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From 2000 to 2018: Examining the Relationship Between Net Tuition Revenue and the International Undergraduate Student Enrollment at Public Doctoral Universities

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Abstract

Increased international students could potentially contribute to the institutional financial stability. However, there is limited research evidence regarding the association between net tuition revenue and international undergraduate student enrollment at public doctoral universities through a longitudinal perspective. This research, therefore, fills the gap and investigates the association between international student enrollment and the financial status of institutions. Informed by Cost-Benefit Analysis (CBA), this study used correlational analysis, One-way ANOVA and Post Hoc tests to examine the relationship from different perspectives. These findings indicated a statistically significant positive correlation between net tuition revenue and international undergraduate student enrollment numbers at public doctoral universities from 2000 and 2018. The research also revealed statistically significant differences in net tuition revenue among institutions grouped by international undergraduate student enrollment levels. The results illustrated the nuanced trend in the three waves of international student enrollment.

Keywords: net tuition revenue, international undergraduate student enrollment, longitudinal, quantitative, IPEDS data

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Introduction

Three waves (Choudaha, 2017) of the rapid growth of international students enrollment in U.S. universities and colleges have sparked recent research interests in the consequences of international student enrollment. Under the aforementioned circumstance, this study is interested in the potential association of net tuition revenue and international student enrollment from a higher education budgeting perspective from 2000 to 2018.

In the fall of 1999, there were 514,723 international college students in the United States. These students comprised 3.5% of the total enrollment of college students. In the 2018-2019 school year, 1,095,299 international college students were in the United States. With the doubled number of international students, the percentage was 5.5% of the total enrollment of college students (Institute of International Education, 2019). In the 2019-2020 school year, there were a total of 1,075,496 international college students in the United States (Institute of International Education, 2020). In the latest analysis, NAFSA: Association of International Educators (2020b) found that during the 2019-2020 academic year, international students studying at U.S. colleges and universities contributed $38.7 billion and supported 416 thousand jobs to the U.S. economy.

The guiding theoretical foundation of this study is Cost-Benefit Analysis (CBA), which contributes to informed decision-making through efficient educational investments in higher education. Educators can use economic methods to link resource inputs and outcomes (Hummel-Rossi & Ashdown, 2002). Economists developed CBA in the 1930s and 1950s, and then in the 1960s, these CBA approaches were applied to assess efficiency in education (Levin, 1991; Rice, 1997). CBA values all consequences to all members of society as a policy or project assessment method, and it quantifies these consequences in monetary terms (Boardman et al., 2018). People usually use it to determine opportunities that provide the best approach to achieve more benefits while saving costs. CBA can contribute to decision-making quality through more efficient educational investment in higher education (Belfield, 2015).

While the nation's economy continued its recovery after the Great Recession in 2008 (Rich, 2013), many higher education institutions struggled financially (Society for College and University Planning, 2018). The higher education leaders were responsible for ensuring the tuition-cost equation was being developed and monitored effectively. Higher education is needed to focus on the effective allocation of resources with priorities and maximizing outcomes (Society for College and University Planning, 2018).

Research on the relationship between net tuition revenue and international student enrollment has produced similar findings supporting the strong positive relationship at certain levels, but not every institution (Cantwell, 2015; Komissarova, 2019; Shih, 2017). There has been no study examining the relationship between net tuition revenue and international student enrollment during the three waves of international student mobility (Choudaha, 2017), which is 1999-2020. Both Cantwell (2015) and Komissarova (2019) worked on a larger sample with four-year colleges and universities that award at least bachelor’s degrees. Since both Cantwell and Komissarova found a strong relationship at the public doctoral universities, this study specifically focuses on the category of public doctoral universities from 2000 to 2018.

The purpose of this research is to investigate the association between net tuition revenue at public doctoral universities and the international undergraduate student enrollment from 2000 to 2018 using

secondary data. Here are two research questions:

1. Are the gains in net tuition revenue associated with international undergraduate student enrollment at public doctoral universities?
2. Is there a statistically significant difference for net tuition revenue among public doctoral universities by international undergraduate enrollment level?

According to the two research questions, the association between the gains in net tuition revenue and international undergraduate student enrollment was examined from two different perspectives: the first question investigates the association between net tuition revenue and enrolled international undergraduate student number as a continuous variable, while the second question examines the extent to which net tuition revenue varies among instantiations by grouping universities using the international undergraduate student enrollment levels. The findings were interpreted by the three waves of international student mobility (Choudaha, 2017). This research is significant, given the current effect of the global pandemic of COVID-19 on international education and the immigration reform agenda. With the theoretical background of CBA, the study will provide evidence for informed decision-making through more efficient educational investment in higher education (Belfield, 2015). At the end of the third wave of international education, with a global view of the pandemic's effect on higher education, determining the impact from the budget management perspective is vital to the area of international higher education moving forward.

