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EdWorkingPaper No. 26-1544

More STEM Credentials at What Cost? Unpacking 2-Year Colleges' Response to the STEM Incentive in Performance-Based Funding

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Objective: Performance-based funding (PBF) has gained significant traction in US higher education over the past few decades. It aims to improve student outcomes by tying a portion of state funding to outcomes (e.g., graduation, retention). In recent years, an increasing number of states have added workforce metrics to their PBF policies to promote STEM and health credentials aimed at strengthening the local labor pipeline. This study evaluates whether and how the STEM incentive for 2-year institutions changes total STEM credentials awarded, awards by duration (short, medium, and long-term STEM awards), STEM-to-total awards, and awards by duration among racial and socioeconomically minoritized students. **Methods**: I leverage InformEd States and IPEDS data to create a national panel of 691 institutions and employ difference-in-differences and event study strategies with institutional controls and state-year fixed effects to evaluate changes in awards in response to the state incentive. **Results**: The results suggest that overall STEM awards do not change in response to the incentive. However, colleges shift focus from long-term to medium-term STEM degrees and track minorities into such programs. **Contributions**: The findings underscore that community colleges might pursue a lower-cost path to larger bonuses by awarding more short-term degrees that may be less valued in the labor market. Additionally, minority students might be disproportionately tracked into shorter-term credentials. This analysis highlights the perverse incentives the current reward system generates and recommends a redesign that aligns college and student interests.

VERSION: August 2026

Suggested citation: Sultana, Tasneem. (2026). More STEM Credentials at What Cost? Unpacking 2-Year Colleges' Response to the STEM Incentive in Performance-Based Funding. (EdWorkingPaper: 26-1544). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/2h4x-f187

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Acknowledgments

I wish to thank Matt S. Giani and Paul von Hippel for their feedback on earlier drafts of this manuscript; Meredith S. Billings for her comments at the Association for the Study of Higher Education 2025 virtual conference; and Jessica Myers for her editorial assistance and research support.

Declaration of Conflicting Interests

The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

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Abstract

Objective: Performance-based funding (PBF) has gained significant traction in US higher education over the past few decades. It aims to improve student outcomes by tying a portion of state funding to outcomes (e.g., graduation, retention). In recent years, an increasing number of states have added workforce metrics to their PBF policies to promote STEM and health credentials aimed at strengthening the local labor pipeline. This study evaluates whether and how the STEM incentive for 2-year institutions changes total STEM credentials awarded, awards by duration (short, medium, and long-term STEM awards), STEM-to-total awards, and awards by duration among racial and socioeconomically minoritized students. **Methods:** I leverage InformEd States and IPEDS data to create a national panel of 691 institutions and employ difference-in-differences and event study strategies with institutional controls and state-year fixed effects to evaluate changes in awards in response to the state incentive. **Results:** The results suggest that overall STEM awards do not change in response to the incentive. However, colleges shift focus from long-term to medium-term STEM degrees and track minorities into such programs. **Contributions:** The findings underscore that community colleges might pursue a lower-cost path to larger bonuses by awarding more short-term degrees that may be less valued in the labor market. Additionally, minority students might be disproportionately tracked into shorter-term credentials. This analysis highlights the perverse incentives the current reward system generates and recommends a redesign that aligns college and student interests.

Keywords: Performance-Based Funding, STEM, Workforce metrics, Community College, Principal-Agent model.

Introduction

Performance or outcomes-based funding (PBF) has emerged as a popular state financing approach for postsecondary institutions over the past few decades, as the share of state funding for higher education and the perceived value of a college degree are declining (Burke, 2002; Dougherty et al., 2014b). PBF links state funding to student outcomes (e.g., on-time graduation, retention, underserved student outcomes, degrees in critical fields) rather than to baseline figures such as enrollment (Dougherty, 2016; Hillman et al., 2014; Ortagus et al., 2020). In a resource-dependent framework in which colleges rely on state funding, PBF seeks to optimize funding by incentivizing colleges to improve students' educational and labor market outcomes.

As of 2022, thirty-two states use some form of PBF, with considerable variation in the portion of funds tied (i.e., base or bonus funding), sectors targeted (i.e., 2- or 4-year institutions), and the outcomes emphasized, based on state objectives (ECS, 2024; Kelchen et al., 2023). The dynamic landscape of PBFs can be attributed to unintended consequences of the early wave of simpler models that relied on a limited number of outcomes rather than holistic metrics (Bell et al., 2018; Hillman & Corral, 2017; Ortagus et al., 2020). Researchers identified backward engineering by institutions under a principal-agent framework, leading to cream-skimming (i.e., selective institutions becoming less accessible for underserved students) and concentration of funds in well-financed institutions away from those with limited funding, creating greater inequality in educational inputs and outcomes (Favero & Rutherford, 2020; Li et al., 2018).

These findings encouraged continuous redesigning of PBF, leading to more complex "PBF 2.0" systems (Bell et al., 2018; Ortagus et al., 2020). Under this, many states offer rewards for serving underserved students (e.g., low-income, racial minority, non-traditional). Some states also promote STEM and Health degrees to support local labor market needs (Li, 2020). As of

2020, nineteen states include a STEM metric in their PBF for either 2- or 4-year colleges, or both (Kelchen et al., 2023). Research suggests 4-year colleges respond to the incentive by awarding more STEM credentials at the cost of greater selectivity (Birdsall, 2018; Li, 2020). However, 2-year institutions' response to the STEM metric is yet to be evaluated.

2-year institutions' response to a PBF model with STEM as a target outcome (PBF-STEM) is shaped by their unique operational domain. Community colleges are typically more resource-constrained than 4-year colleges (CCRC, 2022). So, additional funds, having a larger marginal benefit, can encourage greater STEM awards, and possibly a larger response than universities (Li & Kennedy, 2018). However, as broad-access institutions, they cannot explicitly choose the student pool, their level of college readiness, and track them into more rigorous STEM programs (Bragg & Durham, 2012). This inhibits their capacity to increase awards. Launching new programs also remains less feasible, at least in the short run, since it requires expensive classroom setups and hiring additional faculty (McGuinness, 2025). Nevertheless, since they offer a wide range of certification programs varying in length (6 weeks to 2+ years), one possible mechanism community colleges maximize state funds is by shifting focus from costlier, longer-term, to more certain, short-term degrees (Li & Kennedy, 2018). This approach benefits institutions but may reduce students' labor market gains, creating conflicting interests.

To examine how incorporating a STEM component in 2-year institutions' PBF structure influences their degree-granting behavior, I investigate three research questions (RQs):

RQ1: How do the number and composition of STEM degrees awarded at 2-year institutions vary by state adoption of PBF-STEM, both in absolute terms and relative to total awards?

RQ2: Is there evidence of system gaming whereby institutions focus on relatively shorter-term STEM degrees, or award disproportionately greater numbers of degrees to privileged students?

RQ3: How do the outcomes vary by the number of years that PBF-STEM is active?

I leverage the InformEd States data containing state-by-year PBF information and IPEDS data documenting institutional characteristics for 1997-2020, to address the RQs. I use a difference-in-differences (DiD) framework with staggered treatment timing to capture institutional instantaneous and average responses to PBF-STEM, and an event-study technique to study gradual adjustments. The findings suggest overall STEM degrees do not increase significantly, at least within the short time window I can observe following policy implementation. However, I find evidence of a greater focus on shorter-term STEM degrees, accompanied by tracking minorities into these degrees, suggesting possible system gaming.

Literature Review

The dynamic landscape of PBF policies in the U.S. higher education began in Tennessee in 1979, as a simple mechanism aimed at improving student outcomes, primarily graduation rates (Dougherty & Natow, 2015). Despite starting as a single-dimensional model with little guidance for institutional actors, the policy improved graduation rates. This initial success encouraged other states, including Florida, Illinois, and Washington, to follow suit—an uptake largely known as "PBF 1.0" (Burke & Modarresi, 2001; Dougherty et al., 2014b; Ortagus et al., 2020).

However, as state contexts and implementation varied substantially across the early adopters, welfare losses began to emerge (Birdsall, 2018; Favero & Rutherford, 2020; Hillman & Corral, 2017). A few studies reported PBF improved retention and graduation rates, mainly in selective colleges. In contrast, a swathe of literature found it had no effect on the target, and/or negative effects on non-target outcomes (Ortagus et al., 2020; Tandberg & Hillman, 2014). Common concerns include institutions turning away racial minority and low-income students, fearing lower graduation rates that could hurt institutional performance (Favero & Rutherford, 2020; Gándara & Rutherford, 2018). This cream-skimming behavior further concentrated socio-economically marginalized students into financially constrained colleges, reducing their chances of success. Additionally, institutions already facing financial woes, or serving large percentage of low-income students, were penalized for lower student achievement, even though the performance was driven by structural factors (Li, 2019; Li et al., 2018). Consequently, more privileged colleges gained under the policy, intensifying the achievement gap.

