

**Are State Financial Support Lost in the *Iron Triangle*? A Longitudinal
Analysis of Quality, Access and Affordability of Higher Education**

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Abstract

The idea of “iron triangle” in higher education presents that access, affordability, and quality cannot be accomplished all together. Furthermore, state’s financial support has been argued as a critical factor for public universities to balance the three dimensions. The current study attempts to empirically examine i) how the three dimensions are related to each other, leaving institutions to choose/sacrifice specific dimension(s) and ii) how financial support from the states via appropriations and financial aid that are primarily need- and merit-based contribute to the relationship among the three dimensions, respectively. The findings have important implications for public universities regarding how they might navigate both financial pressure and the public mission. The roles of different state financial supports will inform the allocation of resources across states’ public institutions, in order to achieve the important goals of educating more people with quality education, expanding social justice or addressing inequality in educational opportunities.

Introduction

Higher education, particularly public higher education in the United States, has been the means to promote economic development of society (Lane, 2012). Higher education policies and the financial backing from federal and state governments to public higher education institutions aligned with this goal. The role of public universities is to produce an increasing college educated workforce, promote *access* by keeping the costs *affordable* and also ensure the *high quality* of education. Yet these three dimensions are not reconcilable, as choice to prioritize one or two of the dimensions means the third gets automatically fixed (Immerwahr et al., 2008). This *trilemma* faced by higher education institutions has been referred as the “iron triangle” (Finifter, et al., 1991).

Public institutions today are very much in the middle of a tense intersection of the three dimensions, as they face socioeconomic changes and global stress of a pandemic. Federal and state appropriations have decreased, cost-shifts from subsidies to individual institutions and students have accelerated (Barr & Turner, 2013), creating financial burden for students struggling to afford rising tuition costs and obtain high-wage careers upon graduation, as well as pay back their student loans. Meanwhile, the public perception is that higher education institutions could reduce costs without sacrificing quality, and likewise, admit more students while also maintaining tuition costs. Given these obvious tensions, the public is demanding greater accountability, access and affordability to higher education, while the institutions are operating with less public and private financial support and striving to maintain or improve quality. And this has only been worsened by the recent pandemic, with institutions rapidly needing to accommodate virtual accessibility, without sacrificing quality, leading to many

challenges with affordability as the public questions whether cost and fees should remain the same all while institutions are stretched thin financially.

Previous literature mostly focused on state and institutional factors affecting each dimension of the iron triangle, rather than how institutions are asked to negotiate between the dimensions. Studies suggest that the choice between the three might be related to the level of state's financial support, directly to institutions or via financial aid (Immerwahr et al., 2008; Ansell, 2008; Hearn & Holdsworth, 2002). State appropriation has been responsible for universities providing *quality* education via resources for instructions and other support operations and *affordability* via increase in tuition and fees, but mediated by the level of autonomy schools have in the level of tuition and fees. This factors into *access*, with state's financial aid programs explained to expand access to more students as well as to the students from disadvantaged backgrounds.

An institutional-level concern is determining what to compromise, if it is not possible to fulfill all three dimensions simultaneously. In fact, there are key institutional practices related to the three dimensions. For example, understanding motivation for "quality" when considering factors such as reputation, prestige, and rankings might alter admissions and pricing practices, in a direction that sacrifices "access." In order to maintain "affordability" without increasing tuition and fees, institutions may not be able to invest in renown faculty and researchers, or technological infrastructure, thus sacrificing "quality." Institutional differences between research vs. teaching institutions or institutions serving more low-income students, the nexus of university missions and key activities, organizations' contingencies, as well as structure of revenue sources present different choices among the three dimensions of iron triangle.

Purpose

A major role of public universities is to produce a more college educated workforce with high *quality* education, while promoting *access* by keeping the cost *affordable* (Lane, 2012). Yet, the diminishing state financial support has challenged these goals. The cost has shifted from subsidies to individual institutions and students (Barr & Turner, 2013), increasing concerns for affordability and access. In addition to this, institutions have been criticized for students' high attrition/low graduation rates as well as poor learning outcomes (Arum & Roksa, 2011), increasing demand for accountability.

Understanding the iron triangle has primarily been a conceptual exercise to this point with limited empirical examination of how the three dimensions are related and affected as universities make different choices in navigating the iron triangle. Moreover, much remains unknown regarding how the states' policy environments, important higher education policies, as well as institutional characteristics are associated in the patterns of institutions' practices of the three dimensions. Filling the gap in the literature, this research aims to empirically demonstrate the existence of "iron triangle"—trades offs at the institutional level between access, affordability, and quality. We examine the micro-mechanisms underlying this pattern by developing a formal analysis of state and institutional factors and the relationship among the three dimensions. The following research questions guide the study:

1. To what extent are the dimensions access, affordability and quality related to each other?
2. To what extent are three dimensions at four-year public institutions associated with state appropriations and financial aid?

Additionally, we explore the relationship among the three dimensions and the role of state appropriations and financial aid might be differ at the research universities and other 4-year universities.

It is critical that higher education institutional management understand and recognize the relationship of the iron triangle dimensions. The findings of the study will provide important information for use in states' and individual higher education institutional policies with regard to financial support and expenditures. This research is significant in helping to provide an understanding of institutional decisions and responses as they work to promote goals of public higher education and create a culture and identity of their own. This could lead to creative decision and policy making, perhaps, as institutions navigate or perhaps find ways to break the iron triangle. Additionally, the current study informs financial supports for public higher education with different programs, in order to achieve the important and urgent policy goals of educating more people with good quality, expanding social justice or addressing inequality in educational opportunities.

