Performance-Based Funding:

An In-Depth Policy Analysis

by

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DEDICATION

This dissertation is dedicated to my parents, Rick and Susan Burns, and to the love of my life, Darwin Oster.

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ABSTRACT

This dissertation examines performance-based funding policies in higher education. Performance-based funding policies allocate state funding via student outcomes instead of by student enrollments. The first paper in this dissertation provides an in-depth analysis of Ohio's performance-based funding policy for two-year institutions. Then, the second paper empirically evaluates the effect of Ohio's performance-based funding on associate degree and certificate production using a difference-in-differences with propensity score matching technique. The third and final paper investigates the effect of performance-based funding policies across the nation on the level of faculty staff at four-year and two-year institutions.

CHAPTER 1

Introduction

Recently, postsecondary education constituents (e.g., parents, students, policymakers) have made calls for increased accountability as the cost of a postsecondary education has increased, student outcomes have stagnated, and state support has declined (Deming & Figlio, 2016). One policy that state lawmakers utilize to attempt to increase state accountability is performance-based funding (PBF). Broadly described, PBF policies tie a portion or all of state postsecondary education public funds for a public institution to the outcomes of students at that institution – with the purported goal of incentivizing colleges and universities to improve outcomes such as graduation or credit completion (Rutherford, & Rabosky, 2014). This broad definition of PBF policies masks important variation in the design of policies across states. For example, some states subject only "bonus" funding to student outcomes, while other states condition all appropriations on such metrics. Policies also vary on coverage by sector (two-year, four-year, or both), amount of funding determined by student success (ranging from <1% to 100%), and the specific student success metrics incentivized (Dougherty & Natow, 2015).

Performance-based funding policies represent one of the few high-stakes forms of accountability in postsecondary education and have been implemented across many states since Tennessee pioneered a PBF policy in 1979 (Dougherty & Reddy, 2013). Given the stakes and prevalence of PBF policies, researchers have sought to understand whether these policies actually achieve their stated goals of improving student outcomes. Results from prior studies on

the effects of such policies on student outcomes are generally mixed, with some researchers finding null (e.g., Tandberg et al., 2014), negative (Rutherford & Rabosky, 2014), and positive effects (e.g., Hillman et al., 2015). Further, results have varied significantly by state (Tandberg et al., 2014), likely connected to the diverse state contexts and policy differences. While prior research has explored whether or not PBF policies increase student outcomes (e.g., degree production, retention rates), researchers and scholars have not described PBF policies in depth, examined institutional differences within a state to understand if institutions respond differently to the same policy, or examined intermediate outcomes (e.g., staff and faculty changes that potentially precede increases in student outcomes).

To fill these gaps in the literature, I completed the following three paper dissertation that: 1) provides an in-depth analysis of a PBF policy in Ohio, a state that is known as a leader in this policy area; 2) investigates student outcomes of Ohio's PBF policy and examine if subgroups of institutions experience different student outcomes, and 3) examine whether PBF policies have an effect on intermediate (e.g., faculty and staffing changes) outcomes across the country to further understand the effects of policy. Table 1-1 summarizes each paper in the dissertation.

Table 1-1: Summary of Research Questions, Theoretical Frameworks, Methods, and Outcomes

Paper	Research Question	Conceptual Framework	Method	Outcome
1	In Ohio, how does performance-based funding allocate funding to two-year institutions? Which institutions have increased funding and lost funding as a result of PBF?	N/A	Descriptive	Funding allocations; identify institutions that experienced large increases and declines
2	In Ohio, does the effect of PBF policies on student outcomes vary by subgroups	Principal-agent theory; resource dependency theory	Difference-in-differences; propensity score matching; descriptive	Degrees awarded over time
3	Nationally, do PBF policies change the allocation of faculty and staff?	Principal-agent theory; systems theory; education production function	Difference-in-differences; propensity score matching	Change in staffing/faculty levels/amounts over time

Paper 1: What's in a Policy? A Case Study of Ohio's Performance-Based Funding Policy for Two-Year Institutions

The majority of prior research on PBF has focused on the diffusion of the policy (e.g., Li, 2017) or the effect of the policy on student outcomes (e.g., Hillman et al., 2015). Much less research has investigated how a specific PBF policy allocates funding in practice and how state funding to institutions changes as a result of the policy. Some policy researchers have broadly investigated all PBF policies to categorize them and create rubrics for future policies (e.g., Snyder & Boelscher, 2015); but there is no current empirical research on the details of PBF policies.

Therefore, to fill this gap in the literature, I use publicly available data from Ohio to thoroughly describe their higher education funding formulas for two-year institutions and whether, and if so, how they have changed over time. Then, using their funding formula data, I examine how two-year institutional funding has changed over time as a result of the PBF policy.

Finally, in this paper, policy simulations are conducted to understand how two-year institutions would have fared under alternative policy specifications.

Overall, Ohio slowly phased in their PBF policy from FY 2011 through FY 2015. Prior to FY 2011, 100% of state higher education funding for two-year institutions was allocated via student enrollments. After FY 2010, Ohio started to slowly change the funding formula from allocating via student enrollments to funding determined by student outcomes. Within Ohio, specific institutions experienced substantial increases in their funding after the PBF policy was implemented, whereas others experienced minor reductions in state funding. In general, the policy simulations reveal that regardless of how the PBF policy was implemented, all institutions would have experienced about the same change in state funding.

Paper 2: What is Good for the Goose is Good for the Gander: Does Ohio's Performance-Based Funding Policy have Differential Effects on Institutions?

As illustrated in the first paper, two-year institutions in Ohio faired differential under the PBF policy regime. Some institutions were able to capture more institutional funding (e.g., Eastern Gateway Community College, Clark State Community College) while other institutions experienced declines in funding (e.g., Belmont Tech Community College, Hocking Community College). Prior research has not investigated whether changes in funding from a PBF policy has been related to increases in student outcomes.

Therefore, I analyze the effect of Ohio's policy on student success outcomes relative to other institutions across the country and then descriptively examine whether some institutions experienced gains after PBF implementation. For this analysis, institutional characteristics and student outcomes (associate degrees and certificates) were obtained from the Integrated Postsecondary Education Data System from 2004 to 2017. Performance-based funding

information was collected from a variety of sources (see Chapter 3 for details). A generalized difference-in-difference approach with propensity score matching is used to estimate the effect of Ohio's PBF policy on certificate and associate degree production. For the analysis, five difference-in-difference models are specified, and sensitivity tests of the propensity score matching technique are conducted.

According to this analysis, Ohio institutions experienced a reduction in associate degree production after PBF was implemented. Overall, certificate degree production was not significantly affected by the PBF policy. From the descriptive analysis of the subgroups, institutions that experienced large increases did not dramatically increase associate degree or certificate production beyond what would be expected from their prior trend. Institutions that experienced small gains in funding or decreases in funding may have experienced a decline in associate degree and certificate production after PBF was implemented in Ohio.

Paper 3: Whose Performance? Staffing Changes in Response to Performance-Based Funding

Performance-based funding policies were developed to increase student success outcomes. While researchers have focused on the long-range effects of PBF policies by investigating the effect of the policy on student outcomes, there has been less of a concern about how postsecondary institutions make adjustments organizationally to respond to the policies. Researchers have investigated how enrollments (e.g., Kelchen, 2018) and expenditures (e.g., Kelchen & Stedrak, 2016) changed as a result of PBF. However, there has not been an investigation into how staffing and personnel has changed because of PBF policies. Therefore, the third paper of my dissertation examines the effect of PBF policies on staffing levels and salaries at two- and four-year institutions.

For this analysis, institutional characteristics and human resource records from all Title IV institutions are gathered from IPEDS data. The dependent variables are the percent of full- and part-time faculty, full- and part-time professionals, and full-time faculty salaries. Generalized difference-in-difference with propensity score matching approach is used to estimate the average effect of PBF policies on staffing changes. An event study specification is utilized to understand year specific effects of the policy. Additionally, given that there are five dependent variables and several models specified, a Bonferroni correction is applied when necessary.

Overall, four-year and two-year institutions are not adjusting the composition of personnel or full-time faculty salaries after PBF is implemented. These findings suggest that two- and four-year institutions may already be operating efficiently before PBF policies are implemented, and therefore, they cannot make changes at this particular margin to improve student outcomes.

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CHAPTER 2

What's in a Policy? A Case Study of Ohio's Performance-Based Funding Policy for Two-Year Institutions

Performance-based funding (PBF) policies are prevalent in higher education and are used by most states to allocate a portion or all of state higher education institutional funding to public postsecondary institutions (Boelscher & Snyder, 2019). Typically, PBF policies allocate base or bonus state funding via student success outcomes (e.g., retention, graduation, course completion). PBF policies started in 1979 in Tennessee, diffused across the country in the 1990s, plateaued and declined in number slightly in the early 2000s, increased in the late 2000s, experienced another short decline in the early 2010s, and have been increasing in number ever since (Boelscher & Snyder, 2019; Burke & Associates, 2002; Dougherty & Natow, 2015). Currently, there are 32 states implementing or developing PBF policies to allocate state funding (Boelscher & Snyder, 2019).

Given that most states utilize PBF policies, higher education stakeholders, policymakers, and researchers need a detailed understanding of how these policies work, how much money is at stake, and how institutions respond. To that end, HCM Strategists provide a typology of PBF policies for four- and two-year institutions. In their typology, Type IV policies are considered the most advanced and should result in the most dramatic increases in student success outcomes. Of all the states that have PBF policies for two-year institutions, only policies in Arkansas, Kentucky, Louisiana, Nevada, Ohio, Tennessee, and Wisconsin are labeled as Type IV by HCM

Strategists (Boelscher & Snyder, 2019). Because HCM Strategists label these policies from these five states as the most robust in the country, it is possible that other states will look to these states to model their future PBF policies. Additionally, higher education researchers consider two of these policies "exemplars," Tennessee and Ohio (Hillman, Fryar, & Crespín, 2018, p. 2). Therefore, it is critical that these particular PBF policies are understood and effectively evaluated to determine if they have the desired effects on student outcomes.

Therefore, in this paper I conduct an analysis of Ohio's PBF policy for two-year institutions. Ohio's PBF policy is an excellent case study for three reasons. One, the policy is rated as an exemplar policy by an outside source that does extensive research on PBF policies (i.e., HCM Strategists) and researchers (Hillman et al., 2018). Two, Ohio publicly publishes their yearly budgets for two-year institutions with the underlying micro data that is used for the funding calculations. Therefore, I can analyze the exact dollar amounts each institution received and how the metrics results in that funding. Three, empirical research has investigated Ohio's PBF policy and suggests that the policy positively affects certificate completion but decreases associate degree production (Hillman, et al., 2018). Therefore, this policy might have unintended consequences even though it is considered a particularly strong policy. A more thorough understanding of the policy is, therefore, warranted. Specifically, this paper is guided by the following research questions:

1. What is Ohio's policy in detail and how does it differ from the previous funding formula for two-year institutions?
2. After PBF was implemented, which two-year institutions experienced large increases and decreases in funding and how did those changes occur?

3. How would have institutional funding been affected if the PBF policy had been implemented differently?

For several reasons, in this paper I focus exclusively on two-year institutions in Ohio, leaving an analysis for four-year institutions in Ohio for future research. First, two- and four-year institutions are fundamentally different, and therefore, should be treated differently in this type of analysis. Simply doing the exact same analysis for both sectors of higher education may understate important funding differences between the sectors. Two-year institutions serve student populations that are dissimilar to students who typically attend four-year institutions, have different funding sources (e.g., local funding), have different governance structures (e.g., local governing boards), and have different curricular missions than four-year institutions. Second, most but not all of the prior PBF research has focused on either two- and four-year institutions in their analyses (e.g., Rutherford & Rabovsky, 2014; Tandberg, Hillman, & Barakat, 2014), owing to the fact that these two institutions are fundamentally different and should be examined on their own. Therefore, there is precedence to center a single institution type and focus solely on two-year institutions. Finally, I focus specifically on two- instead of four-year institutions because the former enroll a substantial proportion of students who have been previously underserved by postsecondary education (American Association of Community Colleges, 2020). By focusing on two-year institutions, I bring to the foreground how PBF policies are potentially affecting the most vulnerable students in postsecondary education.

This paper proceeds as follows: first, I provide background on two-year institutional funding. Then, I discuss the current state of PBF for two-year institutions. Next, I detail why I chose Ohio as a case study for this analysis. Then, I describe the data and methods I use for this study. Next, I explain my results, which include an in-depth discussion of Ohio's PBF policy, the

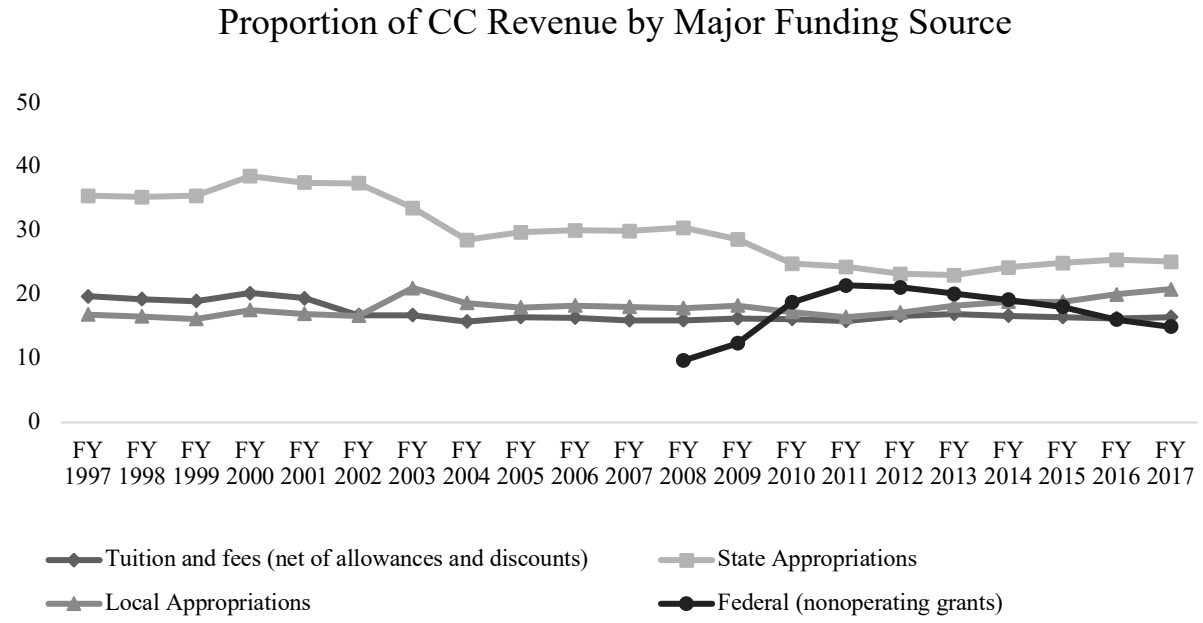
institutions that experienced large increases and decreases after PBF was implemented, and policy simulations. Finally, I end with policy and practice implications, and ideas for future research.

Background

Overview of Two-Year Institution Funding

Two-year postsecondary education institutions are funded from four main sources: tuition and fees (net of allowances and discounts), state appropriations, local appropriations, and federal nonoperating grants (Breneman & Nelson, 1981; Garms, 1977). Figure 2-1 displays funding for community colleges over time. State appropriations make up the largest share of community college funding across the country, with federal, local funds, and tuition and fees providing smaller but similar proportions (about 20% each). The federal government provides a significant amount of funding to public institutions through the federal financial aid program by way of grants (e.g., Pell) which students do not pay back and federal student loans (e.g., Stafford loans). In the past, the federal government has provided public institutions with stimulus money in times of economic crisis when other funding sources declined (Nelson, 2009). While the federal government also provides research funds to postsecondary institutions through faculty applications, two-year institutions rarely receive this type of funding because faculty focus heavily on teaching (Fugate & Amey, 2000).

Figure 2-1. Proportion of Community College Revenue Over Time by Major Funding Source: FY 1958 through FY 2017



Note: See reference list for full citations of National Center for Education Statistic Reports.
Definitions (directly quoted from survey instructions, National Center for Educational Statistics, n.d.):
Tuition & fees (net of allowances and discounts): Report all tuition & fees (including student activity fees) revenue received from students for education purposes. Include revenues for tuition and fees net of discounts & allowances from institutional and governmental scholarships, waivers, etc. (report gross revenues minus discounts and allowances). Include here those tuition and fees that are remitted to the state as an offset to state appropriations. (Charges for room, board, and other services rendered by auxiliary enterprises are not reported here; see line 05.)
Local appropriations, education district taxes & similar support: Report all amounts received from property or other taxes assessed directly by or for an institution below the state level. Include any other similar general support provided to the institution from governments below the state level, including local
State appropriations: Report all amounts received by the institution through acts of a state legislative body, except grants and contracts and amounts reportable on line 20. Funds reported in this category are for meeting current operating expenses, not for specific projects or programs. Do not include any ARRA revenues on this line (see line 19 in this part).
Federal nonoperating grants: Report all amounts reported as nonoperating revenues from federal governmental agencies that are provided on a nonexchange basis. Include Pell Grants and other Federal student grant aid here. Do not include revenues from the Federal Direct Student Loan (FDSL) Program, Federal Work-Study or federal veteran education benefits. These amounts should be captured as tuition and fees and/or sales and services of auxiliary enterprise revenue upon receipt from the student. Do not include capital grants & gifts reported on line 21. Do not include any ARRA revenues on this line (see line 19 in this part).

State governments provide a substantial amount of funding to public postsecondary education institutions by way of general funds, state share of instruction, and state scholarships that go directly to funding student tuition (e.g., Georgia Hope Scholarship, Tennessee Promise). However, states vary tremendously in how much they fund public education and what

mechanisms they use to fund institutions (Garms, 1977). Additionally, local tax dollars can be allocated to public institutions. Usually, two-year public institutions receive a substantial proportion of their funding from the local district because they typically serve local students.

Finally, many students and families contribute to postsecondary education funding. Many students and/or families pay a large share of their tuition, room, and board. Over time, the federal government has shifted its postsecondary education funding priorities from grants, which do not have to be paid back, to loans, which students are obligated to pay back plus interest. Additionally, states have also divested from postsecondary education over time, especially during the Great Recession. While state funding has increased in recent years, it is still below pre-Great Recession levels (State Higher Education Executive Officers Association, 2020).

Although how the federal government, local governments, and students fund postsecondary education is important, this paper focuses specifically on one particular aspect of state funding to postsecondary education, state appropriations. Previously, states funded "inputs," meaning that they reimbursed institutions when students enrolled at the institution. When states use enrollments to fund postsecondary institutions, specific programs and courses are reimbursed at different rates because it costs varying amounts to conduct these courses (Stange, 2015). For example, it is less expensive to educate a student in an English course than it is a chemistry course because the chemistry course likely has a lab component and needs specialized equipment. Furthermore, lower division courses (i.e., larger, introductory courses) are typically less expensive than upper division (i.e., smaller, specialized courses for specific majors), as well as undergraduate courses being inexpensive relative to graduate courses.

A Shift from Enrollments to Student Outcomes

More recently, states have shifted from funding enrollments (i.e., inputs) to funding student outcomes (i.e., outputs). By funding student outcomes, such as course completions, credit accumulation, and degree completion, state legislatures intend to incentivize institutions to focus more on student success than student access. In other words, state lawmakers hope that postsecondary education administrators and faculty prioritize student success and degree completion over simply enrolling more students at the institution without regard to how successful those students are. One could think of these two funding models (enrollment vs. student outcomes funding formulas) as funding either side of an education production function. Education production functions have inputs (e.g., students, institutional resources), and outputs (e.g., faculty research, student outcomes, Titus & Eagan, 2016). Previously, states focused on funding the input side of the education production function. Now, states are shifting to funding the output side of this equation, so institutions are rewarded on how well they produce outputs, not how successfully they recruit inputs. Because institutions are now funded on their "performance," these policies have been named "performance-based funding" (PBF) policies.

Current State of Performance-Based Funding for Two-Year Institutions

Performance-based funding policies have evolved over time and have diffused throughout the country for a variety of reasons. For two-year institutions specifically, PBF policies incentivize institutions to improve student success, a deviation from previous motivations to promote access through increased enrollments at two-year institutions. While PBF policies intend to redirect institutional focus to student outcomes, it is possible for these policies to have adverse effects. For example, Hillman et al. (2015) found that two-year institutions in Washington state did not increase associate degree production but increased short-term

certificates, possibly gaming the funding formula. Institutions may also change their enrollment strategies once subject to PBF in order to manipulate the funding formula. Kelchen and Stedrak (2016) found that institutions under PBF policies decreased Pell grant revenue after the policy was implemented, suggesting that institutions enrolled fewer low-income students and increased the number of higher-income students, who are more likely to be retained and graduate.

Given that PBF policies shift two-year institutions to focus on outcomes instead of access, two-year institutions serve a substantial proportion of undergraduate students, and PBF policies aim to increase accountability but could result in unfavorable effects, it is important to consider how PBF policies are different across the country and why Ohio is used as a case study of this analysis. Boelscher & Snyder (2019) provide a detailed summary of current PBF policies for two and four-year institutions. Specifically, they utilize a typology they developed over time to categorize PBF policies. They consider the following criteria in their typology (Boelscher & Snyder, 2019, page 2):

1. Established completion or attainment goals are linked to the model;
2. Recurring base funding is distributed;
3. A significant level of funding is distributed;
4. Degree/credential completion is prioritized;
5. Institution mission is reflected though varying weights, scales or metrics;
6. The funding structure is formula-driven to ensure incentives for continuous improvement;
7. Success of underrepresented students is prioritized; and
8. Funding is sustained over consecutive years.

Using this criteria, Boelscher & Snyder (2019) classify PBF policies across the country for both four- and two-year institutions from I (1) to IV (4) (see Table 2-1 that details the typology).

Table 2-1. HCM Strategists PBF Typology

Type	State/sector Completion/ Attainment Goals	Funding Source	Funding Level	Institutional Mission	Degree Metric	Premiums	Policy Type	Policy Sustainment
I	Maybe	New funding only	< 5%	No	No	No	Target/recapture likely	< 2 years
II	Maybe	Base funding	< 5%	No	Yes	Maybe	Target/recapture likely	< 2 years
III	Yes	Base funding	5-24.9%	Yes	Yes	Yes	May not be formula-driven	< 2 years
IV	Yes	Base funding	>25%	Yes	Yes	Yes	Formula-driven	2+years

Future research should use this well documented typology to further investigate PBF policies. For example, a researcher could use a multinomial logit to determine if the criteria developed actually distinguishes between the PBF policy types. Also, future research should explore whether these policy variations documented by Boelscher and Snyder (2019) lead to differential effects of PBF on student outcomes. For this study, I focus on a PBF policy that is classified as Type IV because it is rated an advanced policy and, in theory, should result in the most dramatic increases in student success outcomes relative to other PBF policies. Higher education PBF researchers also consider Ohio's PBF policy to be particularly strong (Hillman et al., 2017).

Specifically, Type IV policies include state completion goals, allocation of base funding, a significant amount of funding allocated via performance (above 25%), institutional differentiation, a completion metric, prioritization of marginalized students and continuous improvement, and the policy has been in place for longer than two years. Of all the states that have PBF policies for two-year institutions, policies in Arkansas, Louisiana, Kentucky, Nevada, Ohio, Tennessee, and Wisconsin have been categorized as Type IV.

While prior research on PBF policies examines institutional responses (e.g., Kelchen & Stedrak, 2016) and student outcomes (e.g., Sanford & Hunter, 2011), there are no descriptive analyses and simulations of how PBF policies actually allocate funding to institutions. Even with the growth in PBF policies across the country and this typology, little is still known about how the policies actually affect institutional revenues. For example, how has institutional state funding changed as a result of PBF policies? Which institutions have lost or gained state funding because of PBF? How have the student success outcomes changed over time at institutions that have experienced large increases and decreases? Additionally, we do not know how institutions

would have been impacted if states had implemented the policy in a different way. For example, what if a state had allocated funding using a different formula? A thorough and systematic analysis of how money is allocated via PBF policies is necessary to know more about these policies than just simply describing the policy itself. Therefore, I undertook some of these analyses in this study. I utilize publicly available data from the Ohio state government website that details how funding is allocated to each individual two-year institution and the student success outcomes data that make up the PBF formula to analyze the policy in-depth. Specifically, I attempt to answer the following research questions as outlined above:

1. What is Ohio's policy in detail and how does it differ from the previous funding formula for two-year institutions?
2. After PBF was implemented, which two-year institutions experienced large increases and decreases in funding and how did those changes occur?
3. How would have institutional funding been affected if the PBF policy had been implemented differently?

Data and Methods

Data

For this analysis, I use publicly available data from the state of Ohio. Each year, Ohio publishes documents that detail the funding formula guidelines and the funding formulas. First, the state publishes the "State Share of Instruction Handbook" (SSI Handbook) which details how state funding is determined for higher education institutions (Ohio Department of Education, n.d.). This document is provided online from 2006 through 2020 and describes the funding formula in two-year cycles. State administrators in Ohio produce an SSI Handbook for University Main Campuses, University Regional Campuses, and Community and Technical

Colleges. For this analysis, I use the handbooks for the Community and Technical Colleges to understand the funding formula. The SSI Handbook describes the funding formulas that are put into action in the "State Share of Instruction" (SSI formulas) Excel workbooks that contain the student success metric data and funding formulas that determine how much funding each community college in Ohio receives.

Specifically, the Excel workbooks calculate the funding for each institution using the formula that is detailed in the SSI Handbook (Ohio Department of Education, n.d.). The Excel workbook contains the overall funding amount that has been allocated to two-year institutions, how much each institution will receive that year, how much they received the previous year, and the funding difference between the two years. Additionally, the Excel workbooks include how much funding each institution receives from each factor of the funding formula. The workbooks detail how much funding each institution receives from course completions, student success points, and degree completions, depending on the specific formula for that year. In addition to detailing the formula and funding amount that institutions receive, the workbooks include the underlying micro-data that are used in the formula. For example, the SSI formula workbooks provide the number of course completions for each institution that were completed at each subject level and how many graduates were produced in each program each year. Ohio started publishing the funding formulas with the underlying data in 2006. Therefore, I have funding data from the state of Ohio from 2006 through 2020. It is important to note that I have the underlying data for the funding formula that was in place for each specific year. For years prior to 2011, Ohio published enrollment data because SSI funding was determined by enrollment. In years 2011 through 2014, Ohio published both enrollment and student success data because SSI funding was determined partially by enrollment and partially by student outcomes. From 2015

and forward, Ohio published student outcome data because SSI funding was determined 100% by student outcomes.

Methods

For this descriptive analysis, I use information from the SSI Handbooks to detail the evolution of Ohio's funding formula from 2006 through 2020. To detail the evolution of the funding documents, I created summary documents of each SSI Handbooks and compare the funding formula over time to examine how it has changed.

Once I had an understanding of how the formulas were codified in policy, I use the data from the SSI formula Excel workbooks to examine how SSI funding for two-year institutions has changed and what specific elements of the policies have contributed to these changes over time. Given that Ohio's SSI funding is determined completely by the formulas that I examine, I am able to link specific student outcome data with changes in SSI funding. I expect to find that institutions that experience drastic increases and decreases in student outcomes would experience large changes in funding. Therefore, I identify two-year institutions that have increased and decreased funding over time as illustrated in the SSI formulas. To do this, I examine each institution's state share of instruction funding over time and identify institutions that have gained and lost a substantial percentage of funding between the fiscal year (FY) when state funding changed to 100% determined by PBF formulas and FY 2020, the most recent year of data. I categorize institutions based on how much funding they have gained or lost and conduct a deep dive into their institutional characteristics, state funding amounts, and microlevel data to understand how their funding and outcomes changed after PBF was implemented.

