Loopholes and the Incidence of Public Services: Evidence from Funding Career & Technical Education*

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Abstract

In 2015, Michigan increased its Career and Technical Education (CTE) funding and changed its funding formula to reimburse programs based on student progression through program curricula. Although this change nearly doubled program completion rates, student enrollment and persistence were unaffected; instead, administrators accelerated student progress by reorganizing course curricula around notches in the new funding formula. As a result of response heterogeneity, 30% of the funding increase was transferred away from high-poverty districts to more affluent ones, underscoring how supply-side responses to loopholes shape the incidence of public services.

JEL Codes: I21, J24, I24

*This research result used data structured and maintained by the MERI-Michigan Education Data Center (MEDC). MEDC data is modified for analysis purposes using rules governed by MEDC and are not identical to those data collected and maintained by the Michigan Department of Education (MDE) and/or Michigan's Center for Educational Performance and Information (CEPI). Results, information and opinions solely represent the analysis, information and opinions of the author and are not endorsed by, or reflect the views or positions of, grantors, MDE and CEPI or any employee thereof. We are grateful to our MDE partners for their feedback—particularly Jill Kroll, Brian Pyles, and the staff in the Office of CTE—and to Andrew Simon, Ellen Stuart, and Brenden Timpe for thoughtful comments. We acknowledge support from IES grant number R305A200046, and the Smith-Richardson foundation including grants SRF #2020-2377 and SRF #2022-2932. We have no conflicts of interest to declare.

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1 Introduction

What is the incidence of public services when there are loopholes in regulatory or accountability policy? While there are many policies that could improve welfare, unintended behavioral responses often undermine policy objectives. For example, public school accountability policies can worsen non-tested outcomes (Dinerstein and Opper 2022) and induce teacher cheating (Jacob and Levitt 2003); health insurance reimbursement regulations can lead to over-diagnoses and upcoding (e.g., Dafny 2005; McClellan 2011); and tax changes can result in avoidance and tax cheating (Slemrod and Yitzhaki 2002; Mortenson and Whitten 2020). Even when policymakers are aware of these behavioral responses, predicting who will respond and with what magnitude can be challenging when supply- and demand-side responses are both possible. In such cases, behavioral responses will also determine the incidence of the public services as they do taxation (Rubolino 2023).

This paper studies the incidence of public services in the context of funding high-school Career and Technical Education (CTE) in Michigan. In 2015, the Michigan Department of Education announced a change simplifying CTE program reimbursements. Whereas the complicated older formula reimbursed districts based student enrollment hours, the new formula featured a simplified, curriculum-based scheme with notched reimbursement rates. The new formula reimbursed districts at higher rates for students who became "concentrators" (mastered more than half the curriculum) or "completers" (mastered the full curriculum), but it introduced a loophole that allowed administrators to increase CTE completion by reallocating curricula across courses students were already taking. Although the change was designed to maintain the distribution of state funding—absent behavioral responses—the interaction of demand-side (student) and supply-side (administrator) responses opened the door to potentially large changes in the incidence of CTE funding.

We disentangle the supply- and demand-side responses to the funding change, showing the key role of supply-side curricular adjustments. Using both a within-state event study design and cross-state difference-in-differences, we find that the share of concentrators increased by 8-10 percentage points (27-33%) and the share of completers increased by over 13 percentage points (85%). This large equilibrium response was due entirely to administrator rather than student responses. While student coursetaking behavior remained completely unchanged, we provide evidence of a strong supply-side response: many administrators reorganized program curricula around the funding-formula notches to accelerate student progression through CTE programs.[1]

1. Effects of these changes on student outcomes are not identified because of non-excluded variation in

Even without any change in demand-side behavior, these supply-side responses completely reshaped the incidence of CTE funding. In part, this is because CTE funding (like many other public services) operates on a fixed budget from year to year. As such, behavioral changes can only result in zero-sum transfers between districts. We find that CTE completion rates increased much more in wealthier and less urban districts. These behavioral responses undermined the progressivity of an earlier statewide increase in CTE funding. In 2015, state CTE spending per student increased roughly $21 (40%). But in the three years after the funding formula change, districts in the top quartile of student poverty experienced average gains of only $12 per pupil compared with $25 for all other districts. The supply-side responses transferred almost 30% of the increase away from high-poverty districts by 2018.

