Factors Impacting Enrollment Rates of Foundation Universities: A Multiple Regression Analysis

Yasin Göçgün
Associate Professor of Industrial Engineering
Faculty of Engineering and Natural Sciences
İstinye University
İstanbul, Turkey
yasin.gocgun@istinye.edu.tr

Abstract

We analyze the pre-enrollment data pertaining to foundation universities in Turkey with the view of identifying factors that may impact the enrolment rate of department programs. The goal is to discover which factors have significant impacts on enrollment rate and then to derive policy implications that lead university administrators to have better strategies for enrollment-related issues. Utilizing a widely used statistical technique, multiple regression, we perform a statistical analysis based on the available data. We provide policy implications at the end of the paper.

Keywords
higher education; multiple regression; data analysis

1. Introduction
Due to ongoing financial hardships affecting the entire nation, many families in Turkey have been losing economic power. This negatively affects demand for foundation universities, many of which rely on student tuition fees in order to maintain education standards and make investments for higher education. As such, enrollment rates of many programs belonging to different faculties have been far from ideal or close-to-ideal values. Hence, it is crucial for the upper management of foundation universities to make intelligent decisions about matters that affect enrollment rate.

The related process of higher education in Turkey can be briefly described as follows. Each university determines quotas for the programs of its faculties by taking into account restrictions imposed by the Council of Higher Education (CHE) as well as their internal restrictions or needs. It is also common that new programs (of departments) or faculties are offered by those universities. All the programs and their respective quotas are announced to prospective students. Each year, after the university entrance exam is held, prospective students submit to CHE an ordered list of programs that are feasible according to their scores. Students are then allocated to programs of universities based on their preferences.

In this paper, we examine the university entrance data of Turkey from the perspective of the incentives of foundation universities. Our objective is to propose a variety of policy implications for those universities based on the analysis of the underlying data. Specifically, we identify crucial factors that affect the enrollment rate of programs using multiple regression, a widely used statistical technique. By means of regression results, we are able to address important strategic questions such as which faculties/programs are worth being offered, whether offering specific programs in the most crowded city, Istanbul, would lead to high enrollment rates. Through this statistical analysis, we aim to help foundation universities make more intelligent decisions so that their loss of revenue as well as prestige would be minimized.

Our paper is structured as follows. Related literature is discussed in Section 2. We describe the problem and the respective mathematical model in Section 3. Results of our statistical analysis and associated policy implications are discussed in Section 4. Finally, Section 5 includes concluding remarks.

2. Related Literature

Our work falls into the broad category of data mining in higher education. There are several review papers about this field; examples of them include Du et al. (2020), Baek and Doleck (2021), Malini and Suresh (2018). Here, we briefly summarize papers published in the last decade as well as those closely related to our work.

Ahlawat et al. (2016) investigated factors affecting enrollment pattern in Indian universities using the k-means clustering technique. Their statistical analysis revealed certain patterns in university enrollment. In another study, Liu et al. (2019) examined the factors that affect enrollment in Taiwan's universities using a neural network-based technique. The factors they identified include curriculum, chance of oversea study, and faculty type.

Neill (2009) analyzed the effect of increases on tuition fee in higher education. Their study takes into account the potential endogeneity of this factor and proposes certain policy implications. A similar study was performed by Havranek et al. (2018), who examined the correlation between increases in tuition fee and university enrollment using meta-regression analysis. Their results about tuition-enrollment elasticity are in line with the literature; yet, they identified significant heterogeneity such as the fact that larger elasticity is observed for male students and students enrolled in private universities.

The literature contains certain papers focusing on universities in Turkey in terms of higher education policies. To illustrate, Yuret (2013) analyzed the reason why tuition fees followed a certain pattern during the period between 2003 and 2011. His results reveal that the tuition fees are influenced by factors such as capacity, university location, and faculty type. The author provides recommendations for tuition-related issues faced by those universities. In his work, Özoğlu (2016) investigated the negative effects of the establishment of around fifty public universities in Turkey after 2006 and provided suggestions for remedying those effects. The author refers to interviews made with a number of rectors (of such public universities) who pointed out a variety of challenges resulting from the abundance of public universities in Turkey.