After determining which institutions have lost and gained funding under the PBF policies and describe how these gains and losses resulted from the PBF policy, I conduct simulations to

test what would have happened to SSI funding if the PBF policy had been implemented differently after 2015. For the simulations, I focus on the institutions that have increased and decreased funding substantially to examine how they would have financially fared if the PBF policy had varied. Specifically, I examine how funding would have changed if the funding formula had been 100% determined by enrollments, 100% determined by course completions, 100% determined by student success, 100% determined by degree completions, had evenly weighted all student success outcomes at 33%, if there had been no premiums for access student groups, and if there had been no cost differentials for course and degree completions.

Results

Ohio's Performance-Based Funding Policy

Using the SSI Handbooks, I found that Ohio's funding formula changed drastically in FY 2011. Prior to FY 2011, two-year institutions in Ohio were funded using the number of full-time equivalent students enrolled at the institution and by a small PBF policy that distributed bonus funding. In other words, institutions were funded on their inputs (i.e., enrollments) and received some bonus money from specific "challenges" implemented by the state legislature. Challenges included an "Access Challenge," a "Jobs Challenge," a "School Success Challenge," and a "Technology Challenge." The Access Challenge provided additional money to institutions for enrollment in order to lower student fees. The Jobs Challenge gave institutions more money for non-credit job-related training programs. School Success Challenge provided additional funds for clear alignment between K-12 curriculum and two-year institutions. The Technology Challenge awarded funding if institutions invested in technology. These challenges were in place from FY 1995 through FY 2009.

In FY 2009 and FY 2010, two-year institutions were funded solely on enrollments. From FY 2011 and forward, Ohio state legislatures slowly phased in a PBF policy for two-year institutions through FY 2014. In FY 2011, 95% of funding was determined by enrollments while 5% was determined by student outcomes. In FY 2012, the funding formula increased to 7.5% determined by student outcomes and 92.5% determined by FTE enrollments. In FY 2013, the percent determined by student success metrics increased to 10%. In FY 2014, there was a substantial shift of the formula such that 50% was determined by enrollments, 25% was determined by course completions, and 25% was allocated via other student success outcomes, called student success points. In FY 2015, SSI was 100% determined by student outcomes, with 50% allocated via course completion, 25% by student success points, and 25% by completions. Table 2-2 below summarizes the policy over time. From FY 2011 through FY 2014, there was a stop loss provision in the PBF policy. Given that Ohio included this stop-loss provision and ultimately protecting institutions from experiencing drastic changes in SSI funding because of student outcomes, it is impossible to include these years in this financial analysis.

Table 2-2. Ohio's State Share of Instruction: General Formula

Year	Enrollment (FTES)	Course Completion	PBF 2.0 Student Success Points	Degree Completion	Stop-Loss
Prior to 2011	100%				
2011	95%		5%		98%
2012	92.5%		7.5%		88%
2013	90%		10%		96%
2014	50%	25%	25%		97%
2015 and forward		50%	25%	25%	

FY 2015 and Forward Policy Specifics

From FY 2015 and forward, Ohio has allocated 100% of SSI funding using student success outcomes without a stop-loss provision in place. Ohio provided "premiums" for specific students who complete particular student success outcomes. The following details the general

formula and how institutional funding is calculated, describes each student success metric and how funding is calculated from that metric, and explains how Ohio included student premiums within the formula.

General Funding Formula

First, the state government determines how much overall funding is allocated to two-year institutions in each budget cycle. Then, institutional funding is allocated in proportion to the percentage that the institution contributes to that particular metric. For example, 50% of SSI funding is determined by course completions. In FY 2020, the total amount of SSI funding allocated via the state budget was $465,426,250. Therefore, $232,713,125 (50%) was determined by course completion. If Institution A contributed 5% of the total course completions, Institution A received $11,635,656 for course completions. This basic formula is followed for each funding metric although cost differentials are accounted for in the course completion and degree completion calculations.

To be sure, there is a substantial amount of uncertainty in this formula from year-to-year because it is a fixed amount of SSI funding that institutions are competing for. For example, if Institution B increases course completions drastically one year and all other institutions maintain their course completions, funding from course completions would decrease for all other institutions except for Institution B. In this scenario, Institution B is able to capture additional funding from other institutions because the other institutions simply did not keep up with Institution B. Therefore, institutions cannot accurately predict their year-to-year SSI funding because they did not have perfect information about student outcomes at other institutions. Because of this uncertainty, two-year institutions in Ohio may change their funding strategies such that they rely more on stable and predictable sources of revenue (e.g., tuition and fees, local

taxes). While some is some uncertainty in the formula, policymakers attempted to decrease uncertainty by publishing the funding formulas and total amounts in two-year increments and using three-year rolling averages to account for large changes in student outcomes.

Course Completions

In Ohio, 50% of the SSI is based on course completions. Specifically, it is the number of completed full-time equivalent students (FTE) at the institution on a three-year rolling average from the previous three years. Three-year rolling averages are used to smooth out funding allocations. It is cost based, meaning that course completions are reimbursed at different rates depending on how much it costs to "educate" that particular FTE. Additionally, this metric also includes student premiums (discussed below).

Student Success Points

For the fully implemented PBF policy in FY 2015 and forward, 25% of funding is allocated by student success points. A success point is awarded for each student that completes 12, 24, and 25 semester credit hours. For the semester credit hours, a student can earn up to 3 student success points for the institution. Additionally, an institution is awarded a success point if a student enrolls in developmental math or English and then enrolls in a college-level math or English course anywhere in the system. To be specific, the institution that enrolled the student in a developmental course receives the success point for their college level course. Student success points are a three-year rolling average for the institution. There are no student premiums for this metric.

Completions

For FY 2015 and forward, 25% of SSI funding in Ohio is determined by degree completions. Associate degrees and long-term certificates (greater than 30 semester credit hours)

are included in degree completions as well as completed transfers. To be considered a transfer student, the student must earn at least 12 credit hours at the two-year institution. High school students can be included in this metric. For example, dual enrolled students who earn 12 credits for high school and college and then attend a four-year institution would be considered a transfer student for the two-year institution. Both in-state and out-of-state transfers are included in this metric, tracked via National Student Clearinghouse. Similar to course completions, degree completions are reimbursed at a certain cost depending on the students' major. Certificates are reimbursed at 50% of the cost of an associate degree in the same major. All transfers are reimbursed at 25% of the average associate degree cost for that year.

Student Premiums

For FY 2015 and forward, institutions received additional funding when specific students completed courses and degrees (including transfers). Adult students, low-income, underrepresented minorities, and academically underprepared students (starting in FY 2016). Adult students are students who begin at the institution when they are over the age of 25. Low-income students are identified as those students who receive Pell Grants. Underrepresented students are African Americans, American Indians, or Hispanics students. Academically underprepared students are students who enroll in development math or English in the first eight years of college.

Now that I have described the PBF policy in detail, I turn to describing SSI funding received by institutions from FY 2015 to FY 2020. I limit my analysis for this section to FY 2015 to FY 2020 because the funding formula was stable during this period and there was no stop-loss included. All information included in this section is in nominal dollars to ensure that this analysis can be replicated by others in the future and so the analysis can be confirmed with

the publicly available data. First, I detail how much funding was allocated by each metric over time. Then, funding over time for individual institutions, focusing on seven institutions that experienced large increases and decreases in their funding from FY 2015 to FY 2020, is examined. Then, I breakdown both the metric and funding change from FY 2015 and FY 2020 for each of these institutions to explain how their funding changed during this time period. Finally, I describe the policy simulations I implemented and the results for each of the institutions of interest.

PBF Funding Allocations from FY 2015 through FY 2020 by Metric

Table 2-3 displays the dollar amounts allocated for each metric in FY 2015 and FY 2020, the dollar amount change from FY 2015 to FY 2020, and the percent change from FY 2015 to FY 2020. From FY 2015 to FY 2020, SSI funding in Ohio for two-year institutions increased by 11%, however funding within each metric did not systematically increase by that much. Course completions and success points each increased by 11%, whereas course completions for access students increased by 15%. Interestingly, funding within the degrees portion of the funding model experienced increases and decreases in allocations. Because associate degrees, certificates, and transfer metrics share 25% of the funding, these metrics are essentially "fighting" for funding from a pre-determined "slice of the pie." Therefore, as specific completion metrics and subsequently allocations increase, allocations in other areas associated with the completion metrics decrease to keep the funding allocation within 25% of total funding. Therefore, the amount of funding determined by total associate degrees (transfers) decreased by 1% (15%). However, allocations for total certificates (access certificates) increased by 218% (339%) and access associate degrees (access transfers) increased by 40% (17%). It is important to note that the percentage increase for certificates is noticeably larger than other metrics because

the initial funding in FY 2015 was small relative to the other metrics. For example, in FY 2015, $687,818 was allocated via certificates whereas $57 million was allocated via associate degrees. Overall, these findings illustrate that even though Ohio increased funding to two-year institutions by 11% during this time period, the increased funding was not shared evenly across metrics.

Table 2-3. Change in Metric Funding from FY 2015 to FY 2020

Metric	Share of Funding	FY 2015	FY 2020	$ Change	% Change
Course Completions	50%	190,123,842	210,283,328	20,159,486	11%
Course Completions – Access		19,426,872	22,429,797	3,002,925	15%
Success Points	25%	104,775,357	116,356,563	11,581,206	11%
Associate Degrees	25%	56,967,916	56,544,841	-423,075	-1%
Associate Degrees – Access		19,209,767	26,918,996	7,709,229	40%
Certificates		1,766,715	5,612,735	3,846,020	218%
Certificates Access		687,818	3,016,462	2,328,644	339%
Transfer		19,963,132	17,006,394	-2,956,738	-15%
Transfer Access		6,180,010	7,257,134	1,077,124	17%
Total		**419,101,428**	**465,426,250**	**46,324,822**	**11%**

Funding Changes Over Time

Using a criterion of at least a 25% increase in SSI funding from FY 2015 to FY 2020 and at least a 5% decrease in SSI funding from FY 2015 to FY 2020, I found seven institutions that experienced dramatic changes to their funding once PBF was fully implemented (see Table 2-4). I use these cutoffs because there was a natural break in the funding changes (see Appendix A for the percentage change in SSI funding for all two-year institutions in Ohio). For example, the next largest decrease from the institution not included in the analysis was -1% for Central Ohio. The next largest increase was five percentage points smaller than the smallest increase of the institutions included the analysis (North Central and Sinclair, each at 20% increases). From FY 2015 to FY 2020, Belmont Tech (-14%), Hocking (-11%), Owens State (-9%), and Zane State (-

8%) all experienced decreases whereas Lorain County (25%), Clark State (36%), and Eastern Gateway (97%) experienced substantial increases to their funding.

Table 2-4. SSI Funding for Two-Year Institutions: FY 2015 through FY 2020

Institution	2015	2016	2017	2018	2019	2020	% change
Belmont Tech	5,129,052	5,036,546	4,850,869	4,496,526	4,520,720	4,418,369	-14%
Hocking	13,302,962	13,339,250	12,485,949	12,604,051	12,225,264	11,834,514	-11%
Owens State	30,562,911	31,639,377	32,605,962	30,082,339	28,935,666	27,786,163	-9%
Zane State	8,307,840	8,888,756	8,370,777	8,395,643	8,056,479	7,665,740	-8%
Lorain County	24,541,622	26,580,544	25,455,636	29,140,026	29,569,294	30,678,558	25%
Clark State	11,154,767	11,987,351	13,259,670	13,804,624	14,631,745	15,165,207	36%
Eastern Gateway	5,766,060	6,412,549	6,995,974	8,744,983	9,519,799	11,373,448	97%

In addition to examining how their funding changes, it is also important to consider how institutional characteristics changed during this time period that might account for some changes in funding. Table 2-5 depicts the percent change in institutions characteristics from 2015-2016 to 2018-2019, sourced from the Integrated Postsecondary Education Data System. Institutions that experienced decreases in funding (Belmont Tech, Hocking, Owens State, and Zane State) also had decreases in the number of associate degrees produced and enrollments (both headcount and FTES). All institutions examined experienced increases in short-term certificates (at least one year but less than four years to complete the certificate) with Belmont Tech experiencing the largest increase at 150%. All institutions increased their in-district price except for Zane State, which dropped the price by 9%. The institutions that experienced gains in funding highlighted in this analysis (Lorain County, Clark State, and Eastern Gateway) increased the number of associate degrees produced. In fact, Eastern Gateway experienced a 187% increase in associate degree produced.

Eastern Gateway is the only institution to increase enrollment during the time period examined. Specifically, FTES and headcount enrollment increased by 247% and 455%, respectively. This is especially of note because the time period examined is during an economic boom when college enrollments, particularly enrollments at two-year institutions, typically

decline because jobs are readily available. In 2015-2016, Eastern Gateway enrolled 4,808 students and in 2018-2019, the institution enrolled 26,701 students, driven heavily by distance education enrollment. Given that Eastern Gateway experienced the largest increase in funding during this time period, essentially doubling their state funding, while their enrollment increased substantially at the same time, it is possible that Ohio's PBF formula simply is continuing to reward institutions that are able to increase enrollment.

Table 2-5. Percentage Change in Institutional Characteristics: 2015-2016 to 2018-2019

Institution Name	Associate Degree	Short-Term Certificates	FTES	Headcount	In-District Total Price (Not living at home)
Belmont Tech	-25%	150%	-19%	-17%	9%
Hocking	-22%	65%	-25%	-20%	14%
Owens State	-18%	2%	-10%	-5%	11%
Zane State	-9%	10%	-24%	-27%	-9%
Lorain County	13%	31%	-9%	0%	3%
Clark State	19%	13%	-8%	-3%	16%
Eastern Gateway	187%	58%	247%	455%	8%

Given these various increases and decreases in funding and how institutional characteristics changed over this time, it is instructive to establish which changes in student success metrics lead to these funding outcomes. The next section examines individual institutional changes in each metric and how their funding subsequently changed as a result.

PBF Funding Allocations from FY 2015 through FY 2020 by Metric and Institution

To fully understand Ohio's PBF policy, I examine how individual metrics changed and subsequentially, how SSI funding changes for the institutions of interest. Table 2-6 depicts the percent change in total course completions and the total funding change from overall course completions from FY 2015 to FY 2020 for these institutions. Institutions with substantial declines in course completions (over 30%) from FY 2015 to FY 2020 experienced a decline in *funding* from course completions (specifically, Belmont Tech, Hocking, Owens State, and Zane

State). However, Lorain County experienced a smaller decline in course completions (9%) but experienced 21% increase in SSI funding from course completions. Lorain County's funding increase can be attributed to other institutions' sharp decline in course completions. Decreases in metrics but increases in funding can happen when other institutions experience larger relative declines and therefore, leave money available for other institutions to capture that do not have as large a decrease. Additionally, institutions that experience increases in metrics, such as Eastern Gateway (34%) and Clark State (2%), receive a substantial boost in their funding (66% and 30%, respectively) because of the drastic decline from other institutions. These decreases in course completions could be related to the decline in overall enrollments at all of these institutions except for Eastern Gateway, which as able to increase enrollment during this time period.

Table 2-6 also illustrates course completions from individuals identified as access students (see above for an explanation of access students). *All* institutions (i.e., not just the ones presented in this case study) analyzed experienced large increases in access course completions. Therefore, because all institutions improve course completion for access students, an increase in access course completions did not correspond with an increase in funding from this metric. For the institutions examined, they had to experience over 500% growth in access course completions to obtain even a small increase in funding from this metric. For example, Eastern Gateway increased access course completion by 889% from FY 2015 to FY 2020 (152 access course completions in FY 2015 to 1,508 in FY 2020) and experienced an 87% increase in funding ($283,331 in 2015 to $530,937 in 2020). A "back of the envelop" calculation found that for each additional access course completion for Eastern Gateway, the institution obtained an additional $182 in FY 2020 funding (($530,937-$283,331)/ (1,508-152)).

Table 2-6. Change in Metric and Funding from FY 2015 to FY 2020: Course Completion

Institution	Course Completion - Total		Course Completion - Access	
	Metric Δ	Funding Δ	Metric Δ	Funding Δ
Belmont Tech	-35%	-17%	343%	-14%
Hocking	-37%	-22%	353%	-14%
Owens State	-39%	-13%	325%	-7%
Zane State	-33%	-4%	284%	-15%
Lorain County	-9%	21%	572%	34%
Clark State	2%	30%	593%	36%
Eastern Gateway	34%	66%	889%	87%

Note: Course completions are calculated using a three-year average. Courses completions are reimbursed at a cost rate. See Appendix B for cost rates over the years.

Table 2-7 presents the percent change in the metric and funding for student success points. Analysis of student success points illustrates once again that institutions can experience an increase in funding without increasing the metric because other institutions experience drastic declines. For example, student success points declined by 4% at Lorain County, however, funding increased by 26%. Funding from student success points increased at Lorain County because other institutions experienced much larger declines. For the other colleges examined, institutions that experienced large declines (over 30%) experienced subsequent declines in funding while institutions that improved their student success metrics over 8% saw growth in funding from this source. For example, Clark State increased student success points by 8% (3,916 to 4,222) but experienced a 42% increase in funding ($2,721,152 in FY 2015 to $3,861,431 in FY 2020). For each additional student success point between FY 2015 and FY 2020, Clark State increase funding by approximately $3,722 in FY 2020 (($3,861,431-$2,721,152)/ (4,222-3,916)).

Table 2-7. Change in Metric and Funding from FY 2015 to FY 2020: Success Points

Institution	Success Points	
	Metric Δ	Funding Δ
Belmont Tech	-31%	-9%
Hocking	-32%	-10%
Owens State	-34%	-13%
Zane State	-34%	-13%
Lorain County	-4%	26%
Clark State	8%	42%
Eastern Gateway	77%	133%

Note: Success Points are calculated using a three-year rolling average.

Table 2-8 demonstrates the percent change in total associate degree and access associate degree from FY 2015 to FY 2020 and the related percent change in funding. In order to increase funding from associate degrees, institutions had to increase the number of associate degrees produce. If institutions remained flat (e.g., Hocking) or declined (Belmont Tech), they experienced declines in funding from associate degrees. Interestingly, a one percentage point change in the metric resulted in an approximate one percentage point change in funding for associate degrees.

Table 2-8 also indicates the percent change for access associate degrees and the percent change in funding from access associate degrees. Overall, institutions gained funding from access associate degree production, regardless of whether they experienced increases or decreases in the number of access associate degrees they produced. For example, Belmont Tech decreased the number of access associate degrees produced by 14% while the funding from this metric increased by 11%. The amount of funding allocated via access associate degree increased by 40% from FY 2015 to FY 2020; therefore, while institutions may have decreased their access associate degree production, they could increase their funding because more money went to this particular metric. This is likely due to the change in policy that added an additional student group

to the access category in FY 2016, illustrating that small changes in the policy can lead to large ramifications in funding for institutions.

Table 2-8. Change in Metric and Funding from FY 2015 to FY 2020: Associate Degrees

Institution	Associate Degree - Total		Associate Degree - Access	
	Metric Δ	Funding Δ	Metric Δ	Funding Δ
Belmont Tech	-22%	-20%	-14%	11%
Hocking	0%	-2%	22%	67%
Owens State	-4%	-2%	8%	36%
Zane State	-18%	-18%	-14%	4%
Lorain County	12%	10%	30%	73%
Clark State	12%	14%	25%	73%
Eastern Gateway	87%	84%	128%	279%

Note: Degree completions are calculated using a three-year average and reimbursed at a cost rate. See Appendix C for cost rates over the years.

Table 2-9 depicts the percentage change in total and access certificates awarded and the change in funding associated with each metric from FY 2015 to FY 2020. Overall funding allocated via total certificates and access certificates increased 281% and 339%, respectively. Therefore, all examined institutions increased their total and access certificate production and subsequently increased their funding allocation from this metric from FY 2015 to FY 2020.

Table 2-9. Change in Metric and Funding from FY 2015 to FY 2020: Certificates

Institution	Certificates – Total		Certificates - Access	
	Metric Δ	Funding Δ	Metric Δ	Funding Δ
Belmont Tech	273%	240%	283%	380%
Hocking	68%	67%	82%	213%
Owens State	242%	236%	248%	337%
Zane State	105%	117%	109%	115%
Lorain County	276%	231%	293%	402%
Clark State	193%	177%	200%	320%
Eastern Gateway	130%	145%	152%	340%

Note: Certificates are calculated using a three-year average and reimbursed at a cost rate. See Appendix C for cost rates over the years.

For total transfers, there is an approximate one-to-one relationship between the percent increase (decrease) in the total number of transferred produced and the percent increase

(decrease) in funding (see Table 2-10). For access transfers, three institutions experienced declines (Belmont Tech, Hocking, and Owens State) while all other institutions examined increased the number of access students transferring to four-year institutions. Notably, Eastern Gateway increased the number of access students transfer by 143% from FY 2015 to FY 2020 and experienced a 255% increase in funding from this metric.

Table 2-10. Change in Metric and Funding from FY 2015 to FY 2020: Transfer

Institution	Transfer- Total		Transfer - Access	
	Metric Δ	Funding Δ	Metric Δ	Funding Δ
Belmont Tech	-42%	-43%	-34%	-23%
Hocking	-21%	-23%	-14%	12%
Owens State	-22%	-23%	-13%	1%
Zane State	2%	0%	2%	15%
Lorain County	13%	12%	55%	108%
Clark State	37%	35%	57%	93%
Eastern Gateway	43%	41%	143%	255%

Note: Transfers are calculated using a three-year rolling average and reimbursed at a constant rate in a given year. See Appendix C for their reimbursement rate.

Policy Simulations

In addition to investigating SSI funding changes from FY 2015 to FY 2020, I simulate how funding would have been affected if the policy had been implemented in seven different ways. I conduct these policy simulations to inform future policies in other states that may be interested in replicating Ohio's PBF policy. While Ohio's policy is considered one of the most robust in the country, it is a complicated formula that has several different factors and may be difficult to replicate in other states. Therefore, these simulations answer the following questions:

1. What if Ohio's policy had not changed and funding had continued to be allocated via enrollments? (Simulation 1)
2. What if Ohio's policy had focused on one student outcome? (Simulations 2 through 4)
3. What if Ohio's policy had evenly weighted all outcomes? (Simulation 5)

4. What if Ohio's policy had not included premiums for specific groups? (Simulation 6)
5. What if Ohio's policy had not used cost differentials in the funding formula? (Simulation 7)

I first simulate if Ohio had continued to used enrollments to fund two-year institutions. This simulation approximates what would have happened in Ohio had done nothing and not change their funding allocation method. Then, I simulate policies that allocated 100% of funding by course completions, student success points, and degree completions each. This analysis is conducted to examine whether less complicated and more focused policies would result in similar funding changes for the examined institutions. Then, I examine an alternative policy scenario where funding is spread evenly across the three elements of the funding formula (33% for course completions, 33% for student success points, and 34% for degree completions). I simulate this policy to illustrate how funding would have been affected if all metrics were given even weight. A criticism of early PBF policies is that they did not differentiate funding depending on metrics. I investigate whether Ohio's differential allocation of funding actually affected institutional funding.

Third, I replicate the funding formula if there had not been premiums for access groups. Premiums are a recent development for PBF policies, and little is known about their effect on organizational funding although research on premiums has found that there is a positive effect on low-income and Hispanic enrollment but a negative effect on Black student enrollment at four-year institutions subject to policy premiums (Gándara & Rutherford, 2017). Finally, I simulate no cost differentials for course and degree completions. Differential funding for course and degree completion incentivizes institutions to potentially focus on courses and degrees that are

reimbursed at higher rates in order to gain additional money. Also, this formula element potentially favors institutions that already focus on programs that are reimbursed at higher rates.

For this analysis, I compare simulated FY 2015 to simulated FY 2020 funding to understand how institutions would have fared between FY 2015 to FY 2020. To complete each of these analyses, I manipulate the Excel workbooks published publicly by Ohio to simulate the policy change. In order to change how the policy was implemented, I adapt the Excel in FY 2015 and FY 2020 to reflect the policy simulation of interest.

It is important to note that these policy simulations are a biased estimate of what funding actually would have been had the policy been different. For these simulations, it is impossible to know how institutions would have reacted to a different policy over this time period. I use the real student enrollment data and student success metric data and simply change the funding formula to the policy to understand how SSI funding would have been affected under a different policy, but I do not change the student data. In other words, I am simulating what would have happened with a different policy but if student enrollment and success had remained the same at these institutions, an obvious oversimplification but one that may nonetheless provide additional insights. Table 2-11 presents the result of the policy simulations for each case study institution.

Table 2-11. Policy Simulations

Percent Change in Funding from FY 2015 to FY 2020	Belmont Tech	Hocking	Owens State	Zane State	Lorain County	Clark State	Eastern Gateway
100% Determined by FTES	-7%	1%	-23%	11%	3%	20%	468%
100% Determined by Course Completion	-17%	-21%	-13%	-5%	22%	31%	68%
100% Determined by Student Success Points	-9%	-10%	-13%	-13%	26%	42%	133%
100% Determined by Degree Completion	-12%	9%	3%	-6%	30%	41%	125%
Even Distribution of Funding (33% for each element)	-13%	-8%	-8%	-8%	26%	38%	108%
No Funding for Access Groups	-14%	-12%	-9%	-6%	24%	35%	91%
No Cost Differentials	-12%	-7%	-12%	-10%	27%	40%	105%
Actual	**-14%**	**-11%**	**-9%**	**-8%**	**25%**	**36%**	**97%**

100% of Funding Determined by FTES

To simulate what would have happened in Ohio had it not changed to performance-based funding and maintained funding via student enrollments, I used Fall 2013 FTES enrollments to estimate two-year institution funding for FY 2015 and Fall 2018 FTES enrollments to estimate institutional funding for FY 2020. I used fall enrollments from the prior-prior year to account for the fiscal year starting in the previous calendar year. For example, FY 2020 allocations happen in calendar year 2019, therefore, the most recent FTES enrollment data is associated with Fall 2018. To calculate the amount of funding each institution received, I determined the percentage each institution contributed to total enrollments and multiplied that by the total allocation. For example, Belmont Tech contributed 1% to the total enrollment of two-year institutions in Fall 2018; therefore, this institution is assumed to receive 1% of the total funding allocation in hypothetical academic year 2018-2019

Overall, this simulation resulted in the most substantial differences from what actually happened in Ohio. While Belmont Tech and Owens State likely would have continued to lose funding if allocations would have been determined by enrollments, all other examined institutions would have experienced increases. For example, Hocking, which lost 11% of funding under PBF would have possibly gained 1% if the policy had not changed. Eastern Gateway, the institution that increased their funding the most under PBF, would have increased their funding even more so if the policy had remained the same. Under PBF, Eastern Gateway increased funding by 97% while under this policy simulation, their funding would have increased by 468%, from $6.7 million to $38.2 million. This simulation provides additional evidence that Eastern Gateway's substantial increase in enrollment was unique during this time period. Overall enrollment at two-year institutions dropped by 7% during this time period in Ohio and the median enrollment change was a decline of 12%.

100% of Funding Determined by Course Completion

Overall, institutions that captured more (less) funding under the implemented policy would have had a similar result if Ohio had just used course completion. However, institutions would have experienced small increases and decreases depending on where they were in the funding distribution pre-change. For example, Eastern Gateway experienced a 97% increase in funding under the actual PBF policy but would have increased funding by 68% if the funding formula had only considered course enrollments. Whereas, Belmont Tech experienced a 14% decline under PBF but would have experienced a 21% decline under this particular policy.

