Incentivizing Equity? The Effects of Performance-Based Funding on Race-Based Gaps in College Completion

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Abstract

Performance-based funding models for higher education, which tie state support for institutions to performance on student outcomes, have proliferated in recent decades. Some states have designed these policies to also address educational attainment gaps by including bonus payments for traditionally low-performing groups. Using a Synthetic Control Method research design, we examine the impact of these funding regimes on race-based completion gaps in Tennessee and Ohio. We find no evidence that performance-based funding narrowed race-based completion gaps. In fact, contrary to their intended purpose, we find that performance-based funding widened existing gaps in certificate completion in Tennessee. Across both states, the estimated impacts on associate degree outcomes are also directionally consistent with performance-based funding exacerbating racial inequities in associate degree attainment.

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Introduction

The economic return to completing college is large and increasing (Autor, 2014; Avery & Turner, 2012; Carnevale, Jayasundera, & Gulish, 2016), yet low-income students and students of color are significantly less likely to graduate than their high-income and White peers and these disparities have widened over time (Bailey & Dynarski, 2011; Chetty, Friedman, Saez, Turner, & Yagan, 2017; Ziol-Guest & Lee, 2016). With social mobility declining in the United States and the payoff to completing postsecondary education increasing, raising college completion rates among populations at high risk of dropout can create more equitable opportunities for economic prosperity.

Over the last twenty years, state policymakers and higher education advocacy organizations have often turned to performance-based funding (PBF) policies as one strategy to increase degree attainment rates. PBF policies tie state support for public higher education institutions to performance on student outcomes, such as year-to-year persistence and degree completion. PBF policies first gained popularity in the 1990s and were often structured as bonus payouts on top of the base funding allocation appropriated to higher education institutions. The weak effects and unintended consequences of past policies informed the development of a new generation of policies in the 2010s (Dougherty & Natow, 2015). These policies, commonly referred to as "PBF 2.0", focus on allocating shares of base funding (rather than a bonus payment) and often tie funding to increasing persistence and completion rates among high-risk students, including underrepresented racial/ethnic minorities, older adult students, and low-income students (Dougherty & Natow, 2015). Currently, 37 states have implemented or developed funding models that allocate a portion of state higher education appropriations based on institutional performance, and more than half of those states prioritize performance of at-risk student groups through “equity provisions”.[1]

Two early and vigorous adopters of PBF policies that include equity provisions are Tennessee and Ohio. PBF policies in these states do not appear to have increased bachelor’s degree completion overall and may have shifted students at two-year colleges to earn certificates instead of associates degrees (Hillman, Hicklin Fryar, & Crespín-Trujillo, 2018; Ward & Ost, 2019). However, we are aware of no studies to date that analyze whether the PBF policies in these two states have increased degree completion among underrepresented students or reduced degree completion gaps between traditional and underrepresented student groups. Understanding whether the PBF policies in Tennessee and Ohio had the desired effect on degree attainment among underrepresented students promises to inform the design of future PBF policies in states interested in leveraging these policies towards more equitable educational outcomes.

This study contributes to the literature on the effects of PBF policies by examining two research questions:

i) Do PBF policies with equity provisions in Tennessee and Ohio impact the number of certificates and degrees awarded to underrepresented minority (URM) students?[2]
ii) Do these policies reduce completion gaps between URM and non-URM students?

To answer these questions, we employ the Synthetic Control Method (SCM) that has become a popular econometric strategy for comparative case studies (Abadie & Gardeazabal, 2003; Abadie, Diamond & Hainmuller, 2010; 2015; Peri & Yasenov, 2018). Using this approach and administrative data on certificate and degree conferrals reported by the census of public colleges and universities in the United States to the Integrated Postsecondary Education Data

System (IPEDS), we compare the gap in credentials conferred at public institutions to non-URM versus URM students in Tennessee and Ohio after the adoption of PBF (2009 in Ohio and 2010 in Tennessee) to a "synthetic" state.[3] We construct comparison groups, separately for Tennessee and Ohio, using the set of states that either did not utilize PBF or adopted only rudimentary PBF policies (tying less than 5 percent of funding to institutions) from 2004 through 2015 and weighting them to minimize the difference between Tennessee/Ohio and the comparison group in the pre-PBF period.

We find that PBF in Tennessee roughly doubled the number of certificates conferred to URM students but tripled the number of certificates conferred to non-URM students. As a result, the share of less-than-two-year certificates awarded to URM students decreased by 6.2 percentage points, from 19.4 percent to 13.2 percent, one year after the policy change. The share of certificates awarded to URM students in Tennessee continued to decline over the next five years: by 2015, only 8.6 percent of less-than-two-year certificates were awarded to URM students. We also estimate consistently negative, though non-statistically significant, impacts on the number of associate degrees conferred to URM students and positive impacts on the number of associate degrees conferred to non-URM students in Tennessee. Furthermore, we find that PBF decreased the number of bachelor's degrees awarded to URM students by 3-6 percent per year and had null or slightly positive impacts on bachelor's degree completion among non-URM students in Tennessee.

In Ohio, we find limited evidence that PBF widened the race-based gap in certificate conferrals (as measured by the share of certificates conferred to URM students), although the direction of the estimates is also suggestive of differential impacts by race, with declines in certificate production experienced by URM students and gains experienced by non-URM students.

We find more conclusive evidence that PBF decreased associate degree production for URM students in Ohio. By 2015, PBF decreased the number of associates degrees awarded to URM students by 26 percent. In contrast, we find no evidence that PBF altered the number of associate degrees conferred to non-URM students in Ohio. We also find no evidence that PBF differentially impacted bachelor's degree production by race in Ohio.

While PBF policies are an active area of policy work, with states revising and modifying their policies frequently, our results suggest that PBF models that allocate most state appropriations to colleges based on performance outcomes, as in Tennessee and Ohio, may be in tension with other higher education policies aimed at closing college attainment disparities. This may be true even when PBF formulas include bonus payments to incentivize completion among underrepresented student populations. Both Tennessee and Ohio enacted PBF policies with equity-based bonus payments to incentivize completion among traditionally disadvantaged students, yet our findings suggest that public institutions in those states may have focused on increasing attainment overall to avoid or minimize loss of state appropriations instead of prioritizing completion among low-performing groups. Doing so perpetuated existing race-based completion gaps in bachelor's degree attainment and exacerbated race-based completion gaps in certificate and associate degree production.

We structure the remainder of the paper into four sections. In the next section, we briefly review the objectives that underpin performance management in higher education and present background information on the PBF models in Tennessee and Ohio. In the third section, we describe our data, sample, and research design. We present our results in the fourth section. We conclude in the fifth section with a discussion of specific features of the PBF policies in Tennessee and Ohio that may explain differences in institutional responses across the two states, as well as directions for future research.

Background

Performance Management

PBF models in higher education are grounded in principal-agent theory and the management practice of performance contracts. According to this framework, the principals are state governments, which seek to hold higher education institutions (the agents) accountable for performance across a range of student outcomes and incentivize increased degree production. The literature on performance contracts, however, suggests that incentivizing increased productivity is easier to theorize than accomplish. Two major complications appear to diminish the efficacy of performance contracts: imperfect information on the part of the agent and the details of the contract, such as the size of the incentive (Lazear, 2018).

In the case of PBF, there is reason to believe these policies may not have the intended effect of improving the performance of postsecondary institutions. First, the incentives may not be effective in changing the behavior of institutions if colleges lack the resources or knowledge to achieve the intended goals. In Tennessee and Ohio, for example, PBF resulted in minority-serving institutions losing a disproportionately large share of funding, exacerbating funding gaps between high- and low-resourced institutions (Hillman & Coral, 2018). New research suggests that widening resource disparities across institutions may be common across states that have adopted PBF policies (Favero & Rutherford, 2020; Hagood, 2019; Jones et al., 2017).

Second, because PBF policies put pressure on institutions to improve their performance (both via risk of financial loss and by making performance more transparent and comparable across institutions), colleges may seek out the easiest means by which to improve short-term performance at the expense of other outcomes. This includes becoming more selective and/or enrolling students with a higher likelihood of completing their degree, i.e., “cream skimming” (Dougherty, et al., 2016). Including equity provisions in PBF policies does appear to mitigate efforts to enroll more advantaged students (Kelchen, 2018). However, these policies overall appear to have null or very small positive effects on the enrollment of underrepresented student groups (Gandara & Rutherford, 2018; Kelchen, 2018).

Even in states that have adopted PBF policies with equity provisions, attainment gaps may remain unchanged. One case study in Tennessee finds that higher education administrators consider the equity premiums to be too small to impact persistence and completion of historically underrepresented student groups (Ness, Deupree, & Gándara, 2015). Furthermore, completion gaps may even increase if equity-based bonus payments are small relative to sanctions for poor overall improvement. Colleges and universities that operate in such settings may focus on increasing overall attainment to avoid financial hardship and ignore the incentive structures intended to prioritize gains among low-performing groups.

Performance Funding in Tennessee and Ohio

Tennessee and Ohio offer the best opportunity to examine the potential for PBF with equity provisions to reduce disparities in college outcomes because these states are often cited as exemplars among PBF advocates (Snyder & Fox, 2016). During our study period, North Dakota, Nevada, and Missouri, Ohio, and Tennessee were the only states that tied a majority of all state appropriations to performance outcomes. The share of state appropriations allocated via performance funding did not exceed 25 percent in other states from 2004-2015. In contrast to North Dakota, Nevada, and Missouri, both Tennessee and Ohio enacted robust PBF policy regimes by 2010, which allows a long enough time horizon to examine impacts on college completion, particularly in the four-year sector.[4] Tennessee and Ohio have also embraced equity provisions that reward public institutions with funding premiums for increasing persistence and degree completion for adult, minority, and/or low-income students. The funding models in Tennessee and Ohio have been studied extensively in the PBF literature (e.g. Dougherty, et. al., 2016; Hillman, et. al., 2018; Kelchen, 2018; Ward & Ost, 2019), although we are not aware of any studies that have examined whether the policies have impacted college attainment gaps.