To make PBF more effective with minimal negative externalities, researchers highlighted the need for policy reform that include holistic outcome metrics, institutional mission differentiation, rewards for continuous improvement, and greater funds for counseling and mentoring resources (Birdsall, 2018; Hillman & Corral, 2017; Ortagus et al., 2020). These suggestions lead to separate models by sectors, and inclusion of additional outcome metrics—including those for low-income, racial minorities, first-generation students, and adult learners; degrees in critical fields (i.e., Health, STEM); and employment and wages post-graduation (Kelchen et al., 2023). Alongside these changes, some states moved away from bonus funding and embedded formula funding into base appropriations (Kelchen et al., 2019; SHEOO, 2023).

PBF 2.0 is documented to yield relatively fewer unintended consequences than PBF 1.0, although efficacy remains mixed. One theme consistent in the literature is backward engineering, where institutions learn to use the policy that maximizes their rewards while undermining student gains (Bell et al., 2018; Li & Kennedy, 2018). For instance, when states tied PBF bonus to STEM-degrees for 4-year institutions, many responded by turning away students who seemed less ready to succeed in such programs. Considering these themes and concerns about PBF models, we look at PBF for community colleges and for STEM degrees.

PBF for 2-Year Institutions

As of 2023, twenty-eight states finance 2-year institutions through PBF (Mullen & Norris, 2025). Commonly used metrics include on-time completion (e.g., completing an associate's degree in 2 years), progress toward milestones, transfer to 4-year colleges, dual enrollment, workforce outcomes, and outcomes for nontraditional and minority students (ECS, 2024). As community colleges operate in a resource-constrained setting with a broad-access mission, their ability to select students is limited, and their response to monetary incentives is relatively more rigid than 4-year colleges (Lahr et al., 2014; McKinney & Hagedorn, 2017). Despite this, studies show mixed evidence on outcomes, depending on the PBF structure.

The most commonly used outcome in 2-year institutions' PBF is credentials awarded, with some states even targeting awards in high-demand fields (ECS, 2024; Kelchen et al., 2023). While the policy encourages greater completions, whether funds are allocated as base or bonus is pivotal to the actual outcome (Bell et al., 2018; Li, 2019; Ortagus et al., 2023). For example, California, Texas, and others integrate outcomes directly into their base appropriations formula, heightening incentives to meet PBF standards. These states report completion gains coupled with widening achievement gaps, which is particularly concerning for less privileged students and adult learners in the absence of equity metrics (Umbricht et al., 2017). In addition to cream-skimming, institutions have an incentive to invest in shorter-term degrees to maximize rewards, which can steer students away from longer-term degrees that may carry higher incompletion risks but also higher labor market returns (Li & Kennedy, 2018).

In contrast, when states award bonus for higher completion rates, as in Indiana and Pennsylvania, among others, institutions respond less since base funds are protected (Hillman, 2016; Hillman et al., 2015). These findings reflect the equity-efficiency trade-off policymakers often face in balancing institutions' financial stability with ample incentives for better performance. A few states use term-by-term retention to reward momentum toward completion and reduce the relative cost of producing longer-term degrees. This structure is promising in presence of greater advising resources and clearer guided pathways (Harnisch, 2011).

Another set of commonly used metrics in the recent wave of 2-year PBF encompasses outcomes for low-income, racial minority, adult learner, career and technical education (CTE), and academically underprepared groups (Kelchen et al., 2023). They aim to offset the costs of serving students who may need additional support to reach degree milestones, stemming from the college-preparation gap created by systematic barriers. As of 2023, at least twenty-two states practice a combination of these equity metrics for 2-year institutions, mostly in bonus form (Kelchen et al., 2023). Researchers have noted these structures improve outcomes, although the gains are heterogeneous across institutions (Kelchen, 2019; Ortagus et al., 2023). Notably, the enrollment effects are visible, meaning the equity metrics can inhibit cream-skimming.

PBF-STEM Incentives

A recent PBF development is the inclusion of workforce metrics targeting high-demand degrees, especially in STEM and Health, as many states face labor shortage in these fields. As of 2020, nineteen states used a STEM metric in their 2-year PBF, and most used a separate Health metric. As PBF-STEM was first launched in 2008, a national study evaluating PBF-STEM for 2-year colleges is yet to be performed due to its relative novelty. Li (2020) analyzed a decade of IPEDS data (2003-2014) and found a modest rise in 4-year STEM awards in treated states.

STEM careers in advanced manufacturing and technology are high-wage and growing for their salience in innovation and growth. While existing research focuses on 4-year institutions, community colleges are important partners in growing this talent pipeline by offering lower-cost, specialized STEM programs of varying length. However, community colleges are also more financially constrained than 4-year colleges, which limits their ability to redirect resources to STEM programs. This limitation is intensified by their open access mission[1], leaving less room to tailor programs given many of their students have family responsibilities, study part-time, and/or are interested in specific programs that fine-tune their skills (CCCSE, 2022). This unique set-up with opposing forces and scope to differentiate degrees by duration presents an interesting case-study, motivating us to evaluate STEM incentives for community colleges.

Theoretical Framework

We view institutional response to state PBF-STEM as a combination of the principal-agent and resource dependence frameworks. The principal-agent theory suggests, when the principal (i.e., higher education governing body) sets a target for the agent (i.e., 2-year institutions), and can only observe the outcome without a mechanism to explicitly observe the efforts that manifest the outcome, the agent has an incentive to identify the least costly path to achieve it (Jensen & Meckling, 1976). In the process, this may create negative externalities unaccounted for in the compensation scheme.

In this case, the state higher education entity incentivizes institutions to improve STEM completion through STEM curriculum development, faculty and staff hiring, and capital investment (Bell et al., 2018). However, since state entities cannot fully monitor how institutions increase attainment, institutions may backward engineer the target outcome by awarding less costly, more certain, short- and medium-term credentials (Mullen & Norris, 2025). Additionally, since minority students might seem less STEM-ready due to systematic barriers, colleges can track them away from STEM programs to attain higher completion rates (Reber et al., 2019). Community colleges may also lower STEM graduation standards to increase completion rates

(Li, 2020). We examine these sorting possibilities by measuring STEM as a proportion of all credentials, degrees by duration, and awards to minorities by duration.

The resource dependency framework posits, agents rely on the principal for setting standards for securing funds essential for the agent's operations (Bell et al., 2018; Ortagus et al., 2023). In this context, public community colleges are financially dependent on state appropriations to cover the growing costs of educating students, facilitating classrooms and labs, providing institutional support and services, and preparing students for the labor market through practical skill development. Since these costs often exceed tuition revenue, institutions are attentive to state targets, and their efforts are proportional to the funding amount that can reduce their fiscal constraints (Li & Kennedy, 2018; Community College Research Center, 2022).

This is especially applicable to STEM education, which can have higher training costs due to specialized facilities and equipment, higher professor salaries, and greater research expenditures (Hemelt et al., 2018). In fact, STEM bonuses are provided to offset this additional cost (Li, 2020). However, since the bonus only comes at the end of the academic year, after institutions have incurred the cost, they cannot fully ramp up operations unless they have some initial financial support from the state or local industries. Together, these two frameworks suggest institutions may increase STEM awards but in ways that can undermine student gains.

Methods

Data

I leverage two publicly available datasets to address the RQs: InformEd States data documenting state-by-year PBF practices, and IPEDS data recording degree completions and institutional characteristics. These allowed me to link state PBF policies between 1997-2020 to degree completions at each institution-state pair, and control for institutional characteristics associated with awards, thereby isolating any influence PBF-STEM has on credentials.

InformEd States

This dataset documents state funding mechanisms for postsecondary institutions between 1997-2020. Each state-year record includes indicators for any PBF; STEM and Health bonuses; minority, low-income, adult learner, and academically underprepared metrics; and the sectors for each metric. I use these indicators to construct the primary independent variable, STEM bonus for 2-year colleges. While this records whether PBF applies to base or bonus and the overall PBF funding percentage, it does not explicitly break down the percentages by metric.

InformEd States documents a rapid increase in states using PBF, rising from seven in 1997 to thirty-three in 2020—meaning almost two-thirds of all states adopted it by 2020, as illustrated in Figure A1, panel a. The share of formula funding also increased over the years, and many states moved away from bonus to base funding. Additionally, many states adopted a combination of three or more metrics since 2010, including the STEM metrics. Figure A1 shows, as of 2020, nineteen states have included STEM bonus in their PBF structure, with notable growth around 2012. Figure A1, panel b, shows a state-by-state breakdown for the number of years states practice PBF and PBF-STEM for 2-year institutions. The incentive was first adopted by Minnesota in 2008 but discontinued in 2010. Hawaii adopted it in 2009, the same year it implemented PBF, and has continued to include it, making it the longest user of the incentive.

