman and Haughwout [24] investigate how school size affects the dropout rate. They assume that size not only indirectly influences the dropout rate but also directly affects the diversity of academic offerings and the school's social climate. They find that the social climate creates potential links between school size and the dropout rate.

Third, the location of the university—for example, rural versus urban—changes the dropout rate. Although Jordan et al. [25] show that high school graduation rates were very similar across the rural–urban continuum in the early 2000s, Pallas [26] finds that urban students drop out more frequently. He reports that a rural education is better than that obtained in a congested urban area because a rural environment leads to fewer problems. Gitto et al. [4] demonstrate that universities located in Northern Italy show lower dropout rates.

The previous studies show that university dropout is closely related to the four factors which were described above. However, few studies have considered the four factors in a model. The aim of this study is to inquire into a systematic and thorough understanding of university dropout with a more integrated model. For this purpose, we adopt a modified balanced model including the four factors, examine it with the nonlinear panel data regression models and test for the hypotheses as follows:

H1: Dropout decreases when students are more qualified and more benefits are expected from the university; it increases when students have to bear higher costs.

H2: Increased quality and quantity among faculty decreases university dropout.

H3: As resource factors, better financial and facility conditions reduce university dropout.

H4: Dropout rates at public universities are higher than at private ones. The smaller the size of the university, the smaller the dropout rate. Universities located in rural areas have less dropout than those in urban areas.

3. Model

Let $\{(X_{it}, y_{it}) : i = 1, 2, \ldots, N; t = 1, 2, \ldots, T\}$ denote the panel data observations where X_{it} is a $1 \times P$ vector of the explanatory variables and y_{it} is the dependent variable. Let $E(y_{it}|X_{it}, a_i)$ be the conditional expectation of y_{it} given X_{it} and a_i where $a_i = e^{\mu_i}$ is the unobserved effect. As the dependent variable is a count variable that takes on nonnegative integer values,$y_{it} \geq 0$, the most popular parametric function is an exponential function of X_{it} and the $P \times 1$ vector of parameters β_0; $\exp(X_{it}\beta_0)$. If the unobserved and time-constant effect a_i is multiplicative and independent of explanatory variables, $E(y_{it}|x_{it}, a_i) = a_i \exp(X_{it}\beta_0)$.

Assume that

$$y_{it}|X_i,\ a_i \sim Poisson[a_i \exp(X_{it}\beta_0)] \tag{1}$$

$$y_{it}\ and\ y_{is}\ for\ t \neq s \text{ are independent conditional on } X_{it} \text{ and } a_i \tag{2}$$

$$a_i = e^{\mu_i} \sim Gamma(\delta_0, \delta_0) \text{ and } a_i \text{ is independent of } X_{it} \tag{3}$$

The Poisson probability specification is derived under the assumptions (1)–(3):

$$pr(y_{it}|X_{it}, \mu_i) = \frac{e^{-\lambda_{it}e^{\mu_i}}(\lambda_{it}e^{\mu_i})^{y_{it}}}{y_{it}!}. \tag{4}$$

The joint density of $(y_{i1},\ y_{i2},\ \ldots,\ y_{iT})$ and μ_i takes the form

$$\begin{aligned} &pr(y_{i1},\ y_{i2},\ \ldots,\ y_{iT},\ \mu_i|X_{i1},\ X_{i2},\ \ldots,\ X_{iT}) \\ &= pr(y_{i1},\ y_{i2},\ \ldots,\ y_{iT}|X_{i1},\ X_{i2},\ \ldots,\ X_{iT},\ \mu_i)g(\mu_i) \\ &= \prod_t \frac{\lambda_{it}^{y_{it}}}{y_{it}!} e^{-e^{\mu_i}\sum_t \lambda_{it}} e^{\mu_i \sum_t y_{it}} g(\mu_i) \end{aligned} \tag{5}$$

where $g(\mu_i)$ is the probability density function of μ_i. The conditional density of μ_i given X_{it} is the same as the unconditional density of μ_i in Equation (5). Since μ_i is an unobservable random variable, it can be integrated out from Equation (5) as follows:

