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The Effects of K-12 Computer Science Education Policies on Postsecondary CS Participation

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ABSTRACT

States have increasingly adopted policies to promote computer science education at the elementary and secondary levels. These policies are intended, in part, to promote the pursuit of computer science at the postsecondary level. We collect novel longitudinal data on adoption and implementation dates of nine policies promoted by the Code.org Advocacy Coalition in the United States since 2000 and use event study methods to evaluate their impacts on computer science undergraduate degree completion and teacher certification. We find little evidence that any policy we consider has meaningful impacts on either outcome. We conclude that these policies are too light-touch to matter and largely reflect, rather than cause, rising interest in computer science among undergraduates.

Keywords: computer science education, STEM education, state policy, event study

INTRODUCTION

Computer science (CS) education is widely viewed as providing important opportunities to students (Code.org Advocacy Coalition, 2024a; National Governors Association, 2022). Learning CS is often believed to help students access lucrative career opportunities, which may be especially important for helping marginalized students to climb the economic ladder (Liu et al., 2024). More generally, CS education is often claimed to provide students with assets that are useful across disciplines and pursuits, like computational thinking skills, knowledge of cybersecurity, or problem-solving ability (Salehi et al., 2020; Wing, 2006; Yett et al., 2020). Additionally, many advocates of CS education argue that broader macroeconomic success requires a growing supply of workers with CS or CS-related skills (Grover & Pea, 2013; National Governors Association, 2022). This has motivated sustained advocacy for broadening participation in CS education in the form of coordinated initiatives, such as CSforAll and CS10K, and global demands for CS educational opportunities among students and employers (Lim & Lewis, 2020; Zilberman & Ice, 2021).

However, schools have generally not offered CS coursework to students at the rates desired by advocates. This appears to reflect, at least in part, challenges associated with finding teachers who possess both CS content knowledge and knowledge about how to teach CS (Delyser et al., 2018; Poirot & Early, 1975; Sentance & Csizmadia, 2017; Statz & Miller, 1975). Other recent work highlights concerns of educators and school leaders that CS will displace important elective or arts courses or courses needed for students to prepare for and be accepted into college (Bruno & Lewis, 2022; Century et al., 2013; Israel et al., 2015; Koshy et al., 2022; Wang et al., 2016). Schools also face accountability pressures related to math and reading proficiency as well as graduation requirements that are perceived to limit time available to implement CS curricula (Israel et al., 2015; Wang et al., 2016). Even if schools offer CS courses, students may choose not to participate in them; many CS teachers cite students' lack of interest as a challenge to expanding CS education (Koshy et al., 2022). Rates of participation in CS courses are low for Black, Hispanic, and Indigenous students, girls, students with disabilities, and low-income students, and sometimes geographic challenges (e.g., rurality) reinforce these disparities (Bruno & Lewis, 2021; Fancsali & Israel, 2021; Kemp et al., 2020; Kim, 2025; Wang et al., 2016; Warner et al., 2021).

Advocates of CS education argue that state policy has an important role to play in removing these barriers to K-12 CS education because states play large roles in preparing teachers and determining curricular priorities. This has motivated concerted efforts in recent years to encourage states to adopt policies that promote CS education. These efforts have coalesced around a set of nine policies, discussed in greater detail below, tracked and advocated for in annual reports produced by the Code.org Advocacy Coalition (CAC) (Code.org Advocacy Coalition, 2022), an alliance of diverse corporate and non-profit organizations. These policies have been adopted by states at a steady pace (Code.org Advocacy Coalition, 2023). For example, as of 2022, every state in the country had adopted at least one of these policies, and half of states had adopted at least seven (Code.org Advocacy Coalition, 2022).

Background on State Policies of Interest

As noted above, we focus on nine policies that have received the greatest attention by virtue of how the CAC has promoted and tracked their adoption at the state level, primarily in annual "State of Computer Science Education" reports. Code.org itself began as a non-profit CS education advocacy organization in 2013. Much of this advocacy includes curriculum development and distribution; the organization claims the "most widely used CS curriculum in the U.S." (*Free K–12 Curriculum for Computer Science and AI | Code.Org*, n.d.). Additionally, Code.org frequently engages in activity aimed at raising attention or CS education, such as through annual global "Hour of Code" events (*One Hour*, n.d.).

Much of Code.org's policy advocacy operates through reports, one of the first of which was published in 2017 "collaboratively by a team of authors" from Code.org and four other organizations with similar agendas (Stanton et al., 2017). Originally framed as a "landscape report", it outlined "policy priorities" for states to pursue at the elementary and secondary levels. By the following year, many of these organizations were collectively referenced as the "Code.org Advocacy Coalition" and the report adopted the "State of Computer Science Education" title that would persist through all subsequent annual reports to date.

While described as involving "more than 50 industry, non-profit, and advocacy organizations" in the 2018 report (Code.org Advocacy Coalition, 2018), at present the CAC website lists over 100 organizations as members (Code.org Advocacy Coalition, n.d.) representing many different interests. For example, listed members include large technology-focused companies (e.g., Adobe, Amazon, Microsoft), teacher organizations (e.g., the National Education Association, various branches of the Computer Science Teachers Association), nonprofit CS education advocacy organizations (e.g., CS4All), organizations that sell educational materials and services (e.g., College Board, CodeHS), and organizations with broader education advocacy and reform missions (e.g., ExcelinEd, Whiteboard Advisors).

The CAC outlines criteria for a state's policy to satisfy the CAC's objectives, tracks the rate at which each policy is adopted nationwide, and issues state-by-state report cards documenting which policies have been adopted and which additional steps the CAC recommends. Because we largely follow the CAC's policy criteria in our own data collection, here we briefly summarize each policy, its logic and associated criteria, and its prevalence.

The nine policies

Though details of Code.org's policy recommendations have in some cases varied slightly over time, in this section describing the nine policies of interest we draw from the policy rubrics and adoption data published as part of the 2024 "State of Computer Science Education" report (Code.org Advocacy Coalition, 2024a) and a document summarizing the CAC's policy positions and motivations (Code.org Advocacy Coalition, 2024b).

First, CAC advocates *creating a statewide plan for K-12 CS education*. This is motivated by concerns that schools and school districts will have little idea about how to expand CS education because CS has not historically been a major part of most schools' curricular programming in the way that, say, math and social studies have. The CAC therefore imagines statewide plans for CS education will be developed by state education agencies; be specific to CS; include timelines, goals, and strategies; and be available to the public. In this way these plans can both convey that CS education *per se* is a state priority and serve as credible guidance for school leaders to implement CS educational expansions. As of 2024, the CAC credited 35 states with such plans.

Second, with similar goals related to policy "clarity," the CAC encourages states to *establish standards for K-12 CS*. Specifically, the CAC believes that state content standards can accomplish two things. First, they have the potential to create shared expectations for teachers and common, logically-sequenced learning experiences for students. Second, the CAC views CS standards as means of explicitly distinguishing CS from "digital literacy" content that they worry schools might otherwise promote in lieu of CS. To that end, adopted standards are expected to be both publicly accessible and to be structured logically across grade levels. Forty-four states had standards that met CAC requirements in 2024.

Third, the CAC recommends that states build capacity for CS education statewide by *funding CS teacher professional learning*. This is motivated by concerns that, because CS is a newer and less common content area in schools, many current teachers will not be adequately prepared to teach it absent additional professional development. For the CAC, funding is sufficient if it has been formally allocated in normal state budgetary processes during the previous two fiscal years, though older funding is also considered sufficient if more than 75% of state high schools offer CS. In 2024 the CAC identified 39 states meeting these requirements. This is one area where we depart from the CAC's definition for both methodological and conceptual reasons; as we discuss below, we consider a state to have adopted this policy if it ever adopted such funding (i.e., even if funding is no longer allocated, regardless of the prevalence of CS at the high school level).

Fourth, also based on concerns about school and teacher capacity, the CAC advocates *implementing CS teacher certification pathways*. Much like in-service professional development, the CAC views formal CS certification options as a way to help current teachers acquire CS-specific knowledge and skills. The CAC stipulates that such pathways should authorize teachers to teach CS courses and be explicitly named in such a way that it is clear they focus primarily on CS content (e.g., as "computer programming" endorsements). The CAC identified 44 states with adequate pathways in 2024.