IPEDS

IPEDS data on institution-by-year awards, expenditures, demographics, size, and locale for 1997-2020 complement the PBF data, forming the full set of institutional controls. The primary dependent variable, annual STEM awards, is from the completion files where each row corresponds to awards per 2-digit Classification of Program (CIP) code-degree type (e.g., CIP code 14-Engineering, degree type - Associates). It also classifies awards by race-gender groups. Following Li (2020), I classify credentials as STEM or non-STEM and programs by duration as short-, medium-, and long-term, to address RQ2, as described in the variable subsections.

I construct institutional demographic composition measures from IPEDS Enrollment files. These files record the number of undergraduates; students in each racial, gender, and age group; and enrollment intensity, leading to the following measures: percentage of students in each racial group; male-female, traditional-to-nontraditional age, and full-to part-time ratio[3]. Additionally, the Scholarship and Financial Aid files document the percentage of students receiving the Pell grant (considered low-income). I compile institutional instruction, support, and service expenditures—that could influence degree outcomes—from the expenditure files. Finally, I link the institution code in each file to Institutional Characteristic file, to map institutions to states and identify the state financing policy. This file also contains the institution locale, completing our set of controls related to credential completion.

Outcome Variables

I construct the primary outcome variable, log STEM degrees based on 2-digit CIP code. I designate CIP codes - 01 (Agriculture), 02 (Agricultural Sciences), 03 (Conservation and Natural Sciences), 04 (Architecture), 11 (Computer and Information Science), 14 and 15 (Engineering and Related Technologies/Technicians), 26 (Biology and Biological Sciences), 27 (Math and Statistics), 40 (Physical Sciences and related), and 41 (Science Technologies and Technicians)—as STEM degrees. I consider the log of degrees since the raw numbers vary considerably by institution size. Since PBF-STEM states (except for Indiana, New York, and Ohio[4]) have a separate healthcare metric in addition to STEM, and I use state fixed effects accounting for state-by-state policy differences, I categorize health degrees as non-STEM with the remaining majors. I use an alternative STEM definition that includes Health credentials and report the results in the appendix. To answer RQ1, I also calculate STEM-to-total ratio, to identify if institutions redistribute resources across fields, which is unlikely to be captured by an absolute measure.

I classify degrees by duration to trace system-gaming efforts (Li & Kennedy, 2018). I separately measure short- (<15 credits or <1 year in length), medium- (16-30 credits or 1-2 years in length), and long-term (2+ years) credentials. Finally, to detect cream-skimming through systematic tracking, I define STEM degrees awarded to female, Black, and Hispanic students as awards to minorities and check if they vary by PBF structure (Kelchen et al., 2024).

Independent Variables

The key treatment variable is an indicator of whether a state practices PBF-STEM for 2-year colleges in a year (1 = state-year with PBF-STEM). In addressing RQ3, I capture the lag between institutional response and the desired outcome, utilizing an event study method which models degree outcomes in each post-policy year. This accounts for 2-year institutions' resource-constrained environment and open-access mission, which may limit their ability to upscale current STEM offerings or select and sift students in the short term.

To isolate policy influence on awards, I use a host of institutional controls that could predict completions. I account for demographic composition using percentage of low-income students; percentage of students in each racial category: Asian, Black, Hispanic, Non-Hispanic White, and all other races; and male-female, traditional-non-traditional age, and full-part-time ratios. I control for institution size through the number of undergraduates, since larger colleges could award more degrees. I include the log of instructional, services, and support expenditures to account for their positive relation with outcomes. Finally, I use four indicators: city, suburb, town, and rural, that account for the locale, offerings, and degree outcomes correlation.

Analytic Strategy

To address RQs 1 and 2, I start with a difference-in-differences (DiD) strategy with two-way, state-year fixed effects (TWFE) to get baseline estimates of STEM award changes in response to the PBF-STEM incentive and the controls. The canonical DiD model is as follows:

$$(1)\ Y_{ijt} = \beta_0 + \beta_1\,(PBF - STEM)_{jt} + X_{ijt} + \gamma_s + \eta_t + \varepsilon_{ijt}$$

Here, Y is the outcome (i.e., log STEM degrees, STEM-to-total, degrees by duration, and awards to minorities) for institution i in state j in year t. PBF-STEM is an indicator for state j having STEM metric for 2-year institutions in year t. β_1, the coefficient of interest, measures PBF-STEM's influence on awards. X_{ijt} is a vector of institutional controls (i.e., demographics, expenditures, locale, and size). γ and η represent state and year FEs, respectively. The state FEs account for time-invariant state-level differences that could explain difference in policy adoption and outcomes through unobserved factors (e.g., geographic region). The year FEs isolate any time-variant changes specific to that year (e.g., economic cycle). Using these FEs with institution-level controls, I derive naïve estimates (β_1) for the policy (PBF-STEM) effect. For all models, I cluster the standard errors at the state level to account for serial correlation.

Next, I utilize the Callaway and Santa Anna DiD (CSDiD) method that accommodates staggered policy adoption (Baker et al., 2022). Since not all states adopt the policy in the same year, in any year the sample has four treatment statuses: never-treated, not-yet treated, first-time treated, and already treated in a previous year. In such cases, the TWFE model makes 'forbidden comparison – compares first-time treated units with already-treated and never-treated units (the actual control group). Such comparison can yield biased estimates when treatment effects vary by years and treatment cohorts. The CSDiD constructs group-time average treatment effects and compares just-treated units with never and not-yet treated units to provide unbiased estimates. This way, we obtain the Average Treatment Effect on the Treated (ATT), formally presented by:

$$(2)\ Y_{ijt} = \beta_0 + \sum_{\mathrm{g}} \beta_{\mathrm{g},t}\, \mathbb{I}\{G_S = \mathrm{g}\}\,(PBF - STEM)_{jt} + X_{ijt} + \gamma_s + \eta_t + \varepsilon_{ijt}$$

In equation (2), $\mathbb{I}\{G_S = \mathrm{g}\}$ indicates state *s* belongs to treatment cohort *g*, and all the remaining variables are the same as (2). Here, β_{g} yields the treatment effect on cohort *g*, which we aggregate across all the treated cohorts to obtain the ATT.

I address RQ3 using an event-study setup that estimates the average treatment effect for each additional year of treatment:

$$(3)\ Y_{ijt} = \beta_0 + \sum_{\epsilon=-1} \beta_{\epsilon}\, \mathbb{I}\{t - \mathcal{G}_s = \epsilon\} + X_{ijt} + \gamma_s + \eta_t + \varepsilon_{ijt}$$

Here, β_{ϵ} represents the ATT in each year following policy implementation with the immediate pre-policy year as the reference, indicated by $\epsilon = -1$. For instance, if the PBF-STEM metric was implemented in 2010, for cohort 2010 ($\mathcal{G}_{2010}$), β_{ϵ} in 2015 represents the 5th year policy influence relative to 2009. In the following section, we briefly touch upon the canonical DiD results and elaborate on the CSDiD and event-study findings.

Sample Characteristics

The analytic sample consists of 8,266 records for 639 institutions between 1997-2020. I describe the variables and summary statistics in Appendix Table A1. In Table 1, I report key summary statistics by PBF and PBF-STEM status. Notably, the PBF-STEM states differ demographically and financially from the no-PBF and Non-STEM states. For instance, PBF-STEM states have fewer White and Black but more Hispanic students, along with more part-time and traditional-age students. Treated states have larger revenue and expenditure flows, have larger colleges—with a greater proportion located in towns. Finally, PBF-STEM states award more medium- and long-term degrees, and a larger portion of degrees to minorities, consistent with their demographics. These differences indicate the need to control for these variables to identify policy impact in the presence of state-year FEs that absorb the state- and year-level differences not captured by the variables already in the model.

[Insert Table 1 here]

In figure 1, I plot the state-by-year STEM awards, where each panel represents one of the fifty states. This decomposition is useful for understanding any state-level variation in response, possibly masked at the aggregate level. The figure shows little to no gain in STEM degrees post-policy. Notably, Hawaii—the state treated for the longest time—shows a stable number of STEM awards. Given the differences in variable means but stable degree outcomes over the years, we look at the results from the formal models.

[Insert Figure 1 here]

Results

RQ1 and RQ2

I present the canonical DiD results in Table A2 and discuss some of the control variable coefficients due to their significance for educational equity. Neither log STEM degrees nor degree compositions show any noticeable change in response to PBF-STEM. Among demographic controls, one additional male student is associated with a 28% increase in medium-term certifications. Additionally, Hispanic students are associated with large gains in long-term STEM degrees. Notably, colleges with higher instructional expenditures award more long-term STEM credentials than their lower-spending counterparts. This finding supports that colleges incur greater costs in awarding STEM degrees. Institutions with greater tuition revenue, once controlled for institution size, typically increase awards, but I do not see any strategic redistribution of awards favoring shorter-term credentials. Overall, the canonical DiD results reflect colleges in PBF-STEM states do not increase awards or redistribute resources.