Literature Review

The iron triangle is a “trilemma:” a three-way choice between the institutional goals of access, affordability, and quality; whereas at most, two of these potentially desirable goals could be pursued successfully at the one time, creating different set of distributional choices for institutions. The concept of “trilemma” dates back to the Mundell (1968)’s “unholy trinity” of capital openness, autonomous monetary policy, and fixed exchange rates and has been discussed in the areas of public policy where the concept being developed in this work shows trade-offs in governmental policy goals (Iversen & Wren, 1998).

In the context of higher education, the concept of *trilemma* was used to explain the decision between access, cost/affordability and quality by public higher education policy makers (Daniel et al., 2009; Finifter et al., 1991). Later, the term “iron triangle” was used anecdotally to emphasize the trilemma faced by public university to deal with the dimensions of access, affordability and quality (Immerwahr et al., 2008). Yet, much attention has been paid asynchronously to each of the iron triangle dimensions, rather than how the three factors are related to each other, making institutions to choose from different combinations.

Access

Access is defined in two ways: providing education to “more” students (e.g., number of enrollment) and increasing educational opportunity for disadvantaged students (Heller, 1997). Institutions have the ability to significantly alter their accessibility, passed on such thing as admissions policies and pricing. Tuition and fees, particularly the sticker price has been an important deterrent for enrollment (Heller, 1999; Immerwahr, 2002; Andrews & Stange, 2016), suggesting the importance of affordability which will be discussed in below. It is also important to note that institutions have the autonomy to alter their admission processes to enhance student selectivity. Admitting academically best-prepared students, often determined by their SAT/ACT scores or high school rank percentile, will lead to better outcomes, such as graduation rates and time-to-degree completion (Goenner & Snaith, 2003). Other admission policies such as the early admission process (Chaker, 2004) or the offering of an Honors College are often used to attract students with high admissions credentials. It is easy to see how this element of access is closely tied to quality, by adding emphasis on prestige and selectivity.

Conversely, some institutions adjust admissions policies to increase applications and matriculation. This includes decisions by some institutions to relax admission standards by

dropping SAT/ACT requirements (Kirp, 2003), potentially to attract students who are willing and able to pay the full-price (Brewer et al., 2002; Stecklow, 1995) such as out-of-state students (Zhang, 2007). The removal of standardized test scores is also a strategy for increasing access among the underrepresented students to higher education (Posselt et al., 2012).

Affordability

Often, an institution with tough admission requirements and high fees is considered a “good institution regardless of what happens within its walls” (Daniel et al., 2009). As the sticker price functions as a signal for the quality of education an institution provides (Mumper & Freeman, 2011), high-price high-aid model has been a popular practice among the universities (Geiger, 2002). Furthermore, the increased cost for education and competition for quality contributed to the increase in cost via establishment of or increase in student fees among the public institutions (Schuh, 2003; Kelchen, 2016; Kim & Ikegwuonu, *In Press*). The increased cost in education contributed to the concerns for quality and affordability over the last decades (Archibald & Feldman, 2012; Bowen, 2012), as high tuition and fee levels are often negatively associated with enrollment, particularly that of low-SES students (Hearn & Rosinger, 2014). The most fundamental element of improving affordability then is to provide a significant price discount to students through grants and generous financial aid packages (Leeds & DesJardins, 2015; McPherson & Schapiro, 1991; 1997; Winston, 1997). Previous research has shown positive impact of various types of student financial aid, loan reduction and elimination efforts on increasing affordability (Hillman, 2013; Waddell & Singell, 2011).

Quality

Quality might be the most subjective of the three dimensions of the iron triangle. While various definitions and measurements to assess quality have been utilized by previous research

(e.g., reputation, faculty research, student experiences) (Brooks, 2005), expenditure to support educational activities is often employed as a proxy for the quality of education provided by the respective school (e.g., Webber & Ehrenberg, 2010). A higher level of expenditure on educational activities is believed to indicate an institution's ability to create a better educational environment or its emphasis on undergraduate education and student learning (Pike et al., 2006; Toutkoushian & Smart, 2001). Previous studies showed the positive correlations between expenditures and student outcomes such as retention, degree completion and graduation (Gansemer-Toph & Schuh, 2006; Titus, 2006) as well as collegiate learning outcomes (Pike et al., 2006; Smart et al., 2002; Ryan, 2005). Often the educational cost includes faculty salaries, cost to recruit and retain prominent faculty who not only provide quality of teaching and research (Clotfelter, 1996; O'Meara, 2007) but also can boost the institution's prestige (Grunig, 1997; Massy & Zemsky, 1994; Melguizo & Strober, 2007).

State Appropriations, Financial Aid and Access, Cost, and Quality

States invest in public higher education through appropriations to institutions, capital expenditures for institutions, and support to students in the form of student financial aid (Delaney, 2014). These financial supports from states are important for establishing the level of affordability of higher education in each state. Given the significant dependence of public institutions on public subsidies, many researchers have investigated the association between state appropriations and tuition (e.g., Hearn et al., 1996; Kane, 1999; Paulsen, 2000; Toutkoushian & Hollis, 1998). Most studies have found that decreased state support shifts financial burden from state government to students and their families, against the objective of maintaining broad access to higher education (Berger & Kostal, 2002). Quigley and Rubinfeld (1993) found that states with a higher tuition level tended to have lower state appropriations, *ceteris paribus*. They

concluded that states that choose to support public education by providing for high enrollments also support education by offering relatively low tuitions. Other studies have found that declines in state support were followed by increases of in-state tuition in subsequent years (Koshal & Koshal, 2000). Lowry (2001) found that less state funding for public institutions led to higher net tuition revenue, but the reverse was not true. Rizzo and Ehrenberg (2004) also found that higher state appropriations per students were associated with lower tuition, though the elasticity is far from reaching unity. On average, an increase of \$1,000 in state appropriations per student decreased in-state tuition by \$60.