Ohio first adopted PBF in the mid-1990s, but in 2009, the state budget outlined new formulas for its university and community college sectors focused on student course and degree completion.[5] For four-year institutions, the new system rewards degree production, state science, technology, engineering and math (STEM) goals, and equity across underrepresented groups in degree outcomes (Morris, 2009; Zumeta & Li, 2016). Ohio awards most funding (80-100 percent) to its four-year institutions based on student progression and completion, with greater weight given to completion. However, between 2009 and 2013, four-year institutions were subject to a stop-loss provision that capped annual funding losses at 3-5% of prior year levels.

Ohio also awards premiums to four-year institutions based on the progression and completion of three historically underrepresented student populations: adult, low-income, and minority students.[6] The specific premium amounts are calculated based on the size of the completion gaps between students in each of the above categories and not-at-risk students (Ohio Board of Regents, 2011). The bonus amounts have varied over time, but across most treated years in this study (2009-2015), institutions could receive an additional 30-40 percent in funding for historically underrepresented student performance. Bonus payments are also stackable for students who fit into more than one underrepresented category.[7] Furthermore, since Ohio introduced the new funding formula in 2009, it has placed increasing emphasis on rewarding institutional performance with respect to “at-risk” students.

Two-year institutions in Ohio are awarded funding based on progress, completion, and transfers. Between 2009 and 2015, the share of funds awarded for student progress and completion increased incrementally as the state phased in a transition from its historical, enrollment-based funding model. During this transition period, Ohio began to allocate funding to institutions based on the number of courses students completed, the number of students earning 15 or 30 semester credit hours, the number of students earning an associate degree, and the number of students completing developmental math courses (Turocy, 2013; Ohio Board of Regents, 2013). Funding for course completions and student success surpassed 50 percent of the state’s core appropriations for institutional operations at two-year colleges beginning in 2013 (Boelscher & Snyder, 2019).

Ohio did not immediately introduce equity provisions into its new PBF model for two-year institutions. However, beginning in 2014, the state awarded additional premiums for the academic progression and degree completion of adult, low-income, and racial minority students. Funding for longer-term certificates (i.e., over 30 hours) was also introduced in 2014. As with the four-year sector, a stop-loss provision initially capped annual funding losses at 3-5% of prior year funding levels and was phased out in 2014.

Tennessee was one of the first states to include performance funds in its state funding formula. As early as 1979, Tennessee distributed some funds to institutions for meeting certain state goals for education; however, most funds were still allocated based on enrollment and historical appropriation levels. In 2010, Tennessee passed the Complete College Tennessee Act (CCTA), which overhauled the state’s funding formula and ended enrollment-based funding. Like in Ohio, the new system awards most funding (80-100 percent) to institutions based on student progression, degree production, efficiency, and other institutional factors deemed important by the state. Both two-year and four-year institutions are included in the system, but they are subject to different metrics and weights. Whereas Ohio implemented a stop-loss provision to protect institutions in the early years of PBF 2.0, Tennessee made additional funds available to public colleges and universities in the early years of PBF 2.0 to protect against severe financial losses resulting from the shift away from historical appropriation levels.

Tennessee also rewards institutions for success on progression and completion outcomes for certain student subpopulations. Adult students and students from low-income families garner a 40 percent premium (i.e., if an institution grants undergraduate degrees to 100 students from low-income families, this counts as 140 students in the funding formula). Although Tennessee included equity provisions in its funding formula for both two- and four-year institutions since 2010, it did not include premiums for URM students specifically over the study period. However, because adult and low-income college students in Tennessee are also more likely to be students of color, URM students were more likely to qualify for equity-based bonus payments than non-URM students in Tennessee.

In summary, while there are differences in the specific features and implementation of Ohio and Tennessee's PBF models, these two states nonetheless provide the best opportunity to evaluate the race-based effects of PBF policies given their robust and longstanding policies.

Research Design

Data

The data for this study come primarily from the Integrated Postsecondary Education Data System (IPEDS). IPEDS is a federal database that contains annual institution-level administrative data for nearly all public and private non-profit two- and four-year colleges and universities in the

United States. Each fall, institutions report to IPEDS the number of certificates and degrees conferred overall and separately by race/ethnicity during the previous school year.

We used this data to construct three outcomes of interest separately for URM and non-URM students: the logged number of less-than-two-year certificates conferred at public two-year colleges, the logged number of associates degrees conferred at public two-year colleges, and the logged number of bachelor's degrees conferred at four-year public colleges and universities.[8] We constructed a fourth outcome, the proportion of certificates/degrees awarded to URM students, to examine if PBF policies in Tennessee and Ohio altered racial gaps in college completion.[9]

In addition to completion data, IPEDS includes a rich set of time-varying institutional characteristics that we used as covariates to construct counterfactual states most similar to Tennessee and Ohio. Specifically, we constructed enrollment-weighted, inflation-adjusted measures of the average net price of attendance, instructional expenditures per full-time-equivalent student, and the share of education and general expenditures paid for by state appropriations at the state-by-year level.[10] We also aggregated the number of enrolled URM, non-URM, and students of "other" races reported annually by public institutions to IPEDS up to the state level. Lastly, because the time period in this study spans the Great Recession and the severity of the economic downturn varied across the United States, we used county-level unemployment data from the U.S. Bureau of Labor Statistics to construct a measure of the annual unemployment rate within the commuting zone of each public institution as a proxy for local economic hardship. Like the other covariates, we aggregated the unemployment measure up to the state level and used it to help construct the comparison groups.

Samples

We constructed a state-by-year dataset spanning the 2004 through 2015 school years for this study.[11] Prior to aggregating the data to the state level, we restricted the IPEDS data to public, degree-granting two- and four-year colleges and universities (N=1,695). We then excluded institutions that changed their degree granting status over the time period in our study. We also excluded institutions that did not report undergraduate enrollment, state appropriations, or educational finance data to IPEDS during this time period, resulting in a balanced panel of 1,250 institutions across all states. Our analytic sample accounts for 80 percent of certificates and bachelor's degrees and 82 percent of associate degrees awarded to undergraduates attending public institutions between 2004 and 2015. We aggregated the data to the state-by-year level by summing enrollment and degree counts and by calculating enrollment-weighted averages of institutional revenues, expenditures, and local unemployment rates across all public institutions in each state and year.

After constructing the state-level dataset, we restricted the set of "donor" states used to construct the synthetic control to those that either did not utilize performance funding from 2004 through 2015 or implemented rudimentary PBF policies that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their funding scheme.[12] This set of states provides the cleanest counterfactual for estimating the effects of PBF policies with equity provisions in Tennessee and Ohio since states with more robust PBF policies during the time period we examine may have also been treated. We identified 23 states as having no or rudimentary PBF policies for four-year institutions and 21 states as having no or rudimentary PBF policies for two-year institutions over this timeframe.[13]

Analytic Strategy

The key identifying assumption of our research design is the parallel trends and levels assumption: in the absence of the PBF policies, we assume that race-based completion gaps in Tennessee/Ohio and their respective comparison group would have evolved similarly over time. We use SCM to address the fact that this assumption is violated in a traditional difference-in-differences framework.

The challenge of identifying appropriate comparison groups to Tennessee and Ohio is perhaps unsurprising: while public institutions in those states have some commonalities with other public institutions nationally, they also have several differences. In Table 1, we present descriptive characteristics of public institutions operating in non- or rudimentary-PBF states alongside characteristics of public institutions in the treated states. On average, public institutions in Tennessee and Ohio are similar to public institutions operating in states with no- or rudimentary-PBF policies with respect to average net price and expenditures per full-time equivalent student. However, institutions in both treated states enroll a smaller fraction of URM students (21.6 percent and 14.3 percent in Tennessee and Ohio, respectively) compared to public institutions in the comparison group (25.5 percent). Consequently, both states award a smaller fraction of certificates and degrees to URM students than non- and rudimentary-PBF states. On average, Tennessee also enrolls 31 percent fewer students in two-year colleges and Ohio enrolls almost three times the number of four-year college students compared to states on average in the donor set. Prior to the introduction of high-stakes PBF policies, sizable race-based completion gaps were evident in the treated states. For example, in Tennessee, URM students comprised 21.5 percent of undergraduates attending two-year institutions on average but only 15.9 percent of all certificates and associate degrees conferred per year.[14] Likewise, in Ohio, URM students comprised 18 percent of undergraduates attending two-year institutions on average but only 12.6 percent of all certificates and associate degrees conferred per year.

[Table 1]

To address the concern of identifying an appropriate comparison group, we employ the SCM developed by Abadie and Gardeazabal (2003) and Abadie, Diamond, and Hainmueller (2010; 2014). SCM takes a data-driven approach to finding a comparison group in small-sample comparative studies by constructing a "synthetic" state that resembles Tennessee and Ohio, respectively, in both the mean values and trends of outcomes and covariates during the pre-PBF period. Using this approach, we identify a vector of weights that, when applied to the set of comparison states, minimizes the difference between Tennessee/Ohio and the comparison group in the pre-policy period.[15]

We tested 18 approaches to constructing the counterfactuals separately for Tennessee and Ohio. We modeled the outcomes and covariates over the pre-treatment years (2004-2008 for Ohio and 2004-2009 for Tennessee) in three ways – averaging over all pre-treatment years, using the values in the last two pre-treatment years, and using the values in the last three pre-treatment years – and tested each resulting outcome-by-covariate combination.[16] In addition, we explored using the full set of institutional characteristics described in the Data section in the vector of covariates as well as a more parsimonious vector that only included the URM, non-URM, and "other" race enrollment measures in the list of covariates.[17]

Because we estimate impacts over multiple outcomes (i.e., less-than-two-year certificates, associate degrees, and bachelor's degrees) and groups (i.e., URM, non-URM, and the share of credentials conferred to URM students) in each state, different approaches minimized the difference between the treatment and comparison groups across all outcome-by-group combinations. In our main results, we present effect estimates using the "optimal" criterion that minimized the root mean-squared prediction error (RMSPE) for each outcome-by-group combination. As a robustness check, we examine the sensitivity of using sub-optimal criterion to construct the synthetic state and estimate effects.