I present the CSDiD results in Table 2. The results suggest colleges in PBF-STEM states do not increase awards in any of the STEM programs, nor is there evidence of tracking certain demographic groups into STEM programs. This stands in contrast with Li (2020), which suggests STEM attainment in 4-year colleges increases in response to the incentives. This highlights the difference in 4- and 2-year institutions' capacity to respond to the incentive by choosing and sifting students. The findings also do not align with Li and Kennedy (2018) suggesting, shorter-term degrees rise as states reward completion. To reconcile these findings and view 2-year colleges' response in continuous time that accounts for institutional learning, rather than as a one-time response, I examine the event study results.

RQ3

Figure 2, panel A plots the ATT for log STEM degrees. Since ATT in the 4-year pre-policy window does not differ significantly from 0, STEM outcomes in PBF-STEM and non-STEM states followed a parallel trend. Following PBF-STEM implementation, STEM awards start dropping by about 2% in treated states, although the difference is insignificant, relative to the pre-policy year. In the third and fourth years of treatment, STEM awards rise significantly by approximately 2% relative to the pre-policy year, followed by another round of plummeting the next year. Overall, the estimates are noisy with wide confidence intervals.

[Insert Figure 2 here]

When disaggregated by degree duration (panels B through D), there is a significant, immediate jump in short-term, coupled with an insignificant drop in medium-term STEM credentials. In the following years, short-term credentials in the treated states follow a downward trend, reaching a 5% significant dip in the fifth post-policy year relative to the pre-policy year. Medium-term STEM credentials rise between 2-3% in the first two years followed by a drop in third year, then rising again to reach 4% increase in the fifth policy year. So, one can conclude medium-term STEM credentials are somewhat responsive to the incentive. I cannot determine from the data whether the rise in medium-term credentials is due to newly launched programs or to more awards in existing programs. The long-term degree trajectory follows almost the opposite of the medium-term STEM credential trajectory. This could explain why there is no change in the overall degrees. 2-year institutions might be responding to the incentive by encouraging students into relatively shorter degrees, but at least in the short-term window, observing colleges' post-policy impact, it is felt mostly at the medium-term certification level.

Figure 2 presents the event-study results. Figure 2, panel F, shows STEM degrees to minorities pre- and post-policy oscillate between positive and negative values, limiting my ability to draw any conclusion. Disaggregating the minority credentials by duration in panels I-G, I find longer-term attainments drop, and minority students gain in shorter-term STEM credentials. In sum, some evidence of system gaming is present. Institutions place greater focus on medium-term degrees and track minorities into short-term STEM programs that maximize institutional gain at the potential cost of lower labor market outcomes for minority students. These results should be interpreted with caution, since there is limited post-policy data available, making the sample small and the comparison weaker under staggered treatment.

I also examine whether racial composition and expenditures alter in response to the STEM metric, illustrated in Appendix Figure A2. The trajectories suggest racial compositions do not alter post-policy. Interestingly, the treated states do not increase instructional and support expenditures—which explains why STEM degrees—relatively costlier to produce, do not increase in response to the incentive. At the same time, support expenditures associated with long-term planning see a persistent drop, falling by 5% in the fifth year of treatment. Overall, institutions do not respond to the STEM incentive through student selection or expenditures.

Discussion

As PBF in general, and PBF-STEM in particular, gain momentum, this study analyzes 2-year colleges' response to the STEM metric. Using InformEd States and IPEDS data, I find that 2-year colleges increase shorter-term STEM degrees and track minority students into these programs with lower labor market returns in response to the STEM incentive. Despite the limited post-policy observation years, these findings underscore the need for robust state support to scale up relatively expensive STEM credentials, at least in the first few years—to support institutional capacity building. I recommend the following policies and practices that align student, college, and state interests when designing such incentives.

Stronger Support Pipeline Involving Multiple Stakeholders

Since equipment commonly used in STEM training is specialized and high-cost, states can directly support institutions by subsidizing or procuring it (Hemelt et al., 2018). Although it is highly recommended that states ramp up initial financial and logistical support for community colleges to expand STEM-related training, part of the justification for using this accountability system is states' inability to sustainably fund higher education. Since the STEM measure also supports local workforce needs, a possible alternative is for local industries to support students in form of tuition support, which can make STEM programs affordable to a larger group of students and reduce job search frictions. Alternatively, industries can collaborate with community colleges to provide on-the-job training or work-based learning opportunities, such as apprenticeships. Doing so can minimize the need for immediately installing equipment and laboratories, give students hands-on experience, and, at the same time, upskill current workers.

The Kansas Work-based Learning (WBL) model uses components that smooth the high school-to-college transition and shows promise through initial success (Kansas State Department of Education, 2021). However, implementing these ideas in rural community colleges with limited nearby industry partners could be challenging. Workforce Pell, which expands the Pell program to cover short-term, in-demand credentials, can also help increase STEM attainment.

Ramping up STEM Preparation at HS

While part of the STEM attainment gap is due to the higher rigor of STEM coursework, students attending schools that offer advanced math and science courses tend to be more interested in STEM majors (Costello et al., 2023). So, improving postsecondary STEM attainment requires strengthening college preparation. However, a considerable portion of schools lack advanced math and science course offerings, citing difficulties hiring quality teachers and a mismatch between course rigor and student preparation (Steiner et al., 2023; U.S. Department of Education, 2016). These gaps coincide with the race-SES gradient, largely hampering racial minority students' college preparation and subsequent trajectories (Adelman, 2006; Lee et al., 2017). Greater access, better course design, and broader math and science, Dual Credit (DC), and Career and Technical Education (CTE) course offerings can generate clear career pathways, narrow the preparation gap, and, consequently, encourage more students to attain postsecondary STEM credentials.

Holistic Incentive System, Deterring System Gaming, and Greater Stakeholder Literacy

As stakeholders collaborate to promote STEM attainment for a sustainable workforce, incentive systems such as PBF-STEM design require greater attention. For instance, the current reward system weights all STEM credentials equally, even though they require substantially different levels of investment. This approach is prone to institutional gaming that puts student welfare at stake. Policymakers can consider a stepwise reward system that compensates institutions by the level of investment in degrees (i.e., degrees with longer completion times receive larger rewards). Redesigning the incentive can deter institutions from tracking students and allow them to work toward credentials that maximize long-term benefits, since long-term credentials are often associated with greater labor market returns.

Additionally, rural community colleges require innovative solutions tailored to their operational landscape. Because they have fewer partnership options for apprenticeships and DC courses, the state structure for rural PBF should be differentiated. For example, Texas implemented a PBF model in 2024 that treats rural colleges differently and guarantees fixed base funding (Weissman, 2024). Rural colleges also lack sufficient digital infrastructure, operate below economies of scale, where per-student educational costs are higher, incur higher transportation costs, and therefore have a greater need for wraparound services that colleges often cannot afford. States can support these efforts directly or by offering tax breaks to donors who support the provision of these wraparound services, which first mitigate rural colleges' struggles and align them with workforce needs through funding measures. A final suggestion for making the PBF-STEM strategy more fruitful is to use the bonus on student support, as Austin Community College has subsidized tuition using the PBF bonus since Fall 2024[5] (Weissman, 2024). This can balance the falling purchasing power of the Pell Grant and allow students to pursue majors aligned with their interests, even if they are costlier (Paradise et al., 2025).

Leveraging two decades of national data and DiD and Event Study methods, this study is among the first to evaluate the STEM incentive for 2-year institutions. The findings show that, under the simple reward system that weights all STEM awards equally, community colleges facing stringent fiscal constraints may maximize PBF bonuses by concentrating on shorter-term STEM credentials. Although this could benefit the colleges, it can hamper students' labor market prospects, as longer-term credentials are often associated with better outcomes. Additionally, institutions might track minority students into shorter-term programs, meaning the current structure could be counterproductive for socioeconomic equity. Therefore, state redesigning of metrics that align institutional gains with students' long-term outcomes and provide logistical support as a lever to increase STEM awards is highly recommended. The results are suggestive rather than causal due to the limited post-policy follow-up period and based treatment-cohort matching, which reduces the effective sample size. Future studies can evaluate the STEM metric over a longer post-policy observation period to yield more precise estimates.

Notes

1. Nationwide, most community colleges offer open access to STEM programs, but health programs are highly competitive. Our main analysis considers the STEM metric and outcomes.

2. Students aged 25 or below are considered traditional age, and those enrolled in at least 12 credits per long semester (fall, spring) are considered full-time.

3. These three states never had a separate healthcare metric. Arkansas and Texas started with STEM but added a separate healthcare metric within a year or two. In contrast, Hawaii started with a separate healthcare metric but later discontinued it. Almost 80% of the twenty-one PBF-STEM states that have ever had a separate healthcare metric.

5. Under the new state funding model in Texas, Austin Community College has some surplus that they are utilizing to offer free tuition to all students from Fall 2024 (Fogel, 2025). Within a year of the pilot program, the college has already reported an uptick in persistence.