Meanwhile, volatility, the degree to which an increase or decrease in state appropriations occur, is an essential dimension of higher education finance because higher education takes the form of a balance wheel in state budgets (Delaney & Doyle, 2007; Delaney & Doyle, 2011). From this perspective, Delaney (2016) examined how tuition and fees changed with unstable state support between 1987–2013. The study found that for all four-year institutions, average tuition and fee levels were generally higher following a cut to state spending and lower following an increase in state spending. Net tuition also changed significantly at the 3% change threshold in state appropriations.

While state appropriation is mostly to support general operation of the public institutions, states offer financial aid programs to promote access and maintain affordability (St. John, Hu, & Weber, 2001). Specifically, the state need-based aid is often considered for improving access for underprivileged students (Heller & Marin, 2004; Baum & Lapovsky, 2006) while merit-based aid is considered for increasing in-state enrollment and keeping students at the state schools (Dynarski, 2002; Cornwell et al., 2006; Zhang & Ness, 2010). While about 64% was awarded as

need-based grants for undergraduates, there has been marked growth in state undergraduate non-need-based grant aid (Delaney, 2014).

While there is significant evidence that state aid programs, whether through merit-based, need-based, or hybrid programs, can increase college attendance rates and completion rates, results vary by state (Castleman & Long, 2016; Cornwell, Mustard, & Sridhar, 2006; Dynarski, 2000, 2004, 2008; Kane, 2006; Scott-Clayton, 2011; Singell & Stone, 2002; Van Der Klaauw, 2002). Using the case from Tennessee HOPE scholarship, Bruce & Carruthers (2014) showed that students substitute away from community colleges in favor of 4-year universities. On the other hand, Cohodes and Goodman (2014)'s analysis on Massachusetts' Adams Scholarship found that students are incentivized to enroll at less prestigious in-state institutions rather than out-of-state institutions, which ultimately decreased students' probability of graduation.

Moreover, some argued that historically underrepresented students are the least likely to receive benefits from state-adopted merit-aid programs, increasing enrollment gap between advantaged and disadvantaged students (Heller & Rogers, 2006). In particular, the adoption of a merit-aid policy can decrease low-income and minority student enrollment at selective 4-year institutions (Griffith, 2011). Studying need-based program in Florida, Castleman and Long (2016) found a significant increase in four-year college enrollment as well as bachelor's degree completion. Finally, Long (2004) provides an example of the potential impact of state financial aid on pricing. The study showed that the introduction of Georgia HOPE resulted in an increase in student charges among four-year colleges at a faster rate than similar schools in nearby states, particularly among the private institutions. Moreover, public colleges increased room and board fees, which can reduce the intended benefits of the program for the recipients (Dynarski, 2000).

Theoretical Framework

To inform the design of this study, we borrowed from North's theory of institutions and institutional change (1990, 1993). The theory of institutions examines institutions (governments) as founders of the rules or ideologies by which all individual organizations (colleges and universities) operate or interact with. The interactions between institutions and organizations create institutional change, which North describes as choices made by organizations based on costs and benefits they perceive as advantageous to their success, which leads to incremental change (1990). North (1993) explains how "institutions consist of formal rules, informal constraints...and the enforcement characteristics of both," (p. 2). Changes in the formal rules occur as results of law or regulatory changes, and changes in informal constraints (norms or conventions) occur gradually as individuals evolve their behaviors based on perceived costs and benefits (North, 1993). Adding in economic theory, North (1990) describes how incentives underlie all decisions and these incentives change over time, therefor influencing the rules or ideologies set by institutions and the perceptions of individuals responding or changing to meet the new rules.

Applying these theories to the framework of this study, while traditionally the institution of higher education served to educate the elite and privileged, overtime, the norms and rules of higher education as an institution changed to benefit the economy by educating the masses and preparing workers for the market economy (Gumport et al., 1997). Federal and state appropriated funding as well as need- and merit-based financial aid programs (i.e., taking the institutional context per North's theories), set incentives and constraints for universities (i.e., individual organizations) to determine how to negotiate the incentives, costs, and benefits of indicators related to quality, affordability and access. As universities make decisions within the iron

triangle, they do so with the intention of stressing one or more dimension, in order to set themselves apart from other intuitions or to remain competitive in today's higher education market. There are increasing concerns for college costs, often explained by the diminishing support from state government, with institutions having to cut expenditures or increase tuition and fees (Doyle & Zumeta, 2014). Additionally, state financial aid programs address the issue of affordability to expand access to higher education for more students (St. John et al., 2001).

With the theory of institutions and institutional change serving as the framework of this study, we are able to examine the incremental change(s) that individual colleges and universities have made over time as they respond to the rules and informal constraints imposed by government laws and regulations, society, and one another as they pursue individual success.

Methodology

Data and Sample

We employed a panel data that captures information on institutions and states. The institutional level data came from the Integrated Postsecondary Education System (IPEDS). The analytic sample consists of 497 public universities that offer baccalaureate or higher degrees for the years of 2000-2016¹. IPEDS provides information on student enrollment and composition, revenue by sources including state appropriations, expenditure on education and general activities, and tuition and levels, and other institutional characteristics such as Carnegie classification, admissions selectivity, and faculty salary.

In addition, we looked at contributions states provide to higher education in the format of educational appropriation and financial aid which are captured by State Higher Education

¹ The date range of 2000-2016 was chosen due to NASSGAP survey data being publicly available up through 2016.