In Tables 2 and 3, we report the optimal weights assigned to donor states to construct the synthetic state for each outcome-by-group combination in Tennessee and Ohio, respectively. The weights vary considerably across donor states to construct the counterfactuals for each outcome-by-group combination. For example, to estimate impacts on the log number of certificates conferred, Iowa, Kentucky, and New York receive nearly all the weight to construct the counterfactual in Ohio for non-URM students, whereas California, Iowa, Kentucky, and Missouri receive most of the weight to construct the counterfactual for URM students. However, across all three bachelor's degree outcomes, Michigan consistently receives more than 60 percent of the weight to construct the synthetic Ohio. We observe similar variability with respect to the donor state weight assignments in Tennessee, although broadly speaking, states in the southern region (Alabama, North Carolina, and South Carolina) receive relatively more weight than in Ohio to construct the counterfactuals in Tennessee.

[Tables 2 & 3]

After constructing the synthetic control groups, we estimate the effect of performance funding in Tennessee/Ohio on completion outcomes by calculating the difference between outcomes in the treated state and the synthetic control state in each post-adoption year. To conduct hypothesis tests, we use a placebo inference approach that provides an empirical *p*-value based on a permutation-based test (Abadie et al., 2010). Through this approach we restrict the sample to comparison states, choose one state as the placebo treated state, and then re-run the SCM model to estimate a placebo treatment effect. We repeat this process over all states in the donor pool and compare the proportion of placebo effect estimates that are at least as large as the main effects in Tennessee/Ohio in the post-treatment period. To account for the fact that the placebo matches vary in quality across donor states in the pre-treatment period, we report adjusted p-values that account for the quality of each placebo match. For each outcome-by-group combination, the adjusted p-values report the proportion of $\left(\frac{placebo\ effect}{pre-treatment\ RMSPE}\right)$ ratios at least as large as the ratio in the actual treated states.

Results

Graphical Evidence

Comparing the completion trends in Tennessee and Ohio before and after the introduction of PBF to trends in the synthetic states suggests that these policies exacerbated race-based disparities in college attainment at two-year colleges. To illustrate this, in Figure 1 we plot the number of associate degrees conferred to URM and non-URM students in Tennessee and Ohio and in their respective synthetic control states before and after PBF-adoption. In Tennessee, the synthetic control group for non-URM students closely tracks the actual outcome path of non-URM students. The synthetic control for URM students in Tennessee aligns less well in the first three pre-treatment years, but almost perfectly tracks the trend in associate degrees conferred to URM students over the next five years. This suggests that the synthetic control groups in Tennessee provide a reasonable approximation of the outcome paths that would have materialized in the absence of PBF 2.0. In Ohio, the synthetic control groups also mirror the completion levels and trends for URM and non-URM students almost identically over the pre-policy period, once again indicating that SCM generates reasonable counterfactuals for estimation of policy effects.

Across both states, we observe differential trends in associate degree conferrals between URM and non-URM students in the post-policy period. The number of associate degrees conferred to URM students was increasing in Tennessee and Ohio before the adoption of PBF 2.0 but leveled off after the policy change. The counterfactual is that those gains would have continued over the post-policy period in the absence of PBF 2.0. In contrast, the outcome paths of non-URM students in the actual Tennessee/Ohio and synthetic control deviate little from each other over the post-treatment period. Across most post-policy years, the counterfactuals even lie slightly below the observed outcomes in the treated states. Taken together, the results in Figure 1 provide suggestive evidence that PBF 2.0 widened racial disparities in associate degree attainment by decreasing degree conferrals to URM students while not altering degree conferrals to non-URM students.

SCM Estimates of Effects on Certificate, Associate, and Bachelor's Degree Conferrals

We now turn to the results of estimating impacts of performance funding in Tennessee and Ohio on completion outcomes for URM and non-URM students, and on race-based completion gaps. In Table 4, we report impacts on less-than-two-year certificate production in each post-adoption year. The results in columns 1-3 indicate that PBF 2.0 in Tennessee exacerbated race-based gaps in certificate production. The estimated impacts for both URM and non-URM students are positive, indicating that the number of degrees conferred to both groups spiked as a result of the policy. However, the magnitude of the effects for URM students are substantially smaller than for non-URM students. As a result, the estimated impacts on the proportion of certificates conferred to URM students are negative and statistically significant. Five years after the policy change, for instance, we estimate that PBF increased the number of certificates conferred to URM students by 76 percent compared to 138 percent among non-URM students.[18] As a result, the policy decreased the share of certificates awarded to URM students by 9.6 percentage points in that year, a decline of more than 50 percent relative to the year before Tennessee implemented PBF 2.0.

The estimates in Ohio for URM and non-URM students in columns 4 and 5, respectively, are not statistically significant, but they are generally opposite signed from each other. In column 4, the estimates are mostly negative and imply that certificate production decreased by 5-8 percent for URM students in years 5-7 following the introduction of PBF 2.0 in Ohio. In column 5, the estimates become increasingly positive over time and suggest that the policy increased certificate production by 7-30 percent for non-URM students in years 5-7 after initial implementation in Ohio. We do not find evidence that this differential pattern attenuated or reversed after 2013, when Ohio introduced equity provisions into its PBF model for two-year institutions. In column 6, the estimated effects on the proportion of certificates conferred to URM students are consistently negative in all post-treatment years, although only two of the estimates are statistically significant at conventional levels. The magnitudes of the effects also attenuate considerably when Ohio incorporated longer-term certificate production and equity provisions into its funding formula. We conclude that the differential pattern of certificate conferrals to URM and non-URM students following the introduction of PBF 2.0 was not large enough to exacerbate race-based gaps in certificate production in Ohio.

[Table 4]

In Table 5, we report analogous impacts on associate degree completion. We find the same pattern of results with respect to associate degree conferrals in Tennessee and Ohio. In column 1, the point estimates for URM students in Tennessee are consistently negative three years after the policy change, but not statistically significant. The estimate in 2015 implies that the number of associate degrees conferred to URM students in Tennessee declined 13 percent six years after the policy change. In contrast, all the estimates for non-URM students in Tennessee are positive in magnitude in column 2. As a result, we consistently estimate negative, though imprecise, effects on the proportion of associate degrees awarded to URM students in Tennessee after the introduction of PBF 2.0. Our estimates imply that six years after the policy change, PBF 2.0 decreased the share of associate degrees conferred to URM students in Tennessee by 3.5 percentage points, a decline of almost 25 percent relative to the year before Tennessee revised its funding model.

In column 4 of Table 5, the estimated impacts on associate degree conferrals to URM students in Ohio are also consistently negative, increase in magnitude over time, and are statistically significant in years 4-7 after the 2009 legislation took effect. In 2015, seven years after the initial legislation and three years after a majority of funds were allocated based on course and degree completion, PBF decreased the number of associate degrees conferred to URM students in Ohio by 26 percent. By comparison, we find no evidence of effects on the number of associate degrees conferred to non-URM students in Ohio. The estimated effects in column 5 are mostly positive, all are near zero, and none are statistically significant. The estimated effects on the share of associate degrees conferred to URM students are consistently negative in all post-treatment years and increase in magnitude over time but are not statistically significant. The magnitude of the estimate in 2015 implies that PBF 2.0 decreased the share of associate degrees conferred to URM students in Ohio by 1.8 percentage points, a 14 percent decline off a baseline of 12.2 percent in the year before the policy change in Ohio.

[Table 5]

The estimated effects of PBF on race-based gaps in bachelor's degree production are less consistent across Tennessee and Ohio. The results in Table 6 indicate that in Tennessee, PBF 2.0 also decreased the number of bachelor's degrees conferred to URM students by 2-6 percent annually but increased or had no impact on the number of degrees conferred to non-URM students.

In Ohio, the results indicate that PBF increased annual bachelor's degree conferrals to URM and non-URM students by similar amounts, ranging from 4-13 percent per year, although only the estimates for non-URM students are statistically significant. In both states, we find little evidence that PBF 2.0 altered the share of bachelor's degrees awarded to URM students. The effect estimates are opposite signed (negative in Tennessee and positive in Ohio), but all are small in magnitude, ranging from -0.6 to 1.2 percentage points, and none are statistically significant. We conclude that PBF 2.0 produced differential impacts on bachelor's degree production by race in Tennessee, but those differences were too small to shift the racial distribution of bachelor's degrees conferred. PBF 2.0 did not have differential impacts by race on bachelor's degree production in Ohio.

[Table 6]

Robustness of the Effect Estimates

We examine the robustness of the certificate and degree effect estimates for URM and non-URM students in Ohio and Tennessee in Figures 2 and 3, respectively. We present analogous results for the share of credentials conferred to URM students in Appendix Figures A1 and A2. In each figure, we plot the outcome trend in the treated state (solid black line), the optimal synthetic state that minimizes the RMSPE in the pre-treatment period (dashed black line), and eight alternative counterfactuals that fit the data more poorly in the pre-treatment period (grey lines).[19] Comparing how closely the dashed black and grey lines align, and the gap between those lines and the solid black line in the post-treatment period, reveals whether the effect estimates are robust to alternative constructions of the counterfactual.

The results in panel A of Figure 2 show that two alternative counterfactuals track the observed pattern of less-than-two-year certificates conferred to URM students in Ohio in the post-treatment period more closely than the optimal synthetic state. The effect estimates generated by those counterfactuals are therefore smaller in magnitude than the main effects we report. However, those counterfactuals demonstrate substantially worse fit in the pre-treatment period than the optimal synthetic state. The effect estimates from alternative synthetic controls that fit the data more closely in the pre-treatment period are equal to or larger in magnitude (i.e., more negative) than our main certificate effect estimates for URM students in Ohio. Likewise, seven years after PBF 2.0 took effect in Ohio, all the effect estimates on certificate production among non-URM students are positive. In panel A of Figure A1, we further show that most of the estimated effects on the share of certificates conferred to URM students are negative in the post-treatment period using different synthetic control groups. We conclude that our main estimates on certificate production in Ohio, which are suggestive of widening race-based gaps, are generally robust to alternative constructions of the counterfactuals.