Fifth, and again related to state capacity, the CAC advocates *creating programs that encourage preservice teachers to gain exposure to CS*. The CAC advocates this kind of exposure for all teachers, regardless of their certification area, in addition to advocating for CS-specific certification options. This broad exposure goal is likely, if not always explicitly, motivated by the belief that CS could or should commonly arise in many non-CS classrooms. The CAC explicitly excludes IHE-specific programs as sufficient toward this end. Rather, their rubric requires statewide efforts in preservice teacher preparation do at least one of the following: require CS exposure for all preservice teachers, provide scholarships for preservice teachers to take CS courses, fund CS education preservice programs, or approve IHEs to prepare CS teachers specifically. The CAC identified 24 states with relevant preservice programs in 2024.

Sixth, the CAC promotes statewide CS education policy leadership in the form of *dedicated CS positions in a state education agency*. This policy goal is motivated by the belief that school officials will need official points of contact for guidance and support. Additionally, the CAC believes that state officials are necessary to monitor school progress and to convey how seriously state takes CS education. To achieve this, the CAC requires that such positions exist in state agencies, have a title that explicitly indicates a focus on CS, and have the capacity and authority to create and regulate CS educational programming. The CAC considered 42 states to have such statewide positions in 2024.

Seventh, the CAC recommends that states *require that all schools offer CS* to their students. Over and above being a prerequisite to students taking CS courses or having other CS learning experiences, the CAC specifically emphasizes that earlier, foundational CS educational experiences facilitate student participation in later and more advanced CS coursework. The CAC requires that such requirements have publicly available descriptions and apply to all public high schools, though they also imagine extending that scope to include all K-12 schools in the future. By the CAC's estimation, 32 states met their current criteria for this policy in 2024.

Eighth, the CAC advocates that states *allow CS to count toward a core graduation requirement*. This policy goal is intended to alleviate the pressure, discussed above, that school leaders, teachers, and students feel to use their limited instructional time efficiently. By allowing CS to satisfy graduation requirements, those parties should feel less pressure to sacrifice CS courses in favor of other requirements. Their primary requirement for such policies, besides having publicly-available descriptions, is that they allow CS to satisfy not just general elective requirements, but to count toward core subject area requirements (e.g., as a math or foreign language credit). All 50 states satisfied the CAC's requirements for this policy in 2024.

Ninth, the CAC suggests that states *allow CS to satisfy an admission requirement at institutions of higher education (IHEs)*. The logic of this policy recommendation is similar to the previous policy around graduation requirements: this policy would reduce disincentives to take CS in favor of other courses prioritized more explicitly by IHEs. The specific requirements for this policy are similar to those for graduation requirements, in particular that CS satisfy a core subject area requirement rather than just a general, college-preparatory elective requirement. The CAC credits 22 states with having adopted satisfactory versions of this policy. [1]

Potential Impact of Policies

Beyond their intended proximal impacts on schools and students, all the policies discussed above are intended at least in part to promote CS participation at the postsecondary level by preparing students to pursue CS and related subjects when they get to college. Moreover, some of these policies target higher education directly, such as policies establishing certification pathways for teaching CS in K-12 schools (Code.org Advocacy Coalition, 2023). Certainly, as these policies have been increasingly adopted by states, participation in CS education has increased at both the K-12 and postsecondary levels (Bruno et al., 2022; Camp et al., 2017; Code.org Advocacy

[1] Recently the CAC has identified the establishment of CS as a course requirement for high school graduation as a 10th policy priority (Code.org Advocacy Coalition, 2023). Because such policies have been implemented only very recently, if at all, we do not consider them here.

Coalition, 2023; Kim, 2025). Yet no clear evidence exists about the extent to which these increases in participation have been driven by state policies. This uncertainty motivates our study.

Prior research provides only limited and mixed evidence about what kinds of effects such policies might have. For example, previous work on expanded science, technology, engineering, and math (STEM) coursework finds that additional access to STEM courses in high school does not increase STEM participation in college (Darolia et al., 2020). However, policy-induced expansion of advanced science courses in England – part of a larger national push for science education – appears to have had larger impacts on students' educational trajectories (De Philippis, 2023). And recent quasi-experimental work in Maryland finds that high schools beginning to offer CS coursework induced substantial additional CS course taking in both high school and college, and drove improvements in students' subsequent employment prospects and earnings (Liu et al., 2024). However, some uncertainty about these Maryland results is warranted given the small sample size relative to the data requirements of the instrumental variables approach the authors use and potential endogeneity in how schools choose to begin offering CS courses.

More generally, previous studies suggest some limits to how much student decision making about higher education can be affected by lighter-touch interventions or interventions that do not substantially alter or meaningfully align with individual students' incentives. For instance, policies creating additional, potentially easier pathways for students to apply to college or to complete bachelor's degrees do not necessarily have any impact on enrollment or degree acquisition (Delaney & Odle, 2025; Odle & Russell, 2023). In contrast, students' pursuit of STEM programs in college may be more effectively promoted by more substantial financial aid programs that more directly target students' incentives or constraints (Castleman et al., 2018). Studies in this vein raise doubts that policies like those advocated for by the CAC are likely to be impactful because they intervene too little or too indirectly on the decision making of individual students. Alternatively, there is evidence that even lighter-touch, “nudge”-type interventions can have larger impacts on educational decision making among populations for whom the intended reaction is clearly consistent with their pre-existing incentives (Castleman et al., 2021). This could offer some reason to think that the CAC’s policies could have more substantial impacts, at least among students for whom CS-related educational pathways are already viewed as promising.

Overall, prior evidence does not clearly indicate that state policies of the kind commonly promoted and adopted to expand CS education have, or are likely to have, the intended effects. Previous work on similar policies is scarce, limited and mixed. And studies of other education-related policy interventions are hard to apply to the policies we consider and make somewhat ambiguous predictions in any case.

Research Questions

Understanding the extent to which these state-level CS education policies have worked is important for future policymaking. Yet the extent to which state CS education policies have driven CS education expansions remains unclear. This uncertainty motivates our two research questions: (RQ1) To what extent do state CS education policies affect student graduation from CS and CS-related majors? And (RQ2) To what extent do state CS education policies change the rate of CS teacher production?

METHODS

Data

Independent variables: computer science policy data

Our state policy dataset builds on the work of the CAC, which has tracked and advocated for the adoption of the nine CS education policies discussed in this study (Code.org Advocacy

Coalition, 2022). CAC reports track the adoption of these policies at the state level over time, from years 2014 through 2022. We expand on this work in two ways.

First, we engage in additional data collection to produce a longer panel of data that extends back further in time through the year 2000 and to include both policy adoption dates and, if different, policy implementation dates. To do this we began with the relevant information from the CAC's State of Computer Science Education Reports from 2017 through 2023 (Code.org Advocacy Coalition, 2018, 2019, 2020, 2021, 2022, 2023; Stanton et al., 2017), as well as Code.org's detailed internal document for tracking state policies, which contains the underlying data used to produce those reports.[2] Then, we conducted a thorough internet search to collect documentation of CS teacher certification from state department of education (DOE) websites from 2000 through 2023, as well as searches of state legislative history via the HeinOnline database. Finally, we leveraged prior work conducted by the Computer Science Teachers Association (CSTA) and the Association for Computing Machinery (ACM) (CSTA Certification Committee, 2013; Ericson et al., 2008; Khoury, 2007; Roberts & Halopoff, 2005; Wilson et al., 2010) to supplement and verify the searched information when possible.