100% of Funding Determined by Student Success Points

Generally, if student success points would have been used as the sole determinate of funding, the examined institutions would have experienced similar funding allocations, except

for Eastern Gateway. Under this policy simulation, Eastern Gateway would have increased funding by 133% from FY 2015 to FY 2020, compared to a 97% increase from the implemented PBF policy. This simulation suggests that funding completely determined by student success points may favor institutions that substantially grow their enrollments, as Eastern Gateway did during this time period. Given that student success points are centered on students completing credits and moving from developmental courses to credit-bearing courses, it follows that this metric may be reenforcing enrollment growth.

100% of Funding Determined by Degree Completion

Of these policy simulations that examined 100% of funding determined by a particular policy element, 100% of funding determined by degree completion led to the results that differed the most from what actually happened in Ohio. While Zane State and Belmont Tech experienced slightly smaller decreases in funding under this policy simulation, Hocking and Owens State actually would have experienced increases in state funding. With the implemented PBF policy, Hocking and Owens State experienced 11% and 9% declines, respectively; however, if Ohio had awarded 100% of SSI funding on degree completions, they would have experienced 9% and 3% increases, respectively. Additionally, each of the institutions that experienced substantial gains in funding under the implemented PBF policy (Lorain County, Clark State, and Eastern Gateway) would have experienced even larger gains if degree completion would have determined 100% of state funding. Using degree completion to determine 100% of state funding would have led to different institutions experience gains and losses as a result of the PBF policy. One possible reason for this is that degree completions are a more difficult student success metric to change given that it takes more time and effort to complete a degree than it does to enroll in course or complete a specific number of courses.

Even Distribution of Funding Across Metrics: 33 Percent

Ohio's PBF policy for two-year institutions heavily weights course completions at 50% while allocating the remaining 50% to success points and degree completions evenly (i.e., 25% each). This allows for two-year institutions to continue to focus on student access through course completions while incentivizes institutions to work toward improving student completion. However, what would have happened to funding had the policy evenly weighted each outcome at 33% and not heavily weighted course enrollments? To simulate this policy, I evenly weight each metric at 33%. Overall, the examined institutions would have experienced similar changes in funding over time as they did under the implemented policy. Institutions that experienced declines in SSI funding from FY 2015 to FY 2020 also experienced similar declines when I simulated an even distribution of funding across student success metrics. Additionally, institutions that experienced increases from FY 2015 to FY 2020 also experienced dramatic increases under this policy simulation. Therefore, disproportionately weighting course completion does not seem to have a substantial effect on the funding allocations.

No Funding for Access Groups

Ohio identifies underrepresented groups as "access groups" in their funding model and provides additional funds when access students complete courses, complete degrees, or transfer. To illustrate how institutional SSI funding would have been affected had Ohio not included access group premiums in the formula, I remove this part of the funding formula. If a metric had a premium for access students, that funding is redistributed within that particular metric. When I examine the difference between simulated FY 2015 and FY 2020 funding and actual FY 2015 and FY 2020 funding, I find that institutions experienced similarly small increases and decreases except for Eastern Gateway. Under the simulated policy of no premiums, Eastern Gateway

would have experienced a 91% funding increase from FY 2015 to FY 2020 whereas they actually experienced a 97% increase in funding when there was a premium. This finding suggests that Eastern Gateway was able to increase their funding by concentrating on access group student success.

No Cost Differentials

For the final policy simulation, I investigate the effect of cost differentials for courses and degree completions. Specifically, I simulate funding in FY 2015 and FY 2020 if the average reimbursement rate would have been used for all courses and degrees. There are 13 course subjects and eight degree cost reimbursement rates (see Appendix C for all the cost reimbursement rates). Given the small number of reimbursement rates, I use the average to simulate if all courses and degrees were reimbursed at the same rate. For FY 2015 and FY 2020, I set the cost of courses to the average reimbursement rate for undergraduate courses in that particular year and set degree completions to the average cost reimbursement for associate degrees. Certificates are set at 50% of the cost of associate degrees and transfers are set at 25% of the cost of an associate degree, per the typical formula.

Eliminating cost differentials would have mitigated Belmont Tech and Hockings funding decline by two and four percentages points, respectively. However, removing cost differentials could have exacerbated Owens State's and Zane State's funding decreases by three and two percentage points, respectively. For institutions that experienced large overall growth from FY 2015 to FY 2020, eliminating cost differentials would have increased their growth over time. Specifically, Lorain County, Clark State, and Eastern Gateway would have increased their growth by two percentage points, four percentage points, and eight percentage points,

respectively. Overall, this suggests that removing cost differential would have resulted in approximately similar increases and decreases for the institutions examined.

Discussion

Ohio's performance-based funding policy for two-year institutions is considered a particularly strong policy (Boelscher & Snyder, 2019). Ohio's policy allocates 100% of SSI funding via metrics, uses programmatic cost differentials, and includes premiums for specific student groups, illustrating that it has many features that policy experts expect will affect student success outcomes positively. However, not much is known about how the policy actually affects institutional SSI funding. Therefore, I analyzed the effect of the policy on SSI funding for two-year institutions.

I found that overall SSI funding increased for each individual metric. However, funding increased at different rates across the metrics. For example, from FY 2015 to FY 2020, funding from metrics associated with access groups grew substantially compared to funding from the overall metrics. Therefore, if institutions focused on increasing student success of access groups students they experienced much larger growth in their SSI funding. Given this finding, policies that replicate Ohio's funding should look closely at their student premiums to ensure that they incentivize institutions to focus on underserved groups in their particular state.

Additionally, SSI funding from certificates increased substantially during this time period. From FY 2015 to FY 2020, funding from certificates and access certificates increased by 218% and 339%, respectively. Given that funding from certificates has increased dramatically, it follows that certificate production also increased during the time period examined. It is likely that two-year institutions focused on certificate production because they take less time and effort to earn. Typically, certificates require fewer course credits and less time than associate degree,

making them an easier metric to increase in the short-term. However, some researchers worry that increasing certificate production may be an adverse effect of PBF policies because these types of credentials have lower labor market returns compared to more advanced degrees (Dadgar & Trimble, 2015)

Regarding institutional SSI funding changes, three institutions increased their funding over 25% while four institutions experienced declines of greater than 5% from FY 2015 to FY 2020. This finding illustrates that institutions can experience large increases and large declines from PBF policies. For this case study, Eastern Gateway almost doubled their SSI funding (from $5.8 million to $11.4 million) while Belmont Tech declined by 14% (from $5.1M to $4.4M). While Eastern Gateway and Belmont Tech had about the same amount of SSI funding in FY 2015, their SSI funding in FY 2020 is substantial different, illustrating that institutions can have varied funding outcomes as a result of this particular PBF policy. States that look to replicate Ohio's policy should be aware of just how drastically funding can change for individual institutions as a result of PBF policies.

Further, given Eastern Gateway's dramatic increase in funding, further research is needed to examine why. At the same time that Eastern Gateway's funding increased, Eastern Gateway's enrollment increased, driven by a dramatic increase in distance education enrollment. Increasing distance education may be an efficient way to increase enrollment and game the course completion metric in this particular formula. By dramatically growing the number of students *enrolling* in courses, Eastern Gateway may have been able to increase the number of course completions without increasing the percentage of students who actually completed courses, effectively gaming the system.

Institutions that experienced substantial increases in SSI funding did so by increasing the majority of student success metrics incentivized by the policy. In other words, for institutions to experience large returns on their investments in student success, they had to ensure that they made a concerted effort to improve most metrics, and not just a select few. To illustrate, Eastern Gateway, the institution with the greatest funding increase, grew course completions by 34%, student success points by 77%, and associate degrees by 87%. By contrast, Belmont Tech experienced a 35%, 31%, and 22% decline in all of those metrics and experienced the greatest decline in funding. For institutions to experience large gains under a policy such as Ohio's, this research suggests that the institutions must focus on increasing most of the metrics incentivized. It is also important to note that the institutions that experienced the largest funding growth also experienced a considerable increase in enrollment during this time, suggesting that this formula is still closely tied to student enrollments.

Institutional administrators and policymakers also must be mindful of how metrics are weighted and how student success is changing at other institutions. For example, Ohio allocates a larger portion of funding to course completions, so institutions are likely to gain additional funding if they focus on that area. If the policy were set up differently and allocated a large portion of funding based on degree completion, institutions would likely focus on that student success metric. With regard to Ohio's policy, institutions must keep pace with other institutions if they want to maintain their funding, leading to a great amount of uncertainty. Institutions are likely unaware of how other institutions are changing their student outcomes from year to year so this formula is unpredictable and difficult to estimate how much funding an individual institution will receive from year to year.

For individual metrics and the funding associated with those metrics, I found that when metrics increased from FY 2015 to FY 2020, funding always increased for the institutions included in this case study. However, when metrics decreased at institutions between FY 2015 and FY 2020, it was not always associated with a decline in funding. For example, Lorain County experienced a 4% decline in student success points between FY 2015 and FY 2020 but experienced a 26% increase in funding from this metric. Lorain County increased funding from student success points because their student success points did not decline as much as other two-year institutions in Ohio. In other words, they increased their funding from student success points because their student success points did not decline as drastically as other institutions. They were able to financially benefit from other institutions producing fewer student success points. For other states that mimic Ohio's PBF policy, they may want to consider ways to write policies such that institutions are not rewarded for student success declines, such as Lorain County was in this instance.

In addition to examine what did happen, I conducted policy examinations to understand what would have had happen in Ohio had implemented a different policy. Overall, I found that regardless of the policy simulation I conducted, funding for FY 2015 and FY 2020 did not change substantially from what actually happened except for one instance, the enrollment simulation. If Ohio had continued to fund institutions based on enrollment, Eastern Gateway would have increased their SSI funding by over 400%, illustrating that this institution significantly increased their enrollment during this time. Under a scenario of funding being 100% determined by degree completions, Hocking and Owens State would have experienced increased in funding compared to the declines that they actually experienced. Conducting these policy simulations illustrates that PBF policy may not need to include complicated weighting

systems, premiums for underrepresented students, or cost differentials for different programs. More policy simulation research is needed to understand how institutions would actually respond to such policies, especially given that some of these policy elements are included to combat serious concerns about PBF policies, such as "creaming" (e.g., Kelchen & Stedrak, 2016).

Conclusion

Performance-based funding policies are prevalent throughout higher education. Research has predominately examined the effects of these policies on student success outcomes. Less research has focused on how state funding to institutions changes as a result of PBF policies. Therefore, these analysis addresses this gap in the literature by detailing Ohio's PBF policy, investigating how SSI funding has changed over time under the PBF policy, and how institutional funding has changed. Institutions that experienced substantial increases and decreases in funding were identified and examined to show how their SSI funding changed given the PBF policy. Future researchers and policymakers should consider this analysis when they are investigating the effect of PBF policies and implementing PBF policies themselves. Given Ohio's PBF policy, this research shows that institutions experienced large changes in both their student success metrics and funding. Future research should use this analysis to guide a policy evaluation of Ohio's two-year institutions to examine whether these institutions increased their student success metrics significantly over two-year institutions in other states that did not experience Ohio's PBF policy.

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Appendix A

Table A2-1. SSI Funding Change for Ohio Two-Year Institutions: FY 2015 to FY 2020

Institution	2015	2020	Difference	% Difference
BELMONT TECH	5,129,052	4,418,369	-710,683	-14%
HOCKING	13,302,962	11,834,514	-1,468,449	-11%
OWENS STATE	30,562,911	27,786,163	-2,776,748	-9%
ZANE STATE	8,307,840	7,665,740	-642,100	-8%
CENTRAL OHIO	11,643,240	11,578,902	-64,338	-1%
CINCINNATI STATE	28,392,404	28,611,236	218,832	1%
TERRA STATE	6,269,134	6,442,459	173,325	3%
SOUTHERN STATE	7,766,644	8,104,376	337,733	4%
WASHINGTON STATE	5,430,116	5,698,532	268,416	5%
JAMES RHODES ST.	10,350,179	10,994,396	644,217	6%
STARK STATE	27,412,507	29,169,236	1,756,729	6%
LAKELAND	18,594,461	20,544,155	1,949,694	10%
RIO GRANDE	5,238,686	5,827,329	588,643	11%
CUYAHOGA	63,733,701	71,627,984	7,894,283	12%
EDISON STATE	7,684,861	8,692,972	1,008,111	13%
COLUMBUS STATE	61,150,177	69,790,276	8,640,099	14%
MARION TECH	6,713,619	7,811,254	1,097,635	16%
NORTHWEST STATE	9,693,959	11,350,856	1,656,897	17%
SINCLAIR	42,916,034	51,429,660	8,513,626	20%
NORTH CENTRAL	7,346,492	8,830,630	1,484,138	20%
LORAIN COUNTY	24,541,622	30,678,558	6,136,936	25%
CLARK STATE	11,154,767	15,165,207	4,010,440	36%
EASTERN GATEWAY	5,766,060	11,373,448	5,607,387	97%

Appendix B

Table B2-1. FY 2015 Undergraduate Course Completion Reimbursement Costs

Model	FY 2015 Model Costs	STEM Target % from FY 2007 Model run	Reimbursement % of Cost	Reimbursement Cost FY 2015
AH 1	$7,940	0	1.00	$7,940
AH 2	$11,018	0	1.00	$11,018
AH 3	$14,234	0	1.00	$14,234
AH 4	$20,598	0	1.00	$20,598
BES 1	$7,235	0	1.00	$7,235
BES 2	$8,249	0	1.00	$8,249
BES 3	$10,827	0	1.00	$10,827
BES 4	$12,869	0	1.00	$12,869
STEM 1	$7,317	0.00%	1.00	$7,317
STEM 2	$10,268	0.17%	1.00	$10,285
STEM 3	$12,138	61.50%	1.62	$19,603
STEM 4	$15,454	69.20%	1.69	$26,147
STEM 5	$20,396	42.22%	1.42	$29,006

Note: Only undergraduate (UG) level reimbursement costs shown.
Source: Public Ohio performance-based funding file for FY 2015.

Table B2-2. FY 2016 & FY 2017 Undergraduate Course Completion Reimbursement Costs

Model	FY 2016 Model Costs	FY 2017 Model Costs	STEM Target % from FY 2007 Model run	Reimbursement % of Cost	Reimbursement Cost FY 2016	Reimbursement Cost FY 2017
AH 1	$7,773	$7,920	0	1.00	$7,773	$7,920
AH 2	$11,093	$11,302	0	1.00	$11,093	$11,302
AH 3	$14,209	$14,477	0	1.00	$14,209	$14,477
AH 4	$21,021	$21,417	0	1.00	$21,021	$21,417
BES 1	$7,311	$7,449	0	1.00	$7,311	$7,449
BES 2	$8,310	$8,467	0	1.00	$8,310	$8,467
BES 3	$10,805	$11,009	0	1.00	$10,805	$11,009
BES 4	$12,842	$13,084	0	1.00	$12,842	$13,084
STEM 1	$7,244	$7,380	0.00%	1.00	$7,244	$7,380
STEM 2	$10,041	$10,231	0.17%	1.00	$10,058	$10,248
STEM 3	$11,841	$12,064	61.50%	1.62	$19,124	$19,484
STEM 4	$14,170	$14,437	69.20%	1.69	$23,975	$24,427
STEM 5	$19,290	$19,654	42.22%	1.42	$27,433	$27,951

Note: Only undergraduate (UG) level reimbursement costs shown.
Source: Public Ohio performance-based funding file for FY 2016.

Table B2-3. FY 2018 & FY 2019 Undergraduate Course Completion Reimbursement Costs

Model	FY 2018 Model Costs	FY 2019 Model Costs	STEM Target % from FY 2007 Model run	Reimbursement % of Cost	Reimbursement Cost FY 2018	Reimbursement Cost FY 2019
AH 1	$8,678	$8,837	0	1.00	$8,678	$8,837
AH 2	$12,238	$12,463	0	1.00	$12,238	$12,463
AH 3	$15,530	$15,814	0	1.00	$15,530	$15,814
AH 4	$24,455	$24,903	0	1.00	$24,455	$24,903
BES 1	$8,258	$8,409	0	1.00	$8,258	$8,409
BES 2	$9,278	$9,448	0	1.00	$9,278	$9,448
BES 3	$11,903	$12,121	0	1.00	$11,903	$12,121
BES 4	$13,855	$14,109	0	1.00	$13,855	$14,109
STEM 1	$8,059	$8,206	0.00%	1.00	$8,059	$8,206
STEM 2	$10,889	$11,088	0.17%	1.00	$10,907	$11,107
STEM 3	$12,615	$12,846	61.50%	1.62	$20,374	$20,747
STEM 4	$14,845	$15,117	69.20%	1.69	$25,117	$25,577
STEM 5	$19,560	$19,918	42.22%	1.42	$27,817	$28,327

Note: Only undergraduate (UG) level reimbursement costs shown.
Source: Public Ohio performance-based funding file for FY 2018.

Table B2-4. FY 2020 Undergraduate Course Completion Reimbursement Costs

Model	FY 2020 Model Costs	STEM Target % from FY 2007 Model run	Reimbursement % of Cost	Reimbursement Cost FY 2020
AH 1	$9,115	0	1.00	$9,115
AH 2	$12,986	0	1.00	$12,986
AH 3	$16,155	0	1.00	$16,155
AH 4	$24,740	0	1.00	$24,740
BES 1	$8,820	0	1.00	$8,820
BES 2	$9,681	0	1.00	$9,681
BES 3	$12,351	0	1.00	$12,351
BES 4	$14,388	0	1.00	$14,388
STEM 1	$8,441	0.00%	1.00	$8,441
STEM 2	$11,326	0.17%	1.00	$11,345
STEM 3	$13,054	61.50%	1.62	$21,083
STEM 4	$15,314	69.20%	1.69	$25,911
STEM 5	$19,665	42.22%	1.42	$27,966

Note: Only undergraduate (UG) level reimbursement costs shown.
Source: Public Ohio performance-based funding file for FY 2020.

Appendix C

Table C2-1. FY 2015 Degree Completion Reimbursement Costs

Level	Subject	Average Cost
Associate Degree	Agriculture Technologies	$52,841
Associate Degree	Business Technologies	$29,162
Associate Degree	Engineering Technologies	$48,654
Associate Degree	Health Technologies	$55,406
Associate Degree	Liberal Arts	$34,385
Associate Degree	Natural Science Technologies	$37,151
Associate Degree	Other	$33,917
Associate Degree	Public Service Technologies	$30,226
Certificates	Agriculture Technologies	$26,420
Certificates	Business Technologies	$14,581
Certificates	Engineering Technologies	$24,327
Certificates	Health Technologies	$27,703
Certificates	Liberal Arts	$17,193
Certificates	Natural Science Technologies	$18,575
Certificates	Other	$16,958
Certificates	Public Service Technologies	$15,113
Transfers	Transfers	$10,442

Table C2-2. FY 2016 Degree Completion Reimbursement Costs

Level	Subject	Average Cost
Associate Degree	Agriculture Technologies	$52,282
Associate Degree	Business Technologies	$29,956
Associate Degree	Engineering Technologies	$49,487
Associate Degree	Health Technologies	$55,309
Associate Degree	Liberal Arts	$35,198
Associate Degree	Natural Science Technologies	$37,999
Associate Degree	Other	$35,618
Associate Degree	Public Service Technologies	$30,710
Certificates	Agriculture Technologies	$26,141
Certificates	Business Technologies	$14,978
Certificates	Engineering Technologies	$24,744
Certificates	Health Technologies	$27,654
Certificates	Liberal Arts	$17,599
Certificates	Natural Science Technologies	$19,000
Certificates	Other	$17,809
Certificates	Public Service Technologies	$15,355
Transfers	Transfers	$10,528

Table C2-3. FY 2017 Degree Completion Reimbursement Costs

Level	Subject	Average Cost
Associate Degree	Agriculture Technologies	$52,282
Associate Degree	Business Technologies	$29,956
Associate Degree	Engineering Technologies	$49,487
Associate Degree	Health Technologies	$55,309
Associate Degree	Liberal Arts	$35,198
Associate Degree	Natural Science Technologies	$37,999
Associate Degree	Other	$35,618
Associate Degree	Public Service Technologies	$30,710
Certificates	Agriculture Technologies	$26,141
Certificates	Business Technologies	$14,978
Certificates	Engineering Technologies	$24,744
Certificates	Health Technologies	$27,654
Certificates	Liberal Arts	$17,599
Certificates	Natural Science Technologies	$19,000
Certificates	Other	$17,809
Certificates	Public Service Technologies	$15,355
Transfers	Transfers	$10,528

Table C2-4. FY 2018 Degree Completion Reimbursement Costs

Level	Subject	Average Cost
Associate Degree	Agriculture Technologies	$53,881
Associate Degree	Business Technologies	$32,453
Associate Degree	Engineering Technologies	$52,948
Associate Degree	Health Technologies	$58,387
Associate Degree	Liberal Arts	$40,387
Associate Degree	Natural Science Technologies	$40,980
Associate Degree	Other	$38,130
Associate Degree	Public Service Technologies	$32,230
Certificates	Agriculture Technologies	$26,941
Certificates	Business Technologies	$16,226
Certificates	Engineering Technologies	$26,474
Certificates	Health Technologies	$29,193
Certificates	Liberal Arts	$20,194
Certificates	Natural Science Technologies	$20,490
Certificates	Other	$19,065
Certificates	Public Service Technologies	$16,115
Transfers	Transfers	$10,877

Table C2-5. FY 2019 Degree Completion Reimbursement Costs

Level	Subject	Average Cost
Associate Degree	Agriculture Technologies	$53,881
Associate Degree	Business Technologies	$32,453
Associate Degree	Engineering Technologies	$52,948
Associate Degree	Health Technologies	$58,387
Associate Degree	Liberal Arts	$40,387
Associate Degree	Natural Science Technologies	$40,980
Associate Degree	Other	$38,130
Associate Degree	Public Service Technologies	$32,230
Certificates	Agriculture Technologies	$26,941
Certificates	Business Technologies	$16,226
Certificates	Engineering Technologies	$26,474
Certificates	Health Technologies	$29,193
Certificates	Liberal Arts	$20,194
Certificates	Natural Science Technologies	$20,490
Certificates	Other	$19,065
Certificates	Public Service Technologies	$16,115
Transfers	Transfers	$10,877

Table C2-6. FY 2020 Degree Completion Reimbursement Costs

Level	Subject	Average Cost
Associate Degree	Agriculture Technologies	$54,015
Associate Degree	Business Technologies	$34,210
Associate Degree	Engineering Technologies	$53,360
Associate Degree	Health Technologies	$60,951
Associate Degree	Liberal Arts	$40,891
Associate Degree	Natural Science Technologies	$42,163
Associate Degree	Other	$38,611
Associate Degree	Public Service Technologies	$32,256
Certificates	Agriculture Technologies	$27,007
Certificates	Business Technologies	$17,105
Certificates	Engineering Technologies	$26,680
Certificates	Health Technologies	$30,475
Certificates	Liberal Arts	$20,445
Certificates	Natural Science Technologies	$21,081
Certificates	Other	$19,306
Certificates	Public Service Technologies	$16,128
Transfers	Transfers	$11,415

CHAPTER 3

What is Good for the Goose is Good for the Gander: The Effects of Ohio's Performance-Based Funding Policy

For most public higher education institutions, state funding is a large proportion of their operating budgets (State Higher Education Executive Officers Association, 2020). However, state appropriations are still below where they were before the Great Recession (State Higher Education Executive Officers Association, 2020). In addition to declining state support over time, *how* states fund postsecondary institutions has changed. Traditionally, state governments funded public higher education through student course enrollments. Under this model, state governments subsidize tuition and fees by reimbursing a portion of what it costs to educate students. By reducing the cost for students, access and opportunity to postsecondary education is expanded so more individuals can benefit from an education beyond high school (Miao, 2012). However, prioritizing student enrollment through state funding possibly resulted in public institutions concentrating on their access missions while de-prioritizing their student success mission (U.S. Department of Education, 2015). As institutions continue to open their doors to more and different students, state governments have looked for ways to fund student success at postsecondary institutions (Bogue & Johnson, 2010).

In addition to state governments turning their focus to student success, there are additional calls for heightened oversight of higher education because of substantial increases in tuition, ballooning student loan debt and student default rates, and fears that undergraduates are

underprepared for the workforce (Keating & Riley, 2005; U.S. Department of Education, 2015). Although these concerns are applicable to four-year institutions, they are particularly relevant to two-year public institutions because of their enduring missions to prepare students for gainful employment or for transfer to four-year institutions at relatively low costs and with little debt (Bragg, 2001).

One policy that non-governmental organizations and state governments believe will promote student success and accountability in public two-year institutions is performance-based funding (PBF) (Dougherty & Natow, 2015). Generally, PBF policies tie state higher education funding to specific student outcomes (e.g., course and/or associate degree completions) instead of student enrollments. National organizations, such as the Lumina Foundation (2009a), National Governors Association (Reindl & Jones, 2012), and Complete College America (Jones, 2013), advocate for PBF as one strategy for improving higher education student outcomes and increasing accountability to stakeholders. An increasing number of states are implementing PBF policies, suggesting that state policymakers believe PBF will increase student outcomes (Dougherty & Natow, 2015).

Although states throughout the U.S. are implementing PBF policies, the policies are not all the same across the nation. To track the different policy elements and to allow for comparison of the policies, HCM Strategists created a typology to classify PBF policies (Boelscher & Snyder, 2019). They consider several different policy elements in their rubric (e.g., a substantial amount of funding determined by the formula, degree completion is emphasized in the formula) and classify PBF policies for both two- and four-year public institutions. According to their classification, Ohio's PBF policy for two-year institutions is labeled as Type IV policy, the highest classification a policy can receive. Ohio's policy has several criteria that HCM

Strategists believe should positively affect student success outcomes in the state, such as a large percentage of state funding determined by student success outcomes, funding tied directly to student completion, and premiums (i.e., additional funding) to promote success of specific underrepresented student groups.

Given that Ohio's PBF policy is considered a particularly strong policy by both HCM Strategists and researchers (Hillman et al., 2018) and has many elements that policy advocates believe should positively affect student success outcomes, researchers should confirm these hypotheses with empirical research. Additionally, it is possible that other states will mimic Ohio's policy because it is highly regarded within the field. Therefore, researchers, policy advocates, and policymakers need to understand the effects of this PBF policy to assess how similar policies in other states may affect student outcomes. Prior research has found Ohio's policy is ineffective at improving student success outcomes (e.g., Hillman et al., 2018, see literature review). However, prior research has examined the overall effect of the PBF policy at the state-level, which does not consider the possibility that institutions may respond differently to a change in the funding formula. Within Ohio, two-year institutions are diverse in size, location, and student population served. Therefore, this study analyzes the effect Ohio's PBF policy at two-year institutions to understand whether the PBF policy had differential effects on the production of associate degrees and certificates. Additionally, I descriptively analyze two subgroups of Ohio institutions to see if their funding changes after PBF was implemented is correlated with increases in associate degrees and certificates.

Overall, the goal of this paper is to examine the effect of Ohio's PBF policy on associate degrees and certificate production at two-year institutions. Using a difference-in-differences framework with propensity score matching, three analyses are conducted:

1) Overall analysis: All two-year institutions in Ohio are compared to matched institutions to evaluate the effect of the PBF policy on associate degree and certificate production.
2) Subgroup analysis: Two-year institutions in Ohio that experienced large increases in state funding after PBF was implemented are examined descriptively to determine if the trend in associate degree and certificate production changed after PBF was implemented.
3) Subgroup analysis: Two-year institutions in Ohio that experienced small increases or decreases in state funding after PBF are examined descriptively to determine if the trend in associate degree and certificate production changed after PBF was implemented.

In summary, compared to two-year institutions that never experienced PBF, Ohio two-year institutions experienced a substantial decline in associate degree production after PBF was implemented. The results for the subgroup analysis of the relationship between funding allocations and associate degree and certificate production after PBF was implemented suggest that these outcomes did not increase beyond what would have been expected if PBF had not been implemented. In other words, these two subgroups continued along the same trend line after implementation, or in some cases, declined.