The results in panels B and C of Figure 2 also suggest that the associate and bachelor's degree effect estimates in Ohio are robust to other synthetic control groups that reasonably fit the outcome paths in Ohio in the pre-treatment period. For example, all nine counterfactuals for estimating effects on associate degree production for URM students closely track each other in the pre- and post-policy period, and the actual outcome path in Ohio deviates from all synthetic states in the post-policy period. Once again, the results in panel B of Figure A1 also show that the estimated effects on the share of associate degrees conferred to URM students in Ohio are negative across all counterfactual constructions, and all but one of the alternative synthetic states produce estimates that are more negative than the main effects we report in Table 5.

In Figure 3 and Appendix Figure A2, we similarly show that the effect estimates in Tennessee are generally robust to alternative counterfactual constructions. In Panel A of Figure 3, for instance, a positive gap in certificate production emerges in the post-treatment period between actual Tennessee and all nine synthetic states, and those gaps are relatively larger for non-URM students than for URM students. As a result, we consistently estimate large declines in the share of certificates conferred to URM students across alternative models, as shown in panel B of Figure A2. The robustness checks in Tennessee also reveal that other synthetic control groups generate larger estimated declines in the share of associate degrees conferred to URM students in Tennessee. Taken together with the results in Ohio, this suggests that our main results may provide conservative estimates of the effect of performance-based funding on the widening of race-based gaps in associate degree attainment.

Conclusions and Future Research

This paper examines the differential impacts of PBF policies with equity provisions for public higher education on certificate and degree completion by race. We compare certificate and degree conferrals among URM and non-URM students at public institutions in Tennessee and Ohio after the adoption of new PBF policies to public institutions in synthetic control groups comprised of states that had no or rudimentary PBF policies. Our findings suggest that PBF policies exacerbated racial disparities in college certificate and associate degree attainment in Tennessee and exacerbated disparities in associate degree attainment in Ohio, even though both states include equity provisions in their funding models to incentivize improved performance of at-risk student groups. We find no evidence that the policies widened racial gaps in bachelor's degree attainment, although in Tennessee the policy decreased bachelor's degree attainment among URM students slightly and had null or slightly positive impacts among non-URM students.

It is notable that in both Tennessee and Ohio, the policies appear to have widened degree inequities at public two-year institutions but not at four-year institutions. This may reflect the fact that community colleges in both states are less insulated from PBF-induced pressures than four-year institutions. Compared to four-year colleges and universities in Tennessee and Ohio, two-year institutions have fewer resources to spend per student, smaller endowments, and rely more on state appropriations to finance educational activities. In addition, because even modest declines in funding can present challenges to resource-constrained institutions, the steps both states took to offset sudden and extreme funding losses after the new PBF regimes took effect may have shielded two-year colleges less from the consequences of the policy change relative to their higher-resourced, four-year counterparts.

Within the two-year sector in Tennessee and Ohio, we find the effects of the PBF policies to be generally similar with respect to associate degree outcomes; however, we find differential effects with respect to certificate outcomes. Because we analyze the impact of the PBF models in their entirety, we are unable to isolate the effects of specific policy components and identify the drivers of the variation in effects across the two states. However, it is possible that race-based gaps in certificate outcomes widened less in Ohio because, unlike Tennessee, Ohio did not tie state funding to short-term certificate production. This may have reduced the pressure felt by two-year institutions in Ohio to increase enrollment in and completion of short-term certificate programs.

The pattern of results across Tennessee and Ohio suggest that other differences in policy design may have little-to-no impact on how institutions are likely to respond in high-stakes PBF environments. For example, with respect to associate degree outcomes, Ohio’s slower phase in of PBF at two-year colleges does not seem to have insulated institutions from PBF-induced pressures, as evidenced by the negative and statistically significant effect on associate degree conferrals to URM students that first emerges in 2012, two years before Ohio phased out its stop-loss provision.

Differences between the bonus payment designs in Tennessee and Ohio also do not appear to have led to differential impacts on associate degree outcomes across the two states. Only Ohio incentivized degree conferrals to URM students directly and made equity-based bonus payments stackable over the time period we study, yet we estimate consistently negative effects on associate degree conferrals to URM students in both Tennessee and Ohio. Furthermore, although the results for URM students are similar in magnitude across the two states, the effect estimates are consistently larger in Ohio. Taken together, those findings suggest that the equity provisions of PBF policies may play a larger role in limiting gains made by traditionally advantaged student populations than improving performance among underrepresented groups.

We conclude with an important limitation that should be considered when interpreting the findings in this study. We examined the effects of PBF in Tennessee and Ohio because they have longstanding and robust PBF regimes that include equity-based provisions. However, both states were unique relative to all other states during the study period with respect to how much they relied on PBF to allocate state appropriations to public institutions. It remains possible that completion gaps at two-year colleges would have been even larger in Tennessee and Ohio in the absence of equity premiums, or if the bonus payments were less generous, bolstering the argument that equity provisions may mitigate the otherwise negative consequences of PBF policies on socioeconomic attainment disparities (Kelchen, 2018). Our findings related to this point are mixed. Although we find evidence that race-based gaps in certificate conferrals widened in Ohio before the introduction of equity provisions and attenuated thereafter, we find no evidence that the introduction of PBF equity provisions had a countervailing influence on race-based gaps in associate degree attainment in Ohio. Because Ohio introduced multiple changes to its PBF model for two-year colleges simultaneously, we were unable to isolate the effects of equity provisions in our empirical work. More research is needed to separate the effects of PBF equity provisions from other features of PBF models.

Nevertheless, our findings suggest that even if equity provisions have a beneficial, countervailing influence, they do not fully mitigate the tendency for completion gaps to grow when states tie most of their state appropriations to performance metrics. The pattern of results we find in both Tennessee and Ohio is largely consistent with our hypothesized effects in response to high-stakes PBF policies: fear of funding reductions and actual revenue losses experienced disproportionately by minority-serving institutions disproportionately affect underrepresented minority students and may supplant the potential for bonus premiums to reduce completion gaps.

Because both states have revised their funding formulas since the period we study, further research is needed to examine whether the evolving nature of PBF 2.0 in Tennessee and Ohio has increased equity in higher education in more recent years. Whether more generous or better targeted PBF equity provisions can narrow college completion gaps also remains a question for future study, as does the question of whether equity provisions can reduce socioeconomic attainment gaps in states with relatively lower-stakes PBF policies. Amidst the widespread adoption of PBF in higher education, developing a clearer understanding of the opportunities and limitations associated with those funding models is critical to financing public higher education systems in service of dismantling, rather than reinforcing historical inequities.

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Table 1. Select characteristics of institutions in Tennessee, Ohio, and donor pool states prior to PBF adoption (averaged over 2004-2008)

	(1)	(2)	(3)	(4)	(5)	(6)
	Two-Year Institutions			Four-Year Institutions		
	Donor Pool States	Tennessee	Ohio	Donor Pool States	Tennessee	Ohio
Total Undergraduate Enrollment	93,959	64,405	119,963	76,141	101,765	200,965
	(167,125)	(2,052)	(2,532)	(81,699)	(3,017)	(3,631)
URM Undergraduate Enrollment	28,859	13,485	20,567	14,483	22,401	25,445
	(64,643)	(502)	(615)	(20,963)	(673)	(1,369)
Non-URM Undergraduate Enrollment	57,513	49,109	93,712	55,156	76,358	165,372
	(86,393)	(1,046)	(1,204)	(51,991)	(1,885)	(1,826)
Total Less-than-Two-Year Certificates Awarded	4,833	1,581	6,287			
	(8,080)	(51)	(1,114)			
Certificates Awarded to URM Students	1,259	301	803			
	(2,881)	(34)	(121)			
Certificates Awards to Non-URM Students	3,236	1,231	5,183			
	(4,715)	(91)	(869)			
Total Degrees Awarded	10,850	7,045	15,986	15,021	17,097	37,125
	(15,625)	(65)	(708)	(17,713)	(774)	(668)
Degrees Awarded to URM Students	2,482	1,043	1,869	2,303	3,040	3,279
	(5,068)	(68)	(93)	(3,708)	(134)	(185)
Degrees Awards to non-URM Students	7,488	5,871	13,405	11,367	13,668	31,717
	(9,107)	(43)	(532)	(11,813)	(540)	(412)
Average Net Price	$8,296	$7,633	$7,759	$14,271	$11,280	$18,479
	(2,973)	(559)	(144)	(2,353)	(186)	(581)
Educational Expenditures per FTE Student	$5,397	$4,925	$5,039	$10,967	$10,025	$10,407
	(1,124)	(202)	(91)	(2,622)	(214)	(395)
Share of Educational Expenditures Covered by State Funds	0.38	0.47	0.39	0.38	0.39	0.30
	(0.13)	(0.03)	(0.01)	(0.11)	(0.02)	(0.01)

Number of Institutions	18.5	13	22	7.5	9	20
	(21.3)			(7.0)		
Number of States	23	1	1	21	1	1

Notes: Means are reported with standard deviations in parentheses. The donor pool is comprised of states that, from 2004-2015, never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. See Table 2 for the list of states by sector included in the donor pool. Black, Latino, and American Indian/Alaskan native students are categorized as under-represented minority (URM) students. White and Asian students are categorized as non-URM. students. Average net price includes costs for tuition, fees, room, and board.