Second, we verify and validate state-level policy adoption timelines, including both CAC's and our own. This validation took two main forms. First, for randomly selected states, we produced our own recent timelines of state policy adoption using the HeinOnline state legislative history database, which we then compared to the CAC report timelines. After verifying that CAC and HeinOnline-produced timelines agreed in recent years, this bolstered our confidence in using HeinOnline to produce policy adoption and implementation timelines in earlier years. Second,

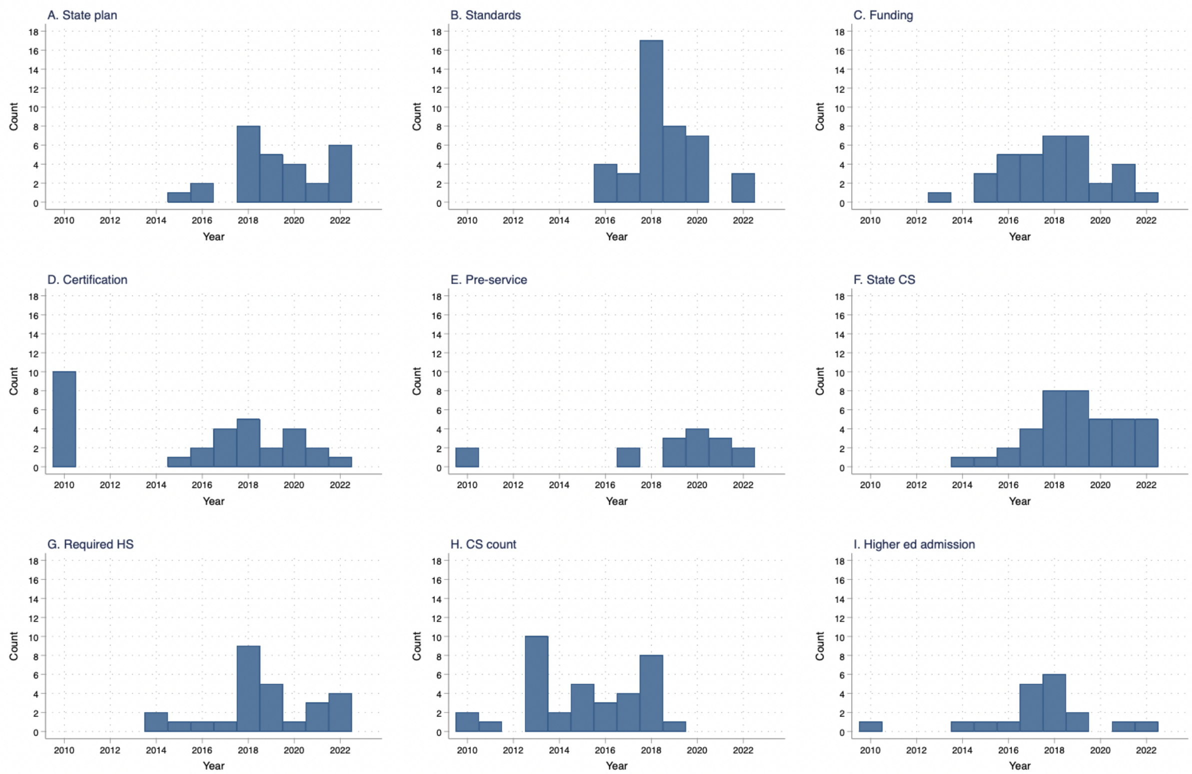
[2] We are grateful for Code.org's support in sharing their internal documentation with us and for helping us understand and work with their state policy data.

after compiling our policy timeline data, we emailed at least one relevant official or stakeholder in every state (e.g., the individual tasked with overseeing K-12 computer science education in the public school system) asking them to verify the information for their state. After emailing stakeholders in all 50 states plus DC, including at least one follow-up reminder email, we received responses from 26 jurisdictions. Of those, 18 confirmed our dates completely. Based on other responses, we ultimately changed 22 dates in our data set. Given that we collect implementation and adoption dates for each of nine policies (i.e., 18 dates total per jurisdiction), these 22 changes affected roughly 2.4% of all of our collected dates.

Ultimately, we collected the dates that all nine CS policies were adopted for all 50 states plus DC from 2000 to 2022. Additionally, we distinguish dates policies were adopted (e.g., signed into law) from dates policies were implemented (e.g., if schools were given a period to prepare to comply). This is the most comprehensive data collection to date on what CS policies have been enacted and implemented. These nine policies serve as the independent variables for our analyses. In our difference-in-differences event study framework, each of these variables or policies is coded as a series of indicators for the number of periods before and after a state has adopted said policy so that they can be compared to states that did not adopt the policy.

Descriptive statistics on CS policy adoption

Figure 1 presents the number of states having adopted each of our nine policies of interest as of each year since 2000. There is considerable variation in when states adopt each of these nine policies. For example, there were only a few states that had CS content standards before 2018, but there were 17 states that adopted CS content standards in 2018. In comparison, state funding was adopted more gradually from 2015 to 2021.



Notes: Each plot corresponds to a separate policy. Bar heights indicate the number of states adopting the policy each year.
Figure 1. States adopting computer science education policies each year.

Dependent variables: postsecondary data

We use two sources of data to measure postsecondary outcomes of interest, corresponding to our two research questions. First, we take data on graduation from postsecondary degree programs from the Integrated Postsecondary Education Data System (IPEDS). IPEDS data include completion in programs of study at the IHE-year level. We classify programs as “CS” using Classification of Instructional Program (CIP) codes and BPCnet program code classifications (CIP code 11.XXXX). We also consider “CS-related” degrees such as Computer Engineering (CIP code 14.0901) and Data Science (CIP code 30.7001). For the full list of CIP codes we include, see Appendix Table A1.

Second, we take data on teacher production from Title II reports made public by the U.S. Department of Education. Title II data from 2008 to 2022 provide the most comprehensive information on the supply of CS teachers at the institutional, state and national level. Title II provides yearly completion counts for traditional and alternative teacher preparation programs. We identify CS teachers in Title II using the same CIP codes as the IPEDS data.

Empirical strategy

Identifying the impacts of these policies is challenging for several reasons. For example, state CS education policy adoption may be contemporaneous with other factors driving expanded interest in CS education, such as wage growth in CS-related occupations. Moreover, the effects of state policies in this area are likely to vary over time, additionally complicating efforts to attribute effects to policy adoption. To address these issues, we employ event study difference-in-differences analyses to examine the effects of CS policies on CS degree and teacher production by comparing trends in states that adopted CS policies to the trends in comparable states that did not adopt CS policies. Specifically, our baseline approach relies on the following event study model:

$$outcome_{ist} = \alpha + \sum_{j=2}^{J} \beta_j (Lead^j) CS_{st} + \sum_{k=1}^{K} \gamma_k (Lag^k) CS_{st} + \theta_i + \delta_t + \epsilon_{ist} \quad (1)$$

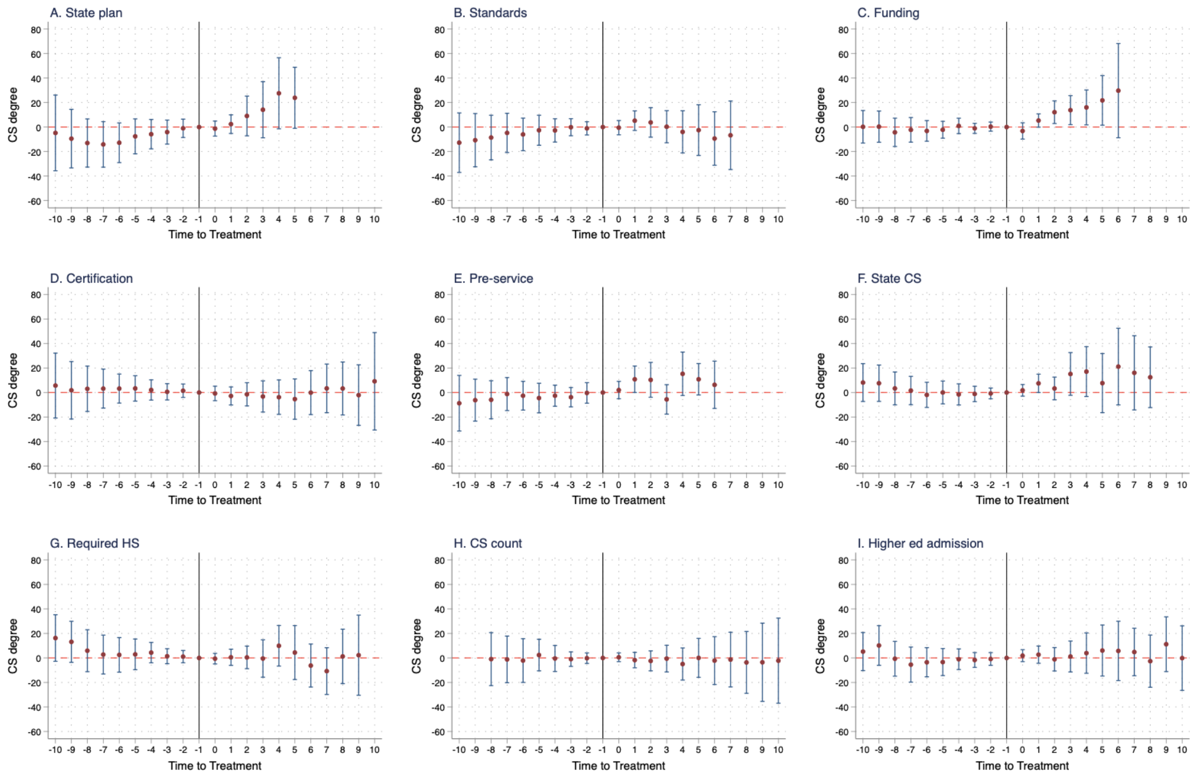
In Model 1, we predict an outcome of interest, specifically the number of CS degrees or CS-related degrees or CS teachers, for institution i in state s in year t. The dummy variables represented by $(Lead^j)CS_{st}$ indicate that state s was j years away from adopting a policy in the policy group. Because we omit the indicator for relative time year j = 1, the coefficients on those dummy variables test whether differences between adopting and non-adopting states were changing in the years leading up to policy adoption. Such changes would indicate a violation of the parallel trends assumption required to interpret post-adoption changes as causal in the difference-in-differences framework.