In the following sections, I provide background on PBF policy research and detail Ohio's PBF policy. Then, the conceptual framework used for the analysis is presented. Next, the data and methods are discussed. Finally, the results of the analysis are provided, and the paper ends with a discussion and conclusion.

Background

Empirical Research on Performance-Based Funding Policy

Quantitative analysis of PBF is prevalent and varied within higher education research. Some studies evaluate policies implemented in the 1990s (e.g., Tandberg et al., 2014) that have since been discontinued or changed drastically, whereas others examine more recent policies (e.g., Hillman et al., 2018). Some researchers evaluate all states that have implemented PBF policies (e.g., Shin & Milton, 2014) and some investigate single states (e.g., Hillman et al., 2015). Researchers examine student success outcomes (e.g., Ward & Ost, 2019) while others consider student enrollment (e.g., Kelchen, 2018) or financial outcomes (e.g., Kelchen & Stedrak, 2015). For this literature review, I focus on research that examines the effect of PBF on student success outcomes at two-year institutions because this study evaluates student success outcomes at two-year institutions in Ohio.

In a recent meta-analysis that investigated the results of several PBF studies, Bell et al. (2018) found that the overall average effect size for PBF policies on completion metrics for two-year institutions was not statistically significant. While this meta-analysis examined studies that considered all PBF policies across the nation, other studies have focused on the effect of the policy on two-year institutions in specific states. Evaluating Ohio and Tennessee specifically (two policies considered particularly robust by policy experts such as Snyder and Fox, 2016), Hillman et al. (2018) found that relative to several different comparison groups, Ohio institutions did not increase associate degree or certificate production after PBF was implemented. They did find, however, that Tennessee significantly increased the number of certificates produced during the time period examined.

This study extends and improves upon the Hillman et al. (2018) analysis in a number of ways. First, the previous study assumes that the effect of the policy starts at adoption rather than implementation. Ohio adopted their PBF policy in fiscal year (FY) 2009. However, it was phased in beginning in FY 2011 and fully implemented in FY 2015. In other words, in FY 2009, the policy was approved by the state government; however, the funding formula did not actually change until FY 2011. For this study, FY 2011 is used as the first year of treatment because that is when the policy took effect (see below for a discussion of Ohio's PBF policy). Second, Hillman et al. (2018) used three different comparison groups: states in the local region, non-PBF states, and PBF states to test the sensitivity of the analysis. For the current study, a matched sample of institutions across the U.S. that never experienced PBF policies is used as the comparison group to simulate the outcomes if the policy had not changed in Ohio. The matched sample improves on Hillman et al. (2018) by creating a statistically similar comparison group that has similar characteristics as Ohio two-year institutions (see methods and result sections for further information and for comparisons of Ohio institutions and the matched sample, respectively). Specifically, the matched sample is created using variables that are correlated with associate degree and certificate production, improving upon the comparison group strategy implemented by Hillman et al. (2018). Finally, the current study has an additional three years of data, which allows for a longer time horizon and more observations in the analysis. Additional observations increase statistical power relative to Hillman et al. (2018).

In other research, Hillman et al. (2015) examined the effect of Washington's PBF policy on student outcomes at two-year institutions. They found that relative to the comparison groups that were never incentivized by PBF, institutions did not increase retention rates or associate degree production. However, they discovered that the "treated" institutions (i.e., two-year

colleges in Washington) produced more short-term certificates than several different comparison groups. These findings suggest that Washington state's PBF policy may have incentivized two-year institutions to focus on short-term certificates.

Finally, Tandberg et al. (2014) examined the influence of PBF on two-year institutions nationally from 1990 to 2010. Using multiple comparison groups, the authors found that PBF did not increase completion rates in states that implemented PBF relative to states that never implemented the policy. However, they found heterogenous treatment effects of the policy at the state level. Some states increased the number of associate degrees (e.g., Minnesota, New Jersey), whereas other states decreased the number of associate degrees (e.g., Colorado, Idaho, New Mexico, Texas, Virginia), and some found no effect (e.g., Florida, Indiana, Kentucky, Ohio). While Tandberg et al. (2014) illustrated that PBF is not having an effect overall, their findings that PBF has different effects at the state level suggests that more work is needed to understand why PBF potentially has differential effects across and possibly within states.

Overall, the body of research on the effect of PBF in higher education for two-year colleges suggests that, on average, the policy does not lead to increased associate degree or certificate production. However, some studies have found that states experience differential effects of PBF on student outcomes, suggesting that individual state studies are important to continue to understand the effect of PBF policies. Toward that end, this study examines whether two-year institutions in Ohio experienced differential changes in associate degrees and certificate production after PBF was implemented relative to institutions that never experienced PBF. In the next section, Ohio's PBF policy is described in detail because it is the focal point of this analysis.

Ohio's Performance-Based Funding Policy

The goal of Ohio's PBF policy is to improve student outcomes at two-year institutions by allocating all state funding via student success metrics. Ohio's PBF policy allocates funding via course completions, student success points, and degree completions (including transfers). Prior to implementing the new PBF policy in FY 2011, State Share of Instruction funding (SSI) for Ohio two-year institutions was allocated using the number of full-time equivalent (FTE) students enrolled at the institution and a small PBF policy that distributed bonus funding (see Oster, 2020). Starting in FY 2011, the Ohio legislature slowly phased in a PBF policy for two-year institutions until FY 2015 when it was fully implemented (see Table 3-1). In FY 2011, 95% of funding was allocated based on FTE enrollments, whereas 5% was allocated based on student success points (see below for a discussion of student success points). In FY 2012, 92.5% of funding was allocated via course enrollments and 7.5% was allotted by student success points. In FY 2013, the percent determined by student success points metrics increased to 10%. In FY 2014, there was a substantial shift of the formula such that 50% was determined by enrollments, 25% was determined by course completions, and 25% was allocated via student success points. In FY 2015, SSI funding was fully (100%) allocated based on student outcomes, with 50% apportioned by course completions, 25% based on student success points, and 25% by degree completions. For FY 2011 through FY 2014, there was a stop-loss provision in place that prevented institutions from experiencing large fluctuates in their SSI funding (see below for a discussion of the stop-loss provision and how it affects this analysis). In FY 2015, this provision was removed.

Table 3-1. Ohio's Performance-Based Funding Policy Over Time

Year	Enrollment (FTES)	Course Completion	PBF 2.0 Student Success Points	Degree Completion	Stop-Loss
Prior to 2011	100.0%				
2011	95.0%		5.0%		98.0%
2012	92.5%		7.5%		88.0%
2013	90.0%		10.0%		96.0%
2014	50.0%	25.0%	25.0%		97.0%
2015 and forward		50.0%	25.0%	25.0%	

For Ohio's fully implemented PBF policy, 50% of SSI funding is based on course completions. Specifically, it is the number of completed FTEs at the institution based on a rolling average of the three prior years. It is cost based, meaning that course completions are reimbursed at different rates depending on how much it costs to "educate" that particular FTE. This metric includes student premiums where institutions are awarded additional funding when specific students complete a course (e.g., adults, see below for a discussion of premiums). Additionally, 25% of funding is allocated by student success points. A student success point is awarded for each student that completes 12, 24, and 25 semester credit hours. Also, an institution is awarded a success point if a student enrolls in developmental math or English, and subsequently enrolls in a college-level math or English course anywhere in the system. These student success points are also calculated using a three-year rolling average for the institution, however, there are no student premiums for this metric.

Finally, Ohio's fully implemented PBF policy awards 25% of SSI funding by degree completions. Associate degrees and long-term certificates (greater than 30 semester credit hours) are included in this metrics as well as completed transfers. Similar to course completions, associate degree completions are reimbursed at a specific rate depending on the students' major and certificates are reimbursed at 50% of the cost of an associate degree in the same major. All

transfers are reimbursed at 25% of the average associate degree cost for that year. Student premiums are included in this metric.

For premiums, Ohio's PBF policy awards additional funding when specific students complete courses and degrees (including transfers). Adult students, low-income, underrepresented minorities, and academically underprepared students (starting in FY 2016) earn extra funding for the institutions when they complete a course or earn a degree. The intent of this policy provision is to prevent two-year institutions from shirking on their responsibility to be open-access institutions.

One important issue related to Ohio's PBF policy is that funding is determined proportionately. For example, 50% of funding is allocated via course completions. That 50% of funding is determined by the percent of course completions an institution contributes to the total number of course completions produced by two-year institutions. For example, if an institution's three-year rolling average is 100 course completions and in total, Ohio's three-year rolling average is 1,000 course completions for two-year institutions that year, the institution would receive 10% of the 50% allocated via course completion. In other words, institutions are funded by the proportion that they contribute to the overall metric. To maintain funding over time, institutions must maintain the *percent* that they contribute to each metric, not the raw number. In essence, institutions are fighting over funding instead of the amount of funding increasing as institutions improve their outcomes.

Conceptual Framework

To frame the empirical work, I tie together two prevalent theories used in PBF research: principal-agent theory and resource dependence theory. Principal-agent theory describes a complex, contractual relationship between independent but connected parties (e.g., individuals,

groups, organizations; Mitnick, 1975; Ross, 1973). In this relationship, an external group (i.e., the principal) attempts to control the actions of the other group (i.e., the agent) through incentives (e.g., funding, Jensen & Meckling, 1976). Agents typically have different knowledge (i.e., information asymmetry) and different goals (i.e., goal misalignment) compare to the principal (Eisenhardt, 1989; Moe, 1984), which can lead to agents not acting in the best interest of the principal (i.e., "shirking"). Sometimes, shirking causes the principal to create monitoring mechanisms within their contracts (Fiorina, 1982; Jensen & Meckling, 1976).

There are two ways that principals create contracts and monitor requirements with agents: behavior-based contracts and outcome-based contracts (Eisenhardt, 1989). A behavior-based contract involves a reward system, such that behaviors result in rewards from the principal when the agent completes a task. Examples of behavior-based contracts within higher education include annual reports and salaries. Outcome-based contracts reward an agent when it meets a pre-specified outcome. Within higher education, PBF is a type of outcome-based contract as institutions are typically rewarded when students complete specific outcomes.

Once the principal establishes a monitoring mechanism, the agent must report data to the principal. The data that is reported by the agent are aligned with goals that the principal wants the agent to achieve. Therefore, monitoring serves two purposes. First, monitoring encourages the agent not to shirk on their responsibilities to the principal because it could lose resources if it did. Second, monitoring aligns the goals of the agent to the goals of the principal because the monitoring metrics are typically tied to incentives (Eisenhardt, 1989). For example, Ohio's PBF policy directly ties the number of course completions to 50% of SSI funding. Ohio two-year colleges, therefore, have to report the number of course completions to the state and cannot shirk on their responsibility because it is codified in their funding.

An important element of principal-agent theory is that there should be a direct and predictable relationship between the contracted outcomes and the incentivizes (Eisenhardt, 1989). In other words, the principal should try to limit the amount of uncertainty between the desired outcome and the incentive they receive because of that outcome. However, it is important to note that within Ohio's PBF policy, there is uncertainty because institutions are competing in a tournament-like scenario over a fixed amount of funding each year. The fixed amount of funding is allocated proportionally; therefore, the final funding amount for an individual institution depends on student outcomes of all institutions. Because individual institutions are unaware of how other institutions are changing their student success productivity, funding is uncertain and can be unpredictable. While Ohio's funding formula attempts to reduce some of this uncertainty by using three-year rolling averages for most of the outcomes, there is still uncertainty regarding how much funding an individual institution will receive from year-to-year.

Principal-agent theory has direct implications for PBF. According to Lane and Kivistö (2008), "no matter how it is constructed or codified, oversight is the lynch pin of the [principal-agent] relationship; for without it the agent has little incentive to pursue the goals of the principal and the principal has no means to ensure that its goals are being pursued by the agent" (p.146). Ultimately, principal-agent theory is grounded in the principal incentivizing the agent to act in a desired way and monitoring those actions through contracts and reporting mechanisms. As such, PBF is one way for state governments (i.e., the principal) to create an explicit outcomes-based contract with higher education institutions (i.e., the agent), monitor outcomes through reporting, and then reward or punish higher education institutions with funding depending on those outcomes. For this study, I hypothesize that because Ohio two-year colleges were incentivized by PBF to improve student success outcomes (specifically associate degree and certificates), they

will produce additional degree and certificates after the policy is implemented relative to similar institutions that never experienced PBF policy.

Resource dependence theory conceptualizes how a focal organization interacts with its environment, which consists of outside organizations (i.e., social actor; Pfeffer & Salancik, 1978). Through this interaction, the focal organization is attempting to keep control of its activities while the social actor is attempting to gain control over the focal organization. While trying to maintain control of its activities and survive within the environment, the focal organization must obtain the necessary resources from outside organizations. By obtaining resources from a social actor, the focal organization becomes dependent on that organization, leading to the outside organization having a degree of control over the activities of the focal organization.

Pfeffer and Salancik (1978) outline eight characteristics of the resource-dependent relationship between a social actor and the focal organization (quoted below, p. 260).

1. The possession of some resource by the social actor
2. The importance of the resource to the focal organization and its criticality for the organization's activity and survival
3. The inability of the focal organization to obtain the resource elsewhere
4. The visibility of the behavior or activity being controlled
5. The social actor's discretion in the allocation, access, and use of the critical resource
6. The focal organization's discretion and capability to take the desired action
7. The focal organization's lack of control over resources critical to the social actor
8. The ability of the social actor to make its preferences known to the focal organization

The degree to which these factors are met influences the amount of control the external organization has over the focal organization. If all of these conditions are not adequately met, the focal organization increases its autonomy from the external organization.

For the relationship between postsecondary institutions and state governments through PBF policies, these eight characteristics are met to varying degrees. Specifically, the state government possesses a resource (i.e., funding) that two-year institutions need (characteristic 1) and can make student success outcomes visible via public reporting (characteristic 4). However, institutions can obtain funding elsewhere from other sources, such as tuition or grants (characteristic 3). Therefore, the particular relevance of funding (characteristic 2) to postsecondary institutions is dependent on the proportion of revenue postsecondary institutions receive from the state and how much funding the state allocates via performance-based metrics (characteristic 5). Many college administrators and faculty believe that outcomes are difficult to affect because of the student populations (e.g., underprepared, non-traditional, part-time) served by two-year institutions, calling into question the ability to affect student outcomes (characteristic 6). Interestingly, two-year institutions have some control over educating citizens, an important resource for the state government (characteristic 7). Regarding characteristic 8, Ohio's PBF policy is well-known in the state and was well-known prior to its implementation so the state's ability to communicate its preference that two-year institutions focus on student success was well-known.

In summary, resource dependence theory conceptualizes how an external organization exerts control over a focal organization by providing resources, and how the focal organization responds to that control (Pfeffer & Salancik, 1978). With respect to PBF and Ohio's two-year institutions, resource dependence theory provides a conceptual mechanism (e.g., how funding is

determined across states) for why PBF may influence Ohio's two-year institutions to respond by changing their production of associate degree and certificates beyond that of institutions that did not experience PBF policies. For this analysis, resource dependence theory suggests that Ohio two-year institutions will experience greater increases in associate degree and certificates than similar institutions.

Data and Methods

Data

For this analysis, I use data from the Integrated Postsecondary Education Data System (IPEDS). Institutions that receive Title IV funding submit yearly surveys to the National Center for Education Statistics (NCES) which then turns these survey responses into a comprehensive data source on postsecondary institutions. Specifically, institutional sector variables, state location, student enrollment, tuition and institutional financial information, associate degrees, and certificates are used for this analysis. As a control variable for the analysis (see below), county level unemployment rate is matched to each institution-year observation.

For information on when PBF policies were implemented in each state, I consult reports from the National Conference of State Legislatures (2015), Dougherty and Natow (2015), Snyder and Fox (2016), and Snyder and Boelscher (2018). From these sources, a state-by-year dataset indicating if two-year institutions within that state and year were under a PBF policy (or not) was created. From these data sources, states that never implemented PBF between 2004 and 2017 are identified and considered the initial counterfactual group for the analysis. See Appendix A for state-by-year information on PBF policies for two-year institutions.

Sample Restrictions

This analysis focuses on two-year institutions in Ohio (i.e., the treatment group) and two-year institutions in the U.S. never subject to PBF policies (i.e., the counterfactual group) between 2004 and 2017. Generally speaking, for the sample restriction, two-year institutions were first identified. Then, the sample was delimited to include only Ohio two-year institutions and two-year institutions in other states that did not operate under PBF between 2004 and 2017.

Specifically, the initial sample contained 74,295 observations. Then, the 23 two-year institutions in Ohio that were awarded SSI funding via PBF formula were flagged in each year. Next, institutions categorized as degree-granting institutions primarily awarding associate degrees and certificates were retained (n= 18,195). Then, using the 2010 Carnegie classification, institutions classified as associate degree institutions were preserved (n=12,573). After these exclusions, two private not-for-profits institutions and 67 Ohio institutions that were not the 23 two-year institutions in the treatment group for this analysis were removed.

As mentioned above, the 23 two-year institutions in the treatment group are included in Ohio's PBF formula for two-year institutions. The additional 67 Ohio institutions in the dataset were satellite campus for four-year institutions (e.g., University of Arkon-Wayne College). Because they were satellite campuses and not included in Ohio's PBF formula for two-year institutions, they were removed from the dataset. Once these institutions were removed, a balanced panel was created by retaining institutions that had 14 observations, removing 898 institutions that either closed or opened between 2004 and 2017. Finally, 6,902 institutions from states that implemented PBF between 2004 and 2017 were exclude. There were a total 4,704 institution-year observations in the final analytical sample.

Dependent Variables

Ohio's PBF policy incentivizes two-year institutions to produce associate degrees, certificates, and transfers to four-year institutions by allocating 25% of their SSI funding to these metrics. The dependent variable for this analysis is the number of associate degree and certificates produced each year by each institution. The number of transfer students was not included in the analysis because it is not reported in IPEDS and transfer is a function of the characteristics of both the transfer-out (i.e., two-year college) and transfer-in (i.e., the other institution) institution. To reduce the influence of outliers on the analysis and for ease of interpretation as percentage increases or decreases, both dependent variables (i.e., the number of associate degrees and the number of certificates) were log transformed.

Method

For this analysis, I utilized a difference-in-differences framework with propensity score matching to estimate the relationship between Ohio's PBF policy and associate degree and certificate production. Prior higher education research has used difference-in-differences with propensity score matching to study the effect of working during high school on educational attainment (Buscha et al., 2012), and the effect of a college promise program on students' college choice (Andrews et al., 2010). More specifically, PBF research has used difference-in-differences frequently to estimate the effect of PBF policies (e.g., Hillman et al., 2018; Hillman et al., 2015; Kelchen, 2018; Tandberg et al., 2014). However, the use of propensity score matching has been limited in the PBF literature. Hu and Villarreal (2019) used difference-in-differences with propensity score matching to estimate the effect of Louisiana's PBF policy on tuition at public institutions. They found that two-year institutions significantly increased their tuition and fees after PBF was implemented relative to the matched control group.

For this analysis, a generalized difference-in-differences model of the following form is used:

$$y_{it} = \alpha + \boldsymbol{x}\beta_t + \delta PBF_{it} + \theta_i + \vartheta_t + \mu_t + \varepsilon_{it} \quad (1)$$

For this analysis, I am particularly interested in coefficient δ, which measures the average effect of Ohio's PBF policy on the dependent variable after the policy was implemented in 2011. The variable associated with δ (PBF) equals 1 for each Ohio institution-year after the PBF policy was implemented, and 0 otherwise. The model also includes fixed effects at the institution (θ_i) and year (ϑ_t) levels. These variables control for unobserved time-invariant institutional characteristics and time-varying confounders common to all institutions, respectively. The institution fixed effects account for differences between Ohio institutions and control institutions, and the year fixed effects account for differences pre- and post-policy implementation in 2011 (Angrist & Pischke, 2009). Standard errors are clustered at the institution level to account for correlation within institutions.

The $\boldsymbol{x}$ vector includes county-level unemployment as a control variable. County-level unemployment accounts for economic differences across geographic locations. Enrollment and subsequently earning an associate degree or certificate are typically counter cyclical with the economy. During recessions or economic downturns, interest in higher education and earning a degree increases. Therefore, individuals' motivation to complete their studies may be associated with the level of unemployment in their county.

As noted in Oster, Furquim, and McNaughtan (2020), prior literature evaluating PBF policies has included a wide range of control variables (e.g., enrollment characteristics, tuition, etc., Hillman, Fryar, & Crespin-Trujillo, 2018; Li, 2018). However, previous models that include these control variables may be over-specifying and "controlling away" some of the effects of the

policy on the outcome of interest. In a quasi-experimental regression framework, such as difference-in-differences, it is inappropriate to include a control variable that may be affected by the treatment variable (Lechner, 2011). In models that examine the effect of PBF policy on student success outcomes, the treatment is years in which PBF policy was active in the state. As a result of PBF implementation, it is possible for institutions to adjust tuition, recruit different students, and receive a different amount of funding from the state. Therefore, it is inappropriate to include these types of variables as controls in the difference-in-differences analysis.

For example, Hillman, Fryar, and Crespin-Trujillo (2017) use the percent of white students as a control variable in their analysis. The percent of each race/ethnicity group could be affected by PBF policies if institutions decide to recruit more white students and enrollment is fixed and at capacity. The percent of white students could also directly affect the outcome of interest. For example, institutions may enroll more white students to improve student outcomes. When the percent of white students is included as a control variable in the difference-in-differences model, it is possible that the percent of white students' coefficient will be significant while the treatment coefficient (post-PBF implementation) will not. In this example, the percent of white students may account for some of the relationship between the PBF policy and the outcome variable.

For the main model in this analysis, only county-level unemployment rates were included to account for different economic conditions across counties. However, it is important to account for differences across institutions prior to PBF implementation in order to create an appropriate counterfactual group for the analysis. Therefore, I use propensity score matching to account for institutional differences without introducing them as control variables in my main model specification.

Propensity Score Matching

The key assumption of the difference-in-differences methodology is the parallel trends assumption (Angrist & Pischke, 2008). The parallel trends assumption assumes that without the policy intervention, the treated group (i.e., Ohio two-year institutions) and the counterfactual group (i.e., two-year institutions in states without PBF) would have had the same average change in the outcome of interest after the policy was implemented. This assumption implies that prior to treatment, the treatment and counterfactual groups had similar trends on the outcomes of interest and other observable and unobservable characteristics that could affect the outcome of interest. Imbalance on outcome variables and related variables prior to treatment can lead to biased difference-in-differences estimates (Stuart et al., 2014). To address the parallel trends assumption by creating a statistically similar counterfactual group on characteristics and prior outcomes, propensity score matching was used. Propensity score matching partially addresses the parallel trend assumption by creating a counterfactual group that is similar on observed variables correlated with the outcomes and the outcomes themselves prior to PBF implementation.

For the propensity score matching, I first determined if Ohio institutions were statistically different on the outcome variables and variables related to associate degrees and certificate production. Specifically, I examined whether Ohio two-year institutions were statistical similar prior to 2011 on the following variables: logged FTE, percent part-time enrolled, percent white student enrolled, logged student tuition, percent operating budget from state, unemployment rate, logged associate degrees, and logged certificates. These variables were used because they are related to associate degree and certificate production at two-year institutions. Prior to 2011, Ohio two-year institutions were statistically different than all other two-year institutions that

never experienced PBF policy on percent part-time enrolled, percent white students enrolled, logged student tuition, unemployment rate, logged associate degrees, and logged certificates ($p<0.05$ for each of these variables, see Appendix C and the results section).

Given this imbalance on key variables prior to 2011, I matched Ohio two-year institutions to institutions that never experienced PBF on the outcome of interest, and the variables listed above using five different matching techniques. Using different algorithms was done in an attempt to test the sensitivity of the treatment and control group balance to the choice of algorithm employed. For the propensity score matching techniques, one-to-one matching without replacement, one-to-one matching with replacement, and the two, three, and four nearest neighbors with replacement methods were used. For each of the matching techniques, if the institution ever matched in a pre-treatment year, all of its observations were kept in order to ensure that the counterfactual group in each year remained the same. Each matching process resulted in a balanced sample prior to 2011 on each variable (see Tables C3-1 through C3-6 in Appendix C). After creating a balanced sample of Ohio institutions and matched institutions using the five different PSM strategies, I conducted my overall analysis using the main difference-in-differences model specified in Equation 1 to confirm that my overall results are not sensitive to the matching algorithm (see Tables C3-7 and C3-8 in Appendix C for the results). The overall results are not sensitive to the matching technique. Therefore, one-to-one matching with replacement is used because it results in better individual matches and decreased bias (Caliendo & Kopeining, 2008).[1]

[1] I attempted a sensitivity test where I only included institutions that matched every pre-treatment year for the one-to-one with replacement matching technique because it was the preferred specification. However, it was not possible to complete this sensitivity test because there were no institutions that matched in every pre-treatment year.

The key assumptions of propensity scoring matching are conditional independence and common support (Caliendo & Kopeining, 2008). Conditional independence assumes that, conditional on the covariates included in the propensity score matching, the outcome of interest is unrelated (i.e., independent) to treatment assignment. Said another way, once covariates that are associated with both treatment and the outcome of interest are accounted for, assignment to treatment is independent of the outcome (Lechner, 2001). To address this assumption, variables related to associate degree and certificate production, such as student enrollment, student population composition, tuition, state support, unemployment rate, and prior outcomes (associate degrees and certificates) are used to create the counterfactual group. Once these covariates are accounted for through PSM match, PBF implementation (i.e., the treatment) is assumed to be unrelated to associate degree and certificates (i.e., the outcome) production in post-treatment years.

Common support assumes that there are similar units (in this case, institutions) in both the treatment and counterfactual group based on the propensity score (Caliendo & Kopeining, 2008). To ensure that treated and counterfactual institutions had common support, the "*common*" option was evoked in Stata during all propensity score matching. The option "*common*" excludes treated institutions that have a propensity score that is either higher than the maximum or lower than the minimum propensity score of the matched counterfactual institutions. Two observations from the treated institutions were removed when common support was invoked. See Appendix D for the common support graphs that illustrate the overlap of propensity score between the treated and non-treated observations.

Subgroup analysis

To investigate the relationship between institutions receiving additional funding under PBF and student outcomes, Ohio institutions were divided into two groups based on how well they functioned under the PBF policy. Specifically, Ohio institutions are grouped by the percentage change in SSI funding from FY 2015 to FY 2020. FY 2015 is used as the base year because that is when Ohio's PBF policy was fully implemented without a stop loss and FY 2020 is the most recent financial data available. Institutions that experienced at least 10% increases during this time period are included in one group, whereas institutions that did not experience 10% increases are in another group (see Appendix B for funding changes over time for two-year institutions in Ohio). A 10% increase in funding is used as the threshold because, in theory, these institutions received a substantial increase in their funding, and they should be increasing their student outcomes during this time period. Once I divided the treated institutions into two groups, I examine the average number of associate degrees and certificates produced by each group from FY 2004 through 2017 to determine if there is a different trend after PBF was implemented. I conduct a descriptive analysis of these subgroups because the amount of funding received from PBF is endogenous to both the PBF being implemented and student outcomes. Therefore, dividing institutions by their funding changes does not identify the causal relationship between receiving additional funding under PBF and these outcomes.