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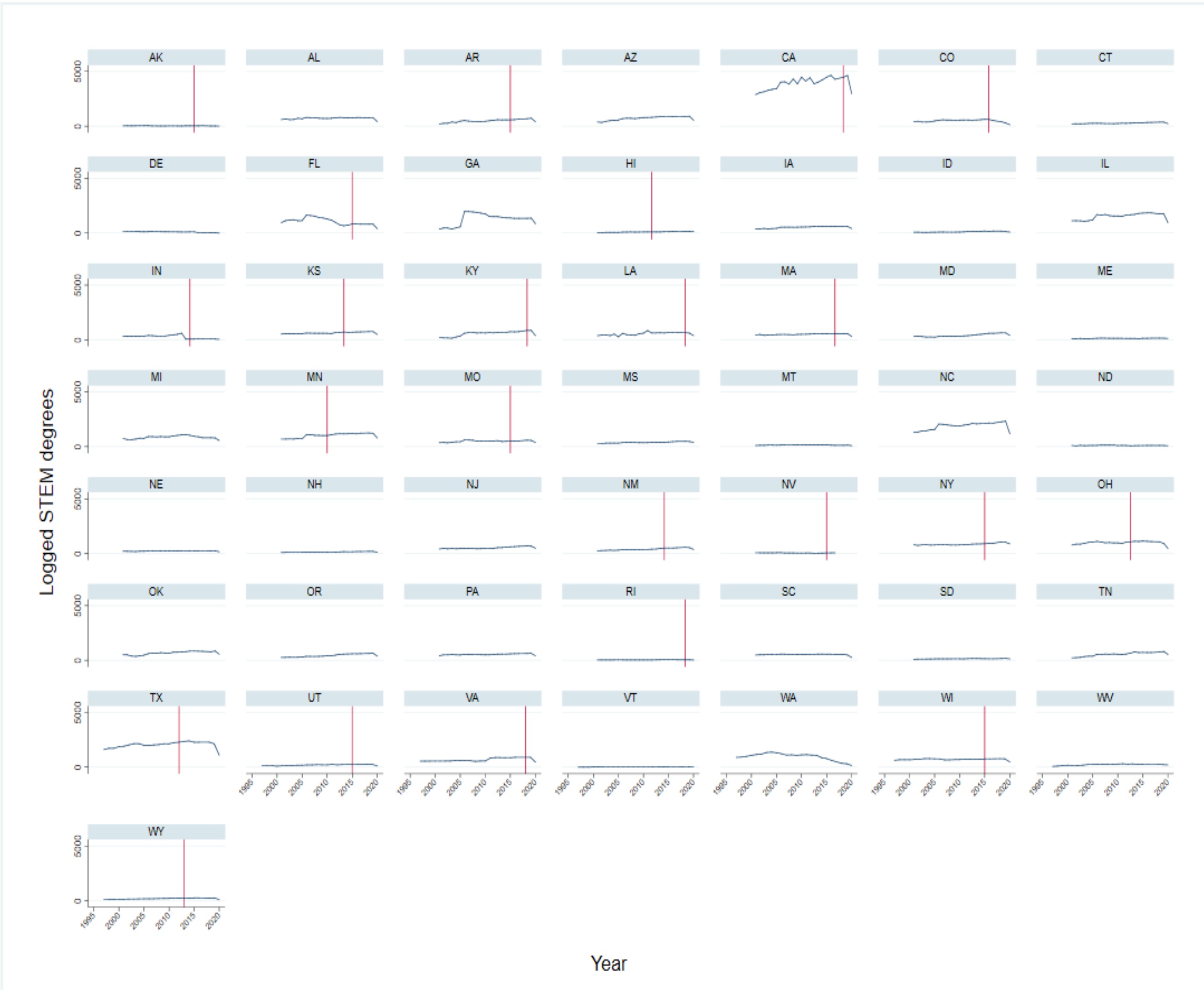
Tables and Figures

Figure 1

STEM Degrees over the Years by State and PBF-STEM Status



Notes. This figure plots the logged STEM degrees awarded in each state over the years 1997-2020. The presence of the red vertical line indicates the state PBF-STEM adoption year. Most of the adopters show no noticeable response, meaning PBF-STEM does not influence the average STEM degrees in the absence of institutional controls.

Data Source: InformEd States and IPEDS (1997-2020).

Table 1

Summary Statistics by Treatment Status

	No PBF		No PBF-STEM		PBF-STEM	
	Mean	SD	Mean	SD	Mean	SD
Asian	0.05	0.07	0.04	0.06	0.04	0.60
Native American	0.01	0.04	0.01	0.04	0.02	0.06
Black	0.13	0.15	0.14	0.16	0.10	0.09
Hispanic	0.16	0.18	0.14	0.17	0.26	0.22
Hawaiian & Pacific Islander	0.03	0.06	0.02	0.05	0.00	0.00
White	0.57	0.25	0.59	0.24	0.50	0.25
Non-resident Alien	0.01	0.02	0.01	0.02	0.01	0.02
Multiracial	0.01	0.02	0.02	0.02	0.03	0.02
Full-part-time ratio	1.30	3.57	1.20	2.98	0.75	0.69
Male-female ratio	0.78	0.32	0.75	0.31	0.77	0.37
City	0.18	0.39	0.18	0.38	0.18	0.38
Suburb	0.24	0.43	0.22	0.41	0.19	0.40
Town	0.18	0.39	0.20	0.40	0.29	0.46
Rural	0.20	0.40	0.21	0.41	0.14	0.35
Traditional-nontraditional age	1.93	1.67	1.91	1.48	2.82	4.60
Total undergraduates	8907.61	7440.3	8072.15	7194.2	9286.39	9882.8
Percentage low-income	49.73	16.28	51.25	15.82	54.04	13.95
Net tuition	97.79	1151.24	97.87	1157.49	107.71	1379.83
State appropriations	161.39	1676.92	154.05	1553.44	198.65	2024.09
Local appropriations	157734.74	183571.55	144917.35	182830.67	220775.47	313166.07
Instructional expenditure	256.51		246.39	2242.53	332.09	3426.69
Support expenditure	48.30	535.32	47.17	538.80	66.68	891.61
Service expenditure	62.40	556.14	59.03	561.76	88.84	928.97
State budget for 2-year institutions' PBF (%)	0.00	0	0.39	1.42	9.69	13.00
Undergraduate awards	13698.8	11410.7	12461.94	11132.5	13848.85	14747.8
Total STEM awards	95.23	98.86	97.83	104.8	156.51	189.7
STEM-to-total degrees	0.01	0.02	0.01	0.02	0.01	0.01
Short-term STEM degrees	22.30	46.43	25.18	51.64	33.16	74.84
Medium-term STEM degrees	12.69	23.54	13.05	26.33	25.54	50.06
Long-term STEM degrees	59.77	67.76	59.21	66.03	97.63	125.20
Awards to minorities	0.26	0.27	0.25	0.26	0.33	0.27
STEM awards to minorities	0.34	0.28	0.32	0.27	0.41	0.28
N	4741		6949		1308	

Notes. This table presents the means and standard deviations (SD) for the key variables by PBF policy. No PBF refers to the observations related to no PBF policy in place, no PBF-STEM refers to observations with a PBF policy in place but without the STEM metric, and PBF-STEM refers to the observations under PBF policy with a STEM metric. All monetary amounts are presented in $1,000. Results are rounded up to two decimal places.

Data Source: InformEd States and IPEDS (1997-2020).

Table 2

Change in STEM Awards, Degree Compositions, Institutional Composition, and Expenditures Following State Implementation of PBF-STEM

Panel A: Overall Awards					
	(1) Log STEM	(2) Short-term	(3) Medium-term	(4) Long-term	(5) STEM-to-Total
PBF-STEM	-0.18	-0.35	0.72	0.16	-0.41
	(0.46)	(1.51)	(0.40)	(0.60)	(0.51)
N	3651	3393	3061	3575	3651
Panel B: Awards to Minorities					
PBF-STEM	0.17	0.40	-0.16	0.03	
	(0.27)	(0.39)	(0.11)	(0.90)	
N	3651	2253	3061	3575	
Panel C: Change in Racial Composition (%)					
	(1) Asian	(2) Black	(3) Hispanic	(4) White	
ATT	0.08	-0.10	0.04	-0.13	
	(0.06)	(0.11)	(0.06)	(0.13)	
N	3626	3626			
Panel D: Change in Expenditure					
	(1) Instructional	(2) Support	(3) Services		
ATT	-0.37	0.41	0.14		
	(0.30)	(0.53)	(0.80)		
N	3625	3622	3625		