Those post-adoption changes are estimated by the coefficients on the $(Lag^k)CS_{st}$ dummy variables that indicate that a given state in a given year was in the k^{th} year of having adopted the policy. The γ_k coefficients therefore represent our estimates of the dynamic effects of the policies in each year after their adoption. We include institution fixed effects (θ_i) to account for time-invariant differences between institutions and year fixed effects (δ_t) to account for mean differences from year to year. ϵ_{ist} is an error term. We cluster our standard errors at the level of policy intervention (i.e., at the state level). To check the robustness of our results, we also employ Borusyak et al.'s (2024) framework for staggered difference-in-differences design where treatment-effect heterogeneity is unrestricted. This estimation provides an intuitively appealing approach where the estimated treatment effect is computed as the difference between the treated observations and untreated potential outcomes.

RESULTS

Effects on CS degree production (RQ1)

Our primary estimates of the effects of each CS policy adoption on CS undergraduate degree production are presented in Figure 2. For each CS policy, pre-adoption estimates that are statistically significant would indicate that the trends in CS degree production in states that adopted a CS policy were already different at the time of adoption than in states that did not adopt the same CS policy. For example, panel H of Figure 2 compares the number of undergraduate CS degrees awarded by IHEs in states that adopted a policy allowing CS to count as a high school graduation requirement to IHEs in states that did not adopt such a policy. All estimates are relative to the final pre-adoption year in adopting states, indicated by "-1". The estimates prior to allowing CS to count for graduation in this way are all statistically insignificant, indicating that CS degree production in states that adopted this policy was trending in parallel to other states prior to adoption. This pattern is replicated across all nine CS policies, suggesting that policy adoption is not correlated with unobserved factors that might bias estimates of the policies' effects.



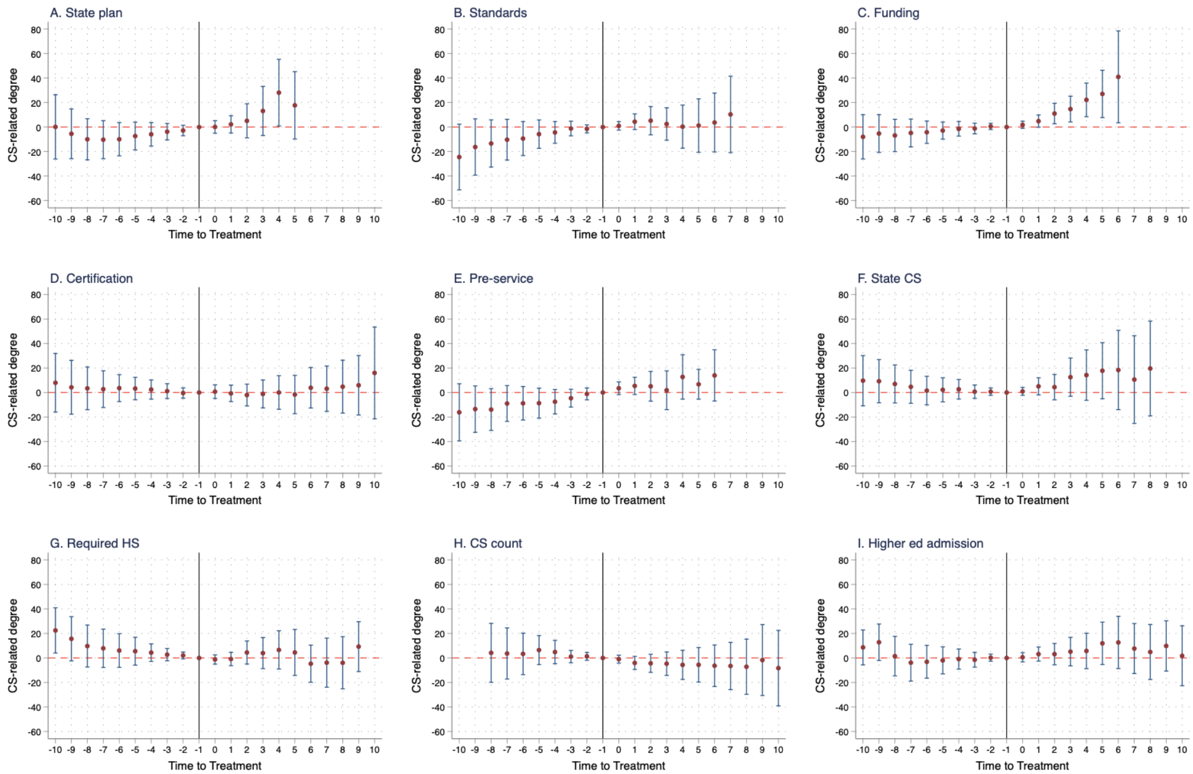
Notes: Bars represent 95% confidence intervals.
Figure 2. Event study estimates of the effects of computer science education policies on the number of computer science degrees awarded.

Our estimates of those policy effects are shown on the right-hand portion of each panel of Figure 2, with year "0" indicating the first year in which the policy was adopted. Most estimates are statistically and practically insignificant for all policies and in all years after adoption. For example, panel H of Figure 2 shows that differences in CS degree completion between states that adopted a policy allowing CS courses to satisfy high school graduation requirements and those that did not were essentially identical even 10 years after the policy was adopted. More generally, any increases in CS degree completion in states adopting these policies were mostly matched in states without such policies, in line with the parallel trends we observe across these states prior to policy adoption.

We note two potential exceptions to this pattern: CS state plans and funding. Specifically, four to five years after the adoption of a CS state plan, the number of CS degrees awarded increased, on average, by 23 to 27 degrees at each IHE. However, these results are only marginally significant statistically ($p<0.10$). Moreover, this is a case where pre-trends between adopting and non-adopting states demonstrate some qualitative – if statistically insignificant – violation of our parallel trends assumption. In particular, there is some evidence of CS degree production already increasing in states that would eventually adopt a CS state plan relative to other states beginning about six years prior to adoption. Our results for adopting funding for CS teacher development show that IHE CS degree production increased by 13 three years after adoption and additionally over time, up to 37 degrees by year seven (when the estimate becomes statistically insignificant due to a loss of precision). No other CS policies seem to affect the number of CS degrees produced.