Limitations

As is true of empirical work generally, this study is limited in a number of ways. While difference-in-differences accounts for time-constant variation in the treatment and control groups, it does not account for other time-varying policies or programs that could be affecting the outcomes at Ohio two-year institutions or institutions in other states. For example, during this

time period examined, some Ohio two-year institutions were replicating the Accelerated Study in Associate Programs, first developed by the City University of New York. Any possible effects of this program on associate degrees and certificates are not directly accounted for in this analysis. There are other programs throughout the country that individual two-year institutions could select to be a part of, such as Achieving the Dream, that could affect the analysis. If institutions in the counterfactual group were selecting to take-up these interventions at a higher rate than Ohio institutions, it could create an imbalance between the treatment group and counterfactual group. Institution fixed effects partially address this issue but do not fully account for differential uptake over time between the treated institutions and the counterfactual institutions.

Second, the data for this analysis is slightly dated, only capturing changes up to 2017. While that captures six years of data since the PBF policy change in Ohio, it is only two years after the policy was fully implemented in 2015. Therefore, future research should continue to evaluate Ohio's policy with data that captures additional years in order to understand the long-term effects of the policy.

This study is also limited because it only considers Ohio's policy. Focusing on a single state eliminates differences across states in PBF policies and allows for a deeper understanding of the PBF policy. However, concentrating on a single state reduces generalizability to other states and PBF policies. If effects are found for Ohio, it is difficult to predict if those results can be replicated in other states with different state circumstances. Future research should attempt to categorize PBF policies across states and use those categories to analyze the effect of PBF policies. This would allow for more generalizability while accounting for a policy differences across states.

Results

All Institutions

Table 3-2 illustrates that there are significant differences between Ohio two-year institutions and all institutions that never experienced PBF. Prior to 2011, Ohio two-year institutions had a statistically significant smaller percentage of students who enrolled part-time, larger percentage of white students, higher student tuition, lower unemployment rate, and produced more associate degrees but fewer certificates than two-year institutions in the analytical sample. To address this imbalance on important institutional characteristics, I used one-to-one matching with replacement to achieve balance prior to PBF implementation in FY 2011. Table 3-3 illustrates that after matching, institutions were balanced on the matching variables and on the variable of interest. As discussed above, matching on these variables prior to PBF implementation creates a counterfactual group that is more similar to the treatment group for the difference-in-differences analysis, improving on prior research that did not do so.

Table 3-2. Balance Table Prior to Propensity Score Matching: 2010 and Prior

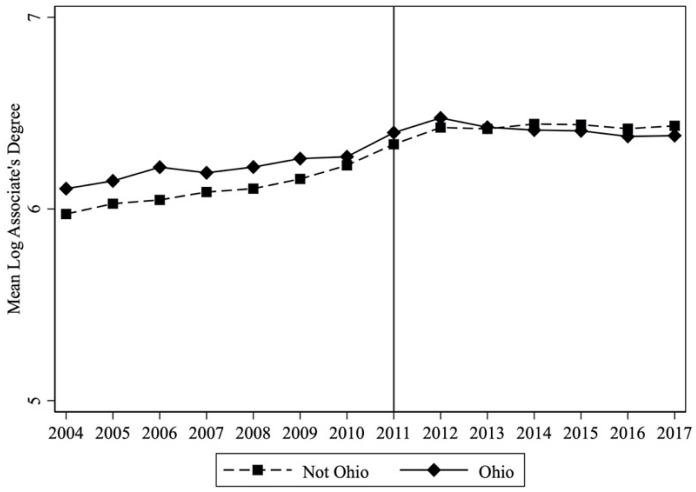
Variables	Ohio	All Other	P-Value
Logged FTE	8.19	8.18	0.93
% part-time enrolled	52.33	58.18	0.00
% white enrolled	82.14	58.42	0.00
Logged student tuition	8.38	7.73	0.00
% operating budget from state	31.79	32.05	0.83
Unemployment rate	7.58	6.93	0.01
Logged associate degrees	6.15	6.00	0.03
Logged certificates	4.71	5.04	0.00

Table 3-3. Balance Table After Propensity Score Matching: 2010 and Prior, Using One-to-One Matching with Replacement

Variables	Associate Degree Match			Certificate Match		
	Ohio	Matched	P-Value	Ohio	Matched	P-Value
Logged FTE	8.22	8.22	0.98	8.21	8.25	0.63
% part-time enrolled	53.77	54.50	0.55	54.72	51.89	0.16
% white enrolled	82.17	82.38	0.86	82.26	83.60	0.25
Logged student tuition	8.31	8.30	0.91	8.31	8.29	0.39
% operating cost from state	31.82	31.20	0.55	31.75	30.68	0.28
Unemployment rate	7.50	7.52	0.97	7.52	7.57	0.87
Logged outcome	6.20	6.22	0.79	4.86	5.02	0.18

Figures 3-1 and 3-2 depict the mean logged number of associate degree and certificates produced by Ohio institutions and their matched control group. These graphs allow for a visual inspection of the parallel trends assumption that is critical for the difference-in-differences analysis. Additionally, these graphs illustrate post-treatment changes in the outcome of interest in Ohio relative to the counterfactual group. Overall, Ohio institutions and matched institutions followed a similar pattern prior to 2011. After 2011, Ohio's production of associate degrees slightly declined while matched institutions continued to increase by a small margin (see Figure 3-1).

Figure 3-1. Associate Degree Over Time for Ohio and Matched Sample: Overall



Overall, certificate production by two-year institutions in Ohio was haphazard relative to the matched institutions, possibly leading to unreliable estimates in the difference-in-differences analysis (see Figure 3-2). As for the parallel trends assumption, Ohio approximately follows the matched institutions from 2006 to 2010, providing support for the parallel trends assumption for those particular years.

Figure 3-2. Certificates Over Time for Ohio and Matched Sample: Overall

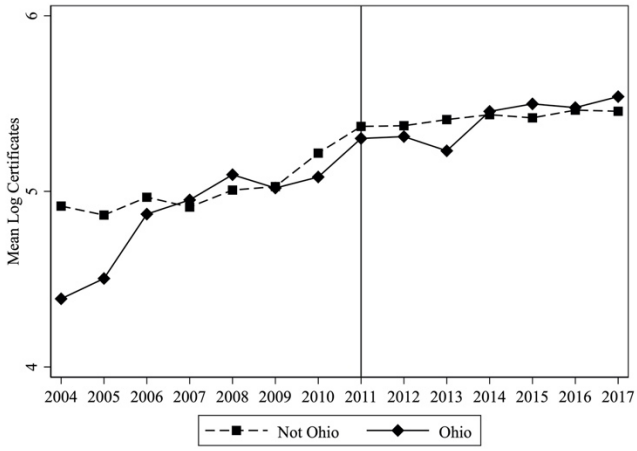


Table 3-4 provides the difference-in-differences estimates for associate degrees and certificates for all two-year institutions in Ohio compared to the matched sample. Five models are presented. Model 1 has no controls but includes year and institution fixed effects. Model 2 adds a control for county-level unemployment to Model 1 (main model specification). Model 3 builds on Model 2 by including enrollment control variables (logged FTE, percentage of part-time enrollment, percentage of white students). Model 4 removes the enrollment controls and adds financial controls (logged student tuition, percentage of operating cost from state) to Model 2. Model 5 contains all control variables. As explained in the methods section, five models are constructed to test the sensitivity of the analysis, but Model 2 is the preferred specification.

Overall, each coefficient estimate for the effect of PBF on associate degree production is negative; however statistical significance and magnitude varies by model. The first two models indicate that the PBF policy had a negative effect on associate degree production, such that Ohio two-year institutions produced 12% and 13% fewer associate degrees after PBF was implemented relative to the matched institutions, respectively ($p < 0.05$ for each). However, once enrollment and financial controls were added to the model, the estimates are smaller (7% to 4%) and no longer statistically significant.

For this analysis, Model 2 is my preferred specification because institutions are matched on enrollment, student body composition, tuition, state support, unemployment rates, and the outcome of interest prior to PBF implementation. However, I include Models 3 through 5 as alternative specifications because prior research on PBF policy has included a similar set of controls (see Hillman et al., 2018). However, as discussed in the methods section, additional controls for enrollment trends and financial trends may overfit the models and potentially over control for the effects of PBF. Enrollment and financial circumstances could be affected by PBF policies and therefore, should not be included in the model. For example, Kelchen (2018) examines the effect of PBF on enrollment, and Kelchen and Stedrak (2016) investigate the effect of PBF on institutional financial characteristics. In a regression framework such as difference-in-differences, it is inappropriate to include control variables that could be affected by the treatment variable (Lechner, 2011).

Table 3-4. Difference-in-Differences Coefficients by Model Specification

Outcome	Model 1	Model 2	Model 3	Model 4	Model 5
Associate degrees	-0.12*	-0.13*	-0.07	-0.07	-0.04
	(0.05)	(0.05)	(0.04)	(0.05)	(0.04)
Certificates	0.11	0.11	0.19	0.15	0.22
	(0.21)	(0.21)	(0.20)	(0.20)	(0.20)
Institution FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
County-level control	NO	YES	YES	YES	YES
Enrollment controls	NO	NO	YES	NO	YES
Financial controls	NO	NO	NO	YES	YES

Note: Each coefficient is a separate regression. Outcome is logged. Robust standard errors clustered at the institution level. County-level control includes county-level unemployment. Enrollment controls include logged FTE, percent part-time enrollment, percent white enrollment. Financial controls include log student tuition and percent operating cost from state. Propensity score matching technique is one-to-one with replacement.
***p<.001; **p<.01; *p<.05

Table 3-4 also provides the difference-in-differences estimates for certificates for all Ohio two-year institutions compared to matched institutions using the five models specified above. While the coefficients are positive and range in magnitude from 11% to 22%, none are

statistically significant. Thinking back to Figure 3-2, the trend line for Ohio was fluctuating relative to the matched sample, suggesting greater variability in certificate production in Ohio than the matched institutions. The standard errors for the models presented in Table 3-4 for certificates are approximately four times larger than the standard errors for associate degrees presented in the same table, suggesting that there is a higher degree of variability in this outcome, which could be contributing to the non-statistically significant findings.

Subgroup Analysis

To investigate the relationship between funding changes and student outcomes in Ohio after PBF was implemented, I examined the mean number of associate degrees and certificates for institutions that experienced large increases in funding and institutions that experienced small increases or decreases. Figure 3-3 depicts the mean number of associate degrees and certificates for institutions that experienced large funding increases. From 2004 through 2011, there was a small increase in associate degree production and substantial increases from 2010 to 2012. After 2012, associate degree production remained flat for institutions that experienced large increases in funding, suggesting that PBF did not have a substantial effect on this outcome.

From 2004 through 2011, certificate production was, in general, on the rise for two-year institutions in Ohio that experienced large increases. After 2011 and the implementation of PBF, certificate production continued to increase. Given that certificate production was already on the rise, it is difficult to determine if PBF implementation is related to the continued increase in certificates.

Figure 3-3. Mean Associate Degree and Certificates for Institutions with Large Increases

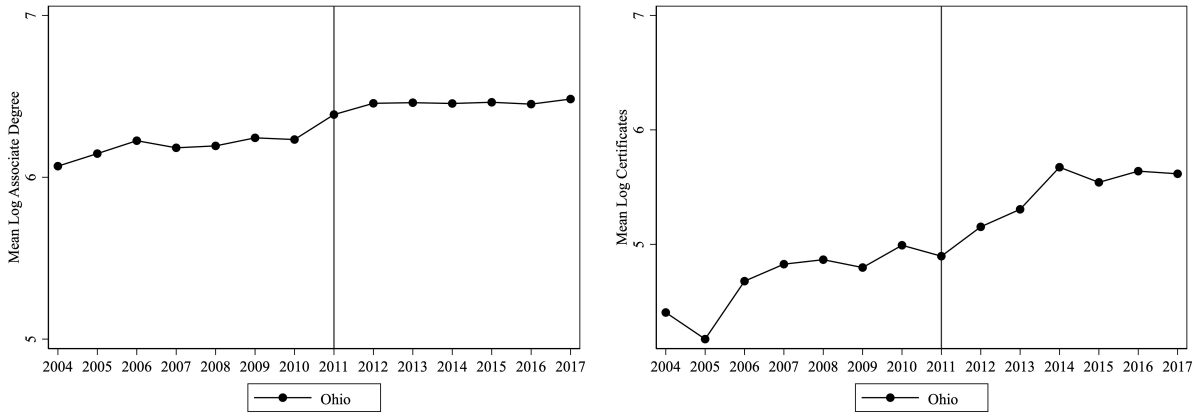
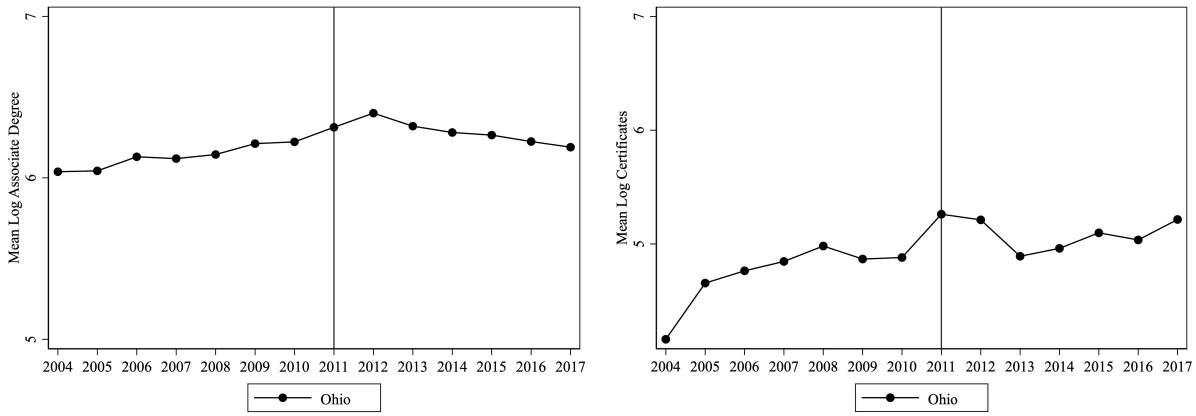


Figure 3-4 illustrates the mean number of associate degrees and certificates for two-year institutions that experienced small increase or declines in SSI funding after PBF was implemented in Ohio. For these institutions, prior to 2011 and the implementation of PBF, associate degree production was slightly increasing. Initially after PBF implementation, associate degree production increased in 2012 but declined each year after that. For institutions with small increases or declines, certificate production was rising prior to PBF but then declined in 2012 and 2013. After 2013, certificate production, in general, has increased. Overall, these graphs suggest that receiving small increases or declines in funding is unlikely to be related to increased student success outcomes and suggests that it might lead to declines in associate degrees.

Figure 3-4. Mean Associate Degree and Certificates for Institutions with Small Increases or Declines



Overall, this descriptive analysis of institutions that experienced different outcomes under PBF policies does not illustrate a clear association between changes in funding and substantial changes in student outcomes. In general, institutions that received additional funding seemed to on an upward trend prior to substantial increases in funding after PBF. For institutions that did not receive large increases, associate degree production possibly declined and certificate production was inconsistent after PBF implementation.

Falsification Test

To test the robust of the associate degree statistically significant findings for all Ohio institutions, I conducted a falsification test where the treatment was implemented in 2005, 2006, 2007, 2008, 2009, and 2010 for the overall sample using the main difference-in-difference specification that was limited to prior to 2011, the actual year of treatment. Assigning treatment to years prior to PBF implementation tests whether any statistically significant finding is likely due to the treatment or some other confounding variable. Overall, this falsification test produced non-significant coefficients for all the placebo treatment years for associate degrees. See Appendix E for the results of this falsification test. The PBF policy was not significantly related to certificate production; therefore, a falsification test for this outcome was not conducted.

Discussion

Performance-based funding policies have increased in popularity across the country in recent years (Dougherty & Natow, 2015). However, the effectiveness of the policy is still in question. Previous research on Ohio's PBF policy has investigated the average effect of the policy across two-year institutions (e.g., Hillman et al., 2018). For this analysis, I investigate whether there is a significant effect of Ohio's PBF policy compared to matched institutions that never experienced PBF policies.

This analysis indicates that Ohio's PBF policy significantly decreased associate degree production after the policy was implemented, relative to institutions that never experienced PBF policies. Specifically, the preferred model indicates that associate degree production decreased by 13% relative to matched institutions. The decline in associate degrees for all institutions suggests that the principal-agent relationship and resource dependency between two-year institutions and the state may be weakening. As Ohio institutions were subjected to PBF policy that prioritized associate degree, they likely had to pivot to other funding sources. For example, institutions could have increased tuition and fees, reduced salaries of faculty and staff, reduced their workforce, or eliminated programs and degrees that were cost inefficient in order to balance their budgets. These changes to other funding sources likely resulted in less of a concern for institutions regarding the state incentivized goals, such as associate degrees. For this study, the effect of Ohio's PBF policy on certificates was also examined. Overall, there was no effect of Ohio's PBF policy on certificate production for all institutions. Prior research on PBF policies has found that institutions typically make changes at the certificate margin because certificates take less time for students to earn. However, I did not find that result for Ohio.

Examining the institutions that experience large increases in funding, I found that associate degree production flatlined and certificate production stayed on trend after PBF was implemented related to prior years. This descriptive analysis suggests that PBF implementation may have hindered associate degree production and had no relationship to certificate production for those institutions that were able to increase funding under the policy. Given that these institutions received additional state funding that is tied to student outcomes, the expectation is that these outcomes would continue to increase after implementation.

There is a different pattern for Ohio two-year institutions that experienced small increases or decreases in SSI funding because of PBF. For these institutions, associate degree production was rising prior to 2011. After 2011, production continued to rise in 2012 but then declined each year after, suggesting that this upward trend has now changed to a downward trajectory. Given that this happened close to PBF implementation, it is possible that PBF implementation is negatively related to associate degree production for these institutions.

For certificates, there was a substantial increase in certificate production from 2004 through 2011. However, once PBF was implemented, certificate production declined and then started to rise after 2013. As noted in the results section, certificate production in Ohio was sporadic during this time period. Future research should examine the variability of certificate production to understand which institutions experienced large changes over time and possibly investigate why. Certificates are a part of the completion portion of Ohio's PBF policy. However, they are reimbursed at half the amount of associate degrees. Therefore, it is possible that Ohio institutions responded differently to the certificate incentive because it was less than the associate degree incentive. The principal-agent relationship codified by incentivizing certificates at half the rate of associate degrees may have resulted in institutions potentially disregarding this student success outcome. Additionally, the reduced reimbursement amount for certificates may have negatively affected the resource dependency between the state and the institutions for this specific metric. A lower amount of money for certificates may have shifted the resource dependency relationship toward other funding sources not incentivized by PBF.

Conclusion

Overall, Ohio's PBF policy affected associate degree production but not certificate production. Two-year institutions in Ohio reduced the number of associate degrees produced

after PBF was implemented. Performance-based funding policies are intended to increase student success outcomes through an explicit contract between the state and institutions and increased resource dependency on student success metrics. Because of this contract, institutions should focus on student success outcomes incentivized by the policy. These findings suggest that the policy is not working as intended and institutions are decreasing associate degree production. More research on Ohio specifically and other states that have implemented PBF to understand the differential effects of PBF policies at the institution level is needed to thoroughly understand the effect of the policy at the micro-level.

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Appendix A

Table A3. Performance-Based Funding by State and Year for Two-Year Institutions

State	04	05	06	07	08	09	10	11	12	13	14	15	16	17
AK														
AL														
AR				X	X	X		X	X	X	X	X		
AZ														
CA														
CO	X							X	X	X	X	X	X	X
CT														
DE														
FL												X	X	X
GA			X	X	X									
HI								X	X	X	X	X	X	X
IA														
ID	X	X												
IL								X	X	X	X	X	X	X
IN				X	X	X	X	X	X	X	X	X	X	X
KS	X	X	X	X	X					X	X	X		
KY														
LA	X	X	X	X	X	X	X	X	X	X	X	X		
MA										X	X	X	X	X
MD														
ME														
MI									X	X	X	X	X	X
MN										X	X	X	X	X
MO										X	X	X	X	X
MS														
MT										X	X	X	X	X
NC	X	X	X	X	X				X	X	X	X	X	X
ND										X	X	X	X	X
NE														
NH														
NJ														
NM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NV										X	X	X	X	X
NY	X	X	X	X	X	X	X	X	X	X	X	X		
OH	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OK	X	X	X	X	X	X	X	X	X	X	X	X		
OR														
PA														
RI														
SC														
SD														
TN	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TX				X	X	X	X	X		X	X	X	X	X
UT										X	X	X	X	X
VA		X	X	X	X	X	X	X	X	X	X	X		
VT														
WA				X	X	X	X	X	X	X	X	X	X	X
WI										X	X	X	X	X
WV														
WY									X	X	X	X	X	X

Appendix B

Table B3. SSI Funding Change for Ohio Two-Year Institutions: FY 2015 to FY 2020

Institution	2015	2020	Difference	% Difference
BELMONT TECH	5,129,052	4,418,369	-710,683	-14%
HOCKING	13,302,962	11,834,514	-1,468,449	-11%
OWENS STATE	30,562,911	27,786,163	-2,776,748	-9%
ZANE STATE	8,307,840	7,665,740	-642,100	-8%
CENTRAL OHIO	11,643,240	11,578,902	-64,338	-1%
CINCINNATI STATE	28,392,404	28,611,236	218,832	1%
TERRA STATE	6,269,134	6,442,459	173,325	3%
SOUTHERN STATE	7,766,644	8,104,376	337,733	4%
WASHINGTON STATE	5,430,116	5,698,532	268,416	5%
JAMES RHODES ST.	10,350,179	10,994,396	644,217	6%
STARK STATE	27,412,507	29,169,236	1,756,729	6%
LAKELAND	18,594,461	20,544,155	1,949,694	10%
RIO GRANDE	5,238,686	5,827,329	588,643	11%
CUYAHOGA	63,733,701	71,627,984	7,894,283	12%
EDISON STATE	7,684,861	8,692,972	1,008,111	13%
COLUMBUS STATE	61,150,177	69,790,276	8,640,099	14%
MARION TECH	6,713,619	7,811,254	1,097,635	16%
NORTHWEST STATE	9,693,959	11,350,856	1,656,897	17%
SINCLAIR	42,916,034	51,429,660	8,513,626	20%
NORTH CENTRAL	7,346,492	8,830,630	1,484,138	20%
LORAIN COUNTY	24,541,622	30,678,558	6,136,936	25%
CLARK STATE	11,154,767	15,165,207	4,010,440	36%
EASTERN GATEWAY	5,766,060	11,373,448	5,607,387	97%

Appendix C

Table C3-1. Balance Table Prior to Propensity Score Matching: 2010 and Prior One-to-One Matching Without Replacement

Variables	Ohio	All Other	P-Value
Logged FTE	8.19	8.18	0.93
% part-time enrolled	52.33	58.18	0.00
% white enrolled	82.14	58.42	0.00
Logged student tuition	8.38	7.73	0.00
% operating budget from state	31.79	32.05	0.83
Unemployment rate	7.58	6.93	0.01
Logged associate degrees	6.15	6.00	0.03
Logged certificates	4.71	5.04	0.00

Table C3-2. Balance Table After Propensity Score Matching: 2010 and Prior One-to-One Matching Without Replacement

Variables	Associate Degree Match			Certificate Match		
	Ohio	Matched	P-Value	Ohio	Matched	P-Value
Logged FTE	8.22	8.22	0.99	8.21	8.27	0.51
% part-time enrolled	53.77	54.00	0.85	53.72	53.20	0.69
% white enrolled	82.28	82.50	0.84	82.36	83.27	0.43
Logged student tuition	8.31	8.33	0.47	8.31	8.30	0.55
% operating cost from state	31.79	30.40	0.19	31.72	30.33	0.19
Unemployment rate	7.56	7.31	0.44	7.58	7.15	0.17
Logged outcome	6.20	6.23	0.74	4.85	4.96	0.41
Number of observations off common support		2			2	

Table C3-3. Balance Table After Propensity Score Matching: 2010 and Prior One-to-One Matching with Replacement

Variables	Associate Degree Match			Certificate Match		
	Ohio	Matched	P-Value	Ohio	Matched	P-Value
Logged FTE	8.22	8.22	0.98	8.21	8.25	0.63
% part-time enrolled	53.77	54.50	0.55	54.72	51.89	0.16
% white enrolled	82.17	82.38	0.86	82.26	83.60	0.25
Logged student tuition	8.31	8.30	0.91	8.31	8.29	0.39
% operating cost from state	31.82	31.20	0.55	31.75	30.68	0.28
Unemployment rate	7.50	7.52	0.97	7.52	7.57	0.87
Logged outcome	6.20	6.22	0.79	4.86	5.02	0.18
Number of observations off common support		2			2	

Table C3-4. Balance Table After Propensity Score Matching: 2010 and Prior Nearest 2 Neighbors

Variables	Associate Degree Match			Certificate Match		
	Ohio	Matched	P-Value	Ohio	Matched	P-Value
Logged FTE	8.22	8.20	0.83	8.21	8.27	0.49
% part-time enrolled	53.77	54.12	0.79	53.72	52.77	0.45
% white enrolled	82.17	82.56	0.74	82.26	82.34	0.95
Logged student tuition	8.31	8.31	0.94	8.31	8.28	0.32
% operating cost from state	31.82	30.71	0.28	31.75	30.39	0.21
Unemployment rate	7.50	7.61	0.74	7.52	7.85	0.32
Logged outcome	6.20	6.20	0.99	4.86	4.98	0.35
Number of observations off common support		2			2	

Table C3-5. Balance Table After Propensity Score Matching: 2010 and Prior Nearest 3 Neighbors

Variables	Associate Degree Match			Certificate Match		
	Ohio	Matched	P-Value	Ohio	Matched	P-Value
Logged FTE	8.22	8.22	0.97	8.21	8.26	0.61
% part-time enrolled	53.77	53.89	0.92	53.72	53.10	0.63
% white enrolled	82.17	82.55	0.75	82.26	81.82	0.72
Logged student tuition	8.31	8.30	0.89	8.31	8.30	0.55
% operating cost from state	31.82	31.20	0.57	31.75	30.71	0.35
Unemployment rate	7.50	7.51	0.98	7.52	7.88	0.27
Logged outcome	6.20	6.22	0.85	4.86	4.93	0.54
Number of observations off common support		2			2	

Table C3-6. Balance Table After Propensity Score Matching: 2010 and Prior Nearest 4 Neighbors

Variables	Associate Degree Match			Certificate Match		
	Ohio	Matched	P-Value	Ohio	Matched	P-Value
Logged FTE	8.22	8.20	0.79	8.21	8.25	0.70
% part-time enrolled	53.77	53.96	0.88	53.72	52.78	0.46
% white enrolled	82.17	82.62	0.70	82.26	82.15	0.93
Logged student tuition	8.31	8.30	0.80	8.31	8.30	0.55
% operating cost from state	31.82	31.65	0.88	31.75	30.88	0.43
Unemployment rate	7.50	7.51	0.88	7.52	7.79	0.41
Logged outcome	6.20	6.19	0.85	4.86	4.92	0.64
Number of observations off common support		2			2	

Table C3-7. Difference-in-Differences Coefficients: Main Model with Different PSM Strategies - Associate Degrees

Outcome	1-to-1 w/o replacement	1-to-1 with replacement	Nearest 2	Nearest 3	Nearest 4
Associate degrees	-0.12*	-0.13*	-0.10*	-0.11*	-0.11*
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)
Institution FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
N	1372	1190	1624	1792	1904
R^2	0.94	0.94	0.94	0.95	0.96

Note: Outcome is logged. Robust standard errors clustered at the institution level. Control includes county-level unemployment.