$$\begin{aligned} & pr(y_{i1},\ y_{i2},\ \ldots,\ y_{iT}|X_{i1},\ X_{i2},\ \ldots,\ X_{iT}\ ) \\ &= \int_0^\infty \prod_t \left[\frac{\lambda_{it}^{y_{it}}}{y_{it}!}\right] e^{-\alpha_i \sum_t \lambda_{it}} \alpha_i^{\sum_t y_{it}} f(\alpha_i) d\alpha_i \\ &= \prod_t \left[\frac{\lambda_{it}^{y_{it}}}{y_{it}!}\right] \left[\frac{\delta}{\sum_t \lambda_{it}+\delta}\right]^{\delta} \left(\sum_t \lambda_{it}+\delta\right)^{-\sum_t y_{it}} \frac{\Gamma\left(\sum_t y_{it}+\delta\right)}{\Gamma(\delta)} \end{aligned} \tag{6}$$

where $\Gamma(\cdot)$ is the gamma function and $\Gamma(z) = t^{z-1}e^{-t}$ for $z > 0$. Equation (6) is the random effects (RE) Poisson model suggested by Hausman, Hall, and Griliches [27] (hereafter, HHG), and the parameters of the model in Equation (6) can be consistently estimated via quasi-maximum likelihood estimation.

Let $u_i = \frac{\delta}{\sum_t \lambda_{it}+\delta}$ and $\lambda_{it} = \exp(X_{it}\beta)$. Then, Equation (6) is rewritten as the likelihood function in Equation (7):

$$\begin{aligned} & pr(y_{i1},\ y_{i2},\ \ldots,\ y_{iT}|X_{i1},\ X_{i2},\ \ldots,\ X_{iT}\ ) \\ &= \frac{\prod_t \lambda_{it}^{y_{it}} \Gamma\left(\sum_t y_{it}+\delta\right)}{\prod_t y_{it}!\ \Gamma(\delta) \left(\sum_t \lambda_{it}\right)^{\sum_t y_{it}}} u_i^{\delta} (1-u_i)^{\sum_t y_{it}} \end{aligned} \tag{7}$$

The estimator of the RE Poisson model can be obtained by maximizing the log likelihood function in Equation (8).

$$\begin{aligned} L(\beta) = \sum_{i=1}^{N} \Bigg\{ & \log\Gamma\left(\delta + \sum_{t=1}^{T} y_{it}\right) - \sum_{t=1}^{T} \log\Gamma(1+y_{it}) - \log\Gamma(\delta) + \delta \log u_i \\ & + \log(1-u_i) \sum_{t=1}^{T} y_{it} + \sum_{t=1}^{T} y_{it}(x_{it}\beta) - \left(\sum_{t=1}^{T} y_{it}\right) \log\left(\sum_{t=1}^{T} \exp(X_{it}\beta)\right) \Bigg\} \end{aligned} \tag{8}$$

where $\Gamma(1+y_{it}) = y_{it}!$.

If assumption (3) is violated, then an arbitrary dependence between X_{it} and a_i exists, and the Poisson RE model can no longer be a consistent estimator. HHG [27] conducted seminal work on this issue and suggest the fixed effects (FE) Poisson estimate. Using $n_i \equiv \sum_{t=1}^{T} y_{it}$ for each cross section i, HHG [27] shows that y_{it} does not depend on a_i and that the conditional distribution of y_{it} given n_i and x_{it} follows multinomial distribution:

$$\begin{aligned} & y_{it}|n_i,\ X_{it}, a_i \ \sim \ Multinomial\{n_i,\ p_{i1}(X_{it},\beta_0),\ p_{i2}(X_{it},\beta_0), \ldots, p_{iT}(X_{it},\beta_0)\} \\ & where\ p_{it}(X_{it},\beta_0) = \frac{a_i \exp(X_{it}\beta_0)}{\sum_{t=1}^{T} a_i \exp(X_{it}\beta_0)} \end{aligned} \tag{9}$$

From Equation (9), the joint density function of $(y_{i1},\ y_{i2},\ \ldots,\ y_{iT})$ is derived as

$$\begin{aligned} pr\left(y_{i1},\ y_{i2},\ \ldots,\ y_{iT}\middle|X_i,\ \sum_t y_{it}\right) &= \left(\sum_t y_{it}\right)! \prod_t \left[\frac{\exp(X_{it}\beta)^{y_{it}}}{y_{it}! \left\{\sum_k \exp(X_{ik}\beta)\right\}^{y_{it}}}\right] \\ &= \left[\frac{\left(\sum_t y_{it}\right)!}{\prod_t y_{it}!} \prod_t p_{it}^{y_{it}}\right] \\ & where\ p_{it} = \frac{\exp(X_{it}\beta)^{y_{it}}}{\left\{\sum_k \exp(X_{ik}\beta)\right\}^{y_{it}}}. \end{aligned} \tag{10}$$