Another work dedicated to higher education in Turkey was performed by Habibi (2017), who analyzed the consequences of a huge increase in student enrollment of universities that was observed since 2000s. The author emphasized the resulting issues such as the escalation of unemployment and underemployment for graduates of those universities. In her work, Tekneci (2016) studied the evolution of the higher education sector in Turkey, concentrating on the changes observed in factors such as enrollment rates, faculty compositions, and expenditures of universities during the last decade. Her analysis revealed that the performance of higher education system in Turkey is sufficient with respect to factors such as enrollment rates and female students, whereas it requires improvement as far as factors like faculty members, doctoral students, and international students are concerned. Further, Acer and Güçlü (2017) investigated a rapid increase in the number of Turkish public universities since 2006 with the view of examining their structural imperatives. Using methods such as factor analysis and hierarchical cluster analysis, the authors concluded that the increase in the number of universities did not have positive impact on the quality of universities.

In this work, we focus on the recent data about university entrance in Turkey, aiming to provide effective policies for the administrators of foundation universities. Examples of those policies include the act of identifying which faculties/programs are worth being offered and determining factors that should be taken into account in intelligently choosing the enrollment capacity of programs. Although restricted to the mere use of multiple regression, our work is unique in that it provides policy implications for Turkish foundation universities with regard to enrollment rate.

We next provide fundamental features of our problem and its mathematical model.

3. Problem Description and the Mathematical Model

As regards the enrollment rate data of 2021, the fundamental problem faced by many foundation universities in Turkey is very low demand for specific programs. Examples of such programs include but not limited to Physiotherapy, Odiology, and Management. In this regard, it is worth noting that the previous enrollment rates pertaining to those programs and in general the rates of previous years are higher as compared to those corresponding to the 2021. Tables 1 and 2 present related statistics about enrollment rates of those programs as well as the overall enrollment rates of the last three years, respectively. For example, average enrollment rate of Physiotherapy for the two-year period (2019-2020) data is 92% whereas it dropped to 30% in 2021. As for Table 2, it reveals that a significant amount of decrease in overall enrollment rate was observed in 2021. To illiustrate, 25% of the programs had the enrollment rates of less

than 100% during the period of 2019-2020, whereas in 2021, that threshold percentage value for 25% of the programs dropped from 100% to 65% (see the last row of Table 2). These facts demonstrate that there was a significant decrease in overall enrollment rates in 2021 (the data were obtained from Measurement, Selection and Placement Center (ÖSYM) and Gökhan Şinel (2022)).

Table 1. Statistics for the enrollment rates of specific programs of foundation universities for the period of 2019-2020, and that of 2021.

	Program Type			
	Physiotherapy	**Odiology**	**Management**	**Social Service**
Average (%)	92 ; 30	91 ; 15	86 ; 38	86 ; 6
Max (%)	100;100	100 ; 59	100; 100	100 ; 17
Median (%)	100 ; 14	100 ; 9.5	100; 20	100 ; 4

Table 2. Overall enrollment rates of foundation universities for the period of 2019-2021.

	2019	**2020**	**2021**
Average(%)	85.1	89.3	78.9
Median (%)	100	100	100
1st quartile (%)	100	100	65

Part of the reason for the abovementioned problem of having low enrollment rates for specific programs is the following. There is no data-driven strategy for determining the best combination of tuition fee and capacity allocation that yields the maximum enrollment rate for each program. Apparently, very high increase in tuition fee generally causes low enrollment rate, as is the case for unnecessarily high increase in capacity allocation. This lack of strategy is associated with variation in tuition fees and allocated capacities, which is illustrated in Table 3. Further, there are certain programs for which the tuition fees are determined relatively so high, which appears to be the main reason for low enrollment rates of respective programs.

Table 3. Allocated capacity and tuition fees determined for specific programs (the 2021 data).

	Program Type			
	Physiotherapy	**Odiology**	**Management**	**Social Service**
Average	(42;27000)	(40;24000)	(36;27000)	(33; 21000)
Minimum	(10;18000)	(20;16000)	(2;13000)	(5;16000)
Max	(68;42000)	(68;32000)	(85;68000)	(68;28000)
Median	(38;27000)	(35;23000)	(34;25000)	(32;21000)
3rd quartile	(51;29000)	(42;27000)	(50;30000)	(39;23000)

3.1 The Mathematical Model

As the process of program selection performed by prospective students is stochastic in nature and its output (i.e., enrollment rate) is observed through data, we model the underlying process as linear regression, a widely used statistical model that is also viewed as one of the techniques of machine learning. The stochasticity of this process pertains to the randomness of demand for programs, and hence the enrollment rate of a given program is a random variable. Let Y denote the enrollment rate of a given program, which is the dependent variable of the underlying process. Let X_i be the value of factor i that has impact on the value of Y, where i = 1,…,N. Here, N denotes the number of factors, which are, by assumption, independent random variables. Within the context of linear regression, Y can be expressed as a linear combination of X_is:

$$Y = a + b_1X_1 + b_2X_2 +… + b_NX_N, \qquad (1)$$

where b_i, i=1,…,N is a parameter the value of each is estimated through the regression model.