Source: 2004-2008 Integrated Postsecondary Education Data System

Table 2. Weights Assigned to Donor States for Each Outcome in the Tennessee Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Log Number of Credentials Conferred to Non-URM Students			Log Number of Credentials Conferred to URM Students			Share of Credentials Conferred to URM Students		
State	Certificate	Associate Degree	Bachelor's Degree	Certificate	Associate Degree	Bachelor's Degree	Certificate	Associate Degree	Bachelor's Degree
AK	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AL	0.485	0.060	0.243	0.279	0.133	0.486	0.000	0.034	0.379
CA	0.000	0.062	0.000	0.063	0.155	0.092	0.293	0.000	0.087
CT	0.000	0.000	0.000	0.006	0.000	0.000	0.229	0.000	0.000
DE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IA	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000
ID	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
KY	0.000	0.000	0.000	0.005	0.000	0.077	0.000	0.000	0.189
MD	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000
MI	0.000	0.000	0.000	0.007	0.000	0.021	0.154	0.000	0.000
MO	0.155	0.005	0.619	0.001	0.000	0.000	0.000	0.333	0.000
NC	0.000	0.433	0.110	0.019	0.000	0.147	0.000	0.471	0.231
ND	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
NE	0.000	0.000	0.000	0.006	0.193	0.000	0.026	0.000	0.000
NH	0.000	0.009	0.000	0.003	0.000	0.000	0.000	0.011	0.000
NJ	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.000
NY	0.273	0.000	0.000	0.358	0.000	0.043	0.062	0.000	0.057
RI	0.000	0.002	0.000	0.004	0.273	0.000	0.000	0.117	0.000
SC	0.000	0.232	0.000	0.019	0.247	0.065	0.000	0.000	0.045
VT	0.087	0.071	0.027	0.002	0.000	0.000	0.000	0.000	0.000
WA	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
WV	0.000	0.127	0.000	0.194	0.000	0.069	0.237	0.034	0.013
WY	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000

Optimal Pre-Period Characteristics used to Create Synthetic Control

Outcomes	Average	Average	Last 3 years	Average	Last 2 years	Last 3 years	Average	Last 3 years	Last 3 years
Covariates	Last 2 years of enrollments	Last 2 years of all covariates	Average of enrollments	Average of enrollments	Average of all covariates	Average of all covariates	Average of all covariates	Last 3 years of all covariates	Last 2 years of all covariates

Notes: The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. Reported weights minimize the root mean squared prediction error of the outcome in the pre-policy period.

Source: 2004-2015 Integrated Postsecondary Education Data System

Table 3. Weights Assigned to Donor States for Each Outcome in the Ohio Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Log Number of Credentials Conferred to Non-URM Students			Log Number of Credentials Conferred to URM Students			Share of Credentials Conferred to URM Students		
State	Certificate	Associate Degree	Bachelor's Degree	Certificate	Associate Degree	Bachelor's Degree	Certificate	Associate Degree	Bachelor's Degree
AK	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AL	0.000	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CA	0.000	0.000	0.299	0.302	0.376	0.125	0.106	0.000	0.000
CT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IA	0.372	0.000	0.035	0.203	0.169	0.000	0.000	0.456	0.254
ID	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
KY	0.463	0.000	0.000	0.280	0.000	0.000	0.000	0.000	0.000
MD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MI	0.000	0.000	0.665	0.000	0.000	0.621	0.679	0.255	0.746
MO	0.000	0.000	0.000	0.183	0.160	0.000	0.215	0.000	0.000
NC	0.000	0.000	0.000	0.000	0.110	0.098	0.000	0.222	0.000
ND	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NE	0.000	0.000	0.000	0.000	0.000	0.129	0.000	0.000	0.000
NH	0.000	0.000	0.000	0.033	0.000	0.000	0.000	0.000	0.000
NJ	0.000	0.453	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NY	0.152	0.404	0.000	0.000	0.000	0.028	0.000	0.000	0.000
RI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.066	0.000
SC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
VT	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WY	0.000	0.000	0.000	0.000	0.185	0.000	0.000	0.000	0.000

Optimal Pre-Period Characteristics used to Create Synthetic Control

Outcomes	Last 3 years	Last 3 years	Average	Last 3 years	Last 3 years	Last 3 years	Average	Last 3 years	Average
Covariates	Average of enrollments	Average of enrollments	Average of all covariates	Average of all covariates	Average of enrollments	Average of enrollments	Average of enrollments	Average of all covariates	Average of all covariates

Notes: The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. Reported weights minimize the root mean squared prediction error of the outcome in the pre-policy period.

Source: 2004-2015 Integrated Postsecondary Education Data System

Table 4. Estimated Effects of Performance-Based Funding on Certificate Production in Tennessee and Ohio, by URM Status and Year

	(1)	(2)	(3)	(4)	(5)	(6)
	Tennessee			Ohio		
	Log Number of Certificates Awarded		Share of Certificates Awarded to URM Students	Log Number of Certificates Awarded		Share of Certificates Awarded to URM Students
	URM Students	Non-URM Students		URM Students	Non-URM Students	
2009				0.023	-0.083	-0.004
				[0.714]	[0.476]	[0.571]
2010	-0.117	0.298**	-0.062***	-0.056	-0.071	-0.009
	[0.476]	[0.048]	[0.000]	[0.381]	[0.524]	[0.143]
2011	0.812**	1.369***	-0.099***	0.003	-0.063	-0.025***
	[0.048]	[0.000]	[0.000]	[0.857]	[0.667]	[0.000]
2012	0.64**	0.907***	-0.078***	-0.021	0.007	-0.019
	[0.048]	[0.000]	[0.000]	[0.619]	[0.905]	[0.143]
2013	0.604*	0.861***	-0.093*	-0.074	0.072	-0.052***
	[0.095]	[0.000]	[0.095]	[0.333]	[0.762]	[0.000]
2014	0.568*	0.869***	-0.096***	-0.074	0.155	-0.016
	[0.095]	[0.000]	[0.000]	[0.333]	[0.429]	[0.143]
2015	0.551	0.776***	-0.108***	-0.056	0.261	-0.004
	[0.190]	[0.000]	[0.000]	[0.571]	[0.381]	[0.714]
Mean (unlogged) in year before policy adoption	408	1,699	0.194	807	4,995	0.139

*** p < 0.01, ** p < 0.05, * p < 0.10

Notes: Effects are estimated using the synthetic control method. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. In each column, the weights assigned to the donor pool are chosen to minimize the root mean squared prediction error of the outcome in the pre-policy period. Reported p-values are derived from placebo permutation tests and account for the quality of each placebo match in the pre-policy period. Years refer to the fall of each school year (e.g., 2009 = 2009-10).

Source: 2004-2015 Integrated Postsecondary Education Data System

Table 5. Estimated Effects of Performance-Based Funding on Associate Degree Production in Tennessee and Ohio, by URM Status and Year

	(1)	(2)	(3)	(4)	(5)	(6)
	Tennessee			Ohio		
	Log Number of Degrees Awarded		Share of Degrees Awarded to URM Students	Log Number of Degrees Awarded		Share of Degrees Awarded to URM Students
Year	URM Students	Non-URM Students		URM Students	Non-URM Students	
2009				-0.050	-0.033	-0.008
				[0.190]	[0.238]	[0.190]
2010	0.004	0.011	-0.000	-0.010	0.003	-0.005
	[0.952]	[0.857]	[0.952]	[0.667]	[0.905]	[0.381]
2011	0.027	0.058	-0.003	-0.007	0.048	-0.005
	[0.762]	[0.143]	[0.857]	[1.000]	[0.333]	[0.476]
2012	-0.062	0.049	-0.010	-0.110***	0.029	-0.013
	[0.667]	[0.238]	[0.524]	[0.000]	[0.571]	[0.190]
2013	-0.11	0.03	-0.017	-0.124***	0.022	-0.012
	[0.381]	[0.238]	[0.286]	[0.000]	[0.524]	[0.238]
2014	-0.144	0.006	-0.023	-0.206***	0.003	-0.015
	[0.333]	[0.857]	[0.286]	[0.000]	[0.952]	[0.190]
2015	-0.143	0.077	-0.035	-0.299***	-0.013	-0.018
	[0.429]	[0.143]	[0.238]	[0.000]	[0.762]	[0.238]
Mean (unlogged) in year before policy adoption	1,069	6,317	0.145	1,944	14,038	0.122

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Notes: Effects are estimated using the synthetic control method. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. In each column, the weights assigned to the donor pool are chosen to minimize the root mean squared prediction error of the outcome in the pre-policy period. P-values are reported in brackets and derived from placebo permutation tests that account for the quality of each placebo match in the pre-policy period. Years refer to the fall of each school year (e.g., 2009 = 2009-10).

Source: 2004-2015 Integrated Postsecondary Education Data System

Table 6. Estimated Effects of Performance-Based Funding on Bachelor's Degree Production in Tennessee and Ohio, by URM Status and Year

	(1)	(2)	(3)	(4)	(5)	(6)
	Tennessee			Ohio		
	Log Number of Degrees Awarded		Share of Degrees Awarded to URM Students	Log Number of Degrees Awarded		Share of Degrees Awarded to URM Students
Year	URM Students	Non-URM Students		URM Students	Non-URM Students	
2009				0.001	0.013	0.005
				[0.957]	[0.609]	[0.696]
2010	-0.038***	0.032*	-0.005	0.091	0.069*	0.007
	[0.000]	[0.087]	[0.217]	[0.174]	[0.087]	[0.565]
2011	-0.016*	0.027	-0.002	0.164	0.123***	0.010
	[0.087]	[0.174]	[0.565]	[0.130]	[0.000]	[0.261]
2012	-0.037**	0.061***	-0.006	0.139	0.091*	0.012
	[0.043]	[0.000]	[0.261]	[0.217]	[0.087]	[0.478]
2013	-0.030**	0.038	-0.003	0.081	0.113**	0.006
	[0.043]	[0.174]	[0.522]	[0.391]	[0.043]	[0.565]
2014	-0.056***	-0.002	-0.004	0.122	0.122**	0.008
	[0.000]	[0.957]	[0.739]	[0.348]	[0.043]	[0.652]
2015	-0.042*	0.006	0.001	0.042	0.123**	0.001
	[0.087]	[0.783]	[1.000]	[0.652]	[0.043]	[0.957]
Mean in year before policy adoption	3,323	14,394	0.188	3,532	32,182	0.099