Effects on CS-related degree production

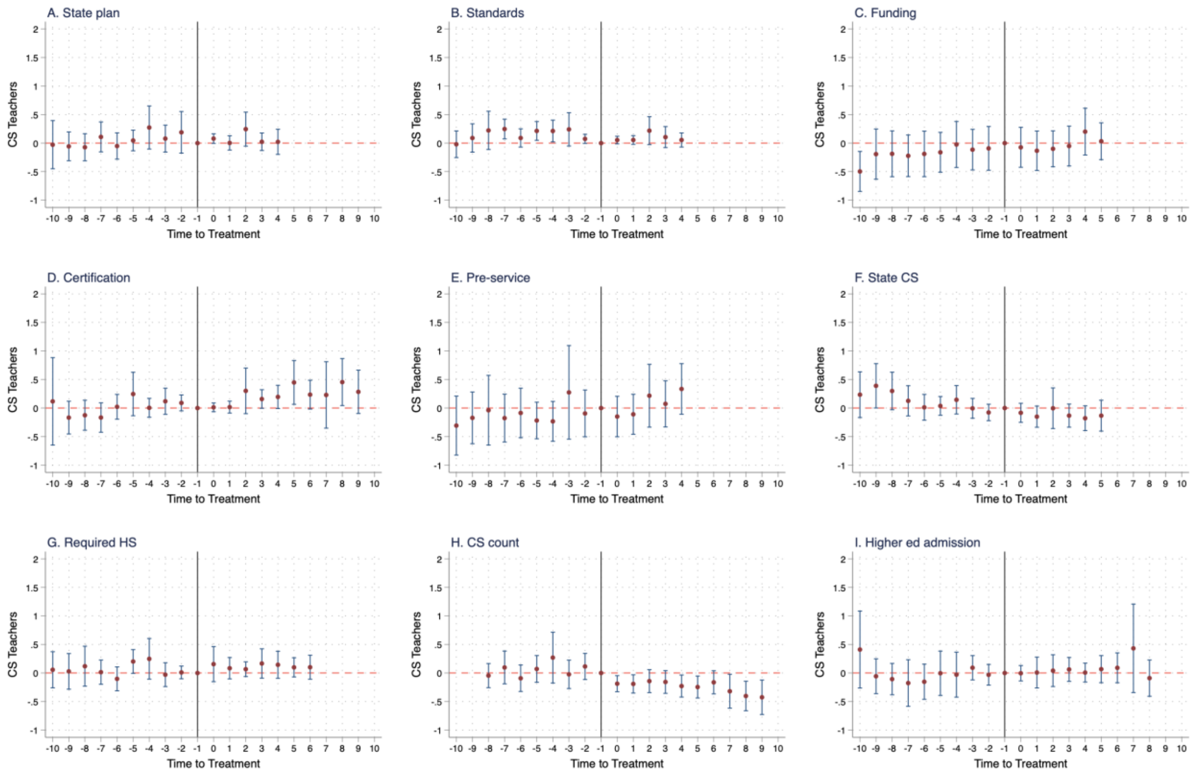
Figure 3 presents analogous estimates for CS-related degrees, which includes both degrees in CS and those in related fields including computer engineering and data science or analytics. Like CS degree production, the pre-trends in the event study results suggest that states that adopted CS policies were on largely parallel paths with states that did not adopt CS policies. Furthermore, the results for the CS state plan are also only significant at the 10% level. The post-treatment estimates for CS funding continue to be statistically significant at conventional levels; seven years after adoption, the number of CS-related degrees at IHEs in adopting states increased by 40, on average, compared to IHEs in other states. Once again, we observe null effects on the other CS policies.



Notes: Bars represent 95% confidence intervals.
Figure 3. Event study estimates of the effects of computer science education policies on the number of computer science-related degrees awarded.

Effects on CS teacher production (RQ2)

As with undergraduate degree completion, we also observe no significant non-parallel trends in CS teacher certification between states adopting CS education policies and other states. These results are presented in Figure 4. We do not observe any statistically significant effects on teacher production in any years for any policy. As shown in panel D of Figure 4, we find suggestive evidence that the adoption of CS teacher certification pathways may have marginally significant impacts after several years. However, these estimates are only significant at, at best, the 10% level, and are substantively small; the implied increased number of CS teachers certified is at most 0.5 teachers at each IHE.



Notes: Bars represent 95% confidence intervals.
Figure 4. Event study estimates of the effects of computer science education policies on the number of computer science teacher certifications issued.

Sensitivity analyses and robustness checks

In this section, we explore the extent to which our main results may be sensitive to model specification and assumptions about policy implementation. First, it may take time before states implement the policies they have adopted. To explore this, we replace policy adoption dates with policy implementation dates. Results, shown in the supplementary materials, are substantively similar (see Appendix Figures A1, A2, and A3).

Our main results consider the effects of each policy individually, but as we note above, the typical state has adopted multiple of these policies. We may therefore be conflating the effects of each policy with the effects of other policies adopted around the same time. We are not overly concerned with this possibility because correlated adoption should tend to positively bias our estimates (so long as these policies do not meaningfully "backfire" in their goals). The fact that we find mostly null effects even in the presence of such a threat of bias primarily bolsters the interpretation that the policies are ineffective.

Still, to test this empirically, we first examine which pairs of CS policies tend to be adopted around the same time by examining the pairwise correlations of their adoption years. We focus on four policy pairs with the largest correlations: state standards and funding; certification and funding; state plan and state standards; and high school requirement and satisfying college admission. These correlations are not high (r = .36-.48), suggesting minimal bias from omitted policies. However, because some of the largest correlations involve the two policies for which we found suggestive evidence of effects, we attempt to remove any bias in those cases. Though it is not feasible with our data to estimate the effects of all policies simultaneously, to estimate the concurrent effects of two policies simultaneously, we modify Equation 1 and add in two sets of additional terms that represent the leads and lags of a second, correlated policy. This accounts for the effects of being an arbitrary number of years into the adoption of the second policy. We consider these exploratory results since there is no guidance on how to estimate multiple staggered interventions in an event study framework. Still, we find no evidence that accounting for the adoption of a contemporaneous policy has any meaningful implications for our estimates (Appendix Table A2).

Next, we employ Borusyak and colleagues' robust and efficient estimator for staggered treatment to assess the extent to which our results may differ by model specification. Similar to our preferred specification, we find no evidence of significant pre-trend for all nine policies.

Moreover, we continue to find that these CS policies have little to no effects on CS degree production except that CS statewide plan increased CS degree production by 33 degrees five or six years after adoption and that CS funding increased 6-20 degrees in years two through six (Appendix Table A3). For CS teacher production, we similarly find no evidence of significant pre-trends and that the CS policies have no effects on the number of CS teachers being produced. We do find a small negative estimate for allowing CS to count as a core graduation requirement ("CS count") , but this represents a decrease of 0.28 teacher per year five to six years after adopting the policy (Appendix Table A4). Overall, we find the results are not driven by model specification or assumptions about policy implementation.

CONCLUSIONS

Despite strong national enthusiasm for state-level CS education policies, including their widespread adoption (Code.org Advocacy Coalition, 2024a), and despite prior research showing that, in at least some cases, expanding K-12 STEM access leads to increased STEM enrollment or degree attainment in college (De Philippis, 2023; Liu et al., 2024; Swiderski, 2024), we find limited evidence that our policies of interest have affected outcomes at the postsecondary level. In our results only two policies, CS education statewide plans and funding for K-12 CS teacher professional development, appear to increase CS and CS-related degree production. The remaining policies, such as requiring all high schools to offer CS courses and allowing CS to count toward college admission, do not appear to matter.

It is not obvious why two of these policies might have larger effects than others, but we propose a few considerations that may be usefully explored in future research. The significance of funding K-12 CS teacher professional development may point to the importance of investing in CS educators – a key priority in CAC frameworks for expanding CS education (Code.org

Advocacy Coalition, 2024a). Currently, many states lack or offer limited pathways for CS teacher preparation and few teachers pursue those options when they are available. While they often lack preparation to teach CS specifically, relative to teachers of other disciplines CS teachers are often better qualified in other respects (e.g., experience, graduate degrees, and National Board Certification) (Bruno, 2025). Funding professional development support for these capable educators may be a particularly high-leverage investment. Moreover, though not strictly required to satisfy CAC's (or our) standards for policy adoption, several states' funding policies extend beyond CS teacher professional development to support other aspects of CS educational programming, such as in Arkansas, Hawai'i, and Washington (Arkansas Department of Education, 2020; Nguyen & Mordecai, 2020; Substitute Senate Bill 6002, 2014). Such investments may be important to increase schools' capacities to offer CS coursework effectively.

The finding that statewide CS state plans are marginally associated with increased CS and CS-related degree production may seem surprising, as a plan itself does not directly alter courses, curricula, instruction, or teachers. However, states that adopt comprehensive plans often demonstrate strong commitment to CS education and tend to adopt multiple, if not all, of the recommended policies (Code.org Advocacy Coalition, 2024a), and often with detailed implementation timelines (e.g., Connecticut) (Connecticut State Board of Education, 2020). These states are also more likely to establish dedicated CS leadership at the state level, as most states observed to have adopted a plan also have a dedicated CS staff position (per our state policy data). As we note above, the correlations between individual pairs of policies are not high, but to the extent that state plans reflect a strong commitment to improving K-12 CS learning and participation, they may make implementation efforts more coherent or otherwise more effective.

In contrast, the null findings for other policies suggest that when adopted in isolation or without deliberate sequencing, they may lack the coherence, incentives, and the support needed to create change. For instance, allowing CS to count toward high school graduation or college admission requirements may have limited impact if districts lack the incentive or capacity to offer CS courses (e.g., because they lack qualified teachers). To succeed, states may need to adopt additional policies, such as investing in CS teachers (Code.org, 2017) or even mandating that all students complete CS to graduate, which has recently been introduced as the tenth recommended policy by Code.org and allies (Code.org, 2023). Our results suggest that meaningful impact may be more likely when these policies are enacted as part of an integrated strategy, as originally envisioned by advocates (Code.org, 2023). Of course, larger investments or more coercive policies, such as graduation requirements, may also entail different costs, trade-offs, or political resistance.