Literature Review

This section provides the theoretical foundation that guides the overarching research questions and design, along with the relevant literature to help the authors define and measure the interested variables for this study.

Net Tuition Revenue

After Lingenfelter (2012) reviewed the history of higher education in the United States, especially the trends and milestones that have shaped the evolution and financing of public colleges and universities, it concluded that effective budgeting required analysis, engagement, adaption, and negotiation over ends, means, and values. Higher education policymakers have been asked to continue to rely at least to some extent on economic foundations (Brewer et al., 2015). Cost analysis, as the core of formula budgeting, is required for fairness and efficiency. Understanding the causes of cost and pricing in higher education is important to craft meaningful policy recommendations (Massy, 2012).

In the 2019 NACUBO Tuition Discounting Study (National Association of College and University Business Officers, 2020), 366 private and nonprofit colleges and universities reported an estimated 52.6% average institutional discount rate for first-time, full-time, first-year students in 2019-20 and 47.6% for all undergraduate students. Both represent the highest values in the last decade. However, the rising discount rates could lead to flat or declining net tuition revenue. Even institutions were generating revenues from other sources, but they were likely not enough to offset any declines in net tuition. From the budgeting perspective, discounting tuition is a double-edged sword, which increases institutional grant aid and flattens growth in revenues. That is why the term of net tuition revenue was

applied in this study. Net tuition revenue is the total amount of tuition and fees, minus state and institutional financial aid and medical tuition and fees (Laderman & Weeden, 2020).

Three Waves of International Student Enrollment

2019 Open Doors (Institute of International Education, 2019) showed that in the 1999 school year, there were 489,866 enrolled international students and 24,857 Optional Practical Training (OPT) international students, for a total of 514,723 international college students in the United States. It accounted for 3.5% of the total enrollment of college students. NAFSA found that during the 2019-2020 academic year, international students studying at U.S. colleges and universities contributed $38.7 billion to and supported 415,996 jobs in the U.S. economy (NAFSA, 2020a).

Choudaha (2017) analyzed the change in international student mobility from the lens of three overlapping waves spread over 20 years between 1999 and 2020. A wave was defined by the key events and trends impacting international student mobility in a period. Wave one started in 1999 and ended in 2006. It was shaped by the terrorist attacks of 2001 and the enrollment of international students at institutions seeking to build research excellence. The second wave (2006-2013) has its origins in the global financial crisis, which triggered financial motivations among some institutions in traditional top destinations to expand international student enrollment aggressively. Economics and the English language were the key factors. From 2013 to 2020 was the third wave. With the slowdown in the Chinese economy, United Kingdom's referendum to leave the European Union, and American Presidential elections, the third wave showed increasing competition among new and traditional destinations to attract and retain international students.

International Student Enrollment and Economic Impacts

Shih (2017) examined the data from 1995 to 2005 to explore how international students impact domestic enrollment at the graduate level and found that high net tuition payments from international students helped subsidize the cost of enrolling domestic students. Cantwell (2015) concluded that some, but not all institutions were able to generate additional tuition revenue by enrolling international students, and the significantly positive relationship happened at public research and doctoral universities only, and the study was focused on the time period from 2000 to 2009. Komissarova (2019) used the years from 2003-04 to 2016-17 to analyze a sample of public and private not-for-profit U.S. colleges and universities. The conclusion was that the relationship between international undergraduate enrollment and net tuition revenue varied by sector and by Carnegie classification. Also, the strongest association was found at the public research universities level, which echoed what Cantwell (2015) found. The existing research about the relationship between net tuition revenue and international has produced quite convincing findings, despite these studies' many differences on their focused areas (Cantwell, 2015; Komissarova, 2019). The primary findings revealed that international student enrollment positively impacted domestic enrollment at graduate level, and net tuition revenue at the undergraduate level at public doctoral universities.

The institution's reputation was an important factor for international students to choose to study in a U.S. institution (Lee, 2010). Lee (2010) revealed that students from East Asia, even with limited information about the institutions, heavily relied on institutional rankings, such as the *U.S. News and*

World Report. This study focused on the institutions which were on the list of *U.S. News & World Report Find the Best Colleges for You* (U.S. News & World Report, 2018).