Executive Officers' (SHEEO's) State Higher Education Finance (SHEF) survey as well as the National Association of State Student Grant and Aid Programs (NASSGAP) Annual Survey on Grant Aid. SHEF provides education appropriations and net full-time enrollment (FTE) in the state's public higher education, along with the total state financial aid amount. SHEF also captures information on tuition setting policies within each state. NASSGAP's survey provides further details on state financial aid: the total amount distributed through a primarily need-based grant program, other grants that are need-based, and grants that are non-need based for undergraduate and graduate students, respectively. Finally, the Bureau of Labor statistics data provides states' unemployment rate each year, which we use to serve as a proxy for economic conditions. These datasets were merged based on the state identifier in which each institution was located and year.

For the purposes of this research, we are focusing on public universities that offer baccalaureate or higher degrees. We also distinguish the institutions into: i) public baccalaureate institutions having the designation of a doctoral or *research institution* (Shulman, 2000), meaning they confer doctorate degrees and are required to meet specific annual research expenditures and ii) *Non-research institutions*, those that confer baccalaureate degrees and may also be known as liberal arts colleges (Shulman, 2000) but do not have the same requirements with regard to doctorate programs or research expenditures. From here forward, we will refer to research and non-research institutions.

Variables

We employed a set of dependent variables to capture the three dimensions of iron triangle. First, *Access* is defined two ways: i) size/scale of the enrollment (Finifter et al., 1991), which is captured by the number of total full-time, first-time degree seeking undergraduate

enrollment; ii) providing more opportunity for financially disadvantaged students, which is measured through the proportion of full-time, first-time undergraduate students receiving Pell grants. Second, we define *Quality* as how much institutions spend in education and other support services for students and academic activities (Brooks, 2005). Therefore, the total annual expenses spent on instruction and student and academic services per full-time equivalent student is used in the analysis. Finally, *Affordability* was measured by the level of tuition and fees for in-state students.

In order to explain how state's financial support to public institutions in different formats is connected to the dimensions of the iron triangle, we employ variables on state appropriation and financial aid. In particular, per full-time student education appropriations; state financial aid: total amount of financial aid per full-time student; financial aid distributed based primarily on need and non-need-based financial aid per full-time student, respectively. All financial variables are adjusted for the inflation and log-transformed (i.e., transforming skewed data to normal distribution) except for the variables that present values in percent. See Table 1 for the descriptive statistics and summary of the key variables employed in the analysis.

Identification Strategy.

While access, affordability and quality have been often explained separately, the idea of the iron triangle considers the three dimensions together. Thus, we test the relationship that is systematically structured: each of the three as a dependent variable, while they also become an independent variable for other two factors. Thus, a simple ordinary least squares (OLS) regression is not suitable because i) the error is correlated with the dependent variable (endogeneity), and ii) error terms among the equations are expected to be correlated (standard errors are biased). In other words, the degree of errors, or correlation, is explained by one of the

other variables. As a solution to these issues, we employed a 3-stage least square (3SLS) regression using Stata data analysis and statistical software, specifically the `reg3` command. This 3SLS extension of the linear regression model allows for simultaneous estimation of how state's financial support in the form of appropriation and financial aid predict access, quality and affordability that are related to each other. Therefore, we estimate the three simultaneous equations specified as below:

$$Access_t = f(Tuition_t, Expenditure_t, State Appropriation_t, State Financial Aid_t, Admissions Selectivity_t) \quad (1)$$

$$Expenditure_t = f(Access_t, Tuition_t, State Appropriation_t, State Financial Aid_t, Faculty Salary_t, Student_Faculty Ratio_t) \quad (2)$$

$$Tuition_t = f(Access_t, Expenditure_t, State Appropriation_t, State Financial Aid_t, Tuition Setting Authority_t, Tuition Reliance_t) \quad (3)$$

The first equation relates access related outcomes to the state appropriations, state need-based and non-need-based financial aid, admission selectivity of the institution, as well as educational expenditure and in-state tuition rate. The second equation defines educational and general expenditure to be a function of state appropriations and state financial aid, along with the number of faculty per 100 FTE students, and average faculty salaries, along with tuition level and the size of the enrollment or % of the students who receive Pell-grant. The final equation relates in-state tuition level with the access variable and expenditure, along with the state financial support variables. Additionally, an institution's reliance on tuition revenue and tuition setting authority are considered in the model (See Table 1 for the definitions of the variables).

The estimated coefficients suggest how the three dimensions of the iron triangle are related to each other as well as how the financial supports from the states predict each dimension. Once the analysis is conducted on all public institutions, the analysis will be repeated separately for research institutions and non-research institutions, in order to examine whether or not access, expenditure, and tuition differ, and whether state financial support holds different weights on the pillars of iron triangle, depending the institutional characteristics. Specific factors related to calendar year were controlled for by including fixed effects (e.g., non-random intercepts).

Results

Descriptive Statistics

Table 1 explains the descriptive statistics on the sample used for the preliminary analysis. The mean number of first-time full-time degree seeking undergraduate students was 2033.5 (SD=2375.52). On average, during the years of 2000-2016, approximately 36% of students attending each school received Pell grants (SD=16.70); this proportion of Pell supported students began increasing slightly from $\approx 32\%$ in 2010, to 38% in 2011, to $\approx 42\text{-}43\%$ after 2012. The average in-state tuition and fee rate was \$5,494.68 (SD=2,579.62) per year during the span of 2000-2016, with a dramatic increase year over year with annual tuition starting at about \$3,045 in 2000 and climbed to an average of \$8,362 per year in 2016 (i.e., an average increase of 175% over the 17 year timespan). Public 4-year institutions included in the sample spent on average \$14,791 per student on education and student support services (SD=7587.94). State appropriation during this time was an average of \$8,308 per FTE student (SD=5340.49) across the universities. As the state appropriation declined over the years, the proportion of tuition that

accounted for total revenue has had to increase over time: in 2000, tuition represented on average, 24.19% of an institution's total revenue, climbing to 31% in 2009 and 38% in 2013, respectively. Meanwhile, states provided an average of \$828 of financial aid for each undergraduate student (SD=570.45) during the 17-year analytic period, which includes grants that are primarily based on need (M=576.39, SD=496.04) and non-need-based financial aid (M=182.30, SD=354.51).