Beyond the challenges of comprehensive policy implementation, the lack of impact on CS teacher production likely reflects distinct challenges within teacher education. Many universities do not offer dedicated pathways for CS teacher preparation. In Washington State, for example, only Western Washington University offers a direct undergraduate degree in secondary CS education, while other institutions, including the University of Washington-Seattle, only offer minor or add-on endorsement programs (Claflin, 2023; Washington State Professional Educator Standards Board, n.d.). Moreover, even when certification pathways are available to teachers, incentives to pursue CS education are limited because teachers typically cannot expect to receive an increase in pay for a CS teaching certification. Fragmented pathways and undifferentiated compensation structures for teachers are likely to contribute to any current shortage of formally prepared CS teachers, and to the ineffectiveness of policies intended to boost CS teacher supply.

In summary, while CS education policies have gained substantial public enthusiasm and adoption momentum across the U.S., their impact remains limited, at least at the postsecondary level. We take no position on the proper role of CS in the elementary and secondary curriculum, on the appropriate role of state policy in promoting CS education, or on the private or social benefits of more students pursuing CS at the postsecondary level. Indeed, we caution that predictions about the role of CS in the future economy are necessarily uncertain, particularly in the early years of widespread generative artificial intelligence technology. At the same time, to the extent that policymakers wish to expand CS education, they may need to consider policies more intensive than those we consider here. That lesson may also apply more generally to other content areas of growing interest in some states, such as high school ethnic studies course requirements.

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Appendices for The Effects of K-12 Computer Science Education Policies on Postsecondary CS Participation

Appendix Tables

Table A1. Classification of instructional program (CIP) codes used to classify degree programs.

CS CIP code	Field	CS-related CIP code	Field
11.0101	Computer and Information Sciences, General	10.0304	Animation, Interactive Technology, Video Graphics and Special Effects
11.0102	Artificial Intelligence	14.0901	Computer Engineering, General
11.0103	Information Technology	14.0902	Computer Hardware Engineering
11.0104	Informatics	14.0903	Computer Software Engineering
11.0105	Human-Centered Technology Design	14.0999	Computer Engineering, Other
11.0199	Computer Science, Other	26.1103	Bioinformatics
11.0201	Computer Programming/Programmer, General	26.1104	Computational Biology
11.0202	Computer Programming Special Applications	26.1199	Biomathematics, Bioinformatics, and Computational Biology, Other
11.0203	Computer Programming, Vendor/Product Certification	27.0303	Computational Mathematics
11.0204	Computer Game Programming	27.0304	Computational and Applied Mathematics
11.0205	Computer Programming, Specific Platforms	30.0801	Mathematics and Computer Science
11.0299	Computer Programming, Other	30.1601	Accounting and Computer Science
11.0301	Data Processing and Data Processing Technology/Technician	30.3001	Computational Science
11.0401	Information Science/Studies	30.3101	Human Computer Interaction
11.0501	Computer Systems Analysis/Analyst	30.4801	Linguistics and Computer Science
11.0701	Computer Science	30.7001	Data Science, General
11.0801	Web Page, Digital/Multimedia and Information Resources Design	30.7101	Data Analytics, General
11.0802	Data Modeling/Warehousing and Database Administration	30.7102	Business Analytics
11.0803	Computer Graphics	30.7104	Financial Analytics
11.0804	Modeling, Virtual Environments and Simulation	30.7199	Data Analytics, Other
11.0899	Computer Software and Media Applications, Other	50.0102	Digital Arts
11.0901	Computer Systems Networking and Telecommunications	51.2706	Medical Informatics
11.0902	Cloud Computing	52.1201	Management Information Systems, General
11.1001	Network and System Administration/Administrator	9.0702	Digital Communication and Media/Multimedia
11.1002	System, Networking, and LAN/WAN Management/Manager		
11.1003	Computer and Information Systems Security/Information		
11.1004	Web/Multimedia Management and Webmaster		
11.1005	Information Technology Project Management		
11.1006	Computer Support Specialist		
11.1099	Computer/Information Technology Services Administration and Management, Other		
11.9999	Computer and Information Sciences and Support Services		

Table A2. Event study estimates of the effects of computer science education policies, accounting for the effects of a second policy.

	(1) State plan and State CS	(2) Funding and Standards	(3) Funding and Certification
State plan	-6.192		
Ten years prior	(15.836)		
State plan	-11.555		
Nine years prior	(11.842)		
State plan	-14.887		
Eight years prior	(9.500)		
State plan	-15.701+		
Seven years prior	(9.014)		
State plan	-14.147+		
Six years prior	(7.777)		
State plan	-8.163		
Five years prior	(7.034)		
State plan	-6.402		
Four years prior	(5.783)		
State plan	-4.631		
Three years prior	(4.910)		
State plan	-1.946		
Two years prior	(3.623)		
State plan	-2.680		
One year after	(3.059)		
State plan	1.253		
Two years after	(3.795)		
State plan	7.361		
Three years after	(7.873)		
State plan	12.361		
Four years after	(10.350)		
State plan	28.299+		
Five years after	(14.933)		
State plan	27.646+		
Six years after	(16.342)		
State CS	15.949+		
Nine years prior	(8.048)		
State CS	13.599*		
Eight years prior	(6.741)		
State CS	8.263		
Seven years prior	(6.529)		
State CS	6.631		
Six years prior	(5.472)		
State CS	2.672		
Five years prior	(4.846)		
State CS	4.035		
Four years prior	(4.402)		
State CS	1.702		
Three years prior	(4.128)		
State CS	1.468		
Two years prior	(2.834)		
State CS	0.456		

One year prior	(2.251)		
State CS	0.687		
One year after	(2.386)		
State CS	3.591		
Two years after	(3.609)		
State CS	-0.409		
Three years after	(4.162)		
State CS	8.324		
Four years after	(7.132)		
State CS	5.771		
Five years after	(8.459)		
State CS	-10.067		
Six years after	(13.011)		
State CS	-2.989		
Seven years after	(17.078)		
State CS	-6.587		
Eight years after	(18.030)		
State CS	-14.510		
Nine years after	(17.974)		
Funding		0.503	-3.651
Nine years prior		(8.483)	(10.753)
Funding		0.521	-2.364
Eight years prior		(8.045)	(9.595)
Funding		-4.674	-6.601
Seven years prior		(7.026)	(7.996)
Funding		-2.237	-4.983
Six years prior		(6.052)	(6.951)
Funding		-3.521	-4.806
Five years prior		(4.850)	(6.105)
Funding		-2.644	-3.740
Four years prior		(3.910)	(5.130)
Funding		0.720	0.097
Three years prior		(3.358)	(4.654)
Funding		-1.306	-1.897
Two years prior		(2.283)	(2.995)
Funding		-0.411	0.014
One year prior		(1.779)	(2.429)
Funding		-2.617	-2.907
One year after		(3.553)	(3.727)
Funding		6.276^{+}	5.198
Two years after		(3.147)	(3.956)
Funding		13.169*	13.364*
Three years after		(4.925)	(5.941)
Funding		16.515*	17.188*
Four years after		(6.263)	(7.900)
Funding		19.497*	20.352*
Five years after		(7.921)	(9.309)
Funding		25.413*	27.847*
Six years after		(10.236)	(12.760)
Funding		37.627^{+}	35.965
Seven years after		(22.149)	(21.504)
Standards		-5.941	

Nine years prior	(10.165)	
Standards	-4.881	
Eight years prior	(9.898)	
Standards	-3.835	
Seven years prior	(8.390)	
Standards	-0.375	
Six years prior	(7.387)	
Standards	-2.640	
Five years prior	(5.918)	
Standards	0.723	
Four years prior	(5.285)	
Standards	-0.454	
Three years prior	(4.169)	
Standards	2.072	
Two years prior	(3.075)	
Standards	0.755	
One year prior	(2.536)	
Standards	-1.770	
One year after	(2.587)	
Standards	1.815	
Two years after	(3.544)	
Standards	-2.603	
Three years after	(5.302)	
Standards	-7.913	
Four years after	(6.107)	
Standards	-13.706	
Five years after	(8.893)	
Standards	-16.367	
Six years after	(12.869)	
Standards	-26.602	
Seven years after	(16.109)	
Standards	-25.270	
Eight years after	(17.462)	
Certification		14.720
Nine years prior		(15.581)
Certification		9.994
Eight years prior		(13.777)
Certification		10.614
Seven years prior		(11.396)
Certification		8.933
Six years prior		(10.255)
Certification		7.584
Five years prior		(7.687)
Certification		7.170
Four years prior		(6.760)
Certification		5.389
Three years prior		(5.468)
Certification		4.963
Two years prior		(3.889)
Certification		3.355
One year prior		(2.955)
Certification		-2.610