In summary, the theoretical framework, CBA, can improve the quality of decision making by estimating the strengths and weaknesses for policy and project assessment. Considering the current financial situation with discounted tuition, the term of net tuition revenue was applied in this study. On the other hand, Choudaha (2017) analyzed the change in international student mobility in three overlapping waves spread over 20 years between 1999 and 2020. Existing research about the relationship between net tuition revenue and international have produced quite convincing findings (Cantwell, 2015; Komissarova, 2019; Shih, 2017) supporting the string positive relationships at certain levels. However, there was a lack of longitudinal study for the three waves. In addition, no current research had a deep evaluation of the association between international student number and net tuition revenue through international student enrollment levels, which could identify the relationship and the variance.

Theoretical Framework

Boardman et al. (2018) introduced Cost-Benefit Analysis (CBA) as a policy or project assessment method that values all consequences to all members of society and quantifies the consequences in monetary terms. People could use CBA as a systematic approach to estimate the strengths and weaknesses of alternatives and determine the best options to achieve more benefits while saving costs. CBA supplements commonly use effectiveness and efficacy-related evaluation methods by adding an economic component to the evaluation (Belfield, 2015).

Pareto efficiency is the foundation of CBA (Boardman et al., 2018). Pareto efficiency, or Pareto optimality, is an economic state where people cannot reallocate resources to make one individual better off without making at least one individual worse off (Chappelow, 2019). However, using a decision rule to implement only Pareto efficient policies is impractical for different reasons: the information burden of measuring, the administrative burden of making a transfer, and compensation to overstate costs and understand benefits (Boardman et al., 2018). On the other hand, it gives policymakers a realistic sense of the overall cost and benefit of an invention by identifying and assigning a value to the inputs and outputs. It is not just to the budget but also to the community (Rice, 1997). Tsang (1997) suggested that recognizing the importance and usefulness of cost analysis in educational policymaking and evaluation is needed. As CBA and Pareto efficiency cannot directly implement this study's data analysis, recognizing it would help policymakers to apply CBA to determine the best options to achieve more benefits and save costs in each higher education institution.

Economic evaluation is broadly applied to optimize the production of particular outcomes within budgetary constraints with certain inputs (Barnett, 1993; Chambers, 1999; Hummel-Rossi & Ashdown, 2002). Educators can use economic methods to provide linkage between resource inputs and outcomes (Hummel-Rossi & Ashdown, 2002). Levin (1975) demonstrated the applicability of cost-effectiveness, which was considered the first work to appear in the education literature seriously advocating for economic evaluation in educational decision-making (Hummel-Rossi & Ashdown, 2002; McLaughlin & Phillips, 1991). CBA has been frequently applied in the area of education. The outstanding examples of cost-benefit analysis include the Perry Preschool Program (Barnett, 1985), the Chicago Child-Parent Center programs, and the Abecedarian Child Development Program (Barnett & Masse, 2007; Belfield,

2015; Heckman et al., 2010).

The analysis of the costs and benefits of an educational program is more complex than it initially appeared. Adopting either CBA or CEA (Cost-Effective Analysis) in educational evaluations had been slow (Levin, 1991; Levin & McEwan, 2001). Monk and King (1993) concluded that the lower utilization of cost analyses was because of the complexity of the inputs and outputs in education. Tsang (1997) summarized that the applications of cost-benefit studies in policy analysis and evaluation could achieve through determining the rate of return or choosing among alternative investment options using efficiency as one of the criteria. Furthermore, education decision-makers need complete information about the relationship between expenditures and outcomes. And the information should include details of how services are delivered to make informed decisions about how to allocate the best funds (Chambers, 1999; Hummel-Rossi & Ashdown, 2002). In summary, as the application in education, CBA does not directly identify the best alternatives; rather, it provides information that may assist in decision making. CBA can contribute toward improving the quality of decision-making through more efficient educational investment in higher education (Belfield, 2015).

CBA is the theoretical foundation that supports the overarching inquiry of this research, which highlights the association between the benefit as net tuition revenue and international undergraduate student enrollment as investment. This research did not use the CBA framework from the economic felid to methodologically inform data analysis, which should adopt more advanced analysis and is beyond the scope of this study due to the data limitation of using the secondary data. The following research is needed to investigate the association between next tuition revenue and international student enrollment by controlling more contextual costs while the data availability is increased with a more specific study design.

Methodology

The study assessed the association between international undergraduate enrollment and net tuition revenue at public doctoral universities from 2000 to 2018 in the United States. This longitudinal research implemented a secondary database using quantitative research methods. The research first used international student enrollment numbers as the independent variable, for which the study used Pearson correlational analysis. For the second research question, ANOVA was used as the analytical approach because the researchers categorized all the universities into nine groups based on the student enrollment numbers, which will be detailed in the following section.