As multiple factors are likely to affect the enrollment rate, we use multiple regression model in our statistical analysis. Those factors are listed below:
(scholarship type; faculty type; city; language of education; tuition fee)

Among these factors, all but tuition fee are categorical variables. For example, scholarship type for a given program is any of the following: 100%, 50%, 25%, and 0% scholarship. As another example, language of education is among Turkish, English, German, etc. Such differences in the types of variables are handled throughout the implementation of multiple regression via R, a statistical computing language.

4. Results

We first consider the data of 2021, viewing it as a representation of the *low-demand* scenario. The reason is that, as stated above, the overall enrollment rate for foundation universities dropped significantly in 2021. The data contain a variety of information about programs offered by each foundation university. In particular, faculty type, scholarship type, location, language of education, tuition fee, and enrollment rate are provided for each program. We are constrained with the data of 2021 also because the data of tuition fee are not available for the earlier years. The number of data points for enrollment rate is around 4000, which is large enough for a multiple regression study to derive policy implications. Furrther, it is worth noting that nearly 70% of the data belong to programs offered by foundation universities located in Istanbul, the most crowded city of Turkey.

As regards faculty type, we combine the enrollment rate data for the faculties of medicine, pharmacy, and dentistry due to the following reason. The amount of respective data for those faculties is significantly low as compared to those for others such as engineering and health sciences, each of which possesses a number of programs.

The results of our regression anlaysis based on the 2021 data are reported in Table 4, which contains factor levels that have significant impact on enrollment rate. Note that, as stated earlier, the 2021 data can be viewed as representing the *low-demand* scenario (Tables 1 and 2). The results reveal that, among faculty types considered, only the faculty of Law has positive impact on enrollment rate, whereas faculties of Economics and Administrative Sciences, Health Sciences, and Fine Arts adversely affect enrollment rate. What is more, enrollment rates are affected significantly by the location as well as the language of the program. Particularly, that a program belongs to a university located in Istanbul and is offered in Turkish likely has a negative impact on enrollment rate. Finally, the results also reveal that scholarship type and tuition fee have positive impact on the enrollment rate.

Table 4. Multiple regression results based on the 2021 data.

Factor Levels	Estimated coefficients	p-value	Significant?
Intercept	**23.1**	4×10^{-12}	**HIGHLY**
25% Scholarship	**25.3**	$< 2\times10^{-16}$	**HIGHLY**
50% Scholarship	**26.8**	$< 2\times10^{-16}$	**HIGHLY**
Full Scholarship	**88.2**	$< 2\times10^{-16}$	**HIGHLY**
Faculties of Medic., Pharm., and Dent.	-1.3	0.6	NO
Faculty of Law	**17**	2.5×10^{-8}	**HIGHLY**
Faculty of Econ. and Admin. Sciences	***-15***	$< 2\times10^{-16}$	**HIGHLY**
Faculty of Health Sciences	***-8.8***	6×10^{-9}	**HIGHLY**
Faculty of Communication	-3.1	0.15	NO
Faculty of Arts and Sciences	-2.7	0.38	NO
Faculty of Fine Arts	***-3.6***	0.01	**YES**
Faculty of Engineering	0.6	0.68	NO
Istanbul	***-5.8***	2.6×10^{-9}	**HIGHLY**
Language: Turkish	***-7.2***	1.6×10^{-13}	**HIGHLY**
Tuition fee	**0.8**	$< 2\times10^{-16}$	**HIGHLY**
Multiple R-squared	0.38		
Adjusted R-squared	0.38		

Based on our regression analysis, we can draw the following inferences as part of policy implications.
- For a relatively new foundation university, it is reasonable to offer programs belonging to faculties of Law, but not to faculties of Economics and Administrative Sciences, Health Sciences, and Fine Arts.