Equation (10) is the likelihood function of the FE Poisson model. The conditional log likelihood function is given by taking logarithms of the model in Equation (10) and summing up over individual observation i:

$$L(\beta) = \sum_{i=1}^{N} \left\{ \log \Gamma \left(\sum_{t=1}^{T} y_{it} + 1 \right) - \sum_{t=1}^{T} \log \Gamma (y_{it} + 1) + \sum_{t=1}^{T} y_{it} \log p_{it} \right\} \quad (11)$$

The FE Poisson model is estimated by maximizing Equation (11).

4. Empirical Findings

4.1. Data Description

According to the Act on Information Disclosure of Educational Institutions, Section 6, all educational institutions in South Korea must have thorough information disclosure and regulated relevant details. The purpose of this Act is to ensure the right to be informed, promote academic and policy research, encourage participation in school education, and improve efficiency and transparency in educational administration. The educational website Higher Education in Korea (www.academyinfo.go.kr), designed and operated by the Korean Council for University Education, collects detailed information for all universities in Korea and makes it available to the public. The website provides 63 items in 14 categories (e.g., students enrolled, tenure-track faculty, annual tuition and fees, scholarship recipients, graduate employment, research funding, journal publications, student accommodations, library budget and holdings, financial resources, university budget and settlement, donation and reserves). These items are updated once or twice a year, usually in August, and are available to the public for three years. The raw data were obtained from this website. The original dataset contained academic information on a total of 214 four-year universities. Among them, 22 universities reported imprecise and erroneous information and were removed from the dataset. After removing and adjusting the missing values, a three-year balanced panel dataset of 192 universities from 2013 to 2015 was constructed for the study.

We selected and arranged the variables for the study under four comprehensive categories, which are discussed in Section 2. They were student, faculty, resource, and university characteristics. Table 2 explains the variables in these four categories.

Dropout is the total number of university dropouts, and it is considered the dependent variable for regression analysis. The student category contained seven variables in three subcategories. Special HS is the rate of students from special high schools to all newly enrolled students. Grad school is the rate of students who go on to graduate school. Job is the rate of students who find jobs after they graduate. Tuition is annual tuition measured in units of 1000 Korean won. Scholarship is the average amount of financial scholarship funding received per student and is also expressed in units of 1000 Korean won. Loan is the rate of students who receive loans. The faculty category contained five variables: students/prof, lecture, tenure, sci, and external fund. Students/prof is the number of students per tenure-track professor. Lecture is the rate of lectures taught by tenure-track professors. Tenure is the number of tenure-track professors. Sci is the average number of articles per professor published in SCI (Science Citation Index) or SSCI (Social Science Citation Index) journals. External fund is the average amount of research funds received from other institutions or organizations. The resource category contained four variables in two subcategories: bookkeep, donation, project, and facility. Bookkeep is the annual settlement amount measured in units of 1000 Korean won. Donation is the annual increase in donations measured in units of 1000 Korean won. Project is the total amount of financial subsidy granted by the Ministry of Education, Science, and Technology (MEST) and is measured in units of 1000 Korean won. Facility is the professor facilities provision rate.

Table 2. Explanation of variables.

Factor	Concept	Variable	Explanation
	Dependent Variable	Dropout	Number of Dropouts
Student Factor	Quality of Student	special HS	Rate of freshmen from special high schools
	Benefit	grad school job	Rate of graduates to grad school Rate of graduates who find jobs
	Cost	tuition scholarship loan	Annual tuition Average scholarship Rate of students who receive loans
Faculty Factor	Quantity of Faculty	students/prof lecture tenure	Number of students per professor on tenure track Rate of lectures taught by professors on tenure track Number of professors on tenure track
	Quality of Faculty	sci external fund	Number of SCI/SSCI articles published Research funds from outside the university
Resource Factor	Finance	bookkeep	Settlement amount
		donation	Annual amount of donations
		project	Total amount of project funds from government
	Facility	facility	Facility provision rate
Structural Characteristics of University	Size	students staff	Total number of enrolled students Number of staff
	Type: Public/Private University	state_d	State dummy: 1 if state university, 0 otherwise
	Location	city_d	Location dummy: 1 if in city, 0 otherwise
	Age	age	Total number of years since a four-year institution

Lastly, the university characteristics category contained five variables in four subcategories: students, staff, state_d, city_d, and age. Students is the total number of currently enrolled students. Staff is the number of staff members. State_d is a status dummy variable. It was assigned 1 if a university was a national, state, or city university and 0 if otherwise. City_d is a location dummy variable. It was assigned 1 if a university was located in a city area and 0 if otherwise. Age is the number of years since the university became a four-year university.