Participants

This study used secondary data from the Integrated Postsecondary Education Data System (IPEDS) (National Center for Education Statistics, 2020) collected by the Postsecondary Branch of the National Center for Education Statistics (U.S. News & World Report, 2018).

The samples were limited to public doctoral universities based on the research interest. The identification of the sample from the IPEDS data involved five steps. It started from 405 U.S. doctoral universities included public and private ones from the IPEDS data. After eliminating the institutions with missing data for either revenue from tuition and fees, international student enrollment, and private doctoral universities, there were 205 institutions left. In the last step, the U.S. News & World Report Best

Colleges (U.S. News & World Report, 2018) were merged for ranking. So, the final sample was 180 public doctoral universities, which reported revenue from tuition and fees, enrolled first-time degree/ certificate-seeking undergraduate students from foreign countries, and had the U.S. News rankings.

Data and Variables

The data analyzed covered the period 2000 through 2018 with the three waves of international student mobility (Choudaha, 2017). As mentioned previously, this study primarily used secondary data from the IPEDS (National Center for Education Statistics, 2020) developed by the Postsecondary Branch of the National Center for Education Statistics. IPEDS is an annual data collection distributed by the Postsecondary Branch of the NCES, a non-partisan center under the Institute of Education Sciences management under the U.S. Department of Education (IPEDS, 2018). The NCES is considered the primary federal entity for collecting and analyzing data related to higher education.

For the two interested variables, the first variable of net tuition revenue is the total amount of tuition and fees, minus state and institutional financial aid and medical tuition and fees (Laderman & Weeden, 2020). IPEDS defines net tuition revenue as the amount of money the institution takes in from students after institutional grant aid is provided (IPEDS, 2020). The IPEDS data is labeled as "nettuition 01," which stands for the net tuition and fees revenue and is measured in United States dollars. In the IPEDS data, for public institutions, tuition and fees, and institutions grants are collected separately. Based on the Governmental Accounting Standards Board (GASB), in IPEDS data, net tuition revenue is a deprived variable, which is calculated by subtracting institution grants (restricted and unrestricted) from tuition and fees (IPEDS, 2015).

The independent variable is the number of international students enrolled in a university for a specific year. An international student is defined as an individual who is enrolled for credit at an accredited higher education institution in the U.S. on a temporary visa, and who is not an immigrant (permanent resident with an I-51 or Green Card), or an undocumented immigrant, or a refugee (UNESCO Institute For Statistics, 2020). In this study, the independent variable is international undergraduate student enrollment, and the IPEDS definition was applied as the number of first-time degree/certificate-seeking undergraduate students from foreign countries (IPEDS, 2020). Since the IPEDS foreign country data is only required in even-numbered years, the numbers of first-time degree/certificate-seeking undergraduate students from foreign countries of 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018 were collected for the study.

After retrieving the number of undergraduate international student enrollment, the sample of 180 institutions was divided into nine groups by international undergraduate enrollment levels as: one (1-19), two (20-39), three (40-59), four (60-79), five (80-99), six (100-199), seven (200-299), eight (300-399), and nine (more than 400). The decision of dividing the sampled universities into nine levels was based the data distribution. The researchers tested on the data distribution with intervals as 50, 100, 200, and 350, respectively, and found the overly large interval size missed some categories, and the small interval size led to too many categories with minimal groups. The challenge of the unnormal distribution of data across years was particularly due the drastic change of international student enrollment size in almost two decades. After five failure experiments with different intervals, the researchers finally decided to code the way listed above, which had the samples distributed in each group normally.

Analytic Strategy

This study investigated the relationship between two variables, net tuition revenue and the enrollment of undergraduate international students at public doctoral universities from 2000 to 2018, using two approaches. Research question one was interested in the linear relationship between the net tuition revenue and the enrollment of international undergraduate students. Prior research has shown that the relationship was strongest for undergraduate students in public doctoral universities during a shorter time period (Cantwell, 2015; Komissarova, 2019). This study emphasized public doctoral universities with a much more extended period from 2000 to2018, which corresponds to the three waves of international student mobility (Choudaha, 2017). Since the international undergraduate student data were collected by IPEDS every other year in even-numbered years, from 2000 to 2018, 10 Pearson correlation analyses were conducted to examine the relationship, and the results was interpreted by incorporating the three waves of international student enrollment. The higher the absolute value of the correlation coefficient, the stronger the relationship is.