One year after			(3.343)
Certification			-6.411
Two years after			(4.165)
Certification			-6.037
Three years after			(5.660)
Certification			-7.727
Four years after			(7.024)
Certification			-8.360
Five years after			(8.607)
Certification			-8.401
Six years after			(10.142)
Certification			-2.776
Seven years after			(10.658)
Certification			-2.973
Eight years after			(12.468)
Certification			-5.718
Nine years after			(12.223)
Certification			-9.967
Ten years after			(13.778)
Constant	29.209*	39.824**	29.213**
	(14.373)	(6.316)	(8.954)
Observations	35680	35680	35680

Note. Heteroskedastic-robust standard errors clustered at the state level are in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A3. Event study estimates of the effects of computer science education policies on CS degree production using Borusyak et al.'s imputation difference-in-difference estimator

	(1) State plan	(2) Standards	(3) Funding	(4) Certification	(5) Pre-service	(6) State CS	(7) Required HS	(8) CS count	(9) Higher ed admission
Lead 6	11.77	2.00	2.08	-1.81	3.26	0.88	-2.99	6.71	1.19
	(8.63)	(5.05)	(3.68)	(6.34)	(7.14)	(5.52)	(6.87)	(4.89)	(5.47)
Lead 5	10.82^{+}	1.89	2.43	-0.34	2.83	0.51	-1.57	4.10	-0.21
	(6.42)	(3.48)	(3.17)	(4.92)	(5.86)	(4.05)	(5.63)	(4.07)	(4.62)
Lead 4	7.97^{+}	3.05	0.97	-1.50	-0.52	-0.78	-1.72	3.21	-0.95
	(4.82)	(3.09)	(2.67)	(4.52)	(6.15)	(3.21)	(4.78)	(3.69)	(3.92)
Lead 3	6.26	1.49	2.62	-0.30	0.80	-1.73	0.75	3.12	0.12
	(4.24)	(2.29)	(2.35)	(3.65)	(4.22)	(3.41)	(4.09)	(3.42)	(3.38)
Lead 2	4.00	2.67	-0.02	0.63	-0.91	-0.98	-2.08	3.88	-1.44
	(3.03)	(2.08)	(1.72)	(2.98)	(2.70)	(1.92)	(2.81)	(3.12)	(3.03)
Lag 1	4.25	-0.72	-1.06	-0.69	4.12	2.03	-2.66	0.85	1.94
	(4.56)	(3.21)	(3.25)	(4.33)	(6.54)	(3.44)	(3.79)	(1.63)	(2.92)
Lag 2	8.20^{+}	4.60	6.74*	-4.27	15.61^{+}	8.05	-1.28	-0.50	2.85
	(4.95)	(3.76)	(3.01)	(5.66)	(9.08)	(5.15)	(5.22)	(2.42)	(3.74)
Lag 3	13.04^{+}	3.94	13.76**	-2.02	13.48	3.41	-0.12	-0.79	-1.37
	(7.32)	(7.03)	(4.94)	(7.06)	(10.74)	(5.97)	(5.85)	(3.38)	(4.69)
Lag 4	18.20^{+}	1.98	16.22**	-5.14	-6.00	14.22	-1.29	0.05	1.14
	(10.94)	(8.29)	(6.11)	(8.79)	(9.48)	(10.12)	(7.40)	(5.17)	(6.49)
Lag 5	34.39*	-1.08	17.12*	-8.94	24.65*	15.81	9.61	-2.19	6.15
	(14.79)	(10.17)	(7.92)	(10.21)	(10.22)	(11.31)	(9.27)	(6.39)	(8.78)
Lag 6	34.33**	1.76	20.95*	-12.59	12.66	7.66	7.01	0.79	8.03
	(12.00)	(10.41)	(9.72)	(12.47)	(8.80)	(12.15)	(10.98)	(8.06)	(10.68)
Observations	35436	35092	34539	26893	33281	35127	34477	28393	33098

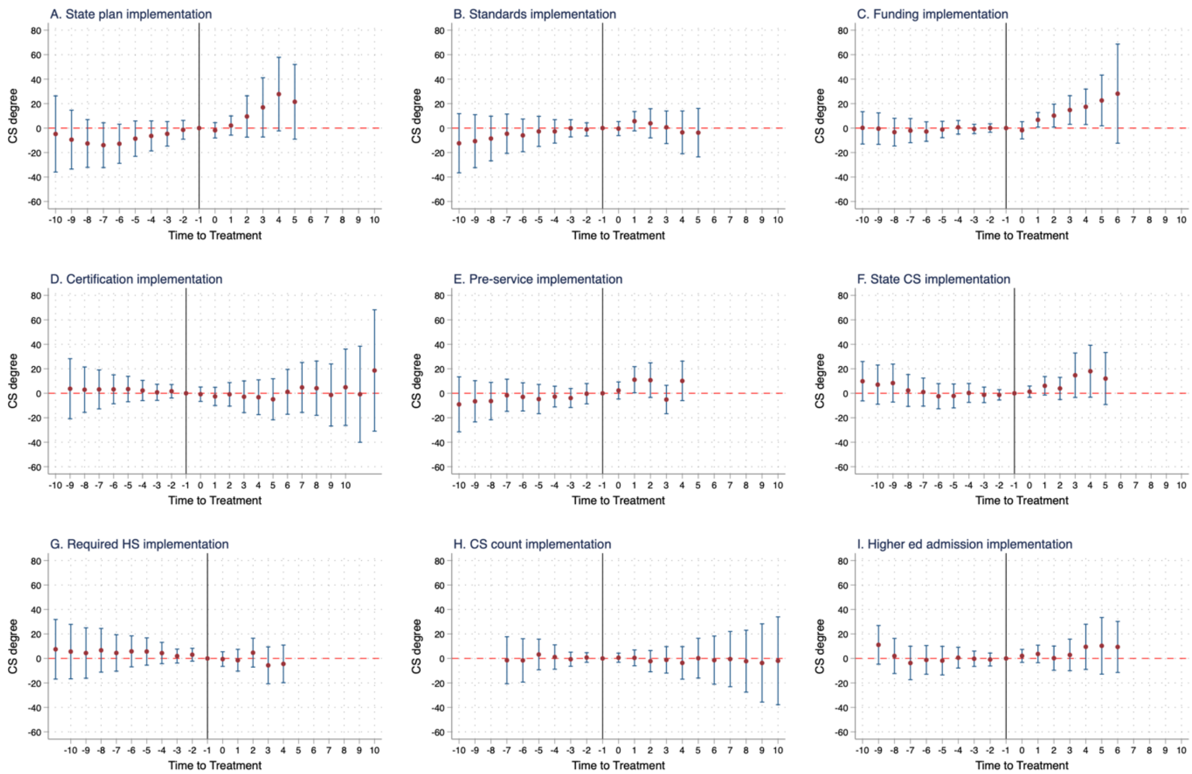
Note. Standard errors clustered at the state level are in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A4. Event study estimates of the effects of computer science education policies on CS teacher production using Borusyak et al.'s imputation difference-in-difference estimator