Table 3 reports the means and standard deviations as summary statistics for the variables from 2013 to 2015 listed in Table 2. Most variables show a very steady pattern. For example, the average number of dropouts per university is just under 400 and maintains stability: 392.73 in 2013, 396.75 in 2014, and 395.11 in 2015. Although the average tuition is almost fixed, the amount of scholarship funds per student keeps increasing from 2,773,000 won in 2013 to 3,407,000 won in 2015. This reflects the compulsory policy by MEST in Korea. However, lavishing scholarship funds on students while holding back tuition has been criticized as one of the leading reasons for universities' aggravated budget situation.

Table 4 reports the total number of enrolled and dropout students. The total number of dropout students comes from eight different categories in the original data, three of which were directly related to the students' studies. To analyze possible factors that prompt students to leave university, the other five non-study-related categories were considered in this study. These five categories are unregistered, unenrolled, drop off, exceeding due periods, etc. The total number of students at the 192 universities slightly increased from 2,002,163 to 2,043,902 over three years, while the total number of dropouts was almost stagnant. The dropout rate varied slightly, from 3.71% to 3.77%.

Table 3. Means and standard deviations for the variables, 2013–2015.

Variable	2013	2014	2015
dropout	392.73 (316.51)	396.75 (304.57)	395.11 (298.49)
special HS	4.217 (7.928)	4.081 (7.242)	3.892 (5.902)
grad school	11.12 (15.23)	11.47 (10.21)	10.16 (15.23)
job	62.72 (17.14)	61.69 (16.51)	53.08 (17.92)
tuition	6464.22 (1609.19)	6502.26 (1555.34)	6511.10 (1557.97)
scholarship	2773.16 (961.99)	3169.65 (945.12)	3406.86 (926.98)
loan	17.41 (6.64)	16.95 (6.43)	15.33 (5.99)
students/prof	28.88 (7.74)	28.37 (6.84)	27.91 (6.79)
lecture	59.36 (12.64)	62.18 (11.44)	63.24 (11.16)
tenure	348.81 (346.18)	353.78 (347.01)	355.23 (350.27)
sci	0.20 (0.23)	0.21 (0.24)	0.24 (0.25)
external fund	49,652.61 (130,315.2)	40,187.26 (60,893.39)	89,134.08 (636,924.7)
bookkeep	2.18×10^8 (2.80×10^8)	2.38×10^8 (3.80×10^8)	2.28×10^8 (2.94×10^8)
donation	4,056,260 (8,081,197)	6,962,536 (2.08×10^7)	4,273,196 (9,532,227)
project	2.07×10^7 (4.64×10^7)	2.12×10^7 (2.79×10^7)	2.85×10^7 (5.29×10^7)
facility	140.88 (85.22)	169.65 (209.00)	170.89 (198.73)
students	10,427.93 (8756.37)	10,567.15 (8717.693)	10,645.32 (8665.892)
staff	212.01 (212.06)	211.05 (214.38)	214.47 (217.70)
age	33.51 (18.28)	34.51 (18.28)	35.51 (18.28)

Table 4. Total number of dropout students, 2013–2015.