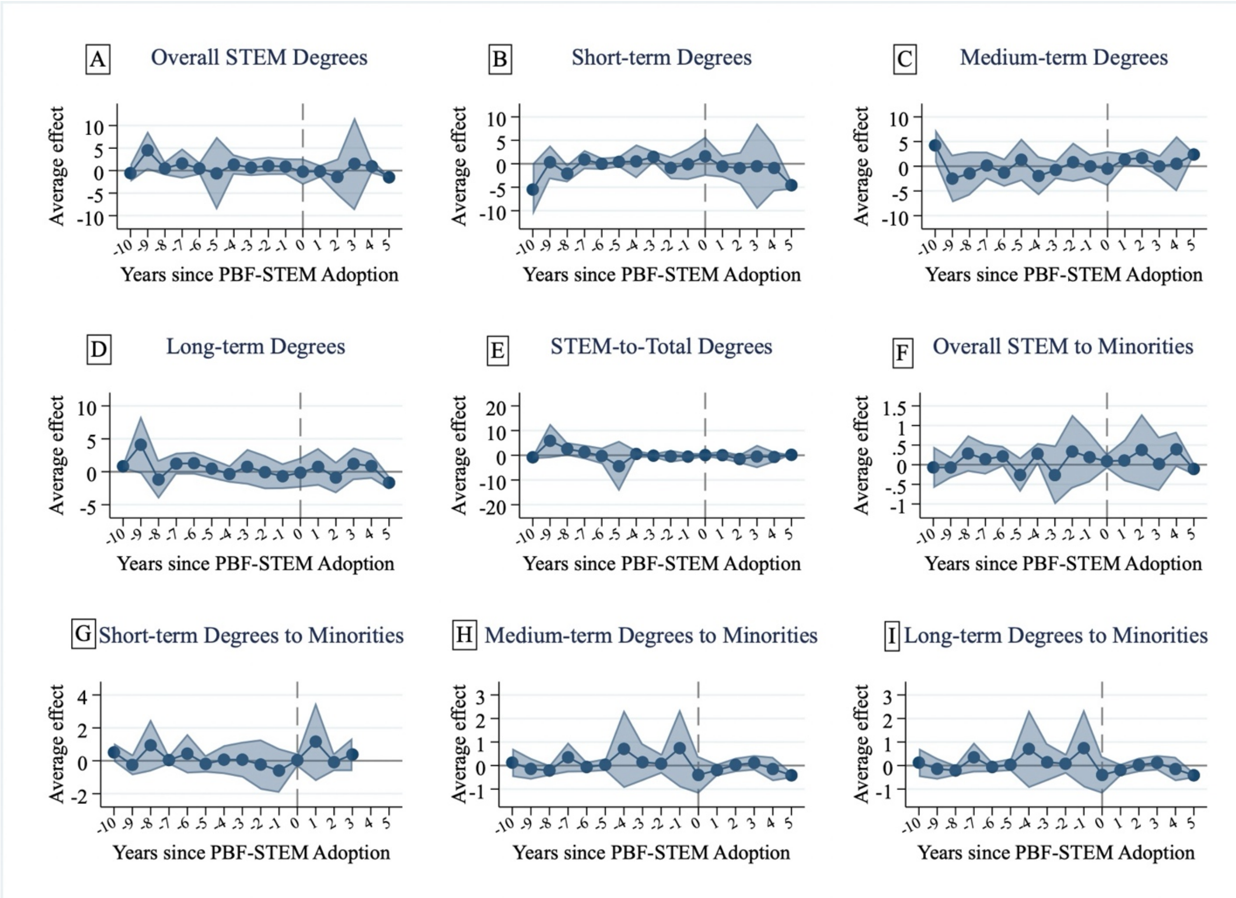
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes. This table presents Callaway and Santa Anna DiD estimates of PBF-STEM on log STEM awards, awards by duration, and awards to minority students from a model with institutional demographic controls (i.e., racial, SES, enrollment intensity, gender, and age compositions, and college locale), financial controls (i.e., tuition and expenditures), and state-year fixed effects. Sample sizes vary because not all institutions offer all types of credentials (e.g., short-term, medium-term). Standard errors are in parentheses. I cluster the SEs at the state level. Coefficients are rounded to two decimal places.

Data Source: InformEd States and IPEDS (1997-2020).

Figure 2

Change in STEM Awards and Composition Following State Implementation of PBF-STEM



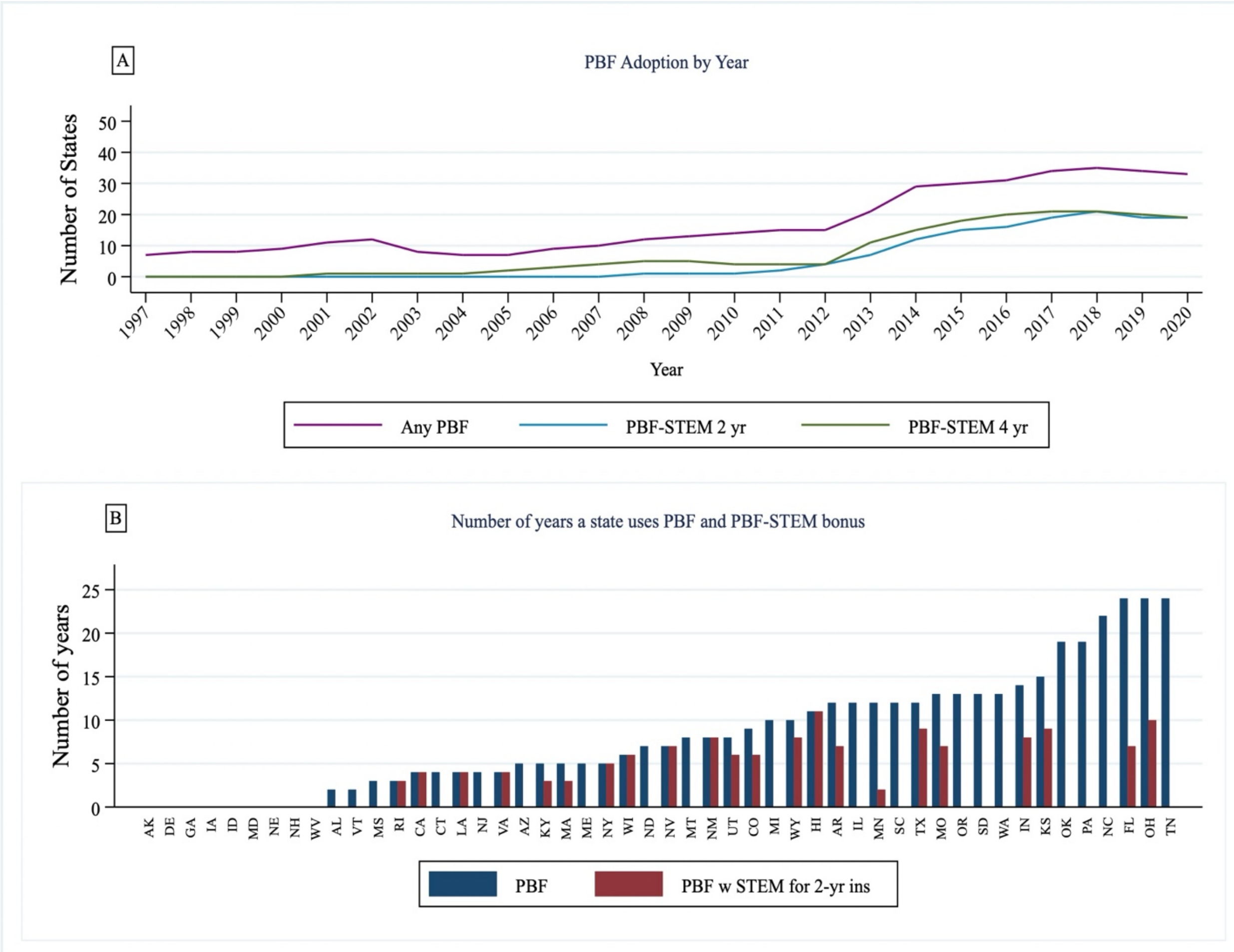
Notes. This figure presents the event study plots from Callaway and Santa Anna estimates of PBF-STEM incentive. Panels A to E relate to overall STEM degrees and panels F to I relate to STEM degrees to minorities. The x-axes present the years pre- and post-policy (negative and positive values, respectively), and 0 indicates the policy year. The y-axes represent average treatment effects on the treated units. I rescale the y-axes for better visibility. All post-policy comparisons are relative to the pre-policy year, and shaded regions represent 95% confidence intervals.

Data Source: InformEd States and IPEDS (1997-2020).

Appendix

Figure A1

PBF Adoption Over the Years and a State-by-State Snapshot of Policy in Place



Notes. In this figure, panel A illustrates the number of states that have PBF, PBF-STEM for 2-year institutions, and PBF-STEM for 4-year institutions. It shows that an increasing number of states adopted PBF over the years. PBF-STEM was first adopted in 2001 for 4-year institutions and in 2008 for 2-year institutions. In 2020, 19 states had PBF-STEM for 2-year colleges. In panel B, each bar represents one of the 50 US states, and the y-axis shows the number of years each state has had PBF (blue bar) and PBF-STEM for 2-year institutions (red bar) in practice. This panel shows 9 states that never implemented any form of PBF, Tennessee having PBF for the longest, and PBF-STEM for 0 years. Some of the other states with the longest practice of PBF never adopted PBF-STEM by 2020. Instead, states that are more recent adopters of PBF have either adopted PBF-STEM simultaneously with STEM adoption or within a few years of STEM adoption.