For the second question, the interest was to further reveal the significant variance among public doctoral universities for the net tuition revenue based on the international undergraduate student enrollment level. As mentioned above, the sample of 180 institutions was divided into nine groups by international undergraduate enrollment levels. The ANOVA analyses provided more nuanced evidence which public doctoral university net revenue differs by the undergraduate international student enrollment, when grouping the universities in different categories. Since it was a longitudinal study, 10 one-way ANOVA with Post Hoc tests were conducted to examine the difference. The Post Hoc tests helped reveal where the difference lies between different levels (Salkind, 2017).

Results

This section presents the statistical results. Table 1 presents descriptive statistics of all variables from 2000 to 2018. The dependent variable is net tuition revenue, and the independent variable is international undergraduate enrollment number. The first column reports both variables from 2000 to 2018 in each even-numbered year. Table 1 shows considerable differences among the minimum, mean, and maximum. The observations indicated the variables were widely distributed.

The first question was to identify whether the gains in net tuition revenue are associated with international undergraduate student enrollment numbers at public doctoral universities from 2000 to 2018. Table 2 shows the results from the 10 Pearson correlation analyses' findings in detail with the Pearson correlation coefficient and the significant *p*-value between net tuition revenue and international undergraduate student enrollment. Since the study was concurrent with the three waves of international student enrollment by Choudaha (2017), Table 2 lists the results in three waves. In addition, the means of international undergraduate student enrollment were displayed.

In summary, the results indicated correlations between net tuition revenue and international undergraduate student enrollment number in all sampled years. Specifically, from 2000 to 2018, the average international student enrollment number increased from around 50 to over 150. Meanwhile, when the public doctoral universities recruited more international students, more net tuition revenue was gained. This resonates with the existing research that indicated the net gains in tuition revenue by enrolling more international undergraduate students in public research institutions (Cantwell, 2015;

Komissarova, 2019). An interesting finding from this study is that the coefficient was gradually getting

Table 1: Descriptive Statistics of the Variables

Variable	Min.	Max.	*M*	*SD*
Net tuition revenue				
2000	-660208	326821768	53603363.428	46997019.360
2002	-31929174	334967865	58296813.939	53084614.641
2004	3979899	357206000	79116431.200	62022994.999
2006	3834693	390852000	96228610.933	75946089.835
2008	255000	456182000	110945466.467	90061006.286
2010	5157681	523186000	129354613.750	103933901.145
2012	6168628	631461000	155102678.350	125373452.854
2014	6497931	683858010	169840829.506	136412009.147
2016	5468311	821076000	186468939.494	151479550.626
2018	2672758	873336000	195221431.156	163692093.112
International undergraduate enrollment				
2000	1	511	56.628	75.067
2002	1	544	53.500	74.005
2004	1	583	55.221	80.269
2006	2	740	68.025	97.291
2008	2	712	81.654	116.359
2010	1	907	98.277	150.951
2012	1	1282	142.757	217.655
2014	1	1238	155.099	232.390
2016	2	1542	172.382	257.945
2018	2	1290	158.247	249.570

Note. *M* = Mean, *SD* = Standard Deviation

Table 2: Correlation between Net Tuition Revenue and International Undergraduate Student Enrollment and Number of Enrollment from 2000 to 2018

	Wave One (2000-2006)			
	2000	2002	2004	2006
Mean of first-time international undergraduate student enrollment	56.63	53.50	55.22	68.02
Correlation between Net tuition revenue and International undergraduate student enrollment	.340***	.330***	.352***	.392***
P	0.001	0.001	0.001	0.001
	Wave Two (2006-2013)			
	2008	2010	2012	2014
Mean of first-time international undergraduate students	81.65	98.28	142.76	155.10
Net tuition revenue*International undergraduate student enrollment	.547***	.692***	.724***	.758***
P	0.001	0.001	0.001	0.001
	Wave Three (2013-2020)			
	2014	2016	2018	
Mean of first-time international undergraduate students	155.10	172.38	158.25	
Net tuition revenue*International undergraduate student enrollment	.758***	.735***	.739***	
P	0.001	0.001	0.001	

Note. ***. Correlation is significant at the .001 level (2-tailed).