Year	Total Students	Total Dropouts
2013	2,002,163	75,404
2014	2,028,892	76,175
2015	2,043,902	75,862

4.2. Regression Results

Initially, 28 variables were considered for setting up a model. Among them, dropout, a count variable, was used as the dependent variable, five dummy variables for time and university characteristics, and 22 variables from the four categories were considered as a set of independent variables. Based on the preliminary regression analysis, some redundant variables were removed. The finalized nonlinear panel regression model for the study is given in Equation (12):

$$dropout_{it} = a_i \exp\left(\begin{array}{l} \beta_0 + \delta_1 state\_d_{it} + \delta_2 city\_d_{it} + \delta_3 d14_{it} + \delta_4 d15_{it} + \beta_1 special\ HS \\ +\beta_2 grad\ school_{it} + \beta_3 job_{it} + \beta_4 \log(tuition)_{it} + \beta_5 \log(scholarship)_{it} \\ +\beta_6 loan_{it} + \beta_7 students/prof_{it} + \beta_8 lecuture_{it} + \beta_9 \log(tenure)_{it} \\ +\beta_{10} sci_{it} + \beta_{11} \log(external\ fund)_{it} + \beta_{12} \log(bookkeep) \\ +\beta_{13} \log(donation)_{it} + \beta_{14} \log(project)_{it} + \beta_{15} facility_{it} \\ +\beta_{16} \log(students)_{it} + \beta_{17} staff_{it} \end{array}\right) v_{it} \quad (12)$$

where v_{it} is idiosyncratic errors, d14 is the year dummy for 2014, and d15 is the dummy for 2015. The independent variable "age" was removed in the model due to the perfect collinearity problem with the year dummy variables.

Table 5 reports the regression results. Columns 4–6 list the regression results from the linear models—ordinary least squares, RE model, and FE model, respectively. These models presume that there exists a linear relationship between the dependent and independent variables, which was not appropriate in the case of the count dependent variable. Columns 7 and 8 list the regression results from the nonlinear panel data models, the Poisson RE and Poisson FE models, respectively.

Table 5. Regression Results.

Factor	Concept	Variable	OLS	RE	FE	Poisson RE	Poisson FE
Student Factor	Quality of Student	special HS	−9.047 *** (2.557)	−3.844 (3.122)	−1.245 (1.482)	−0.013 *** (0.004)	−0.006 (0.005)
	Benefit	grad school	1.144 (1.723)	−1.708 (1.351)	2.117 (1.543)	−0.002 (0.003)	0.010 *** (0.004)
		job	−1.402 (0.908)	−0.687 (0.536)	−0.154 (0.333)	−0.003 *** (0.001)	−0.002 * (0.001)
	Cost	log (tuition)	−204.025 * (107.092)	−308.138 * (160.156)	652.505 (795.899)	−0.177 (0.277)	−0.523 (0.981)
		log (scholarship)	76.664 (59.641)	−16.933 (51.096)	−76.312 (62.754)	−0.231 *** (0.051)	−0.248 *** (0.055)
		loan	−1.538 (2.393)	−0.240 (3.130)	1.949 (5.190)	0.004 (0.005)	0.009 (0.006)
Faculty Factor	Quantity of Faculty	students/prof	7.774 ** (3.055)	10.640 *** (2.811)	1.757 (5.592)	−0.003 (0.004)	−0.006 (0.007)
		lecture	5.156 *** (1.163)	3.816 *** (1.019)	1.491 (1.242)	0.005 *** (0.001)	0.004 *** (0.001)
		log (tenure)	268.188 *** (49.969)	227.432 *** (52.478)	−87.667 (143.649)	−0.537 *** (0.084)	−0.548 *** (0.193)
	Quality of Faculty	sci	−337.74 *** (86.193)	−192.806 ** (90.338)	255.089 (159.120)	0.009 (0.1115)	0.401 *** (0.135)
		log (external fund)	−29.683 *** (10.035)	−8.520 (9.271)	12.170 (13.138)	−0.004 (0.010)	0.012 (0.011)
Resource Factor	Finance	log (bookkeep)	−95.605 *** (18.633)	−48.856 ** (22.401)	9.636 (11.301)	−0.045 ** (0.018)	−0.001 (0.019)
		log (donation)	−27.739 *** (8.997)	−12.294 * (7.193)	−2.787 (6.712)	−0.026 *** (0.007)	−0.015 ** (0.007)
		log (project)	4.641 (6.471)	10.813 (8.012)	15.547 (13.275)	0.026 *** (0.008)	0.038 *** (0.008)
	Facility	facility	0.686 *** (0.215)	0.089 (0.140)	0.116 * (0.068)	0.0003 (0.0002)	0.001 ** (0.0003)
Structural Characteristics of University	Type: Public/private Univ.	state_d	−406.994 *** (71.121)	−419.171 *** (103.312)		−0.464 *** (0.184)	-
	Size	log (students)	164.371 *** (43.927)	81.972 ** (35.279)	76.693 *** (23.279)	1.298 *** (0.062)	1.202 *** (0.081)
		staff	0.101 (0.099)	0.095 (0.113)	0.099 (0.095)	−0.00004 (0.0001)	0.0001 (0.0001)
	Location	city_d	−43.391 * (23.318)	−76.925 ** (32.122)		−0.145 *** (0.064)	-
	Year	d14	−19.564 (21.383)	−8.190 (11.241)	−0.243 (11.438)	0.013 (0.010)	0.016 (0.011)
		d15	−59.680 ** (28.946)	−13.441 (19.172)	1.196 (19.316)	−0.014 (0.020)	0.0003 (0.023)
		constant	747.937 (935.648)	1970.879 (1400.857)		1.456 (2.425)	-
			R^2 = 0.749	R^2 = 0.707	R^2 = 0.055	LL = −2286.829	LL = −1176.318
		Hausman test				207.83 *p*-value = 0.000	