Access, Quality, Affordability and State Financial Support for Higher Education

Table 2 provides the results of the structural 3SLS estimations. Overall, the regression estimates from equations (1)-(3) suggest that public universities not only face the iron triangle, but decisions made with one dimension have repercussions for the other two dimensions. To expand *access* (measured by the enrollment size of full-time, first-time undergraduate students), *affordability* needs to be improved by reducing tuition and fee levels, which simultaneously leads to higher enrollment, an indicator of *quality*. A 10% increase in in-state tuition and fee rate is associated with an 8% reduction in enrollment size, while a 10% increase in educational and support expenses (i.e., quality) is associated with about 13% increase in enrollment size (Column (1)). Yet, increasing *quality* might be justified by not only attracting more students (a 10% increase in students is associated with a 1.21% increase in expenditure; Column (3)) but also require an increase in tuition: 10% increase in per student expenditure results in about 7.7% increase in tuition (Column (2)). This trend was the same for the model where access was defined as the representation of lower-income students. While a 10% increase in expenditure as well as in-state tuition and fees predicts a 19% and 8% reduction in % students receiving Pell grant respectively (Column (4)). Expenditures seem to increase when the in-state tuition and fees

increase ($B=.220$, $p<.000$) and there are more students who are from lower-income backgrounds ($B=.014$, $p<.000$) (Column (6)).

Increased financial support, particularly those from the state government, has been pointed as a way to remedy the iron triangle faced by public universities. Our results support this argument, showing that state appropriations and state financial aid might play a significant role in addressing the iron triangle. Yet, each contributes to the three dimensions in different ways. State appropriations do not necessarily expand access, in terms of the size of the first-year full-time enrollment, but state appropriations do allow an increase in the number of students who receive Pell grants. A one percent increase in state appropriation per full-time student is associated with about 5.47% increase in the percent of Pell recipients (Column (4)). State appropriation allows public universities to increase quality while enhancing affordability: when per student state appropriations increased by 10%, educational expenditures increased from 0.4% to 1.85% (Columns (3) and (6)), while tuition decreased by 0.3% to 1.93% (Columns (2) and (5)). State financial aid that are primarily based on students' needs increase access by increasing the size of the enrollment ($b=.019$, $p<.000$) but not significantly changing % students who receive federal grant aid. Yet, a 10% increase in need-based aid predicted an 0.2% increase in tuition, also increasing expenditures from 0.2 to 0.3%, which is a proxy for educational quality. On the other hand, non-need-based state aid had almost no impact on affordability and quality, but did expand enrollment ($b=.019$, $p<.000$).

It is also worthy to note that each dimension of the iron triangle is related to several state level factors as well as other institutional characteristics. In particular, when unemployment rates increase, there is no change in the enrollment size of the first-time full-time students, except for the proportion of students who receive federal grant aid, which increased. The in-state tuition and

fees were lowest among the schools where tuition is regulated at the state level, followed by the schools where tuition is regulated at the system level, compared to schools that have autonomy to determine tuition. We found that across institutions, as admissions rates increased, the proportion of lower-income students decreased. More faculty resources, measured by student-faculty ratio and average faculty salary is positively correlated with the measure of educational quality. If the institutions relies on tuition as a major source of revenue, they tend to have a higher level of tuition. This suggests a need for separate analysis that focuses on institutions with differing admissions rates, different level of faculty resources as well as availability of other revenue streams. Thus, we compare research universities and other 4-year comprehensive universities in the next section.

Heterogeneous impact: Research Universities vs. Non-research Universities

Tables 3.1. and 3.2. summarize how the iron triangle might appear to various extents at research and other 4-year comprehensive universities, in relation to the provision of appropriated funding from the state as well as need and merit-based financial aid from the state. Overall, we found evidence that iron triangle has greater effects at 4-year comprehensive universities, compared to research universities. First, the association between access and affordability was stronger for non-research universities. At the non-research universities, a 10% increase in in-state tuition resulted in an 8% decrease in first-year enrollment and 17% reduction in the proportion of Pell-receiving students. While larger increases in tuition are required in order for expenditures and enrollment size to increase across the board, the required increase was much larger at non-research ($b=1.412$, $p<.000$) compared to research ($b=.450$, $p<.000$) universities. Tuition tends to increase if an institution increases expenditures, at a higher rate at non-research universities ($b=.647$, $p<.000$) (Table 3.2., Column (2)) than research universities ($b=.476$, $p<.000$). On the

other hand, the expenditures do not change per tuition at non-research universities (Table 3.2., Column (6)). Meanwhile, with research universities, an increase in the in-state tuition was associated with a decrease in enrollment size ($b=-.380$) with no changes among the proportion of Pell-receiving students.