Table 3: 10 one-Way ANOVA of Net Tuition Revenue by International Undergraduate Enrollment Levels in Three Waves from 2000 to 2018

	Wave One (2000-2006)			
	2000	2002	2004	2006
Dfb	7	8	8	8
Dfw	156	151	154	154
F	6.445	6.292	6.677	8.789
P	0.001	0.001	0.001	0.001
	Wave Two (2006-2013)			
	2008	2010	2012	2014
Dfb	8	8	8	8
Dfw	163	157	160	163
F	9.911	19.662	19.17	24.258
P	0.001	0.001	0.001	0.001
	Wave Three (2013-2020)			
	2014	2016	2018	
Dfb	8	8	8	
Dfw	163	164	165	
F	24.258	25.646	25.344	
P	0.001	0.001	0.001	

Note. Dependent variable: net tuition revenue; independent variable: international undergraduate enrollment levels.
Dfb is the degree of freedom between groups. Dfw is the degree of freedom within groups

Table 4: Significant Differences between the Highest Level (More than 400 International Undergraduate Students Enrolled) with Other Levels 2000-2018

9 X	2000	2006	2008	2010	2012	2014	2016	2018
1	-33042381.3	-100147291.8	-187234523.689***	-284673676.638***	-301702178.167***	*-319025650.569***	-355425298.435***	-376631106.313***
2	-18931826.36	-94209053.25	-169831759.417***	-270190519.878***	-286976520.972***	*-333533753.939***	-356131098.406***	-349762165.220***
3	-2985374.958	-82745815.59	-160608834.667***	-239913221.819***	-255093764.273***	*-309709505.611***	-323296968.391***	-326279149.523***
4	10722942	4257690.5	-133347804.750**	-212760773.141***	-244933981.357***	*-241516794.942***	-267948974.019***	-285168592.157***
5	5532364.667	-3827188.333	-95106342.82	-179761418.903***	-241906320.500***	*-264728475.556***	-266209836.191***	-265722510.773***
6	31391615.47	-32886945.02	-111447931	-180798796.932***	-208443537.094***	*-242671835.116***	-233541895.417***	229169004.189***
7	44848317.88	12999529.78	-23130178.97	-152774692.278***	-155940865.833**	*-173511618.889***	-262763105.391***	180542039.473**
8		71034348.17	-60945601.33	-66893283.78	-109491669.1	*-134281253.603***	-172075825.491***	89314423.77

Note. **The mean difference is significant at the .05 level.
***The mean difference is significant at the .001 level.
Column one: 1: 10-19, 2: 20-39, 3: 40-59, 4: 60-79, 5: 80-100, 6: 100-199, 7: 200-299, 8: 300-399

bigger along with the increased international student enrollment number, which means the association between the two interested variables was getting even more stronger when there are more international students enrolled. During the period from 2000 to 2018, the statistically significant correlational coefficients increased from moderately positive (0.330) to strongly positive (0.758) for the three waves.

The second question examined the difference in net tuition revenue among public doctoral universities based on the international student enrollment categories/levels from 2000 to 2018. After several attempts and failures, finally, the sampled institutions were categorized into nine categories. The coding of categorization contributed to the existing literature by identifying the specific differences among institutions with varied enrollment levels. 10 one-way analyses of variance Tukey's Post Hoc tests were conducted.

All 10 one-way ANOVA findings are displayed in Table 3, with the three waves of international student mobility identified (Choudaha, 2017). The findings revealed there was a significant difference in net tuition revenue among public doctoral universities by the international undergraduate student enrollment levels. The differences were statistically significant in each ANOVA. The F value increased from 6.292 in 2002 to 25.646 in 2016. The F values ranged between 6.292 to 8.789 in wave one and rose to the range of 9.911 to 24.258 in wave two. In the end, the F values steadily stayed around 25 in wave three. The findings showed that the F value boosted from 2000 to 2018, demonstrating increasing differences among universities based on international student enrollment.

Interestingly, Tukey's Post Hoc analysis specified the difference among different groups in all sampled years. In earlier years, the positions of significant differences were more scattered. Since 2008, findings of the highest international undergraduate student enrollment level showed the trend of significant differences with others. Table 4 demonstrates the Tukey's Post Hoc findings of the position between more than 400 with each other category from 2000 to 2018. From 2008, the category with more than 400 students became significantly different with four lower levels. Furthermore, in 2014 and 2016, the highest level had significantly different net tuition revenue from all other eight levels. From 2010 to 2018, the highest level was significantly different from each of the lower seven levels. In summary, Tukey's Post Hoc findings reported that the highest-level universities, which enrolled the most international undergraduate students, exhibited significant differences from lower levels since 2008. In the second and third waves, when the universities recruited more international students, and the relationship between net tuition revenue and the international undergraduate student enrollment was stronger, this level of institutions gained significantly different net tuition revenue.

In summary, the study found that the net tuition revenue was statistically different among institutions with varied international undergraduate enrollment levels in each ANOVA analysis from 2000 to 2018. Through the paired post hoc analysis, it is evident the institutions with the highest international undergraduate student enrollment gained significantly more net tuition revenue than the lower levels since 2008. The quantitative research advances the current understanding from a longitudinal perspective (2000 - 2018) with three waves of international student enrollment (Choudaha, 2017).