Notes: 1. *, **, and *** denote 10%, 5%, and 1% levels of significance, respectively; 2. LL in columns 7 and 8 stands for log likelihood; 3. Standard errors in the linear models are heteroscedasticity robust standard errors.

As shown in columns 7 and 8 in Table 5, most of the regression results from both the Poisson RE and FE regression models look very similar, which is not an uncommon incidence, though. Among them, seven coefficients from both models were statistically significant: the coefficients of job and log (scholarship) in the student category, the coefficients of lecture and log (tenure) in the faculty category, the coefficients of log (donation) and log (project) in the resource category; and the coefficient of log (student) in the characteristics-of-university category. Meanwhile, few coefficients showed opposite signs or different magnitudes. The coefficient of grad school in the student category had opposite

signs, but only the coefficient from the FE Poisson was significant at the one-percent significance level. The coefficients of sci in the faculty category and facility in the resource category in the FE Poisson were also significant at the one- and five-percent significance levels, respectively. Although both the RE and FE Poisson models yielded similar regression results, it was worth discerning the correctly specified model between them. For this purpose, the Hausman test was applied; it is reported in the bottom row of Table 5. The Hausman test statistic was 207.23 with a p-value of 0.00, which indicated that the FE Poisson model was preferable to the RE model.

The main empirical findings based on the FE Poisson regression results in column 8 in Table 5 are listed as follows:

1. Grad school, job, and log (scholarship) in the student category are significant.
    - A. The coefficient of grad school is 0.010 and significant at the one-percent significance level.
        - i. Interpretation: If the rate of going to graduate school goes up one percent, then the dropout rate is also increased by one percent.
    - B. The coefficient of job is −0.002 and significant at the ten-percent significance level.
        - i. Interpretation: Dropout rate decreases by two percent if the rate of employment increases by ten percent.
        - ii. This coincides with Simpson et al. [14].
    - C. Going to graduate school and finding jobs are regarded as important factors for evaluating good academic institutions. However, this empirical result showed that these two have opposite effects, indicating that students seem to use the university as a means of finding a job.
    - D. Special HS as a proxy for the quality of students had a coefficient of −0.006 but was not significant, and the effect of special high schools on the dropout rate is not clear.
    - E. The coefficient of log (scholarship)—the dropout elasticity of scholarships—was −0.248 and significant at the 1% significance level.
        - i. Interpretation: If scholarships increase by one percent, dropout decreases by 0.248%.
        - ii. Implication: Financial situation is a very important factor in determining whether one stays in school.
        - iii. This result is concurrent with Li and Killian [15], Ishitani et al. [16], and Arendt [17].
2. Lecture, log (tenure), and sci in the faculty category had significant coefficients.
    - A. The coefficient of lectures was 0.004 and also significant at the one-percent significance level.
        - i. Interpretation: A one-percent increase in professors' lectures causes dropout to increase by 0.4%.
        - ii. This is an interesting finding because it suggests that students drop out when more lectures are given by tenure-track professors.
        - iii. This empirical finding appears to contradict the fact that a better quality of education boosts students' persistence at university.
        - iv. However, as shown by Gitto et al. [4], students may see better-quality education as a heavier learning burden.
    - B. The coefficient of log (tenure) was −0.548 and significant at the one-percent significance level.
        - i. Interpretation: If the number of tenure-track professors increases by one-percent, dropout decreases by 0.55%.

ii. The number of tenure-track professors plays a very important role in reducing college dropout.