*** p < 0.01, ** p < 0.05, * p < 0.10

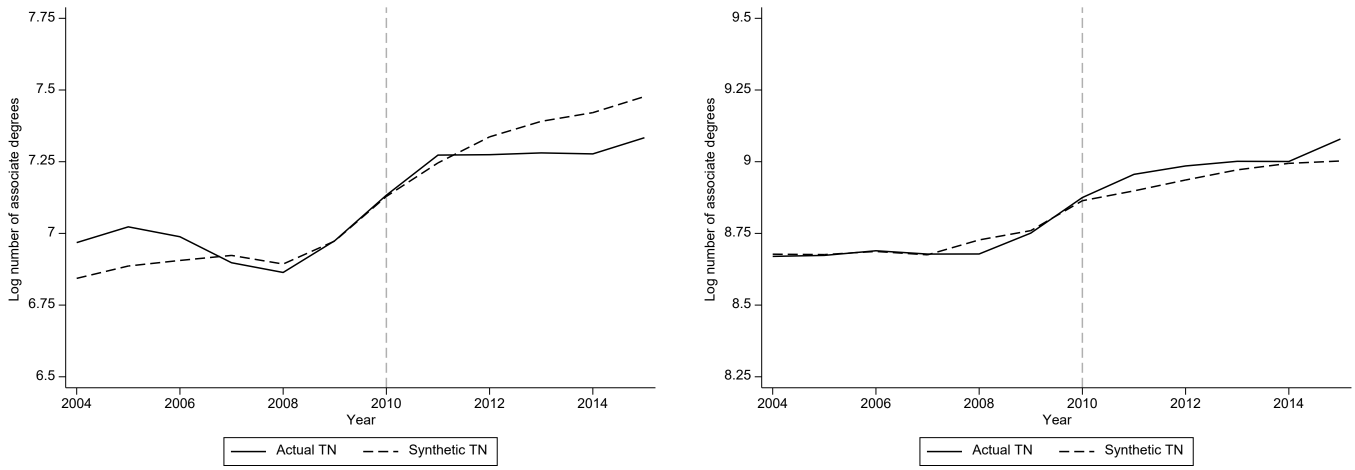
Notes: Effects are estimated using the synthetic control method. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. In each column, the weights assigned to the donor pool are chosen to minimize the root mean squared prediction error of the outcome in the pre-policy period. P-values are reported in brackets and derived from placebo permutation tests that account for the quality of each placebo match in the pre-policy period. Years refer to the fall of each school year (e.g., 2009 = 2009-10).

Source: 2004-2015 Integrated Postsecondary Education Data System

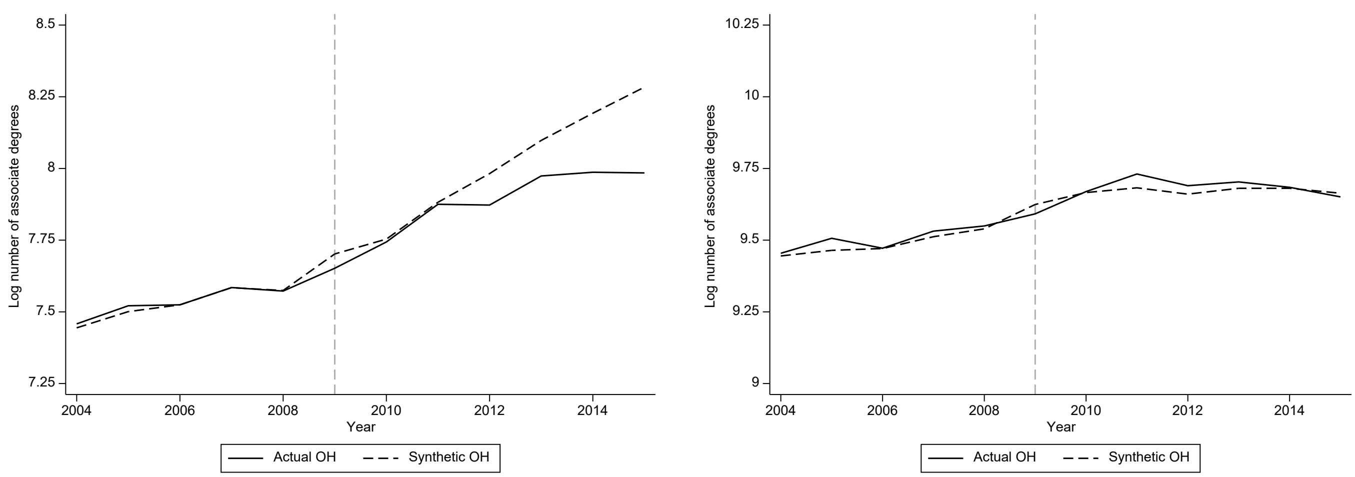
Figure 1. Trends in associate degree conferrals to URM and non-URM students in Tennessee, Ohio, and synthetic control groups.

URM Non-URM

A. Tennessee



B. Ohio



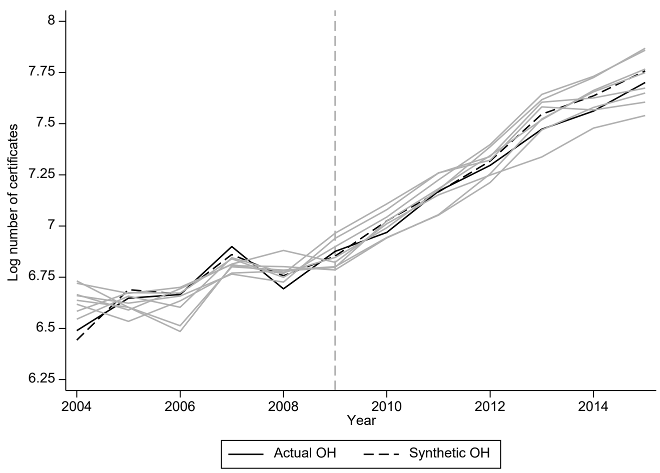
Notes: The Synthetic Control Method is used to construct the counterfactual outcome paths. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. The synthetic control state is constructed by assigning weights to the donor pool that minimize the root mean squared prediction error of the outcome in the pre-policy period. Years refer to the fall of each school year (e.g., 2004 = 2004-05).

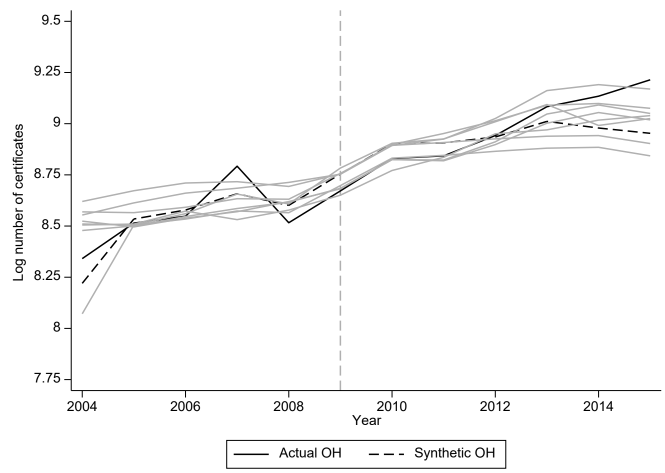
Source: 2004-2015 Integrated Postsecondary Education Data System

Figure 2. Robustness of the certificate and degree effect estimates in Ohio for URM and non-URM students to alternative constructions of the synthetic control group