Discussion

This paper assessed whether and to what extent that public doctoral universities in the U.S. generated net tuition revenue by enrolling international undergraduate students using two different

approaches: 1. by enrollment number and 2. by enrollment category. It delves deeper into the association between international student numbers and institution net tuition revenue by investigating both the linear relationship and the variance among institutions with different enrolled international students.

Findings of question one indicated that sampled public doctoral universities did gain more net tuition revenue by enrolling additional international undergraduate students from 2000 to 2018. From a longitudinal perspective, the coefficient strength gradually got stronger when universities recruited more international students. Between 2000 and 2018, the 180 public doctoral universities experienced a 287% increase in new international undergraduate student enrollment and a 364% increase in net tuition revenue. It resonates with previous evidence (Bound et al., 2020; Komissarova, 2019; Shen, 2015) of the revenue stream from international students as an approach to counteract diminishing state support for public higher education. Empirical studies have demonstrated that whenever state funding is insufficient, public universities intended to collect more tuition revenue (Jaquette & Curs, 2015). The findings of this study could also be considered as selective public research universities gained net tuition revenue and buffered declines in state funding in the last two decades.

The quantitative research advances the current understanding with three waves of international student enrollment (Choudaha, 2017). In the first wave from 1999 to 2006, this research supports the chronological division by finding the increase of international undergraduate student enrollment and a significantly positive correlation between net tuition revenue and international undergraduate student enrollment. In this research, public doctoral universities witnessed a modest decline in both the number of new international undergraduate student enrollments and the relationship between net tuition revenue after 2001, which matched the changing trend after the terrorist attacks of 9/11 (Choudaha, 2017) and a robust growth right after.

With its origins in the global financial crisis, the second wave (2006-2013) had the outcome of the recession as severe budget cuts in higher education in many countries around the world (Choudaha, 2017; Eggins & West, 2010). The leading institutional emphasis shifted to finance, and meanwhile, China's middle-class was growing, and many could afford to send children to study overseas (Choudaha, 2017). This study supported it by finding a 227% increase in international students increase and a 193% increase in Pearson correlation from 2006 to 2014 (by research's calculation). The findings were aligned with such a change in the way tuition was paid by international students. The correlation coefficients between net tuition revenue and international undergraduate student enrollment were statistically significant, and they increased from moderate to strong in the second wave.

Due to the economic and political turbulence, from 2013 to 2020, the increase of international student enrollment slowed down in the third wave. The findings supported it with the decreased enrollment number and the slowdown of the increasing trend in the correlation coefficients. The change of correlation strength in wave three also echoes the decline of international student enrollment from the economic slowdown in China, Brexit, the election of Donald Trump, and so on (Choudaha, 2017).

This research found statistically significant differences in net tuition revenue among institutions grouped by international undergraduate student enrollment levels for the second research question. The trend of increasing significant differences started less (four to six) in wave one to the peak of 17 in wave two and ended with fairly more (around 15) in wave three. Through Post Hoc analysis, the highest international enrollment level gained significantly more net tuition revenue than the lower levels since

2008. In 2014 and 2016, the highest level gained significantly different net tuition revenue from every other level. The study deeply identified the top universities in 2014 and 2016, which were the peaks years of international student enrollment. There were 18 institutions in the highest level that recruited more than 400 international undergraduate students in 2014. The top five institutions with most international undergraduate students enrollment were Michigan State University (1238), Purdue University-Main Campus (1125), the University of Illinois at Urbana – Champaign (1065), University of California – San Diego (941), and University of Washington -Seattle Campus (918). In 2016, there were 22 institutions in the level that recruited more than 400 international undergraduate students. The top five institutions were the University of California - Irvine (1542), University of California – San Diego (1136), Michigan State University (1127), the University of Illinois at Urbana – Champaign (1042), and University of Washington -Seattle Campus (955).

From the perspective of host institutions, revenue generation has become an essential rationale for universities in the United States to increase international enrollments (Deschamps & Lee, 2015; Lee et al., 2006). In this longitudinal study, Tukey's Post Hoc findings contributed to the existing literature by identifying the specific differences among institutions with varied enrollment levels. The findings discovered more universities proactively developed the capability to recruit many international undergraduate students after 2008, which was a significant indicator of the university tuition revenue.