C. The coefficient of sci was 0.401 and significant at the one-percent significance level, which is a very large effect.

i. Interpretation: Publishing one more SCI/SSCI journal article increases dropout by 40.1%.
ii. This might seem odd, but it provides strong empirical evidence that research and education might not go in the same direction.
iii. Professors' research abilities, such as publishing academic journal articles or obtaining research funds, did not seem to encourage students to stay in school.

D. The rate of students to professors was not significant in this empirical study, which is contrary to Astin [13] and Bound et al. [2].

3. Log (donation), log (project), and facility in the resource category were significant.

A. The coefficient of donations was −0.015 and significant at the five-percent significance level.
B. The coefficient of log (project) was 0.038 and significant at the one-percent significance level.

i. Interpretation: A 10% increase in government funding raises the dropout rate by 0.4%.
ii. This finding implies that government subsidies granted by MEST were not very helpful for keeping students in school.
iii. This finding also indicates that while government subsidies might be a very important resource for easing financial burdens on universities, they do not reduce university dropout.
iv. This is the opposite of the empirical findings in Bound et al. [2], Titus [12], and Gross et al. [20].

C. The coefficient of facility was 0.001 and significant at the five-percent significance level.

i. This finding implies that a better educational environment plays a negative role in reducing dropout, which is unusual and merits further research.
ii. This empirical finding is the opposite of McGowen [23].

4. Only log (student) in the structural characteristics of the university category affected dropout.

A. The coefficient of log (students) was 1.202 and significant at the one-percent significance level.

i. This finding implies that the old principle in the educational field that "small is beautiful" holds true for universities in South Korea.
ii. This result aligns with Pittman and Haughwout [24].

5. Due to the nature of the FE regression model, all of the time-constant variables were eliminated and could not be estimated. However, they were estimated in the Poisson RE model. Both the status and location dummy variables in the university characteristics category were significant.

A. The coefficient of state_d was −0.464 and significant at the one-percent significance level.

i. Implication: Public universities, such as national, city, or state universities, have 46.4% fewer dropouts than private ones.

B. The coefficient of city_d was −0.145 and significant at the one-percent significance level.

i. Implication: Universities in urban areas have 14.5% fewer dropouts than those in rural areas.

5. Summary

The aim of the paper was to examine possible causes for university dropout with a focus on objective factors at the aggregate level. For this purpose, four fundamental factors of university education were selected and categorized: student, faculty, resource, and structural factors. We assumed that these four categories would have consistent effects on university dropout. Using nonlinear panel data models, we carried out an empirical analysis with three-year balanced panel data from 2013 to 2015, which were obtained from the Higher Education in Korea website. The empirical findings of the study can be summarized as follows.

First, getting a job and receiving a scholarship in the student category were two major factors in lowering the university dropout rate. Sending students to graduate schools is one of the most important tasks of a university, but it might put stress or extra burdens on students and discourage them from staying at university.

Second, lecture, tenure, and sci in the faculty category affected university dropout. A larger number of professors was a very supportive factor for students' persistence, but a better quality of education, represented as lectures from professors on the tenure track, was regarded as an extra burden for students and made them consider quitting school. Publishing many articles is a very important virtue of professors and also creates a good reputation for the university. However, the dark side of a research-oriented university, especially for undergraduate, is that students may feel maltreated.

Third, donations, projects, and facilities in the resource category affected university dropout. Even though donations and projects are two good resources for improving a university's financial situation, these two factors had opposite effects on university dropout. The former can be directly used to improve the educational environment and make students more satisfied with their university. The latter, however, requires limited university resources (e.g., professors' time, effort, and energy) to apply for and obtain funds; as such, it helps to improve the university's financial situation at the cost of taking less care of students.

Finally, the size factor in the university characteristics category was very closely related to university dropout. It seems that "small is beautiful" is also valid for universities in South Korea.

6. Conclusion and Policy Implications

In South Korea, university dropout has become a nagging problem for universities as well as society. The country also faces a serious population cliff problem, which is another negative factor that will only worsen university dropout. The total number of students entering high school in 2018 will be about 500,126 while the total number of university freshmen will be 530,655. To examine this issue and evaluate the situation universities currently face, we investigated the possible causes of university dropout with a focus on objective factors at the aggregate level.