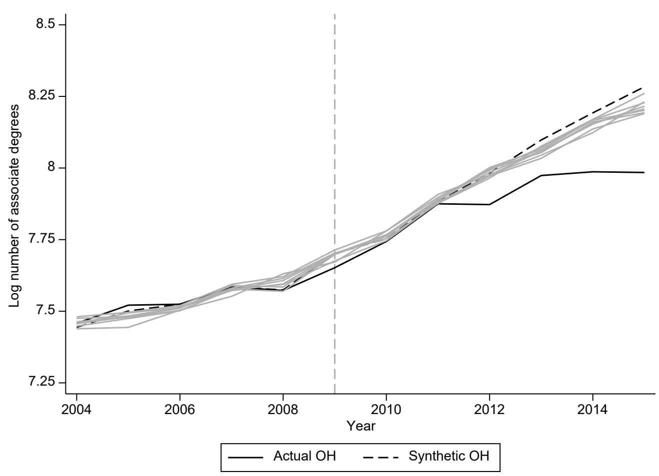
URM Non-URM

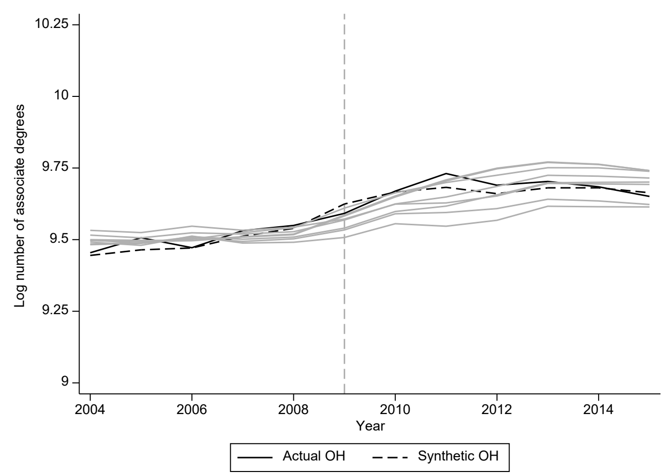
A. Log number of certificates awarded



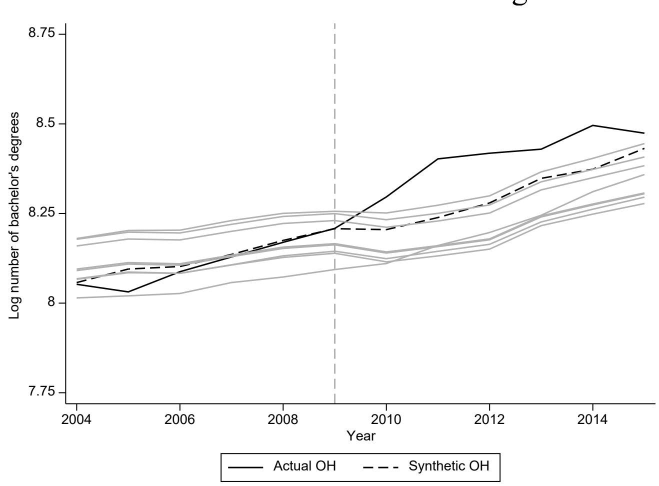


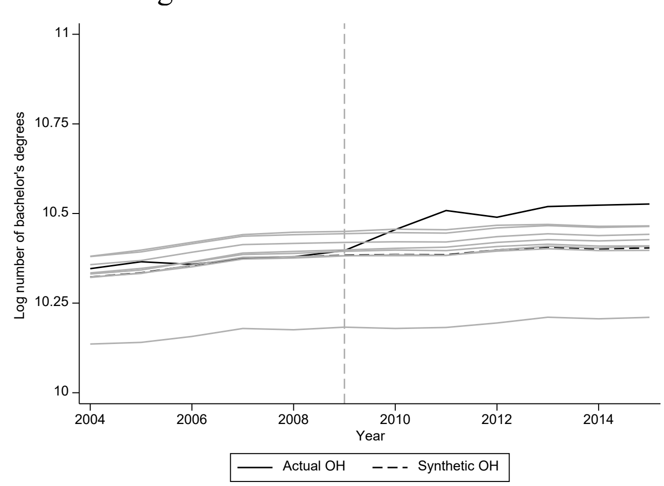
B. Log number of associate degrees awarded





C. Log number of bachelor's degrees awarded





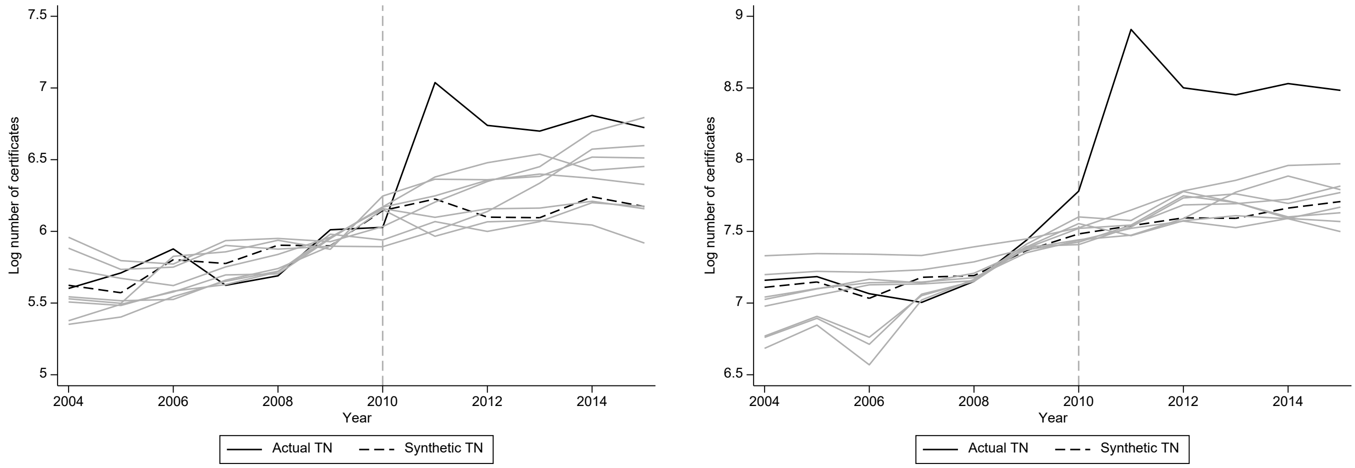
Notes: The Synthetic Control Method is used to construct the counterfactual outcome paths. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. The dashed black line is the “optimal” counterfactual that minimizes the root mean squared prediction error in the pre-policy period. The grey lines depict alternative counterfactuals that best fit the data in the pre-treatment period for at least one other outcome-by-group combination in Ohio or Tennessee. Years refer to the fall of each school year (e.g., 2004 = 2004-05).

Source: 2004-2015 Integrated Postsecondary Education Data System

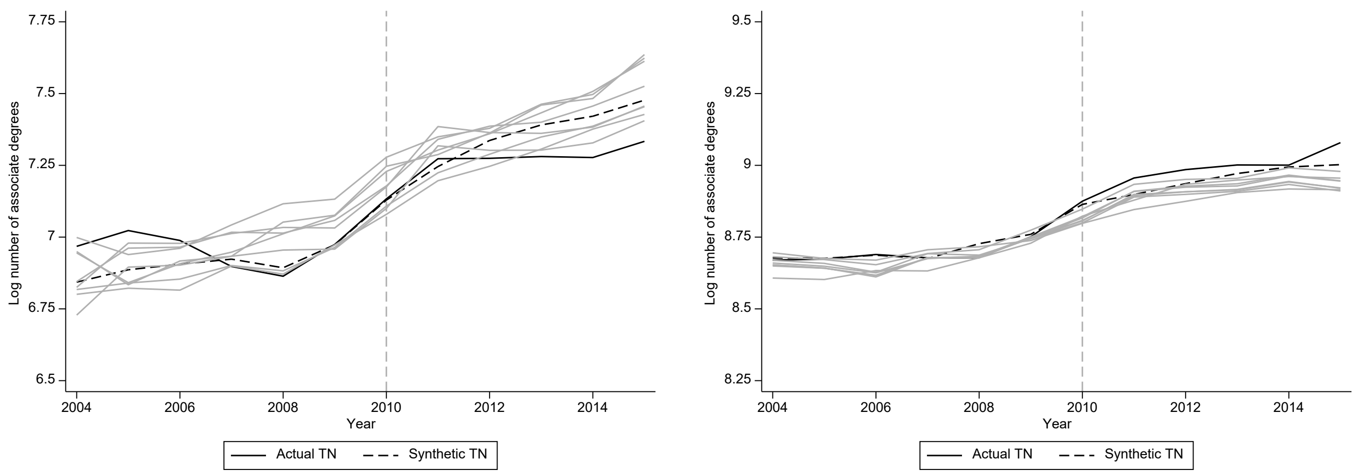
Figure 3. Robustness of the certificate and degree effect estimates in Tennessee for URM and non-URM students to alternative constructions of the synthetic control group

URM Non-URM

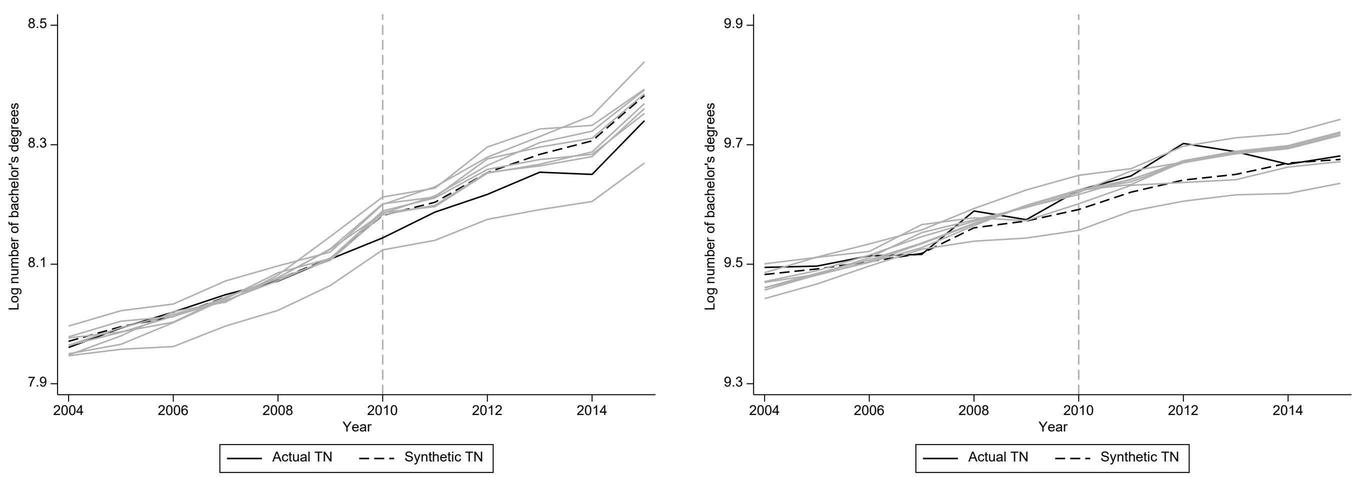
A. Log number of certificates awarded



B. Log number of associate degrees awarded



C. Log number of bachelor's degrees awarded



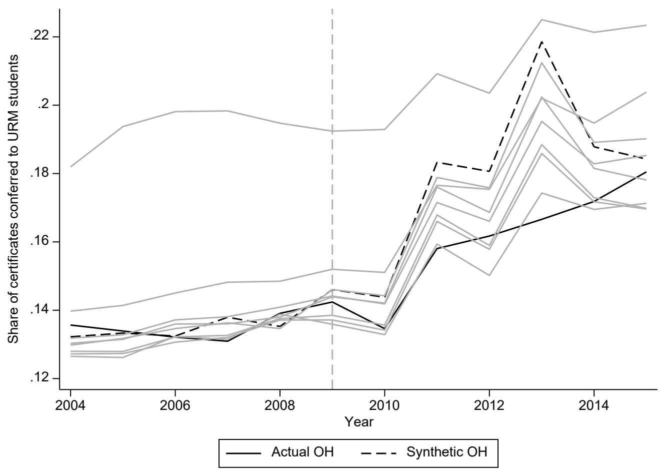
Notes: The Synthetic Control Method is used to construct the counterfactual outcome paths. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. The dashed black line is the "optimal" counterfactual that minimizes the root mean squared prediction error in the pre-policy period. The grey lines depict alternative counterfactuals that best fit the data in the pre-treatment period for at least one other outcome-by-group combination in Ohio or Tennessee. Years refer to the fall of each school year (e.g., 2004 = 2004-05).