***p<.001; **p<.01; *p<.05

Table C3-8. Difference-in-Differences Coefficients: Main Model with Different PSM Strategies - Certificates

Outcome	1-to-1 w/o replacement	1-to-1 with replacement	Nearest 2	Nearest 3	Nearest 4
Certificates	0.08	0.11	0.06	0.04	0.07
	(0.20)	(0.21)	(0.20)	(0.20)	(0.20)
Institution FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
N	1298	1132	1551	1769	1867
R^2	0.82	0.82	0.81	0.80	0.79

Note: Outcome is logged. Robust standard errors clustered at the institution level. Control includes county-level unemployment.

***p < 0.001; **p < 0.01; *p < 0.05

Appendix D

Figure D3-1. Common Support for One-to-One Matching Without Replacement

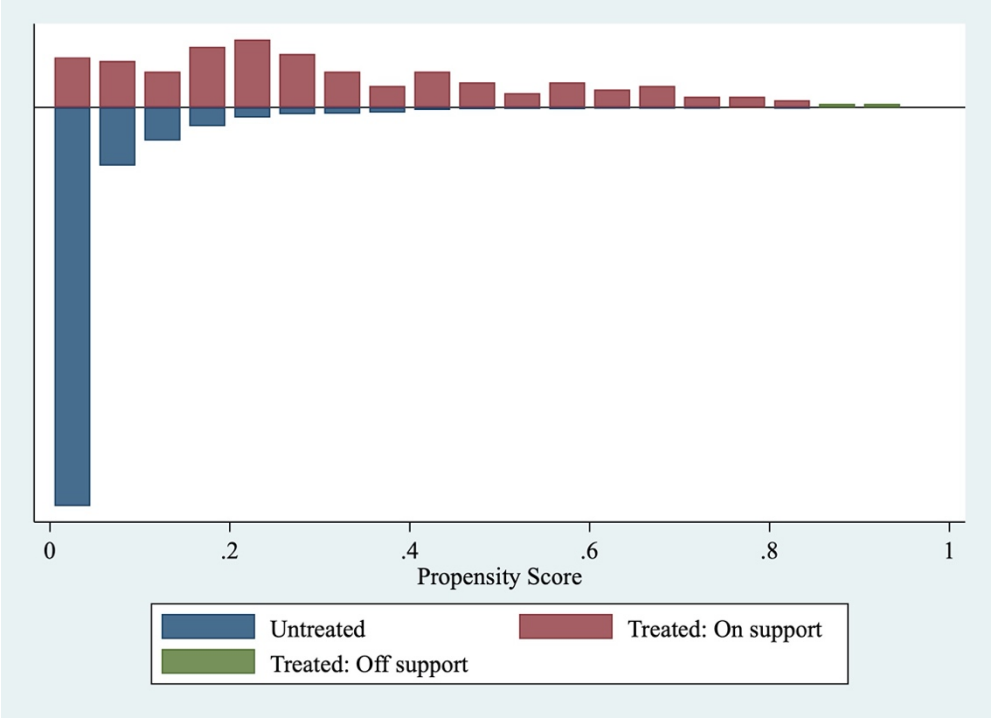


Figure D3-2. Common Support for One-to-One Matching with Replacement

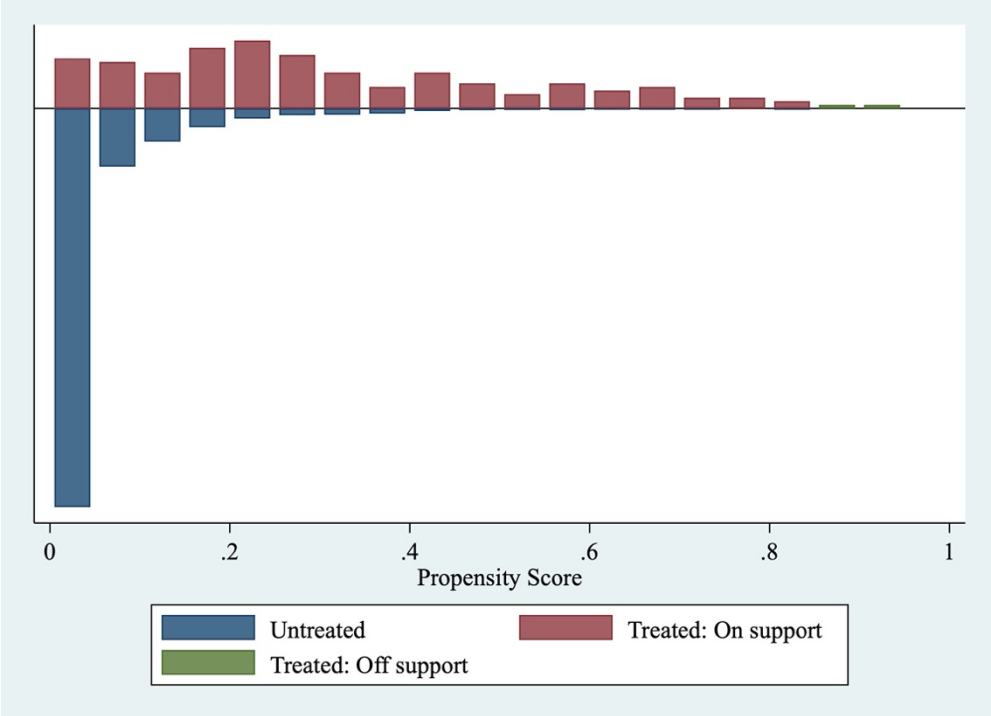


Figure D3-3. Common Support for Nearest Two Neighbors

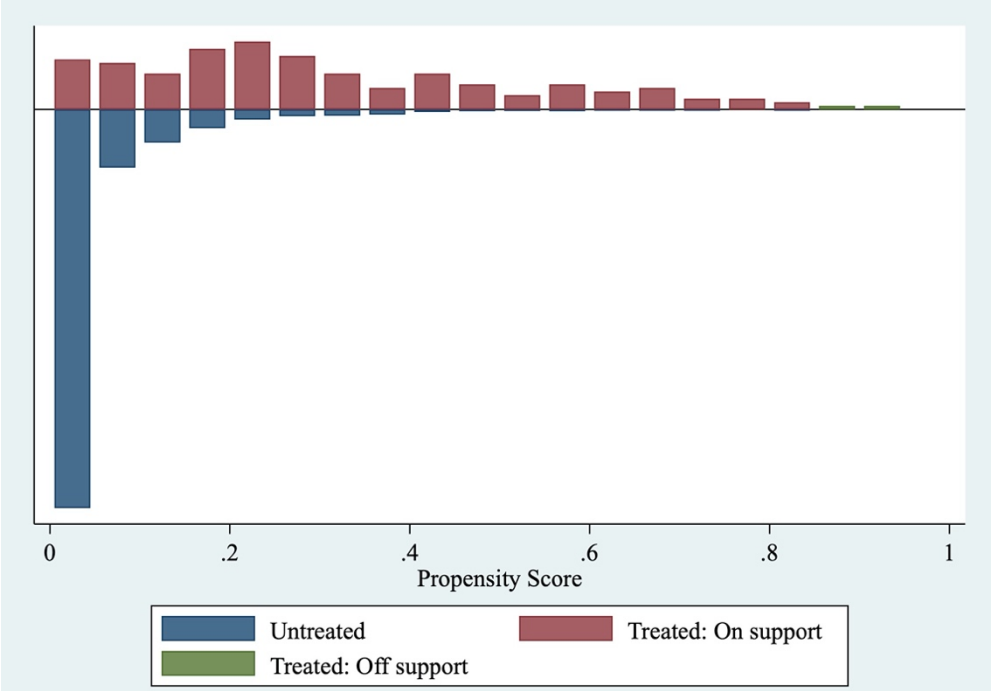


Figure D3-4. Common Support for Nearest Three Neighbors

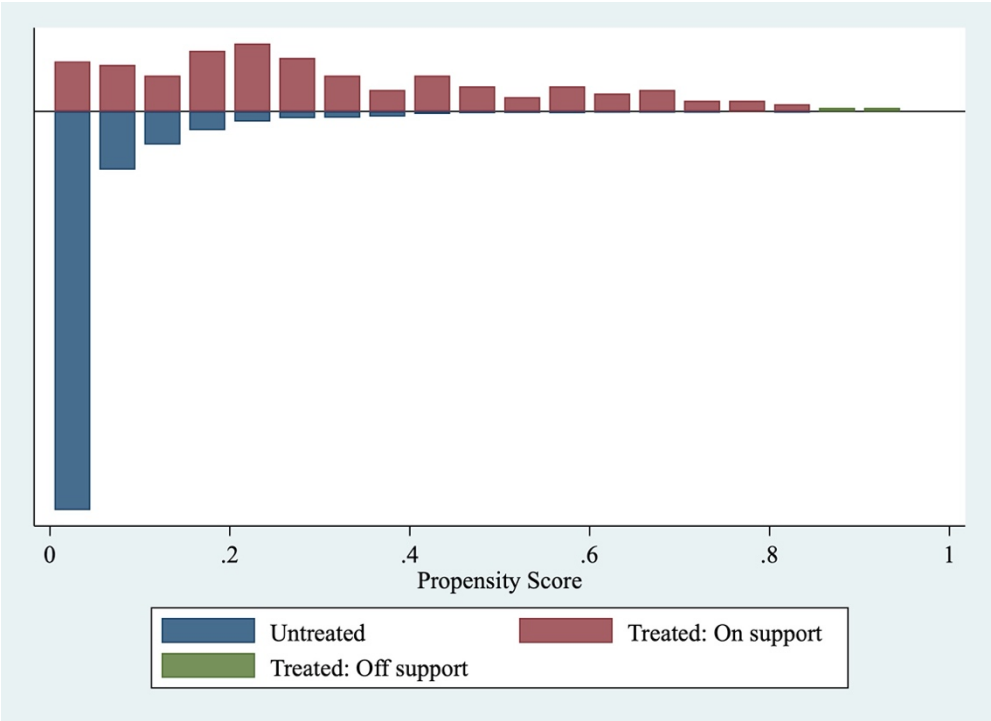
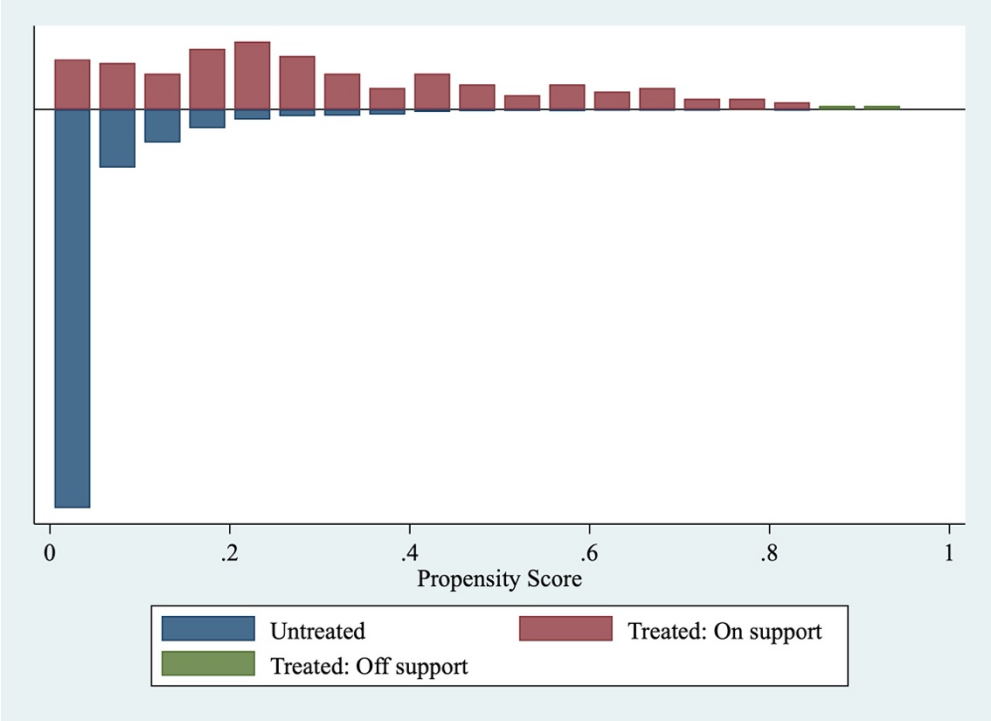


Figure D3-5. Common Support for Nearest Four Neighbors



Appendix E

Table E3-1. Falsification Difference-in-Differences Coefficients: Main Model with Different Treatment Years - Associate Degrees

Outcome	2005	2006	2007	2008	2009
Associate Degrees	-0.03	-0.02	-0.06	-0.05	-0.06
	-0.05	-0.05	-0.05	-0.05	-0.05
Institution FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
N	595	595	595	595	595
R^2	0.96	0.96	0.96	0.96	0.96

Note: Outcome is logged. Robust standard errors clustered at the institution level. Control includes county-level unemployment.

***p < 0.001; **p < 0.01; *p < 0.05

CHAPTER 4

Whose Performance? Staffing Changes in Response to Performance-Based Funding

Increased calls for higher education accountability recently gained urgency in the context of rising college prices, increased student loan debt, stagnant completion rates, concerns that undergraduate students are ill prepared for the workforce, and decreased state financial support allocated to public institutions (Deming & Figlio, 2016, Keating et al., 2005; U.S. Department of Education, 2015). One approach taken by state legislatures to bolster accountability is the implementation of performance-based funding (PBF) policies, which aim to hold institutions accountable to the state by tying state appropriations to specific student outcomes such as completion, persistence, or transfer rates. These policies have garnered support from numerous high-profile organizations advocating for increased higher education attainment such as the Lumina Foundation (2009), National Governors Association (Reindl & Jones, 2012), and Complete College America (Jones, 2013). Such support, combined with the precarious financial situation of many state budgets, has led to the rapid diffusion of PBF policies to 32 states as of fiscal year 2019 (Boelscher & Snyder, 2019).

Research on the effectiveness of PBF policies in improving targeted outcomes has generally found that the policy intervention is ineffective (Bell, Fryar, & Hillman, 2018). Several studies have found PBF policies to lead to no improvement of graduation and retention rates (e.g., Hillman, Tandberg, & Gross, 2014; Rutherford & Rabovsky, 2014; Sanford & Hunter, 2011; Tandberg & Hillman, 2014). In fact, some scholars have found PBF policies to result in

potentially detrimental unintended consequences, such as restricting access to higher education for marginalized students (Dougherty et al., 2016; Li & Zumeta, 2016; Umbricht et al., 2015). The effectiveness of PBF policies as tools for improving outcomes of public institutions depends in large part on how institutions respond to such policies; that is, how institutions change their approach to serving students when subjected to PBF policies. However, research into institutional actions in response to PBF remains quite sparse.

Therefore, the purpose of this study is to focus on one potential area institutional administrators could adjust in response to the implementation of PBF policies: the composition of faculty and staff directly serving students. The composition of institutions' staff is an important mechanism for improving student outcomes, as higher education employees shape students' collegiate experiences and prospects for academic success (Winston, Creamer, & Miller, 2013). For example, access to academic advisers (Bahr, 2008) and the frequency of interactions with advisers (Swecker, Fifolt, & Searby, 2013) are both associated with persistence and graduation – as is the presence of staff directly and indirectly involved in the provision of student services and support (Kuh et al., 2008; Chen, 2012). Faculty also greatly influence student outcomes: higher shares of part-time faculty are associated with lower graduation rates (Jacoby, 2006), and larger class sizes generally lead to worse outcomes (Monks & Schmidt, 2010). Therefore, improving the student outcomes codified in PBF policies may require institutions to change their staffing strategies to increase resources dedicated to functions more directly associated with student success, either by altering the composition or percent of staff and faculty. On the other hand, if PBF policies introduce uncertainty to institutional budgets and leaders in these institutions may be hesitant to commit resources to increased staffing, constraining such a response. The absence of changes to staff allocation or levels may explain

previous null findings on the effects of PBF policies on student success. Indeed, we find that public four-year and two-year institutions operating under PBF do not adjust the level or composition of faculty or staff or full-time faculty salaries, at least in the short run.

In the sections that follow, we first review the literature on PBF with an emphasis on its history, the effect of the policy on desired outcomes, and institutional responses to its implementation. We also discuss the relationship between faculty and staff and student outcomes. Second, we introduce our guiding conceptual framework comprised of principal-agent theory, education production function, and systems theory. We then discuss the data, dependent variables, and methods utilized in this analysis. Finally, we end with our results, discussion, and policy implications.

Literature Review

Performance-Based Funding History

Performance-based funding policies in higher education date back to 1979, when Tennessee adopted such a policy for its public four- and two-year institutions (Burke & Associates, 2002). Other states did not follow Tennessee's lead until approximately a decade later (Burke & Associates, 2002; Dougherty & Natow, 2015). This wave of policies, typically termed "performance-based funding 1.0," conditioned bonus funds on long-term student outcomes such as graduation and job placement rates, along with a few short-term measures such as retention and credit completion (Dougherty & Reddy, 2011, 2013). Importantly, PBF 1.0 policies left base allocations to institutions untouched; those monies were not subject to performance expectations. The economic recession of the early 2000s put significant strain on states' budgets, prompting elimination of PBF 1.0 policies as legislators sought ways to reduce expenditures (Dougherty & Natow, 2015). Combined with inadequate buy-in for such policies

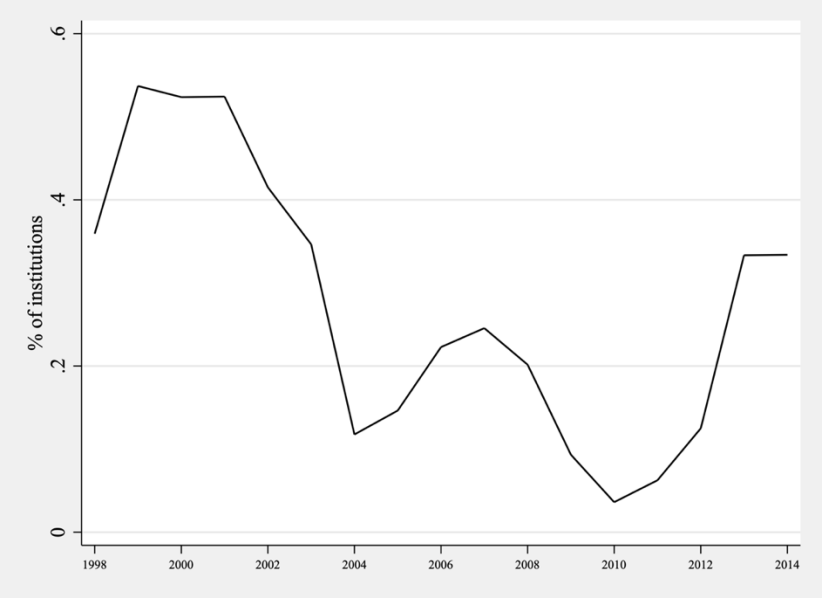
from leaders of public institutions (Snyder, 2015), along with their limited impact on student success, the early 2000s saw the majority of states abandon PBF policies (Miao, 2012).

Performance-based policies experienced a resurgence in 2007, due to increasing tuition rates and cost to states (Dougherty et al., 2016). This new wave of PBF policies, dubbed "performance-based funding 2.0," differed significantly from earlier policies in several ways. Most prominently, these newer policies typically allocate at least a portion of *base funding* on institutional performance, in contrast to PBF 1.0 policies' use of bonus funding to incentivize institutions (Dougherty & Reddy, 2011). These new policies also tend to emphasize short-term metrics (such as course completion) that build to longer-term outcomes, such as degree completion (Offenstein & Shulock, 2010). Unlike PBF 1.0, many new PBF policies attempt to account for differences in mission across institutions, by providing additional funding for some student groups, such as underprepared students and adult students. In spite of these commonalities among PBF 2.0 policies, meaningful differences remain in terms of each state's implementation, such as variation in sectors covered by the policy or specific performance measures used (Dougherty & Natow, 2015). Our analysis (and the majority of prior studies of PBF) exploits variation in policy implementation over time and across states to estimate their impact, requiring an understanding of how PBF has evolved.

Figure 4-1 depicts the percent of institutions under PBF policies by year, showing the increases and decreases of institutions with PBF policies over time. With regard to the proportion of institutions covered, PBF policies peaked in the later 1990s and early 2000s, and then experienced an overall decline during the 2000s. Beginning in 2010, the percent of institutions under PBF policies climbed steadily with approximately 35% of institutions subject to such policies in 2014. Figure 4-2 illustrates the percent of institutions covered by PBF by year and

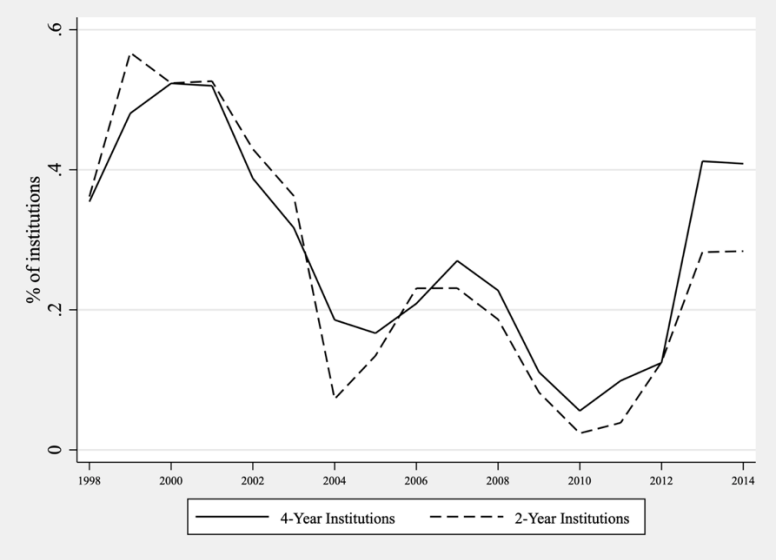
sector. Four- and two-year institution follow a similar trend line until about 2012, with a lower proportion of two-year institution subjected to PBF in recent years.

Figure 4-1. Percent of Institutions Covered by PBF Policies by Year



Note: All public institutions in the U.S.

Figure 4-2. Percent of Institutions Covered by PBF Policies by Year and Sector



Note: All public institutions in the U.S.

Performance-Based Funding Policies and Student Outcomes

Given the prevalence of PBF policies and the important goals that policymakers have attached to such policies, it is not surprising that there is a large body of research that seeks to understand the efficacy of PBF policies. Much of this literature employs quasi-experimental methods to estimate the effects of PBF policies on outcomes such as retention and graduation. Results from prior studies are generally mixed, with some evaluations examining degree completion finding null (e.g., Tandberg, Hillman, & Barakat, 2014), negative (Rutherford & Rabosky, 2014), and positive effects (e.g., Hillman, Tandberg, & Fryar, 2015). Further, results vary significantly across states (Tandberg et al., 2014), likely owing to the variation in policy design by state and differences in context for each state's public higher education system. Taken as a whole, a recent meta-analysis by Bell, Fryar, and Hillman (2018) found that the overall average effect size for PBF policies on completion metrics for both four- and two-year institutions was not distinguishable from zero across 11 studies. Even though PBF research has been inconclusive at best, and negative at worst, support for the policy has remained strong and states continue to adopt the policy. For example, California introduced PBF for community colleges for fiscal year 2019-2020.

Of course, PBF policies can have meaningful impacts on institutions in areas unrelated to the stated outcomes of these policies. One such example is evidence of "creaming" by institutions subject to PBF. Kelchen and Stedrak (2016) concluded that PBF policies reduced the Pell grant revenue of public institutions, suggesting these campuses may enroll a relatively more privileged student body in an attempt to improve measured student outcomes. Kelchen (2018) found further evidence of this, as more selective colleges enrolled fewer low-income students once subjected to PBF, though policies incentivizing enrollment of marginalized groups

counteracted such "creaming." For example, Gándara and Rutherford (2018) found that institutions with premiums increased enrollment of low-income and Hispanic students relative to institutions with a PBF policy without premiums for underrepresented students. However, Li and Ortagus (2017) observed a reduction in the proportion of adults over 25 served in Tennessee community colleges, which served a larger share of traditional students. They also found an increase in the granting of short- and medium-term certificates even as the number of two-year associate degrees remained stagnant, which may or may not be in the best interest of the student and may suggest some gaming of completion metrics by institutions. Such unintended consequences are frequently observed in accountability efforts in K-12 education as well (Deming & Figlio, 2016).

Performance Based Funding and Institutional Change

Student success outcomes incentivized by PBF policies are, to some extent, a product of institutional efforts themselves. A smaller body of PBF research addresses institutional responses to these policies. Kelchen and Stedrak (2016) investigated the patterns of revenue and expenditures for two- and four-year institutions located in PBF states compared to patterns at institutions in states without PBF. They found that revenues and expenditures remained largely unchanged in response to PBF policies, except for a reduction in revenue from Pell grants. The absence of changes to expenditures can have any number of implications: that leaders believe their institutions are already spending most efficiently; that PBF does not represent a sufficiently meaningful incentive to modify institutional operations and expenditures; or that institutions are somehow constrained in how they allocate monies regardless of purported incentives from PBF policies. Additionally, Rabovsky (2012) found that PBF did not change institutional priorities as spending on research or instruction did not significantly change after PBF was implemented.

Presumably, any fluctuations in student success outcomes attributable to PBF should be preceded by organizational changes influenced by these same policies. Extensive prior qualitative work has investigated institutional responses to PBF policies. Dougherty and Hong (2006) found that several administrators indicated that they adapted their developmental education curriculum, adopted new orientation programs, and abandoned academic programs with low student success outcomes as a result of PBF policies, suggesting that some institutions may be willing to adapt in light of PBF policies. However, participants from this study noted that their institutions decreased academic rigor and limited admissions to certain programs, a possible unintended consequence of PBF policies. Research by Li (2018) focused on a single suburban community college in Washington found that administrators made internal changes at the department and institution level to address student success outcomes. However, faculty resisted adapting because they felt as if they already focused on student learning and achievement. In another qualitative study, Harbour and Nagy (2005) found that community colleges responded to PBF policies in a variety of ways, including creating a new advising center, hiring new instructors, forming administrative positions to oversee the institutional response to PBF, focusing on academic programs that required licensure exams, and forming new academic initiatives.

However, an extensive study by the Community College Research Center found that institutions in Indiana, Ohio, and Tennessee were resistant to changing internal organizational practices as a result of PBF policies, but that institutions engaged in curricular reforms in light of the policies. In this study, respondents stated that they perceived little to no effort to improve institutional capacity in response to PBF 2.0 policies (Reddy et al., 2014). Additionally, there were many obstacles to implementing changes in reaction to PBF 2.0 policies, such as the

student body composition of their institution, limited institutional capacity, and a lack of understanding of the policy itself (Pheatt et al., 2014). However, many administrators reported that their institutions made changes to their curricular offerings as a result of PBF policies. For example, participants from at least four institutions indicated that changes were made to course and transfer agreements, science, technology, engineering, and math academic fields, and graduation requirements (Natow et al., 2014). Additionally, Thornton and Friedel (2016) studied four rural institutions' responses to PBF, finding they made programmatic changes to their curriculum and student services, such as creating master schedules, adding stackable credentials, increasing the number of dual credit courses, and increasing staff and resources in student service departments.

Institutional Staff and Student Outcomes

For this study, the relationship between PBF policies and changes in faculty and staff composition is examined because we hypothesize that institutions need to make changes at the faculty and staff margin in order to change student success outcomes. Faculty shape the in-class learning experience and can influence the trajectory of many students each semester. Prior research suggests that there is a negative association between part-time faculty and student success, such that as the percentage of part-time faculty increases, graduation rates decline (Jacoby, 2006). Larger class sizes are associated with worse in-class experiences for both students and faculty (Monks & Schmidt, 2010) and decreased student retention and graduation (Millea et al., 2018), suggesting that the number of faculty and the number of overall courses taught is important for student success. Further, courses taught by adjunct faculty and graduate research assistants decrease interest in subsequent courses relative to full-time faculty (Bettinger & Long, 2004), suggesting that it matters who teaches courses.