For both types of institutions, an increase in state appropriated funding has the potential to slightly decrease the enrollment of first-time, full-time students but increase access for Pell-receiving students. The state funding positively contributes to educational quality by increasing the amount available for student supports and services. When state appropriated funding per FTE increased, the in-state tuition and fees did not change or increase at non-research universities ($b=.564$, $p<.000$), and affordability was improved among the research universities ($b=-.027$, $p<.05$) (Table 3.1., Column (2)). Again, at research universities, the state appropriated need-based financial aid increased access, both in terms of enrollment size and representation of lower-income students (Table 3.1., Columns (1) and (4)). At non-research universities, while the state appropriated need-based financial aid increased overall enrollment, it diminished the proportion of students who received Pell grant (Table 3.2., Columns (1) and (4)). The additional need-based financial aid from the state also allowed research institutions to increase educational expenses which led to an increase in tuition (Table 3.1., Columns (2) and (3)). For non-research universities, the additional state appropriated need-based financial aid lowered tuition but increased educational expenses (Table 3-2, Columns (2) and (3)). On the other hand, an increase in per student non-need-based financial aid was associated with a slight decrease in tuition and fees assumed (Table 3.1., Column (5) and educational expenditures (Table 3.1., Column (3)), respectively. A 10% increase in this state non-need-based grant was associated with a 4% reduction in the % Pell students as well (Table 3-1, Column (4)). Non-need-based financial aid

expanded the enrollment scale with no changes in the representation of lower-income students at non-research universities. Moreover, the financial aid did not influence the tuition and fee rates but slightly decreased the educational expenditures (Table 3-2, Columns (5) and (6)).

Discussion and Implications

The current study focuses on the concept of iron triangle, which explains that access, affordability, and quality cannot be maximally accomplished all together or in other words, when advancing one dimension, another will be sacrificed to some degree. Furthermore, the management at higher education institutions perceive that more financial input through governmental investment in higher education is the one of the important solutions to the eliminate the tensions of iron triangle (Immerwahr et al., 2008). We empirically tested to what degree these ideas are reflected in the way public universities are organized.

Our results suggest that the iron triangle does exist among public universities, both research and non-research universities. The findings indicated that public universities might be left with the options of expanding access by reducing the tuition (increasing affordability) and sacrificing quality (decreasing expenditures); or sacrificing access yet increasing tuition and quality (Ansell, 2008). While the study did not focus on showing what choices schools make, such studies might be a popular option (Bowen, 2012), reflected in the literature on college pricing and its consequences: the trends in steady increase of sticker price (Ma et al., 2020), the role of tuition as a signal for educational quality, hence the use of high tuition/high aid discounting as a famous practice (Geiger, 2002; Mumper & Freeman, 2011), the negative impact of such pricing on access, particularly students from lower-income (Heller, 1999; Immerwahr,

2002; Andrews & Stange, 2016), and the increase in spending to support both educational (Archibald & Feldman, 2012; Bowen, 2012) and auxiliary activities (Jacob et al., 2013).

Yet, not all institutions are the same in their experience of the iron triangle. Particularly the iron triangle might be more significant—i.e. the damages in relation to the change in another factor will be larger—for the 4-year comprehensive, non-research universities compared to research universities. Institutions' contingency factors, such as revenue sources other than tuition, admissions selectivity, and faculty resources were significant factors for the three dimensions of the iron triangle. Furthermore, as North (1993) noted, the formal policy and informal culture change over time, will shape what decisions institutions make at different times. Economic recession, the recent COVID-19 pandemic, change in admissions practices in absence of college admissions tests, upcoming changes to FAFSA and Pell Grant, public's scrutiny on the issue of educational loans, the prevalence of online education might shift institutions' stances on iron triangle over time. Future research should take a longitudinal perspective, analyzing how the negotiation between access, affordability and quality might differ in the past and after significant changes in the society.

In this study, we argue that financial supports coming from the states to higher education in the format of appropriation as well as financial aid to students function as an important influence on access and quality. We found that state appropriation is important for establishing the level of affordability of higher education across the states (Delaney, 2014). Moreover, we found that appropriations support educational quality, without increasing tuition. This suggests that the continuing support from the state will allow institutions to break the iron triangle. It is particularly important to have stable support from the state for non-research universities, as they might lack other alternative funding sources, other than to increase tuition.

The study also points at the interesting role of state financial aid in access, affordability and quality. The state need-based aid is often considered for improving access for underprivileged students (Heller & Marin, 2004; Baum & Lapovsky, 2006) while merit-based aid is considered for increasing in-state enrollment and keeping students at the state schools (Dynarski, 2002; Cornwell et al., 2006; Zhang and Ness, 2010). The results of the current study suggest that need-based aids might increase college enrollment (Castleman & Long, 2016) but increased need-based aid did not have a statistically significant impact on increasing access among the lower-income students. While this might be due to students moving to less-prestigious institutions in-state, rather than out of state institutions (Cohodes & Goodman, 2014), future studies might look into the nature of the scholarship and how it influences where students decide to enroll, particularly for lower-income students. For example, if the need-based aid focuses on community college, there might be increased enrollment at community colleges, while the changes in 4-year institutions might be minor (Harnisch & Lebioda, 2016). Moreover, we found that higher need-based aid amounts were associated with an increase in tuition and quality, particularly among non-research universities. This questions if need-based state aids are fulfilling the “Bennett Hypothesis:” the financial aid increased access yet also increased tuition for all in-state students, which was found from federal aid such as Pell Grant (Li, 1999). It is unclear if some of this increase might be coupled with institutional scholarships to compensate for access (McPherson & Schapiro, 1991).