Data Source: InformEd States (1997-2020).

Table A1
Variable Description and Summary Statistics

Name	Description	Mean (SD)	Mean (SD) of log
Annual Degree Measures for 2-year Institutions Based on CIP code			
STEM degrees	Total STEM credentials an institution awarded	107.12 (124.10)	4.12 (1.15)
Short-term STEM degrees	Total short-term STEM degrees (requiring less than a year) awarded	26.45 (56.03)	1.90 (1.80)
Medium-term STEM degrees	Total medium-term STEM degrees (between one and two year) awarded	15.03 (31.64)	1.91 (1.42)
Long-term STEM degrees	Total long-term STEM degrees (2 years or more) awarded	65.30 (79.67)	3.59 (1.21)
STEM-to-total degrees	Total STEM degrees as proportion of all degrees awarded by the institution	0.01 (0.01)	4.93 (0.92)
Total degrees	Total degrees conferred across all undergraduate disciplines	12,681.64 (11,789.2)	
Awards to minorities (%)	Percentage of all undergraduate degrees awarded to female or racially minoritized (except Asian) students	0.26 (0.26)	
STEM awards to minorities (%)	Percentage of all STEM undergraduate degrees awarded to minoritized students	0.34 (0.28)	
PBF Measures			
PBF-STEM bonus 2-year	The proportion of observations with a PBF-STEM bonus for 2-year institutions	0.16 (0.37)	
Years in practice	The number of years a state has had PBF-STEM for 2-year institutions	0.63 (1.71)	
Percentage budgeted	The percentage of 2-year institutions' budget tied to PBF	1.86 (6.32)	
Demographic Composition			
Asian	The proportion of total students identifying as Asian	0.04 (0.06)	
Native	The proportion of total students identifying as Native American	0.01 (0.04)	
Black	The proportion of total students identifying as Black/African American	0.13 (0.15)	
Hispanic	The proportion of total students identifying as Hispanic/Latino	0.16 (0.18)	
Hawaiian/Pacific Islander	The proportion of total students identifying as Native Hawaiian or Pacific Islander	0.02 (0.05)	
White	The proportion of total students identifying as White	0.58 (0.24)	
Non-resident Alien	The proportion of total students identifying as non-resident aliens	0.01 (0.02)	
Multiracial	The proportion of total students identifying as two or more races	0.02 (0.2)	
Full-part-time ratio	Ratio of students enrolled full-time (12 or more credits) to students enrolled part-time (less than 12 credits)	1.13 (2.76)	

Male-female ratio	Male to female student ratio	0.76 (0.32)	
Traditional-nontraditional age	Ratio of students below age 25 to those at or above 25	2.05 (2.30)	
City	Indicator for an institution located in a city	0.18 (0.38)	
Suburb	Indicator for an institution located in a suburb	0.21 (0.41)	
Town	Indicator for an institution located in a city	0.21 (0.41)	
Rural	Indicator for an institution located in a city	0.20 (0.40)	
Total undergraduates	Number of students enrolled in undergraduate programs	8264.50 (7695.1)	
Percentage low-income	Percentage of students classified as low-income based on Pell eligibility	51.85 (15.48)	
	Annual Revenue and Expenditure (in thousand dollars)		
Net tuition	Total institutional income from tuition adjusted for scholarship and deductions	9,943.81 (11,959,192.30)	15.54 (1.16)
Federal appropriations	Amount of funding through the federal government	106.86 (1360378.8)	13.54 (2.00)
State appropriations	Amount of funding from the state government	16,112.13 (16449837.7)	16.16 (1.00)
Local appropriations	Amount of funding from local sources	15,693.41(21077074.60)	15.68 (1.57)
Instructional expenditure	Expenditure on instruction, classroom, and equipment	25,996.92 (24877745.80)	16.69 (0.90)
Support expenditure	Expenditure on curricular, counseling and other institutional support	5,026.47 (6,125,683.6)	14.89 (1.17)
Service expenditure	Expenditure on services	6,375.84 (6,434,567.5)	15.23 (1.07)

Table A2
Change in STEM Awards Following PBF-STEM Adoption, Results from Simple TWFE Models

	(1) Log STEM	(2) Log Short-term STEM	(3) Log Medium-term STEM	(4) Log Long-term STEM	(5) STEM-Total Ratio
PBF-STEM	0.099	-0.075	0.066	0.129	0.050
	(0.079)	(0.157)	(0.090)	(0.104)	(0.073)
Male-Female Ratio	0.042	-0.004	0.283^{*}	0.016	-0.112
	(0.127)	(0.101)	(0.109)	(0.079)	(0.099)
Asian	-0.044	1.207	-1.067	-0.476	-0.677
	(1.247)	(1.523)	(2.087)	(1.214)	(1.472)
Native American	1.138	2.452	-0.428	0.269	1.715
	(1.415)	(1.520)	(1.776)	(1.459)	(1.598)
Black	0.485	1.056	-0.739	0.939^{*}	0.686
	(0.551)	(1.043)	(0.746)	(0.430)	(0.615)
Hispanic	1.685^{**}	-0.632	1.763	2.161^{**}	1.804^{**}
	(0.477)	(0.782)	(0.899)	(0.620)	(0.523)
Native Hawaiian/Pacific Islander	-1.453^{***}	0.303	0.889^{*}	-3.171^{***}	-1.508^{***}
	(0.231)	(0.715)	(0.390)	(0.196)	(0.279)
White	0.257	0.380	-0.106	0.365	0.436^{*}
	(0.246)	(0.489)	(0.586)	(0.293)	(0.213)
Non-resident Alien	-1.217	3.193	-1.497	-0.617	-0.403
	(1.141)	(2.229)	(1.720)	(1.113)	(1.005)
Traditional - Nontraditional age	-0.032	-0.004	-0.052	-0.040	-0.018
	(0.020)	(0.023)	(0.053)	(0.023)	(0.017)
Full-Part-time ratio	-0.001	0.003	-0.002	-0.002	0.003
	(0.002)	(0.003)	(0.002)	(0.001)	(0.002)
Total Undergraduates	0.000^{*}	0.000	0.000^{*}	0.000	-0.000^{*}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Degrees Awarded	0.000	0.000^{**}	-0.000	-0.000	
	(0.000)	(0.000)	(0.000)	(0.000)	
City	-0.046	-0.037	0.029	0.010	-0.036
	(0.041)	(0.118)	(0.075)	(0.031)	(0.037)
Suburb	0.000	0.154	-0.102	0.021	-0.004
	(0.067)	(0.115)	(0.127)	(0.058)	(0.066)
Town	-0.071	0.188	-0.183	0.061	-0.074
	(0.067)	(0.136)	(0.121)	(0.066)	(0.064)
Rural	-0.030	0.150	-0.216	0.050	-0.011
	(0.052)	(0.096)	(0.127)	(0.047)	(0.048)
Log of Appropriations	-0.062	0.014	-0.013	-0.057	-0.066
	(0.034)	(0.051)	(0.125)	(0.037)	(0.040)
Log of Local Appropriations	0.000	-0.037	-0.060	0.027	0.003
	(0.020)	(0.083)	(0.055)	(0.022)	(0.027)
Log of Instructional Expenditure	0.293^{***}	-0.090	0.332	0.348^{***}	0.112
	(0.070)	(0.099)	(0.178)	(0.054)	(0.059)

Log of Support Expenditure	0.032	0.054	0.027	0.023	0.007
	(0.041)	(0.080)	(0.055)	(0.070)	(0.031)
Log of Service Expenditure	0.063*	0.059	0.032	0.042	0.062*
	(0.027)	(0.110)	(0.086)	(0.035)	(0.023)
Log of Average Pell Amount	0.034*	0.013	0.004	0.060*	0.017
	(0.014)	(0.015)	(0.025)	(0.023)	(0.013)
Log of Net Tuition	0.055**	0.086	0.022	0.042	0.024
	(0.018)	(0.062)	(0.081)	(0.021)	(0.021)
Constant	-3.026*	-0.743	-3.825	-4.643***	-7.693***
	(1.417)	(2.270)	(3.188)	(1.051)	(1.219)
R-squared	0.281	0.323	0.053	0.279	0.285
Num. of observations	8226	7800	6903	8176	8226