In addition to faculty composition being associated with student success and continued interest in higher education, prior research has found that higher education professionals who work with students outside of the classroom are critical to student success. For example, Bahr (2008) found that meeting with an academic advisor was positively associated with students successfully completing remedial math and transferring and was particularly beneficial for underserved populations. Not only is meeting with an academic advisor important, but the frequency that students are able to meet with an advisor is also associated with student success. Swecker, Fifolt and Searby (2013) found that for every additional advisor meeting that a student had, the chances of a student being retained increase by 13%. Prior research also indicates that as institutional expenditures allocated to student services increases, student drop out decreases (Chen, 2012).

In summary, research on institutional responses to PBF policies suggests at least some efforts to shift resources toward departments providing direct service to students. These departments operate at the front lines of students' experiences and are positively associated student success. Therefore, moving more resources to faculty and staff should be critical for the theory of action undergirding PBF, as they link together the incentives these policies intend to create, the actions institutions take in response that affect students, and the observed student outcomes. This study seeks to add to the understanding of the first-stage response to PBF policies. In other words, we seek to understand how PBF policies potentially affect the staffing composition of institutions as a means to improve student success outcomes.

Conceptual Framework

This study combines three theoretical perspectives. Specifically, we draw on principal-agent theory (PAT) to highlight the need to align the many decisions made by institutional staff

with the goals of key stakeholders (Deming & Figlio, 2016; Li, 2018). To this PAT lens, we add a simple education production function to inform a connection between inputs (e.g., staff) and outcomes (Bowles, 1970). Finally, we include a systems theory perspective (Bess & Dee, 2008; Parsons, 1951) to conceptualize the actions of institutions when state-level policy changes occur.

Principal-agent theory describes a complex, contractual relationship between independent but connected parties (e.g., individuals, groups, organizations; Mitnick, 1975; Ross, 1973). In this relationship, an external group (i.e., the principal) attempts to control the actions of the other party (i.e., the agent) through incentives (e.g., funding) because the principal wants to control the goals of the agent and does not have the time or expertise to complete a specific task (Jensen & Meckling, 1976). With regard to state governments and postsecondary institutions, state governments act as the principal and the postsecondary institutions are the agents.

In order to complete specific tasks, such as educating citizens beyond high school, the principal (i.e., state government) contracts with the agent (i.e., postsecondary institutions) because experts reside within the agents' organizations. Typically, experts have differing knowledge (i.e., information asymmetry) and goals (i.e., goal misalignment) then the principal (Eisenhardt, 1989; Moe, 1984). Information asymmetry and goal misalignment between agents and principals often leads to agents not acting in the best interest of the principals (i.e., "shirking"), causing principals to create monitoring mechanisms, such as contracts and report requirements (Fiorina, 1982; Jensen & Meckling, 1976).

Two ways that principals create contracts and monitoring requirements with agents include behavior-based contracts and outcome-based contracts (Eisenhardt, 1989). For this study, we are interested in outcome-based contracts. Outcome-based contracts reward an agent when it meets a pre-specified target. Within higher education, PBF policies are outcome-based contracts

as institutions are typically rewarded when specific targets or goals are reached. However, there is some uncertainty within some policies that undermine the predictability of outcome-based contracts. In some cases, such as Ohio's PBF policy, there is a set amount of state funding that is distributed depending on the proportion of student success milestones an institution contributes to the total amount of student success metrics. Therefore, for some of the PBF policies, it is impossible to determine how much funding a specific institution will receive in a given year. Therefore, these policies act more like competitions than set contracts that could lead to institutions turning to other revenue sources that are more dependable (e.g., tuition and fees, local taxes).

Ultimately, PAT is grounded in the principal incentivizing the agent to act in a desired way and monitoring those actions through contracts and reporting mechanisms. As such, PBF is one way for state governments to create an explicit outcomes-based contract with higher education institutions, monitor outcomes through reporting, and then reward or punish higher education institutions with funding depending on those outcomes.

Inherent to PBF policies and this principal-agent relationship is an assumption that institutions can achieve improved outcomes for students if properly incentivized. That is, policymakers believe that some gain in productivity – how much education colleges and universities produce given a level of funding – is attainable under the "right" incentives. Implicitly, this suggests that institutions of higher education are perceived as inefficient in some way. An education production function is a useful concept for linking the inputs available to institutions and the outcomes they produce. A simple production function may take the form:

$$y = f(x_1, x_2, \dots, x_j) \quad (1)$$

where y measures outcomes produced from j inputs, with the relationship between the two governed by the function f (see Titus & Eagan, 2016, for details). Higher education is obviously more complex than this simple example, as colleges and universities produce multiple outcomes such as instruction, research, and public service; however, PBF policies tend to focus on a few outcomes, such as degrees produced. For PBF policies to improve efficiency of institutions, administrators of these institutions need the ability to improve the production technology (the function, f) or change the mix of inputs (j) in ways that lead to greater productivity.

There are numerous studies of productivity of public institutions suggesting that colleges and universities are relatively efficient. For example, Titus, Vamosiu, and McClure (2017) concluded that few public master's institutions are cost inefficient, a finding consistent with work by Doyle (2015), who concluded that "based on current standards and best practices, most public 4-year, broad-access institutions do not have a tremendous amount of room for improvement" (p. 104). Among community colleges, there is evidence that these institutions have made gains in efficiency over time (Agasisti & Belfield, 2017), bringing into question whether meaningful improvements are possible through PBF policies.

Given that further gains to the production function of colleges and universities appear suspect, we argue that changes to the mix of inputs (j) presents a more plausible response to PBF policies by institutional leaders. While Kelchen and Stedrak (2016) found no effect of PBF on expenditures, a possible input to adjust, institutions can change the mix of inputs they employ without changing expenditures. An obvious example is the choice of employing fewer tenure-track and more contingent faculty: spending may be the same under either scenario, but changes in the composition of the faculty may alter the student experience in numerous ways. Other changes could be reducing librarians in favor of advisors, increasing academic and career

counselors and removing this responsibility for full-time faculty who then have more time to devote to teaching.

To these economic theories that connect funding to institutions and institutional inputs to educational outcomes, we add a systems theory perspective that argues that institutional resource allocation and decision-making are associated with the characteristics of the system (institution), and the contextual factors that the institution inhabits (policy context). In contrast to PAT, which focuses on actors, systems theory places more emphasis on the context with which decisions are made (Bess & Dee, 2008). Specifically, an institution may undergo change in the face of environmental pressures and expectations imposed by the state (as codified in PBF policies), but the institution will also consider their specific goals in their decision-making process (Hill, 1971). This added perspective focuses attention on the variability within systems (i.e., the state) that influence decision-making and resource allocation.

In a review of the strengths and weaknesses of the use of systems theory in higher education research, Enders (2004) argued that the use of systems theory was important as it helped scholars to conceptualize differences between contexts of multiple actors. For example, the political, demographic, and financial situation in each state is unique, which could influence the adoption and implementation of policy. Similarly, governance structures and actions of institutions will be influenced by the context of the institutional system (Kezar, 2011).

Together, PAT, the education production function, and systems theory help conceptualize the notion that for PBF policies to effectively increase student success outcomes, institutional staffing changes likely have to happen. While PBF policies more closely tie funding to outcomes by strengthening the PAT relationship between institutions and the state, it likely is not possible for institutions to increase their productivity (i.e., outcomes) by leaving the mix of inputs

unchanged. However, as institutions reside in complex systems, it is possible that not all institutions will respond in the same way to the policy, potentially leading to differential responses and effects of PBF policies across states and by institution type. Based on our literature review and conceptual framework, we argue that PBF policies might induce changes to institutional staff (i.e., full- and part-time faculty and student support personnel) as institutions seek to improve outcomes and capture additional funds by changing their inputs; we also expect salaries of full-time faculty to change as either (1) institutions employ a growing share of new faculty members at relatively lower cost than more experienced professors or (2) PBF policies generate increased demand for these functions, causing salaries to rise.

Methods

Data

We draw data from two sources for this study. To identify institutions that are subject to PBF policies, we use reports from the National Conference of State Legislatures (2015) and work by Dougherty and Natow (2015). From these two sources, we identify states that have these policies in place, when these policies were first implemented, and which institutions are subject to the policy (two- and/or four-year). This allows us to create a time-varying indicator for whether each institution is under the purview of a PBF policy, or no performance funding policy (see Appendix A). The second data source is the Integrated Postsecondary Education Data System (IPEDS). The National Center for Education Statistics (NCES) collects and makes public information collected annually for the (approximate) universe of Title IV eligible institutions. IPEDS is the original source for all institution-level variables, including characteristics of institutions, the students they serve, their expenditures, and staffing levels.

Because our dependent variables of interest relate to staffing, we rely on the Human Resources survey of IPEDS. This survey measures the number and type of staff employed by colleges and universities in a variety of roles, as well as some detailed information on salaries. While this survey collects a wealth of information, using the survey can be difficult because it was, until recently, conducted biennially, has undergone several significant changes that complicate longitudinal analyses, and the occupation codes used for reporting headcounts have recently been revised (Aliyeva, Cody, & Low, 2018). Because data are collected only every other year, we lose some analytical power because of the reduced sample size. Further, there is an information loss in years when data are not collected that we do not address. Because of revisions to definitions of numerous survey items, we are limited in the staffing nuances we can analyze. Additionally, we match the county of the institution to county-level information from the Department of Labor on county level poverty and unemployment rates in a given year to account for differences in the labor market that could be related to faculty and staff employment and salaries.

Sample Restriction

For this analysis, we began with the universe of public two- and four-year institutions reporting to IPEDS from 1998 through 2014 (n=27,417). Then, Delta Cost Project data was merged onto the data set to obtain the cleaned versions of the Human Resource data. We use the Delta Cost Project version of the IPEDS HR data because they standardized the occupational category data from 1998 through 2014. IPEDS data does not have a crosswalk that accounts for the occupational changes that they made over the years. The merge of IPEDS and Delta Cost data resulted in approximately 200 observations being dropped in each year, owing to differences in the parent/child relationships between IPEDS and Delta Cost (n=24,538; Jaquette & Parra,

2014). While using more recent HR data from IPEDS would be ideal, HR categories in IPEDS changed again in 2016 and Delta Cost has not updated their harmonized data to account for those changes. Therefore, we rely on the Delta Cost Project data that ends in 2014.

Additionally, we were particularly interested in the number and salary of personnel. However, there were some outliers in these data that were top coded or removed because they seemed outside the range of a possible valid response. For example, it seems unlikely that an institution of 1,000 students could have a full-time faculty workforce of 5,000. This would mean that there were five faculty members for every student, which is financial unsustainable. Additionally, individual dot plots for each outcome were examined to inspect the distribution of the data to further identify outliers. As detailed below, a small number of observations were changed or removed due to being outliers.

Observations that had more than 500 full-time faculty per 100 FTEs were changed to missing (nine observations). Similarly, observations indicating that an institution in a particular year had more than 500 full-time staff per 100 FTEs were recoded to missing (six observations). Average full-time faculty salaries were top coded to $150,000 (nine observations). Observations that were greater than 200 part-time faculty per 100 FTEs in a given year and institution were coded to missing (eight observations). Observations that were greater than 100 part-time staff per 100 FTEs in a given year and institution were coded to missing (ten observations). To construct the analytical sample for the difference-in-differences (DID) and event study analysis (see below

for a discussion of these methods), we included observations that had controls and that were five years before and after PBF implementation or that never implemented PBF (n=14,511).

Dependent Variables

We are interested in the level of staffing at colleges and universities, particularly in functions related to instruction and student support. As such, we specify our outcomes as (1) the (logged) number of full-time faculty per 100 FTE students; (2) the (logged) number of full-time student services, non-research professionals per 100 FTE students; (3) the (logged) average salary of all full-time faculty (adjusted to 2018 dollars according to the Higher Education Price Index); (4) the (logged) number of part-time faculty per 100 FTE students, and (5) the (logged) number of part-time student services, non-research professionals per 100 FTE. The student services, non-research professionals include staff in student affairs, service, and support functions. The values are logged to approximate a normal distribution and so the coefficients can be interpreted as percent increases and decreases.

We are interested in how PBF possibly changes the student experience in instruction and student support to support student outcomes. Therefore, the dependent variables measure the level of full- and part-time faculty and staff per 100 students. While this introduces a concern that we do not know which value is changing in the dependent variable (either the numerator of the number of full- or part-time faculty/staff or the denominator of 100 students), we argue that these dependent variables are appropriate because they are a proxy for the student experience. For example, if an institution drastically decreases enrollment in response to PBF, and therefore, increases the number of full-time faculty per 100 students as a result, we would conclude that was a positive change for the student and would likely lead to increased student outcomes. The average student would likely get more one-on-one time with a faculty and possibly develop a

mentorship relationship. On the other hand, if an institution responds by decreasing the number of full-time faculty members while maintaining enrollment, we argue that the average student would be worse off in that situation. Regardless of how institutions potentially respond to PBF, either by adapting their faculty and staff levels or adjusting enrollments, we argue that changes in those two factors are directly related to the student experience and organizational changes that we are interested in for this analysis.

Methods

Following much of the prior work on the effects of PBF on student outcomes, we exploit variation in the timing of the implementation of PBF policies across states to estimate the causal effect these policies have on the level of instructional and student support staff, as well as salaries. Specifically, we implement a generalized difference-in-differences model of the form:

$$y_{it} = \alpha + \boldsymbol{x}\beta_t + \delta PBF_{it} + \theta_i + \vartheta_t + \varepsilon_{it} \quad (2)$$

The coefficient of interest is δ, which measures the effect of a PBF policy affecting institution *i* at time *t*. This variable equals 1 for each institution-year that operates under a PBF policy, and 0 otherwise. The fixed effects at the institution (θ_i) and year (ϑ_t) levels control for unobserved time-invariant characteristics of institutions and time-varying confounders common to all institutions, respectively. These two-way fixed effects enable us to estimate a single coefficient for the effect of PBF policies implemented at different points in time across states: the institution fixed effects account for differences between treated and control institutions, and the year fixed effects account for differences pre- and post-policy implementation (Angrist & Pischke, 2009). Standard errors are clustered at the state level because that is the level of policy implementation, there is a lack of independence of institutional observations across time, and prior literature clustered errors at the state level (e.g., Tandberg et al., 2014).

The $\boldsymbol{x}$ vector includes relevant time-varying control variables at the county level. Specifically, we include a time-varying continuous measure of county-level unemployment and poverty rates to account for economic differences across geographic areas that could contribute to staffing levels and salaries. Prior literature on PBF policies has included a variety of controls (e.g., Hillman, Fryar, & Crespin-Trujillo, 2018; Li, 2018). However, since our analysis is concerned with faculty and staff composition and not student success outcomes, we do not include the same set of controls. For example, some prior literature has controlled for the proportion of low-income students at the institution. However, it is unlikely that the percent of low-income students would have an effect on the level of faculty and staff at the institution; therefore, we do not need to control for the unlikely relationship between percent of low-income students and level of faculty and stuff.

Further, we believe that prior research has possibly mis-specified their models and over controlled for the effect of PBF policies. For example, some research uses the percent of white students as a control variable when considering student outcomes (e.g., Hillman, Fryar, & Crespin-Trujillo, 2017). However, the percent of white students could be affected by PBF policies and could affect the outcome of interest. For example, institutions may enroll more white students in an attempt to "cream" their student population, so their student outcomes improve. Therefore, it is our belief that the article that used low-income students as a control was possibly over-specifying the model and controlling away the effect of PBF policies on student outcomes by controlling for student composition. For this study, we only include controls that could not be affected by PBF policies but could directly affect the level of faculty and staff and salaries. Therefore, we include controls for county-level unemployment and poverty rates to account for different labor market and economic conditions across counties.

The identifying assumption of the generalized difference-in-differences approach is that, outcomes at institutions in PBF states would follow the same trend if PBF policies had not been implemented. That is, treated and control states have parallel trends for each outcome. This assumption is not directly testable, but we use an event study specification to examine whether treated and control institutions diverged on outcomes before the policy and to allow the effect of the policy to vary over time post-implementation (see Equation 3 below):

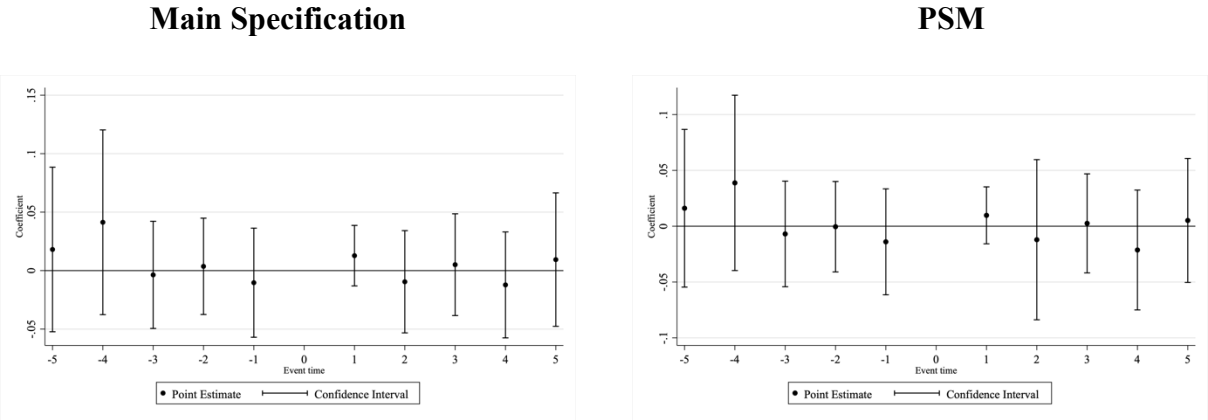
$$y_{it} = \alpha + \boldsymbol{x}\beta_t + \sum_{j=-5}^{5} \delta_j \, PBF_{it}(t = k + j) + \theta_i + \vartheta_t + \varepsilon_{it} \quad (3)$$

In this model, the single DID parameter δ is replaced by a vector of parameters δ_j; in our specification, this includes five leads and five lags of the treatment. These parameters tell us two important things. When j is negative, that is, before the policy change, estimates of δ_j provide suggestive evidence of whether the pre-treatment trends in outcomes for the treated and control institutions were the same (i.e., parallel) or not. For example, if those coefficients are zero, there is suggestive evidence in support of parallel pre-trends. If the coefficients are significantly different from zero (either positively or negatively), it suggests that the trends were not parallel prior to the policy implementation and could affect the interpretation of the coefficient of interest in the DID specifications. Second, coefficients for δ_j when j is positive provide a point estimate for each post-treatment year (whereas Equation 2 estimates δ as a weighted average across years). Said another way, in the post time period, coefficients indistinguishable from zero suggest that the policy had no effect while coefficients statistically different from zero (either positive or negative) suggest an effect for PBF in that particular year.

The results for the event study analysis for full-time faculty per 100 FTE students at four-year institutions is presented below in Figure 4-3. Because all the results are similar, the

remaining event study results are presented in Appendix B. The event study specifications indicate that prior to treatment, the treated institutions subject to PBF were not trending consistently different on the outcomes of interest prior to PBF implementation, providing suggestive evidence that the parallel trends assumption was met. In post-policy years, the event study coefficients do not indicate consistent findings year-over-year within the examined outcomes. Therefore, for this analysis, the event study specification is used to highlight suggestive evidence that the parallel trends assumption is met but individual post-year coefficients are not discussed as they do not show consistent trends that could be reliably interpreted. The difference-in-difference estimates are the main specification for this analysis because they provide the weighted average change after PBF was implemented instead of providing estimates for each year after implementation.

Figure 4-3. Event Study Coefficients for Logged Full-Time Faculty per 100 FTE Students: Four-Year Institutions



Propensity Score Matching

An underlying assumption of DID is that the counterfactual group is an accurate representation of what would have happened to the trend line for the treated group had the treatment not occurred. For our initial specification, we use all institutions in the U.S. that have

data in a given year to increase statistical power of our analysis. However, all untreated states may be different in both observable and, importantly, in unobservable ways from treated states prior to treatment, resulting in biased coefficients.

One way to address observed imbalances between treated and untreated units is through propensity score matching (PSM). Propensity score matching balances untreated and treated units on observable characteristics in pre-treatment years, thereby, creating a more similar counterfactual group. Therefore, we use PSM to balance treated and non-treated institutions on the outcome of interest prior to PBF being implemented.

Propensity score matching is dependent on all observations being untreated for at least one year so observations can be balanced prior to treatment. Therefore, for the PSM specifications, the sample is reduced to states that implemented PBF after 1998 to order to have at least one pre-treatment year. Once institutions subjected to PBF after 1998 were identified, institutions were matched on the outcomes of interest prior to PBF implementation. For example, for the model that examines the logged number of full-time faculty, observations were matched on this outcome prior to PBF implementation.[2] Once institutions were matched on outcomes prior to PBF implementation, we estimated the same DID and event study models discussed above using the same controls. Note that if an institution is ever matched to treated institutions, it is included in the counterfactual group for all time periods. A sensitivity test was conducted of the analysis that *only* institutions that were included in every year as a counterfactual institution was conducted and the results remained similar.

[2]Note that additional variables were initially including in the matching process. However, additional variables did not improve the match beyond what could be accomplished by matching on prior outcomes. For sake of parsimony, we elected to only match on prior outcomes.

The preferred specification is the DID with PSM because the PSM helps provide a plausible counterfactual group. Note that the event study specifications to investigate the parallel trends assumption were conducted with PSM as well. The results are presented in Appendix B and provide similar results that the pre-treated periods provide suggestive evidence that the parallel trends assumption was not violated.

Multiple Hypothesis Testing Adjustment

To address multiple hypothesis testing, we apply a Bonferroni Correction with Correlation to adjust statistically significant p-values to reduce the chances of a Type 1 error. For the main DID analysis, we examine five outcomes for four- and two-year institutions, resulting in 10 coefficients of interest. To reduce the chance of a Type 1 error, we apply the aforementioned correction to any statistically significant coefficients, resulting in adjusted p-values (see Appendix C for further explanation of the correction). We only apply the correction to statistically significant results of the DID analysis because statistically insignificant coefficients would move further away from the critical p-value if they were adjusted.

This specific correction addresses the issue that we are testing multiple *correlated* outcomes. In this analysis, the number of full- and part-time faculty and staff, and full-time faculty salaries are correlated. Within an institution, there are finite funds to employ and pay faculty and staff. Therefore, it is likely that as one of these outcomes changes, others may change as well. For example, as the number of full-time faculty decreases at an institution, it is likely that the number of part-time faculty would rise. Therefore, this type of correction is appropriate.

Results

The identification strategy used requires temporal variation in the presence of PBF policies across states. As Figures 4-1 and 4-2 (discussed above) illustrate, there is variation in the

implementation of PBF across states. Table 4-1 reports descriptive statistics for two-year and four-year institutions and PBF status pooled across years. Outcome variables are scaled to 100 FTE students to control for institutional size. Examining Table 4-1, two-year institutions under PBF policies have lower full-time faculty salaries than institutions who are not subject to PBF policies. Full-time faculty salaries at non-PBF institutions are approximately $68,000 whereas salaries at PBF institutions are about $61,000 ($p < 0.001$). Two-year institutions in states with PBF have more part-time faculty (7.8 vs. 7.1, $p < 0.001$) and statistically fewer student services, non-research professionals (0.55 vs. 0.42, $p < 0.001$). These unconditional averages suggest that PBF is associated with significantly lower full-time faculty salaries and fewer part-time faculty and student services personnel at two-year institutions. Institutions subject to PBF also reside in counties that have lower poverty and unemployment rates than institutions not under PBF policies ($p < 0.001$ each).

Four-year institutions exhibit a slightly different pattern. PBF four-year institutions had more full-time faculty ($p < 0.05$) while paying those faculty less ($p < 0.001$). Specifically, four-year institutions under PBF employ about 6.5 faculty members per 100 students while institutions not subject to the policy employ about 6.0 faculty members per 100 students. However, faculty at PBF institutions make, on average, $76,000 while faculty members at non-PBF institutions earn roughly $79,000. Part-time faculty employment is less for PBF four-year institutions than four-year institutions that are not under the policy ($p < 0.001$). This is possibly in response to hiring additional full-time faculty. Four-year institutions in PBF counties have lower unemployment rate, on average compared to institutions not in PBF states ($p < 0.001$).

Table 4-1. Sample Descriptive Statistics Pooled Across Years

Variable	Two-Year Institutions			Four-Year Institutions		
	Pre-PBF Means	Post-PBF Means	P-value	Pre-PBF Means	Post-PBF Means	P-value
Outcome Variables – Full-Time						
Number of faculty*	3.837	4.003	0.060	5.987	6.456	0.042
	(0.051)	(0.052)		(0.124)	(0.204)	
Number of student services, non-research prof.*	1.525	1.537	0.802	5.196	5.803	0.160
	(0.026)	(0.031)		(0.213)	(0.429)	
Faculty salary	67,557	61,407	0.000	79,482	76,096	0.000
	(215.325)	(266.157)		(300.870)	(382.005)	
Outcome Variables – Part-Time						
Number of faculty*	7.115	7.779	0.000	5.686	4.987	0.000
	(0.079)	(0.178)		(0.119)	(0.122)	
Number of student services, non-research prof. *	0.553	0.422	0.001	0.885	0.813	0.587
	(0.022)	(0.023)		(0.075)	(0.094)	
Controls						
Poverty rate	0.145	0.140	0.000	0.147	0.149	0.246
	(0.001)	(0.001)		(0.001)	(0.001)	
Unemployment rate	0.067	0.054	0.000	0.062	0.053	0.000
	(0.000)	(0.000)		(0.000)	(0.001)	
N	6254	2928		3612	1717	
Proportion of total	0.681	0.319		0.678	0.322	

Note: *indicates per 100 students. Standard errors in parentheses. P-values produced from a t-test of means.

The DID results are reported in Table 4-2 for four- and two-year institutions for the full sample and the matched sample using PSM. The estimates for the full sample are provided in the table but the PSM estimates are the preferred specification. As indicated above, poverty and unemployment rates are controlled for at the county level of the institution. For both four- and two-year institutions, there is no statistically significant results for any of the outcomes of interest, suggesting that institutions, on average, do not make adjustments to faculty and staff margins to improve student success outcomes outlined in PBF policies after PBF is implemented.

While all results were statistically insignificant, some coefficients were substantially larger than zero; therefore, coefficients that were large in magnitude are discussed. Four-year institutions in states that implemented PBF had about 5% more full-time student services and 5% fewer part-time student services personnel after PBF was implemented, suggesting that four-institutions might be making changes to the composition of personnel who provide direct support to students. Four-year institutions in states with PBF also had about 3% less part-time faculty than four-year institutions in states without PBF, suggesting that PBF institutions may be reducing the proportion of part-time faculty. None of the coefficients using the PSM sample for two-year institutions were greater than 2%, suggesting that two-year institutions subject to PBF did not make changes to the composition of their faculty or staff.

Table 4-2. Difference-in-differences regression results for (logged) staffing level: Full Sample and PSM Sample

Outcome variable	4-Year		2-Year	
	Full Sample	PSM Sample	Full Sample	PSM Sample
Full-Time				
FT faculty	-0.001	0.002	-0.003	-0.001
	(0.015)	(0.018)	(0.015)	(0.017)
FT student services, non-research prof.	0.041	0.048	-0.017	0.014
	(0.030)	(0.034)	(0.051)	(0.074)
Average FT faculty salary	0.003	0.002	0.010	0.012
	(0.006)	(0.007)	(0.007)	(0.008)
Part-Time				
PT faculty	-0.048	-0.028	-0.031	-0.001
	(0.066)	(0.067)	(0.057)	(0.050)
PT student services, non-research prof.	-0.038	-0.045	-0.126	-0.009
	(0.074)	(0.076)	(0.106)	(0.128)
Institution FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
County-level controls	YES	YES	YES	YES

Note: All outcomes are logged. All outcomes are per 100 students except for average FT faculty salary. Robust standard errors clustered at the state level.