- If a university decides to offer a new program, then its language should be, in general, English. This also implies that offering a Turkish-based program for a major that is taught in English is generally not reasonable.
- For a university located in Istanbul, offering a new program will likely result in low enrollment rate.
- For a given program, offering full scholarship appears to be three times as effective as offering 50% scholarship in enrollment rate (see the ratio of respective coefficient estimates).
- Tuition fee has statistically significant impact on enrollment rate; however; it is not as effective as other factors such as faculty type and language. This implies that, in general, setting tuition fee to a very low/high value does not appear to have remarkable impact on enrollment rate.
- For a newly opened program, if there are no financial concerns, offering full scholarship appears to be the most reasonable choice.

We also implemented multiple regression using the 2019-2020 data in order to come up with policy implications for a *normal-demand* scenario. The data contain around 8000 enrollment rate values. Differing from the 2021 data, this data set includes another level for scholarship: 75% scholarship.

Regression results obtained through the 2019-2020 data are presented in Table 5. Not surprisingly, any level of scholarship and certain faculty types have positive impact on enrollment rate. However, unlike the previous results (from the 2021 data), these results reveal that faculties of Health Sciences as well as Arts and Sciences affect enrollment rate positively. Additionally, our analysis indicates that English-based programs have positive impact on enrollment rate.

Table 5. Multiple regression results based on the 2019-2020 data.

Factor Levels	Estimated coefficients	p-value	Significant?
Intercept	71.6	$< 2 \times 10^{-16}$	HIGHLY
25% Scholarship	11.6	3.7×10^{-16}	HIGHLY
50% Scholarship	5.7	4×10^{-9}	HIGHLY
75% Scholarship	13.3	$< 2 \times 10^{-16}$	HIGHLY
Full Scholarship	27.6	$< 2 \times 10^{-16}$	HIGHLY
Faculties of Medic., Pharm., and Dent.	11.9	1.3×10^{-9}	HIGHLY
Faculty of Law	7.6	3.7×10^{-5}	HIGHLY
Faculty of Econ. and Admin. Sciences	-7	$< 3.8 \times 10^{-14}$	HIGHLY
Faculty of Health Sciences	5	1.7×10^{-6}	HIGHLY
Faculty of Communication	0.6	0.65	NO
Faculty of Arts and Sciences	3.1	0.01	YES
Faculty of Fine Arts	0.14	0.89	NO
Faculty of Engineering	-13.5	$< 2 \times 10^{-16}$	HIGHLY
Istanbul	-0.12	0.85	NO
Language: English	7.2	$< 2 \times 10^{-16}$	HIGHLY
Multiple R-squared	0.19		
Adjusted R-squared	0.19		

According to the abovementioned regression analysis, we can draw the following inferences for a *normal-demand* scenario.

- It is reasonable for a new foundation university to offer programs belonging to any of the following faculty types: faculties of Medicine, Pharmacy, Dentistry, Law, Health Sciences, and Fine Arts and Sciences. Yet, new programs of engineering faculties and Economics and Administrative Sciences likely have negative impact on enrollment rate.
- The location of a new program does not have impact on enrollment rate.
- If a university decides to offer a new program, then its language should be, in general, English. This implies that an equivalent English-based program of a Turkish-based program can be offered.

- The impact of a 75% scholarship on enrollment rate is twice as high as that of a 50% scholarship.
- The relative effect of a full scholarship on enrollment rate is lower in the normal-demand scenario as compared to the low-demand scenario.

5. Conclusions

We analyzed the recent university entrance data of Turkey with the view of identifying factors that have impact on the enrollment rate of programs offered by foundation universities. Through the implementation of multiple regression, we answered highly important questions such as which factors should be taken into account when making enrollment rate-related decisions, and how the existing data can be utilized for improving strategic decisions such as whether a specific program should be opened or not.

Future work can focus on the implementation of other machine learning techniques such as random forest regression and decision tree learning for this type of problem. With a more comrehensive dataset, it appears to be possible to discover other factors affecting the enrollment rate.

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Biographies

Yasin Göçgün received his B.S. degree and M.S. degree from the Industrial Engineering Department at Bilkent University in 2003 and 2005, respectively. After completing his doctoral studies in the Industrial and Systems Engineering Department at the University of Washington in 2010, Dr. Göçgün worked as a postdoctoral fellow in Canada between 2010 and 2014. Prior to joining the Industrial Engineering Department at İstinye University, Dr. Göçgün worked as an assistant professor in the Industrial Engineering Department at Altınbaş University between 2014 and 2020.