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

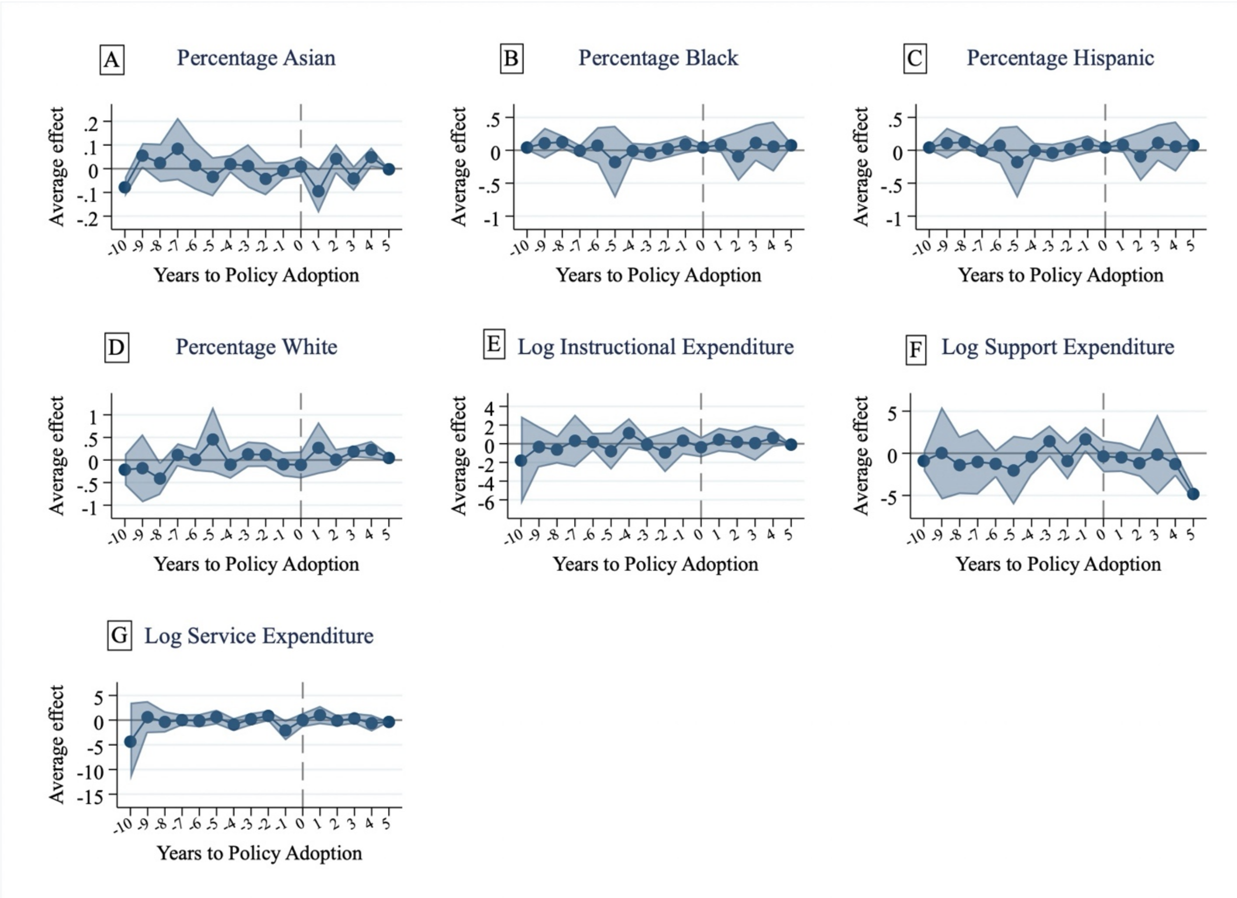
Standard errors in parentheses

Notes. This table displays the DiD estimates of PBF-STEM on log STEM awards, awards by duration, and degree composition from a regression with institutional demographic (i.e., racial, SES, enrollment intensity, gender, and age composition, and locale) and financial controls (i.e., tuition and expenditures), and state-year fixed effects. The treatment variable takes a value of 1 in the years the state is treated and thus effectively acts as an interaction term. I cluster the SEs at the state level.

Data Source: InformEd States and IPEDS (1997-2020).

Figure A2

Change in Institutional Racial Composition and Expenditure Following State Implementation of PBF-STEM

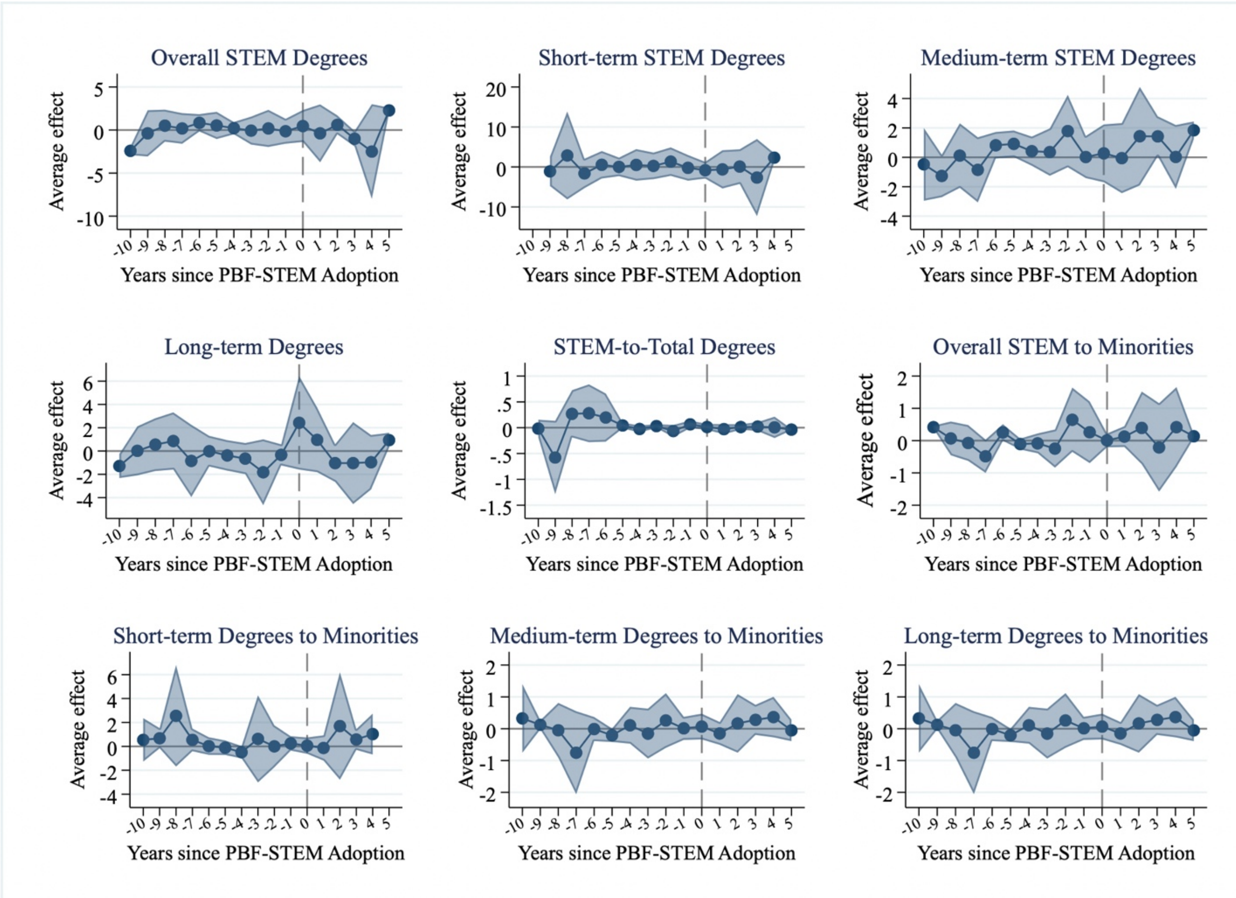


Notes. This figure presents the event study plots from Callaway and Santa Anna estimates of PBF-STEM incentive. Panels A to D relate to institutional racial composition and panels E to G relate to institutional expenditures. The x-axes present the years pre- and post-policy (negative and positive values, respectively), and 0 indicates the policy year. The y-axes represent average treatment effects on the treated units. I rescale the y-axes for better visibility. All post-policy comparisons are relative to the pre-policy year, and shaded regions represent 95% confidence intervals.

Data Source: InformEd States and IPEDS (1997-2020).

Figure A3

Change in STEM Awards and Composition Following State Implementation of PBF-STEM with STEM Definition Inclusive of Health Credentials



Notes. This figure presents the event study plots from Callaway and Santa Anna estimates of PBF-STEM incentive using an alternative definition of STEM credentials that includes Health credentials. Panels A to E relate to overall STEM degrees and panels F to I relate to STEM degrees to minorities. The x-axes present the years pre- and post-policy (negative and positive values, respectively), and 0 indicates the policy year. The y-axes represent average treatment effects on the treated units. I rescale the y-axes for better visibility. All post-policy comparisons are relative to the pre-policy year, and shaded regions represent 95% confidence intervals.

Data Source: InformEd States and IPEDS (1997-2020).