***p<.001; **p<.01; *p<.05 ~p<0.1

Discussion

Overall, the DID estimates suggest that neither four-year nor two-year institutions subjected to PBF policies are making changes to the overall proportion of full-time or part-time faculty and student services staff once the policy is implemented, on average. However, direction and magnitude of some of the coefficients warrant discussion, specifically for the estimates related to four-year institutions.

Although statistically insignificant, we found that four-year institutions under PBF policies had a smaller proportion of part-time faculty (3% smaller) and staff (5% smaller) and a larger proportion of full-time staff (5% larger) than four-year institutions not subject to PBF. This finding suggests that four-year institutions may be making changes at these margins to affect student success outcomes. Prior research suggests that there are specific types of faculty and staff that prompt student success at institutions (e.g., Bahr, 2008; Swecker et al., 2013). These results suggest that some four-year institutions may be making changes to staffing in response to PBF by reducing part-time personnel and increasing full-time student services personnel, which could lead to increased student success outcomes. Although prior research found that institutions do not adapt their expenditures (Kelchen & Stedrak, 2016), this study suggests that four-year institutions may adapt the proportion of faculty and staff at the institution. Future research should investigate why this change in faculty and staff is occurring at four-year institutions but not at two-year institutions.

Our results for two-year institutions suggest that these institutions are already operating quite efficiently given their resources and current mix of faculty and staff and prior research even suggests this (e.g., Agasisti & Belfield, 2016). Taken together, the efficiency levels at two-year institutions and the absence of meaningful changes to inputs in response to PBF suggest these

policies have limited potential to actually lead to improved student outcomes at two-year institutions.

We caution, however, that such analyses need to be situated in their state contexts. It is possible that the changes in staffing observed illustrate more localized influence. One illustration of this is also in the differences between the results for four-year and two-year institutions, which highlight that these two sectors though both adhering to the same state level controls, face different systems when considering personnel decisions.

Overall, our difference-in-differences findings fall in line with prior research on PBF policies. Bell, Fryar, and Hillman (2018) find that PBF policies have not statistically increased completion rates for either four- or two-year institutions. We find that institutions are not making statistically significant changes on average over the years to the composition of full- and part-time faculty and staff that would lead to substantive changes in student success outcomes. Given our conceptual frameworks, we believe that for institutions to actually affect student success outcomes, they need to make internal changes, such as the level of faculty and staff. However, we find that both four-year and two-year institutions are not responding consistently at that margin that would lead to statistically significant results, falling in line with the null effects findings on completion rates for PBF policies (Bell, Fryar, & Hillman, 2018).

Given the large magnitudes on full-time student personnel and part-time faculty and student personnel for four-year institutions, future research should further investigate the effect of PBF on organizational changes at four-year institutions. The data for this analysis ends in 2014. Future research should use more recent data to see if more recent PBF policies have an effect on faculty and staff composition. Additionally, future research should examine these outcomes with a longer time horizon.

Overall, it is unclear through what mechanisms PBF may improve student outcomes since we did not find consistent statistically significant results. It seems that any changes to student outcomes may occur only through unintended effects of PBF, such as "creaming" of students or dilution of quality in the degrees granted. Another possibility is that the assumptions underlying PBF do not hold true, and that legislators overestimate the extent to which their goals and the goals of institutions are misaligned in the first place and institutions ability to increase efficiency.

Conclusion

Performance-based funding policies are prevalent throughout the country. Legislatures, policy advocates, scholars, and higher education administrators seek to know the effect of this policy on student success outcomes. However, only few scholars have quantitatively examined the effect of PBF policies on internal organizational structures that likely should proceed any effects on completion margins. To address this gap in the literature, we examined how PBF policies changed the level of faculty and student services personnel at institutions subjected to the policy. Overall, four-year and two-year institutions were not making changes on the faculty or staff margins. Future research should examine internal organizational changes that institutions subjected to PBF may be implementing in response to the policy. For example, are institutions subjected to PBF reducing the number of academic programs and streamlining the curriculum? Are institutions subjected to PBF increasing or reducing the number of executive staff? Research should continue to investigate the mechanisms that could improve student success outcomes in relation to PBF policy implementation in order to illuminate if and how PBF policies are changing institutions.

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Appendix A

Table A4-1. Performance-Based Funding by State and Year for Four-Year Institutions

State	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
AK																	
AL																	
AR		X	X	X						X	X	X		X	X	X	X
AZ															X	X	X
CA																	
CO	X	X	X	X	X	X	X							X	X	X	X
CT																	
DE																	
FL																X	X
GA									X	X	X						
HI																	
IA																	
ID			X	X	X	X	X	X									
IL														X	X	X	X
IN										X	X	X	X	X	X	X	X
KS		X	X	X	X	X	X	X	X	X	X					X	X
KY	X																
LA				X	X	X	X	X	X	X	X	X	X	X	X	X	X
MA																	
MD																	
ME																X	X
MI															X	X	X
MN	X															X	X
MO	X	X	X	X	X											X	X
MS																X	X
MT																X	X
NC																	
ND																X	X
NE																	
NH																	
NJ		X	X	X	X	X											
NM						X	X	X	X	X	X	X	X	X	X	X	X
NV																X	X
NY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OK	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OR		X	X							X	X	X	X	X	X	X	X
PA			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RI																	
SC	X	X	X	X	X												
SD	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
TN	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TX		X	X	X	X	X				X	X	X	X	X			
UT																X	X
VA								X	X	X	X	X	X	X	X	X	X
VT																	
WA	X	X															
WI																	
WV																	
WY																	

Table A4-2. Performance-Based Funding by State and Year for Two-Year Institutions

State	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
AK																	
AL																	
AR		X	X	X						X	X	X		X	X	X	X
AZ																	
CA																	
CO	X	X	X	X	X	X	X							X	X	X	X
CT																	
DE																	
FL																	
GA									X	X	X						
HI														X	X	X	X
IA																	
ID			X	X	X	X	X	X									
IL	X	X	X	X	X									X	X	X	X
IN										X	X	X	X	X	X	X	X
KS		X	X	X	X	X	X	X	X	X	X					X	X
KY	X																
LA				X	X	X	X	X	X	X	X	X	X	X	X	X	X
MA																X	X
MD																	
ME																	
MI															X	X	X
MN	X															X	X
MO	X	X	X	X	X											X	X
MS																	
MT																X	X
NC		X	X	X	X	X	X	X	X	X	X				X	X	X
ND																X	X
NE																	
NH																	
NJ		X	X	X	X	X											
NM						X	X	X	X	X	X	X	X	X	X	X	X
NV																X	X
NY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OK	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OR																	
PA																	
RI																	
SC	X	X	X	X	X												
SD	X	X	X	X	X												
TN	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TX		X	X	X	X	X				X	X	X	X	X		X	X
UT																X	X
VA								X	X	X	X	X	X	X	X	X	X
VT																	
WA	X	X								X	X	X	X	X	X	X	X
WI																X	X
WV																	
WY															X	X	X

Appendix B

Figure B4-1. Event Study Coefficients for Logged Full-Time Student Services, Non-Research Professionals per 100 FTE Students: Four-Year Institutions

Main Specification **PSM**

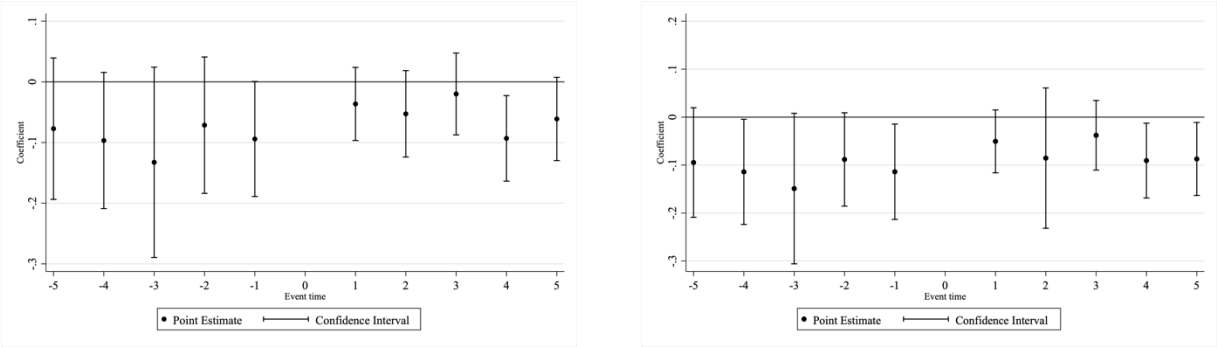


Figure B4-2. Event Study Coefficients for Logged Average Full-Time Faculty Salary: Four-Year Institutions

Main Specification **PSM**

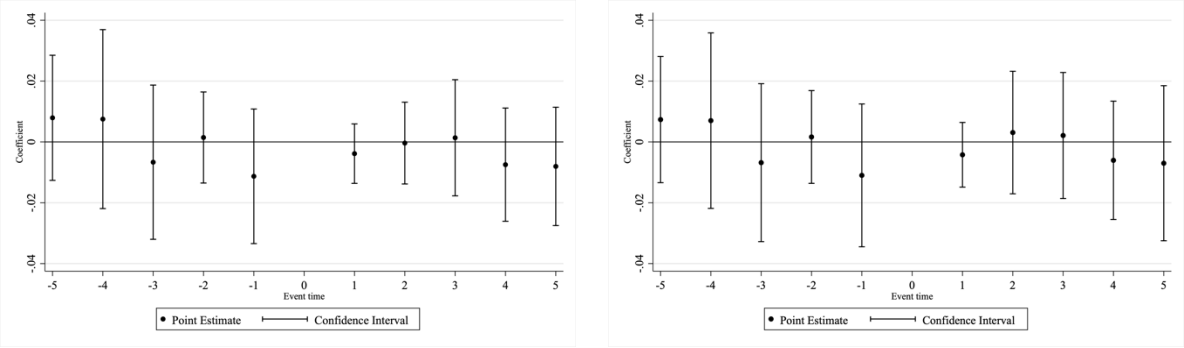


Figure B4-3. Event Study Coefficients for Part-Time Faculty per 100 FTE Students: Four-Year Institutions

Main Specification **PSM**

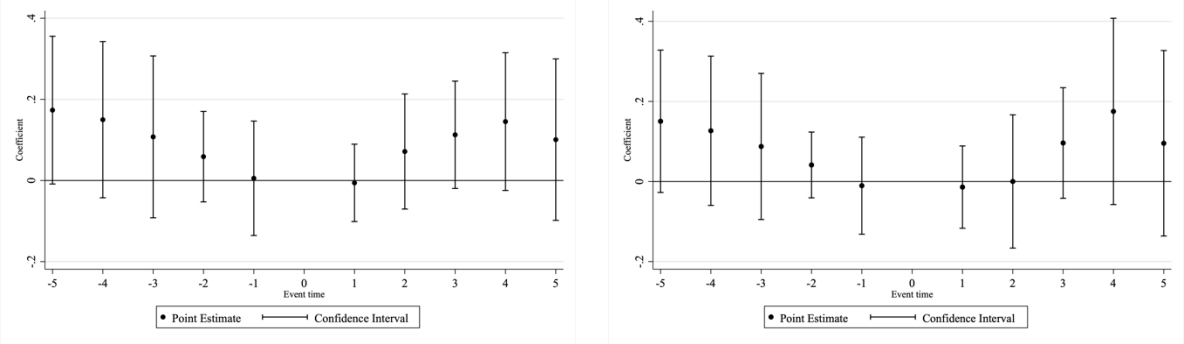


Figure B4-4. Event Study Coefficients for Logged Part-Time Student Services, Non-Research Professionals per 100 FTE Students: Four-Year Institutions

Main Specification **PSM**

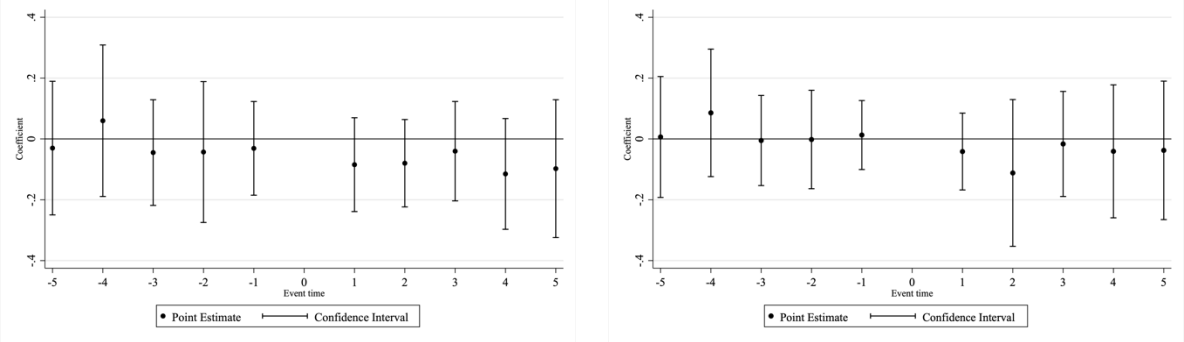
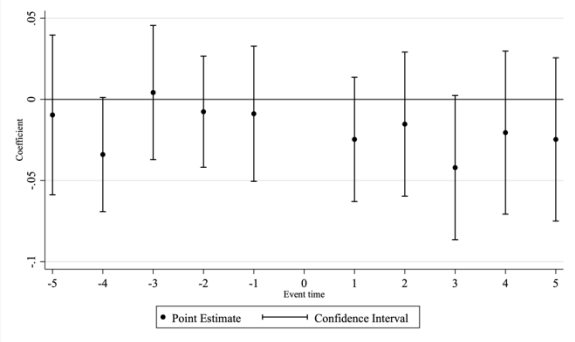


Figure B4-5. Event Study Coefficients for Logged Full-Time Faculty per 100 FTE Students: Two-Year Institutions

Main Specification **PSM**



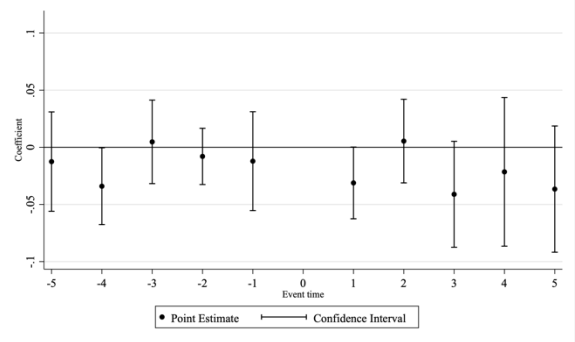
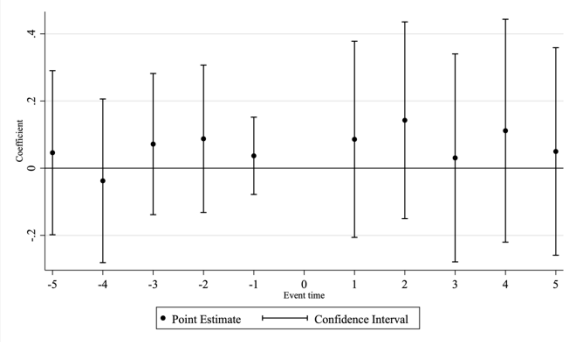


Figure B4-6. Event Study Coefficients for Logged Full-Time Student Services, Non-Research Professionals per 100 FTE Students: Two-Year Institutions

Main Specification **PSM**



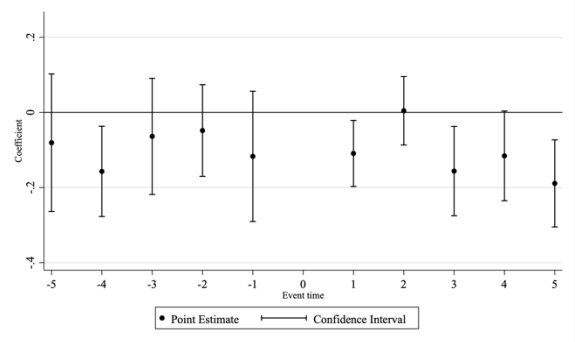


Figure B4-7. Event Study Coefficients for Logged Average Full-Time Faculty Salary: Two-Year Institutions

Main Specification **PSM**

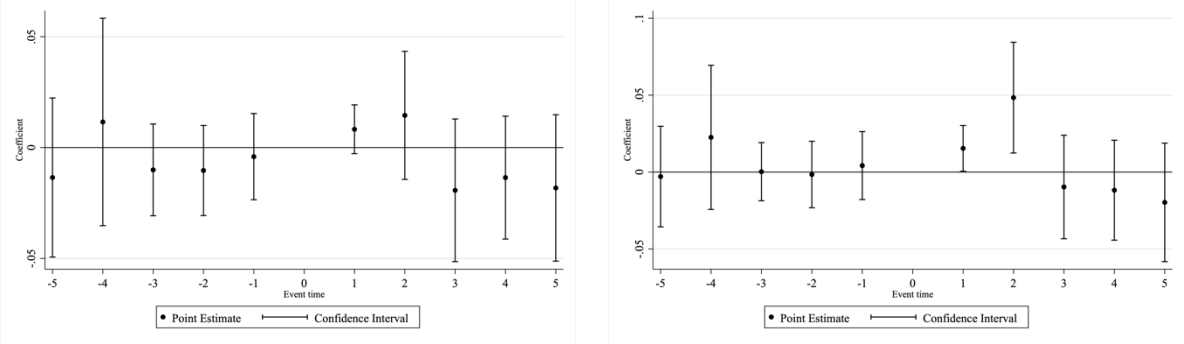


Figure B4-8. Event Study Coefficients for Part-Time Faculty per 100 FTE Students: Two-Year Institutions

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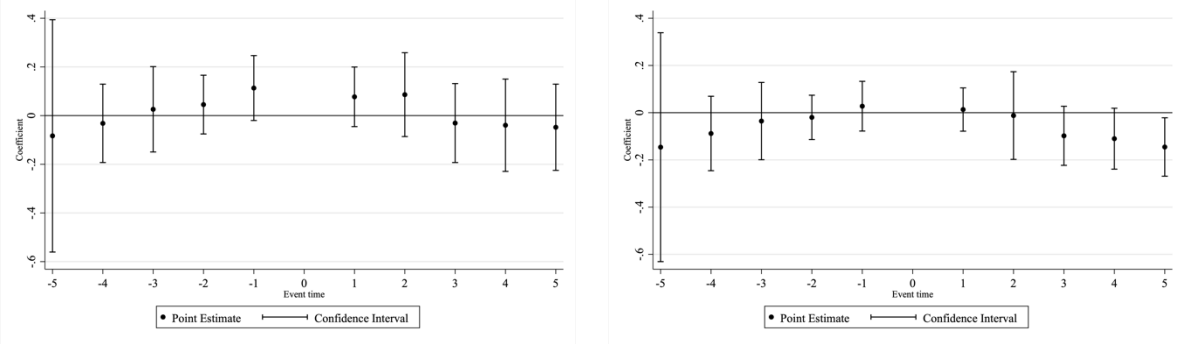
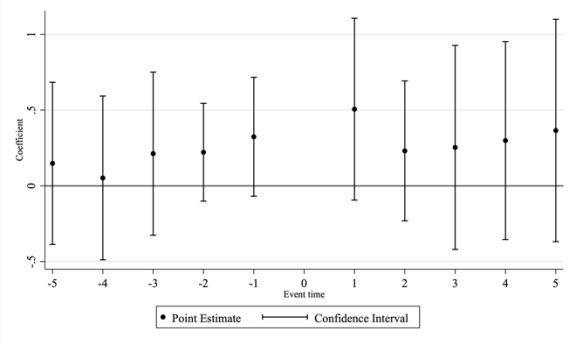
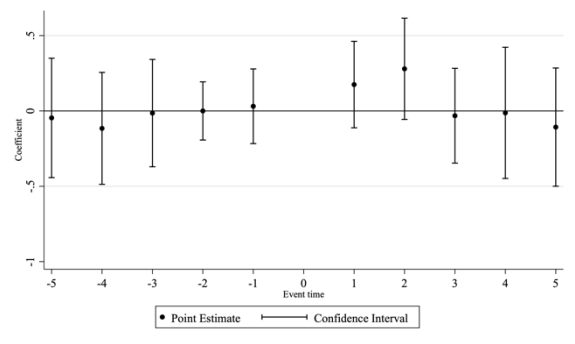


Figure B4-9. Event Study Coefficients for Logged Part-Time Student Services, Non-Research Professionals per 100 FTE Students: Two-Year Institutions

Main Specification



PSM



Appendix C

Bonferroni Correction with Correlation

In this analysis, we construct models for several outcomes and use a variety of specifications. Therefore, we address the issue of multiple hypothesis testing using a Bonferroni Correction with Correlation. There are several methods to overcome multiple hypothesis testing such as the Bonferroni correction, the Bonferroni with correlation correction, and the Holm-Bonferroni correction method. Below, we summarize each correction and provide a rational for our selection of the Bonferroni Correction with Correlation.

Bonferroni Correction

The Bonferroni correction addressed multiple hypothesis testing by scaling alpha by the number of models (Abdi, 2007). Specifically, alpha is adjusted downward by dividing the target alpha level by the number of models. For example, if the target alpha level is 0.05 and there are 10 tests conducted, the adjusted p-value is 0.05/10=0.005. The Bonferroni correction happens prior to the analysis and the adjusted p-value is set before any analysis is completed.

Bonferroni Correction with Correlation

The Bonferroni correction with correlation takes the Bonferroni correction a step further by addressing the possibility that outcomes may be correlated (Sankoh, Huque, & Dubey, 1997). The equation for making this correction is as follows:

$$padj = 1 - (1 - p(k))^{g(k)}$$

$$\text{Where } g(k) = M^{1-r(.k)}$$

In this equation, *M* is the number of outcomes tested and *p(k)* is the original p-value for the *kth* outcome. To adjust for correlation among outcomes, *r(.k)* is the average correlation among the

outcomes excluding outcome *k*. The Bonferroni Correction with Correlation is a post-hoc correction.

Holm-Bonferroni Correction

The Holm-Bonferroni Correction is similar to the Bonferroni correction (Holm, 1979). However, instead of making an overall adjustment to the target alpha level, the p-values are ordered from smallest to largest. Then, beginning with the smallest p-value, an adjustment is made in the following way:

$$\frac{\text{Target Alpha Level}}{\text{n - rank number of pair (by degree of significance) + 1}}$$

where 0.05 is the target alpha level, *n* is the number of tests completed, and rank number of the p-value (starting with 1). For example, if the target alpha level is 0.05, there are10 tests, the first p-value would have an adjusted value of 0.05/(10-1+1)= 0.005 whereas the second p-value would have an adjusted value of 0.05/(10-2+1)= 0.006. This correction is post-hoc and must be done after all the analyses are complete so rank order can be determined.

Preferred Method

Overall, the **Bonferroni Correction** would be the easiest to calculate and integrate into the analysis. However, it does not adjust for correlation among the outcomes, which is likely the case in this analysis. The **Holm-Bonferroni Correction** is less conservative than the Bonferroni Correction (as shown in the examples above). Therefore, we implemented the **Bonferroni Correction with Correlation** in the main model specification because it corrects for correlation among outcomes.

References

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Holm, S. 1979. A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics, 6*, 65-70.

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CHAPTER 5

Conclusion

Performance-based funding policies are currently in effect in 30 states throughout the country (Snyder et al., 2020). From the inception of these student funding policies in Tennessee in 1987, to their current state as a major element of the accountability movement in higher education, PBF policies have adapted from feedback from policymakers, policy advocates, and researchers (Dougherty & Natow, 2015). In the years to come, PBF policies will likely continue to disseminate throughout the country and change as we continue to learn more about the effect of the policies on state funding and short- and long-term outcomes.

In-depth policy analyses, such as those put forth in the first paper of this dissertation, help researchers, policymakers, and policy advocates to understand the practical implications of complicated PBF formulas. In this analysis, the institution (i.e., Eastern Gateway Community College) that continued to grow its enrollment substantial during the time period examined was able to capture much more of state funding than it had previously and outpaced other institutions as well. Therefore, even though this policy meant to incentivize institutions to focus on student success, Ohio's formula still rewarded the institution that was able to increase enrollment.

Additionally, the policy simulations suggest that individualized policy elements did not lead to substantial difference in funding for individual institution. Given that institutions were able to capture similar amounts of funding regardless of the policy formula, it may not be worth it to create complicated policies that are difficult for administrators to understand. In the future,

policymakers should run simulations using longitudinal data from institutions to understand how funding would play out under different scenarios and possibly choose the least complicated formula that results in consistent funding.

The analysis of Ohio suggested that PBF resulted in a decrease in associate degree production and no effect on certificates compared to institutions never incentivized by PBF policies. One reason why Ohio institutions, as demonstrated by this research, and other institutions across the country, as demonstrated by prior research, may not be increasing student success outcomes is because they are not making organizational changes to adapt to these PBF policies. In the concluding paper of this dissertation, the results suggest that institutions are not making changes at the faculty and staff margins in response to PBF policy changes. If institutions are not making changes at the faculty and staff level to change the student experience, it follows that student success outcomes will not change as a result of the policy.

Future Research

Future research on PBF policies should further develop the initial lines of inquiry presented here. More individual PBF policies need to be examined to understand how state funding to institutions has changed. Given COVID-19 and that higher education will likely continue its role as the balance-wheeling in state budgets (Delaney & Doyle, 2011), policy advocates and policymakers need to know how these funding formulas trickle down and affect individual institutions' state funding. Further institution-level analysis should be conducted to provide a more thorough understanding of the implications of PBF policies at the state level. In this analysis, only Ohio two-year institutions were considered. A similar analysis should be conducted for four-year institutions and other states that have robust policies such as Tennessee and Indiana (Snyder et al., 2020). Understanding the effect of PBF on institutions in those states

could help other states formulate their policies. Additionally, institutional characteristics should be considered to understand if some two-year and four-year institutions fair better on PBF policies than others. For example, it is possible that urban institutions that are able to more easily increase enrollments than rural institutions, and are able to game PBF formulas such that increased enrollment mechanically results in increased funding, circumventing the main purpose of PBF policies?

Finally, from this analysis, results suggest that institutions are not making adjustments at the faculty and staff margin in order to affect their student success outcomes. Other intermediary outcomes of PBF policies should be considered and evaluated. Prior research has considered how enrollments and expenditures have changed as a result of PBF policies. This research adds to that work by considering how the share of faculty and staff and faculty salaries might change as a result of PBF policies. While institutions were not making changes at this particular margin, there are possibly other margins where institutions are making changes. Qualitative research suggests that, as a result of PBF policies, institutions made curriculum changes, such as removing programs and increasing admissions standards specific programs. Therefore, future research could investigate how program and course offerings have changed as a result of PBF policies.

Performance-based funding formulas will likely continue in higher education as a way to incentivize student success. Policymakers, policy advocates, higher education administrators, and researchers should continue to interrogate this particular policy because the body of prior research and the work demonstrated in this dissertation suggest that the policy does not have the desired effects. Institutions that continue to grow enrollment are rewarded above and beyond that of other institutions as illustrated in Ohio, Ohio institutions are not out-performing other

institutions that were never under a PBF policy regime, and institutions are not making intermediary changes in response to PBF. This dissertation fills a gap in our knowledge about some important aspects of PBF policies. Nonetheless, additional research is needed to understand the policy formulas, funding implications, and the effect of the policy on both intermediary outcomes and student success outcomes to understand if PBF policies are having the desired effects.

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