Source: 2004-2015 Integrated Postsecondary Education Data System

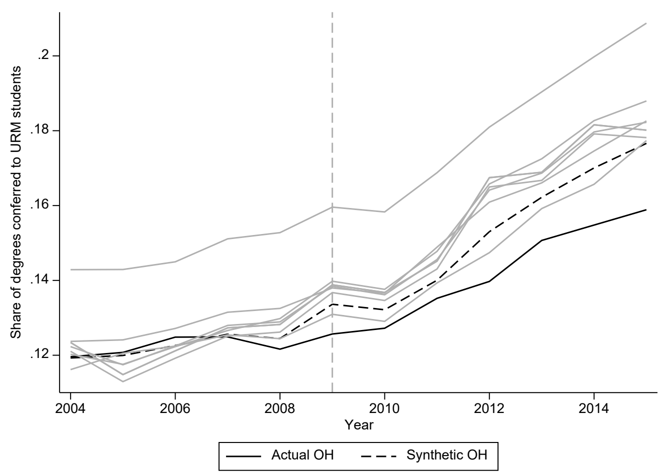
Appendix

Figure A1. Robustness of the share of certificate and degree effect estimates conferred to URM students in Ohio to alternative constructions of the synthetic control group

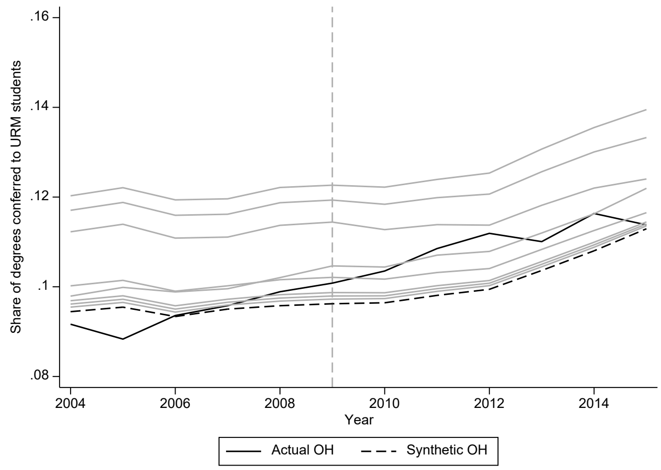
A. Less-than-Two-Year Certificates



B. Associate Degrees



C. Bachelor’s Degrees

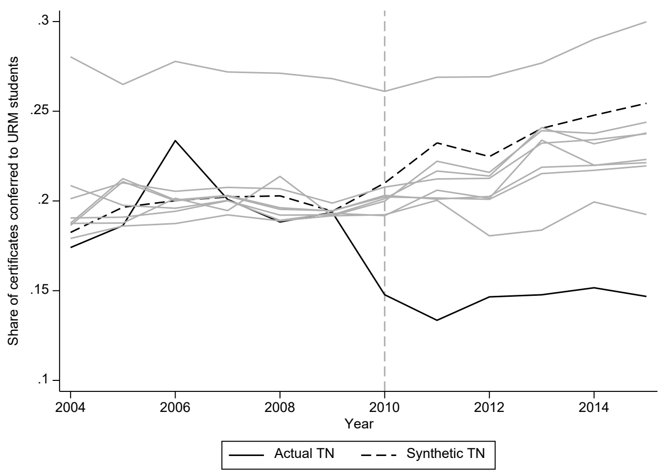


Notes: The Synthetic Control Method is used to construct the counterfactual outcome paths. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. The dashed black line is the "optimal" counterfactual that minimizes the root mean squared prediction error in the pre-policy period. The grey lines depict alternative counterfactuals that best fit the data in the pre-treatment period for at least one other outcome-by-group combination in Ohio or Tennessee. Years refer to the fall of each school year (e.g., 2004 = 2004-05).

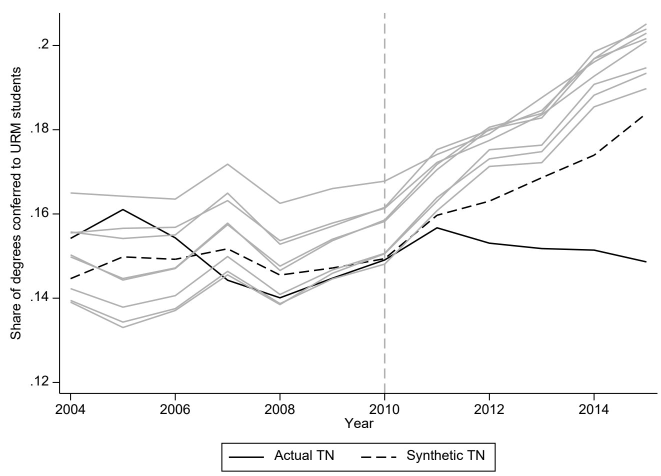
Source: 2004-2015 Integrated Postsecondary Education Data System

Figure A2. Robustness of the share of certificate and degree effect estimates conferred to URM students in Tennessee to alternative constructions of the synthetic control group

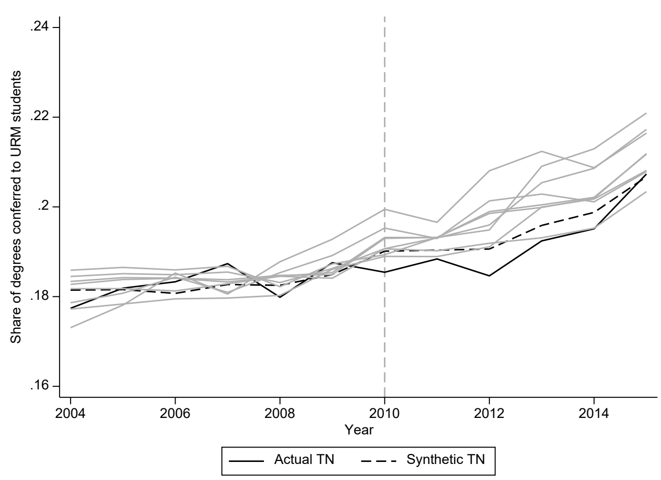
A. Less-than-Two-Year Certificates



B. Associate Degrees



C. Bachelor's Degrees



Notes: The Synthetic Control Method is used to construct the counterfactual outcome paths. The donor pool is comprised of states that never implemented PBF or that tied less than 5 percent of funding to performance outcomes and did not include equity provisions in their PBF funding scheme. The dashed black line is the "optimal" counterfactual that minimizes the root mean squared prediction error in the pre-policy period. The grey lines depict alternative counterfactuals that best fit the data in the pre-treatment period for at least one other outcome-by-group combination in Ohio or Tennessee. Years refer to the fall of each school year (e.g., 2004 = 2004-05).

Source: 2004-2015 Integrated Postsecondary Education Data System

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[1] Authors' calculation based on prior reports and own research.

[2] We define URM as Black, Latino, or American Indian/Alaskan native students and non-URM as White or Asian students.

[3] We index school years by the fall term throughout the paper. For example, 2009 refers to the 2009-10 school year.

[4] North Dakota, Nevada and Missouri enacted PBF 2.0 models in 2013.

[5] In our empirical work, we define the year in which the Tennessee and Ohio state legislatures passed new PBF policies as the first treated year, rather than the first year of implementation. This allows us to capture anticipatory effects on completion that may have arisen as colleges learned of and prepared for funding changes. Our results for two-year institutions in Ohio are robust to defining 2013 as the first treated year, which corresponds to when the state fully phased in PBF with equity provisions for community colleges. Those results are available from the authors upon request.

[6] Ohio also offers premiums for academically underprepared students.

[7] For example, bonus payments for students who were low-income and URM were approximately 60-80 percent over the period we study.

[8] Less-than-two-year certificates include short-term certificates (less than one-year, or less than 30 semester credit hours) and moderate-term certificates (one-to-two-year, or 30-60 semester credit hours). Because some state definitions of "short-term" and "long-term" certificates vary from IPEDS definitions, we include both certificate types in our estimation. Across the entire analytic sample, short-term certificates account for 63% of all less than two-year certificates.

[9] We exclude students of "other" racial categories, comprised of students of two or more races, non-resident aliens, and unknown race, from the construction of the share outcomes because we are unable to determine URM status for those students.

[10] We used the Consumer Price Index (CPI) for inflation adjustment.

[11] We aggregated the data up from the institution level to the state level because SCM constructed a set of synthetic institutions that poorly approximated treated institutions in Tennessee and Ohio in the pre-policy period. SCM performed on state-level data produced more credible counterfactuals for estimation of policy effects.

[12] States with rudimentary PBF policies are included to construct an adequately sized donor set for generating reasonable synthetic controls. We identified the set of no or low-PBF states using multiple sources, including Snyder's (2015) PBF typography, a classification system that is commonly referenced by higher education policymakers, as well as additional reports and research (e.g. Gandara, & Rutherford, 2018, Kelchen, 2018; MacKellar, 2016; Snyder & Fox, 2016; SHEEO, 2019), and our own review of states' performance funding policies and documents.

[13] See Table 2 for the list of states by sector included in the donor pool.

[14] Students whose URM status cannot be identified are excluded from these calculations.

[15] More specifically, the vector of weights is chosen to minimize the root mean-squared prediction error (RMPSE) in the pre-policy period.

[16] We did not attempt to use outcome and covariate values in every pre-treatment year to construct synthetic controls to avoid issues of overfitting to the data.

[17] We initially explored constructing synthetic states using only pre-treatment outcome values, but this resulted in including all or nearly all donor pool states in the counterfactual construction. As a result, the models excluding covariates did not differentiate well between the possible donor states to select the subset that best represented Tennessee/Ohio in the pre-treatment years.

[18] Because we estimate impacts on log-transformed outcomes, percent changes are calculated by exponentiating the effect estimates (i.e., $e^{\hat{\beta}}$).

[19] We plot alternative counterfactuals that best fit the data in the pre-treatment period for at least one other outcome-by-group combination in Ohio or Tennessee. We omit synthetic controls that never yielded an optimal fit to make the figures more legible.