On the other hand, increasing non-need-based financial aid seems to meet the goal of providing access to more students, and our findings show not much change in affordability and no to trivial improvement on quality. Similar to the previous studies, the benefit of non-need-based financial aid seems to be mostly at the elite 4-year institutions (Dynarski, 2004; Cornwell

et al., 2006). Given the marked growth in state undergraduate non-need-based grant aid (Delaney, 2014), it is important to have a closer look at additional data that exists within each of the dimensions of iron triangle. For example, costs beyond tuition and fees, such as room and board were drastically increased in Georgia after the introduction of HOPE scholarship (Long, 2004). Heller and Rogers (2006) found that merit-aid programs adopted by states potentially impact the enrollment gap between the low-income and minority students and other students, particularly at selective public 4-year institutions (Griffith, 2011), as historically underrepresented students are the least likely to receive benefits from these programs. Finally, it is important to note that we looked at the financial aid only by per student amount. Yet there are other dimensions of state financial aid programs that might have impact on access, affordability or quality. For example, different programs are supported by different source of funding (e.g., lottery based), which impacts the sustainability and the scope of cost the aid can cover; some programs were adopted with other changes in the states such as requiring all high school graduates to complete FAFSA for high school graduation, which might have a positive impact on college enrollment, particularly among the lower income students. Future research to unpack the impact of financial aid programs on iron triangle, particularly considering the non-financial side of the program designs, is warranted.

Nonetheless, our findings provide implications for public institutions. Institutions can showcase their status on each dimension of the iron triangle and where they are forced to make a choice. In order to balance the iron triangle, institutions might negotiate which resources from the state they can prioritize: is appropriation important to support quality? Financial aid for affordability and quality? It is also important to note that there are still challenges in increasing representation of students from disadvantaged backgrounds. How an institution can tie state

financial aid to increase access of these students and secure resources to provide adequate support for the students once they arrive on campus might be an important strategy to simultaneously improve access, affordability and quality.

For states, this study underscores the importance of sustaining the level of state appropriation even when the financial aid programs are emphasized (Long, 2004). Prior to making decisions, policy makers need to carefully consider the consequences of the changes in different financial support or allocation of amounts across different programs, depending on what areas to be addressed at their respective state universities between the access, affordability or quality. This decision can be also connected to the accountability policies, how funding is used appropriately to achieve the goals of educating more people with good quality, expanding social justice or addressing inequality in educational opportunities.

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Table 1. Descriptive Statistics

Variables	Mean (SD)/%	Definition
<i>Access</i>		
Number of full-time, first-time first-year student enrollment	2033.50 (2375.52)	Total number of full-time first-time degree/certificate-seeking undergraduates
% Pell recipients	35.12 (16.79)	Percentage of full-time first-time degree/certificate-seeking undergraduates receiving federal grants
<i>Affordability</i>		
In-state tuition and fee	5494.68 (2579.62)	In-state tuition and fees (sticker price) for full-time undergraduates
<i>Quality</i>		
6-year graduation rate	46.98 (15.88)	Percentage of full-time, first-time, bachelor's degree-seeking undergraduate students graduating within 150 percent of normal time from four-year institutions.
<i>State Financial Support</i>		
State appropriation (per FTE)	8307.75 (5340.49)	Revenues received by the institution through acts of a state legislative body (except grants and contracts and capital appropriations), divided by full-time enrollment
Need based (per net FTE)	576.39 (496.04)	Total amounts of state financial aid that are primarily need-based provided to undergraduate students, divided by net full-time enrollment in the state
Non-need based (per net FTE)	182.30 (354.51)	Total amounts of state financial aid that are not need-based provided to undergraduate students, divided by net full-time enrollment in the state
<i>Other Institutional Characteristics</i>		
Admissions rate	68.40 (17.13)	% of applications accepted out of total numbers of applications
Full-time faculty (per 100 FTE)	5.41 (4.30)	Number of full-time faculty per 100 FTE students
Average full-time faculty salary	63750.73 (13920.79)	Average salary for full-time faculty
Tuition reliance	31.10 (12.19)	Share of operating revenues from net tuition
<i>Other State Characteristics</i>		
Unemployment rate	6.04 (1.99)	Unemployment rates for states, seasonally adjusted
Tuition setting authority:		Tuition setting authority for public institutions in each state

State	29.95%
System	43.24%
Institution	26.82%
Observations	7,734
Number of Institutions	452

Table 2. 3SLS regression results on access, cost, quality and state financial support for higher education

Variable	Equation					
	(1)	(2)	(3)	(4)	(5)	(6)
	Access	Affordability	Quality	Access	Affordability	Quality
	Number of First-time, Full-time student	(ln) In-state Tuition and Fees	(ln) Education and General Expenditure	% Pell Receiving Students	(ln) In-state Tuition and Fees	(ln) Education and General Expenditure
Number of First-time, Full-time student		-.171 (.028)***	.121 (.013)***			
% Pell Receiving Students					-.004 (.001)***	.014 (.002)***
(ln) In-state Tuition and Fees	-.829 (.053)***		.175 (.020)***	-8.084 (1.328)***		.220 (.028)***
(ln) Education and General Expenditure	1.325 (.047)***	.769 (.019)***		-19.084 (1.328)***	.519 (.029)***	
(ln) State Appropriations per FTE	-.839 (.009)***	-.193 (.023)***	.185 (.009)***	5.472(.259)***	-.031 (.008)***	.044 (.008)***
(ln) Total UG Need based state aid per FTE	.019 (.008)**	.022 (.003)***	.018 (.003)***	-.397 (.221)*	.021 (.003)***	.030 (.004)***
(ln) Total UG non-need-based state aid per FTE	.019 (.004)***	-.002 (.002)	-.004 (.001)**	-.131 (.112)	-.006 (.002)***	-.002 (.002)
State unemployment rate	-.010 (.007)	-.022 (.003)***	.020 (.002)***	2.491(.198)***	-.012 (.004)**	-.011 (.006)*
Admissions rate	-.001 (.000)**			-.141 (.016)***		
Student-Faculty Ratio			.051 (.001)***			.073 (.002)***
(ln) Faculty Salary			.720 (.031)***			1.105 (.053)***