Limitations

There were obvious limitations related to the secondary data of this research. First, the three waves of international enrollment were from 1999 to 2020. Due to the availability of the secondary data, for the sample of 180 institutions, the IPEDS data were not exactly available. IPEDS collects international student enrollment data in even-numbered years. That was the reason the 1999 and 2019 data were not available. Second, public and private universities apply different accounting standards. In IPEDS data, most public institutions apply the Governmental Accounting Standards Board (GASB), and private and public institutions apply the Financial Accounting Standards Board (FASB). One limitation is that in this study, only public doctoral institutions were included. In the end, this study primarily focused on the relationship between net tuition revenue and the international undergraduate student enrollment at public doctoral universities. However, other variables that may impact the relationship are recommended in further research.

Implications and Conclusion

Based on the current research, this study is one of the first that explored with a specific emphasis on the public doctoral universities, and the findings resonate with the current research (Cantwell, 2015; Komissarova, 2019). Secondly, this research identified the relationship between net tuition revenue and international education enrollment with a dataset extended for almost two decades from 2000 to 2018, which runs almost concurrents with the three waves of international student mobility (Choudaha, 2017). Thirdly, this research contributed to the literature by revealing the nuanced trend of the relationship that from 2000 to 2018, the significantly positive coefficients between the two interested variables were growing stronger since 2006 and peaked in 2014, and then from 2016 to 2018, it slightly decreased but still kept a stable high level. Fourthly, this study was one of the few to categorize institutions by the

international undergraduate student enrollment numbers. The unique contribution creates a new method to reveal the difference in net tuition revenue by a categorized size of international student enrollment for future studies. Since such categorization has never been reported in the literature, this study provided a rational approach for categorizing institutions by the international student enrollment numbers. Last but not least, the findings of Tukey's Post Hoc analyses echo the three waves of international student enrollment (Choudaha, 2017). This study used a statistical method to report that the institutions with the highest capability to enroll international undergraduate students from 2010 to 2018 gained statistically different net tuition revenue than most institutions that enroll lower levels of international students. Since the research was one of the few to categorize international undergraduate student enrollment institutions, Tukey's Post Hoc findings could be applied for a deeper study of different international undergraduate student enrollment levels, especially the top ones.

The scholar-practitioners of international higher education leverage research and scholarship to inform practice and advance the theoretical foundations (Saubert & Ziguras, 2020; Streitwieser & Ogden, 2016). With the cost analysis of different institutions, the scholar-practitioners, researchers, and policymakers can apply the findings of this study to budget management, confirm the efficacy of existing services, modify the provision of current international student enrollment and retention, and design new services. Since a limitation of this study is that IPEDS collects international student data every other year, one recommendation is to continue the research based on each institution's different situation with every year's data. A cost-benefit analysis case study could be quantitative or mixed research with the addition of qualitative research. It would be a great opportunity to assess the cost and benefit from international student enrollment with the guideline of Pareto efficiency, and reflect the impact of policy, reorganization, consolidation, and change of key offices in each year. In addition, it could also identify whether international student enrollment boosts domestic recruitment in individual university.

While this study showed significant evidence of the strong relationship between net tuition revenue and international undergraduate student from a longitudinal perspective, revenue-generating is not the only reason to recruit international students. There are variety of reasons to recruit international students, as fostering a diverse campus, building a culturally diverse learning environment, learning about different cultural perspectives in first hand, enriching campus with cultural perspectives, and so on. The research could be the blueprint cost-benefit analysis in individual universities or other levels of institutions, as private doctoral universities and regional scope, and the benefits should include economic and non-economic impacts. The cost-benefit analysis provides policymakers the foundation for evaluating the institutional support for international 'students' recruitment and enrollment. More research is recommended to include other key variables to explore this topic and deepen the understanding.

To summarize, this study investigated the association between net tuition revenue at public doctoral universities and international student enrolment from 2000 to 2018 with two steps. The first analysis identified a statistically significant positive correlation between net tuition revenue and the international undergraduate student enrollment at public doctoral universities, and the relation developed stronger from 2000 to 2018. Moreover, the findings of the second question demonstrated that the net tuition revenue was statistically different between international undergraduate enrollment levels in each analysis from 2000 to 2018. Furthermore, the highest level institutions, which enrolled more than 400 new international undergraduate students a year, developed a significant difference from the lower levels

since 2008. Yet, the potential for net tuition revenue gain does not mean every institution will achieve it by enrolling additional international undergraduate students. Individual cost-benefit analysis is recommended, and the research contributions can be translated into practical information. From the budget management perspective, institutions can use them to confirm the efficacy of existing services, modify the provision of current international student enrollment and retention, and design new services. The study provides international education practitioners, researchers, and policymakers with evidence for informed decision-making through a cost and benefit lens.

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