	(1) State plan	(2) Standards	(3) Funding	(4) Certification	(5) Pre-service	(6) State CS	(7) Required HS	(8) CS count	(9) Higher ed admission
Lead 6	0.04	-0.20*	0.19	0.10	0.13	-0.09	0.01	-0.13	0.16
	(0.11)	(0.09)	(0.17)	(0.10)	(0.22)	(0.13)	(0.11)	(0.22)	(0.16)
Lead 5	0.21	-0.12	0.07	0.19+	0.06	-0.16	0.09	0.00	0.12
	(0.22)	(0.08)	(0.11)	(0.10)	(0.12)	(0.12)	(0.12)	(0.18)	(0.13)
Lead 4	0.11	0.06	0.06	0.19	0.44	-0.12	0.03	0.04	0.28*
	(0.14)	(0.16)	(0.07)	(0.14)	(0.37)	(0.11)	(0.10)	(0.17)	(0.12)
Lead 3	0.29	0.05	0.14	0.07	-0.08	0.02	0.20	0.31	0.13
	(0.21)	(0.11)	(0.12)	(0.08)	(0.08)	(0.14)	(0.21)	(0.28)	(0.16)
Lead 2	0.06	0.02	0.04	0.33+	-0.07	-0.08	0.20+	0.15	0.15
	(0.10)	(0.09)	(0.06)	(0.17)	(0.09)	(0.08)	(0.12)	(0.12)	(0.11)
Lag 1	0.02	-0.04	0.01	0.00	-0.09	-0.09*	0.09	-0.14*	0.05
	(0.06)	(0.03)	(0.09)	(0.06)	(0.06)	(0.04)	(0.06)	(0.05)	(0.06)
Lag 2	-0.06	-0.01	-0.05	0.02	-0.05	-0.11*	0.08	-0.16*	0.04
	(0.07)	(0.05)	(0.06)	(0.07)	(0.06)	(0.06)	(0.10)	(0.07)	(0.05)
Lag 3	0.19	0.14	-0.03	0.28	0.28*	0.02	0.06	-0.13	0.08
	(0.14)	(0.11)	(0.06)	(0.18)	(0.13)	(0.13)	(0.06)	(0.10)	(0.10)
Lag 4	-0.01	0.03	0.03	0.14	0.15+	-0.14	0.10	-0.18*	0.10
	(0.07)	(0.09)	(0.06)	(0.08)	(0.09)	(0.09)	(0.14)	(0.09)	(0.07)
Lag 5	-0.11	-0.04	0.24	0.10	.	-0.12	0.08	-0.28**	0.06
	(0.13)	(0.06)	(0.17)	(0.12)	.	(0.09)	(0.13)	(0.10)	(0.08)
Lag 6	.	-0.13	0.04	0.46*	.	-0.23+	0.07	-0.28*	0.13
	.	(0.09)	(0.08)	(0.21)	.	(0.13)	(0.06)	(0.12)	(0.10)
Observations	4095	4089	3965	2750	3642	4077	3925	2898	3919

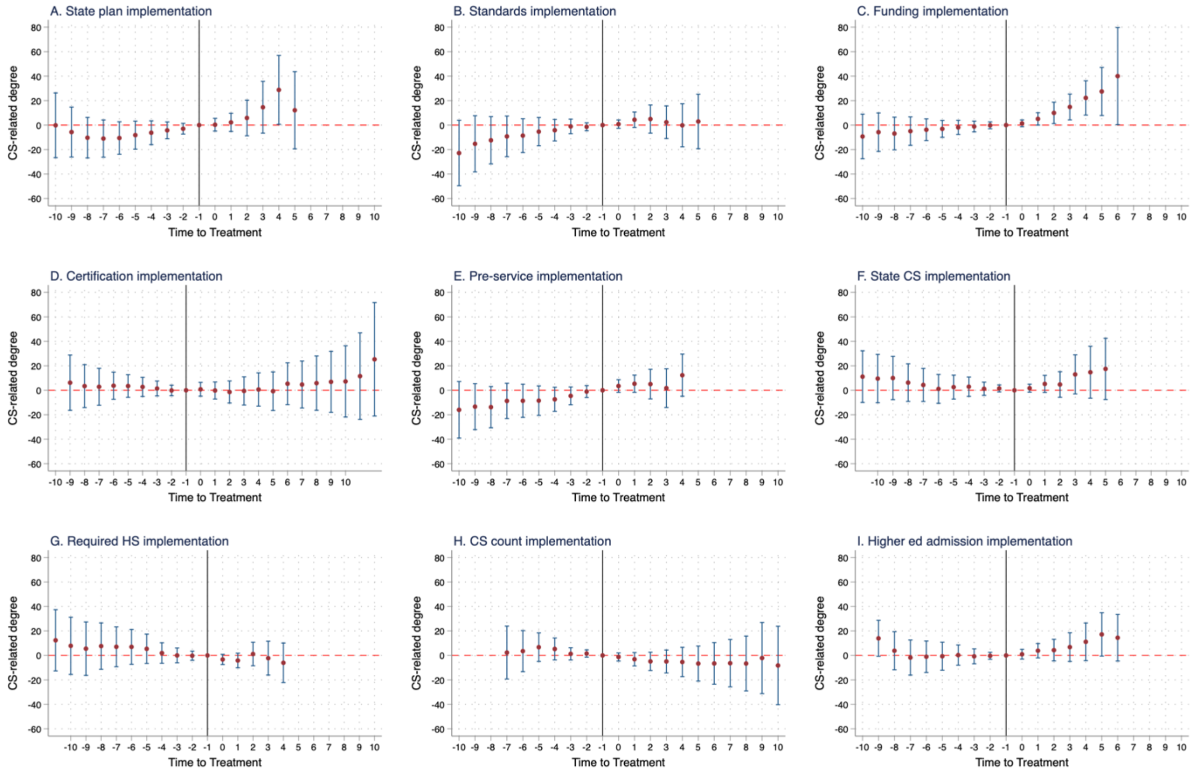
Note. Standard errors clustered at the state level are in parentheses. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Appendix Figures



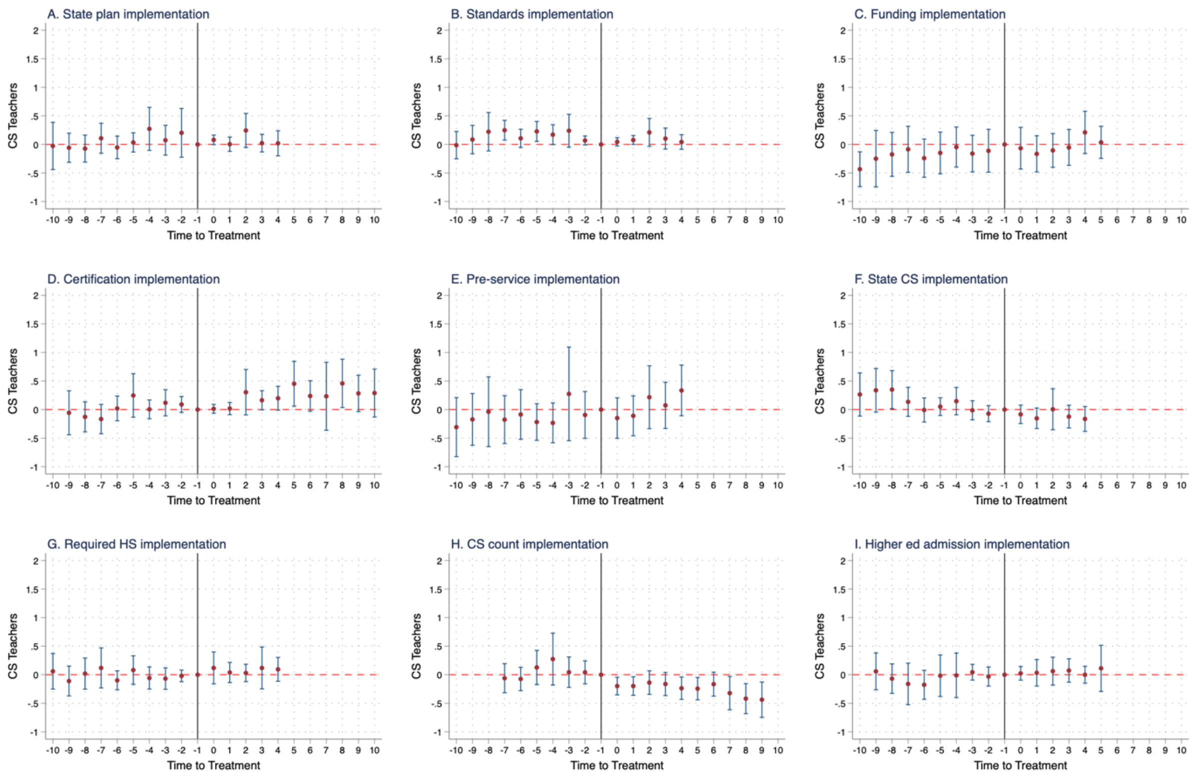
Notes: Bars represent 95% confidence intervals.

Figure A1. Event study estimates (using policy implementation dates) of the effects of computer science education policies on the number of computer science degrees awarded.



Notes: Bars represent 95% confidence intervals.

Figure A2. Event study estimates (using policy implementation dates) of the effects of computer science education policies on the number of computer science-related degrees awarded.



Notes: Bars represent 95% confidence intervals.

Figure A3. Event study estimates (using policy implementation dates) of the effects of computer science education policies on the number of computer science teacher certifications issued.