Tuition setting authority (Ref: Institution)						
State		-.247 (.009)***			-.290 (.009)***	
System		-.099 (.009)***			-.113 (.008)***	
Tuition Reliance		.007 (.001)***			.007 (.000)***	
Constant	1.651 (.417)***	2.370 (.199)***	-1.419 (.224)***	279.755 (12.038)***	3.611 (.292)***	-5.715 (.744)***
Observations	5,824 (424)			5,747 (418)		
R ²	.702***	.690***	.531***	.302***	.399***	.679***

Note. Year-fixed effects included. ***p<0.01, **p<.05. *p<.01

Table 3.1. 3SLS regression results on access, cost, quality and state financial support: Research Universities

Variable	Equation					
	(1)	(2)	(3)	(4)	(5)	(6)
	Access	Affordability	Quality	Access	Affordability	Quality
	Number of First-time, Full-time student	(ln) In-state Tuition and Fees	(ln) Education and General Expenditure	% Pell Receiving Students	(ln) In-state Tuition and Fees	(ln) Education and General Expenditure
Number of First-time, Full-time student		-.036 (.033)	.228 (.039)***			
% Pell Receiving Students					-.005 (.001)**	.014 (.004)**
(ln) In-state Tuition and Fees	-.380 (.083)***		.273 (.036)***	-1.417 (2.153)	.337 (.042)***	.216 (.037)***
(ln) Education and General Expenditure	.450 (.073)***	.476 (.032)***		-21.230 (1.914)***		
(ln) State Appropriations per FTE	-.612 (.016)***	-.020 (.023)	.208 (.022)***	4.498 (.427)***	-.027 (.009)**	.043 (.013)**
(ln) Total UG Need based state aid per FTE	.062 (.013)***	.042 (.007)***	.031 (.006)***	.907 (.349)**	.054 (.006)***	.040 (.007)***
(ln) Total UG non-need-based state aid per FTE	.001 (.007)	-.020 (.003)***	-.006 (.003)**	-.445 (.175)**	-.023 (.003)***	-.002 (.003)
State unemployment rate	.012 (.009)	-.014 (.005)**	.019 (.004)***	2.312 (.258)***	-.003 (.005)	-.005 (.010)
Admissions rate	-.001 (.001)			-.031 (.023)		
Student-Faculty Ratio			.051 (.002)***			.056 (.002)***
(ln) Faculty Salary			.451 (.070)***			1.171 (.187)***

Tuition setting authority (Ref: Institution)						
State		-0.246 (.017)***			-0.280 (.016)***	
System		-0.116 (.014)***			-0.141 (.014)***	
Tuition Reliance		.010 (.001)***			.008 (.001)***	
Constant	6.152 (.724)***	3.546 (.408)***	-0.074 (.486)	228.138 (18.970)***	5.234 (.407)***	-6.333 (2.210)**
Observations	2,053 (142)			2,040 (140)		
R ²	.562***	.630***	.652***	.204***	.536***	.677***

Note. Year-fixed effects included. ***p<0.01, **p<.05. *p<.01

Table 3.2. 3SLS regression results on access, cost, quality and state financial support: Non-research Universities

Variable	Equation					
	(1)	(2)	(3)	(4)	(5)	(6)
	Access	Affordability	Quality	Access	Affordability	Quality
	Number of First-time, Full-time student	In-state Tuition and Fees	(ln) Education and General Expenditure	% Pell Receiving Students	(ln) In-state Tuition and Fees	(ln) Education and General Expenditure
Number of First-time, Full-time student		-.647 (.088)***	.004 (.016)			
% Pell Receiving Students					-.008 (.001)***	.013 (.002)***
(ln) In-state Tuition and Fees	-.860 (.060)***		.040 (.024)*	-17.402 (1.837)***		.268 (.034)***
(ln) Education and General Expenditure	1.412 (.080)***	.180 (.071)**		-5.639 (2.451)**	.580 (.030)***	
(ln) State Appropriations per FTE	-.862 (.014)***	-.564 (.085)***	.099 (.013)***	4.182 (.443)***	-.002 (.008)	.041 (.009)***
(ln) Total UG Need based state aid per FTE	.043 (.010)***	-.005 (.006)	.012 (.003)**	-1.679 (.298)***	.000 (.004)	.034 (.004)***
(ln) Total UG non-need-based state aid per FTE	.020 (.005)***	.003 (.002)	-.005 (.002)**	.032 (.141)	.002 (.002)	-.008 (.002)***
State unemployment rate	-.030 (.009)**	-.033 (.004)***	.017 (.003)***	2.386 (.273)***	-.004 (.006)	-.014 (.005)**
Admissions rate	-.001 (.001)*			-.150 (.020)***		
Student-Faculty Ratio			.102 (.005)***			.109 (.005)***
(ln) Faculty Salary			.961 (.035)***			.943 (.034)***

Tuition setting authority (Ref: Institution)						
State		-.279 (.015)***			-.252 (.010)***	
System		.044 (.029)			-.076 (.009)***	
Tuition Reliance		.028 (.003)***			.008 (.001)***	
Constant	1.024 (.623)	1.614 (.280)***	-2.331 (.275)***	241.759 (19.279)***	3.177 (.305)***	-4.451 (.451)***
Observations		3,771 (282)			3,707 (278)	
R ²	.638***	.679***	.382***	.317***	.308***	.647***

Note. Year-fixed effects included. ***p<0.01, **p<.05. *p<.01