6.1. Theoretical Implications

Previous research has extensively analyzed the determinants of university dropout. However, those studies tended to focus on one of three main trends: demand-side (student) factors, individual-level subjective or psychological factors, and institutional supply-side factors. Gitto et al. [4] noted that many studies have focused only on demand-side factors while few (e.g., Gitto et al. [4] and Larsen et al. [3]) have examined the supply/objective side at the aggregate level. Recently, there has been a focus on adopting a more balanced view that reflects both the demand/subjective side and the supply/objective side, with only a few previous studies (e.g., Tinto [6] and Pierrakeas et al. [11]) having considered both.

Our study has some distinctive features compared to previous research. First, we adopted a modified balanced model and focused on supply-side university factors, including faculty, resource, and structural factors, as well as demand-side student factors. Second, unlike most previous studies using cross-sectional data, our study used three-year balanced panel data. Although panel data

are usually more difficult to collect than cross-sectional data, they allowed us to control for certain unobserved effects of individual units, analyze the significance of lags in behavior, and make causal inferences, all of which are very difficult with cross-sectional data.

6.2. Practical Implications

The empirical findings in Section 4 indicate that 10 of the 19 variables were statistically significant. Going to graduate school, finding a job, and receiving scholarships were significant in the student category. It is worth noting that going to graduate school has a negative impact on lowering dropout. Getting a job and receiving scholarships both help to reduce dropout, which aligns with Li and Killian [15] and Ishitoni et al. [16] for scholarships and Simpson et al. [14] for high vocational orientation. Lectures taught by professors, the number of professors, and the number of published SCI/SSCI articles were significant in the faculty category. The finding that the more faculty, the lower the dropout is congruent with Pascarella and Patrick [19] and Gitto et al. [4]. Astin [13] and Bound et al. [2] found that a lower student–faculty ratio reduced the dropout rate. Our empirical finding for this effect was economically significant but statistically insignificant. It is remarkable that publishing more SCI/SSCI journal article increases dropout. The annual amount of donations, total amount of project funds from the government, and facility provision rates were significant in the resource category. Donations help to reduce dropout, and this result agrees with Gross et al. [20]. The more project funding from government increases dropout. Sewasew [21] found that a lack of facilities was one reason for dropout, while McGowen [23] found no effect on completion rate. However, we found a negative role in reducing dropout, which is unusual and merits further research. Only the total number of enrolled students was significant in the characteristics-of-university category. Our result implies that "small is beautiful," similar to Pittman and Haughwout [24].

Based on our empirical findings, it would seem that university dropout could be lowered by changing some existing policies. First, private universities in South Korea comprised 79.2% of all universities in 2016 (179 out of 226). Unlike those in the US, the majority are in poor financial shape and cannot continue without support from MEST in the form of project-based funding. However, this type of support aggravates the quality of university education and leads to a higher dropout rate. Thus, more direct and instantaneous types of subsidies should be adopted to strengthen universities' financial conditions. Second, even though getting a job is a very important factor for reducing university dropout, universities should fulfill their original purpose and devote themselves to raising the quality of their resources. If this is done, only those who need higher education will come and attempt to complete their studies. Lastly, if education and research cannot go in the same direction, running two tracks, nurturing teaching-oriented professors on the one hand while encouraging research-oriented professors on the other through selection and concentration processes, could also help to lower the university dropout rate.

6.3. Limitations

This study attempted to contribute to the literature on university dropout by examining three supply-side factors as well as demand-side factors. Due to a lack of detailed data, however, we could not divide dropouts into voluntary and involuntary types. For a richer empirical analysis and interpretation, considering university heterogeneity may play an essential role. Unlike schools in the US and some other developed countries, there is no clear division between research-oriented and education-oriented schools in South Korea. In general, two- or three-year colleges are regarded as vocational schools and were excluded in our study. Although we used panel data regression analysis to avoid unnecessary and unobserved effects on the model, we could not successfully control for all the relevant variables. Future research can address such limitations. Moreover, although university heterogeneity and the effect of educational factors such as educational mismatch on university dropout are very important, we did not include them in the model because there was no dataset to support them. Moreover, Di Pietro [28] effectively showed the negative relationship between regional unemployment

rates and university dropout rates. Aina [29] showed that, in Italy, parental background influences dropout: students with fathers or both parents who only had compulsory schooling were more likely to drop out. Our study did not consider those topics. Such limitations can be addressed in future studies.

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