Our main contribution is to highlight the potential that regulatory loopholes can have in shaping the economic incidence of public services. For example, in contrast to existing evidence that mandatory legislative and court-ordered school finance reforms tend to be very progressive (see the metaanalysis in Jackson and Mackevicius 2024),[2] our results demonstrate how increased discretion can shift the incidence of education finance away from poorer students. Furthermore, because of the importance of supply-side responses, our paper underscores the relevance of regulatory loopholes in determining the incidence of other public services like higher education appropriations and tuition (e.g., Turner 2017; Bound and Simon, Forthcoming), medical costs with public health insurance (reviewed by McClellan 2011), and public utilities and environmental equity (Banzhaf, Ma, and Timmins 2019; Fullerton and Muehlegger 2019).

Our findings also indicate how bureaucrats' behavior can undercut policymakers' objectives. We find heterogeneity in responses, suggesting that the interactions between policymakers and the public employees making local (supply-side) decisions are critical determinants of whether legislation, interventions, and public programs achieve their stated aims. Consistent with research on medical reimbursements and tax cheating, we find evidence that administrator responses are geographically correlated (Chetty, Friedman, and Saez 2013; Sacarny 2018; Boning et al. 2020) and are more common among better resourced units (Alstadsæter, Johannesen, and Zucman 2019), suggesting the importance of institutional acumen (as in Slemrod 2007; Dafny and Dranove 2009), opportunity (Dafny and Dranove 2009; Mortenson and Whitten 2020) and market structure (as in Geruso and

other policies (that while unrelated to CTE enrollment) directly tried to improve testing, graduation, and college going.

2. There are examples of spending affecting or not affecting student outcomes. For example, compare Hyman (2017), Lafortune, Rothstein, and Schanzenbach (2018), and Brunner, Hyman, and Ju (2020) with Martorell, Stange, and McFarlin Jr (2016), Baron (2022), and Brunner, Hoen, and Hyman (2022).

Layton 2020). The fact that some (but not all) administrators respond to funding incentives also highlights the importance of both capacity and compunction in taking advantage of regulatory loopholes. Importantly, our work provides evidence of strategic adjustments in situations where the actors do not have direct incentives or career concerns (e.g., Bandiera et al. 2021; Best, Hjort, and Szakonyi 2023).[3]

Lastly, our paper contributes to ongoing research and policy conversations about CTE. Recent economic research has explored the determinants of student participation in CTE programs (e.g. Ecton and Dougherty 2023; Jacob and Ricks 2023) and confirmed that many CTE programs promote academic attainment and early career earnings (e.g., Dougherty 2018; Kreisman and Stange 2020; Brunner, Dougherty, and Ross 2023; Ecton and Dougherty 2023). Our paper presents the first causal evidence about the effects of CTE funding, complementing a fairly sparse descriptive literature (Klein 2001; Foster, Klein, and Elliott 2014, e.g.,). As federal, state, and local funding for CTE increase dramatically,[4] our paper provides a cautionary tale demonstrating the importance of designing systems to mitigate the potential for regressive supply-side responses.

2 CTE in Michigan

Career and Technical Education (CTE) courses prepare students with career-relevant skills and training. In our period of study, public high schools in Michigan could offer 47 state-approved programs of study such as autoshop, computer programming, health sciences, woodworking, cosmetology, accounting, and engineering. The Michigan Department of Education oversees CTE program standards and programs are administered by schools or school districts with oversight (usually) at the county or intermediate-school-district level. Students who take CTE courses typically take 1-4 courses in a program of study and can either take CTE courses at their local high school or travel to other buildings for courses.

During the period of our study, Michigan began tracking student advancement and skill acquisition using curricular units, called "segments." To receive state funding, every program was required to contain courses covering each of 12 program-specific segments. To facilitate compliance with federal CTE legislation, Michigan characterized student progression in CTE based on these segments: completers (who passed courses that covered all

3. For additional examples of incentives see Geys, Heggedal, and Sørensen (2017) and Khan, Khwaja, and Olken (2019), and for career concerns see motivation in Alesina and Tabellini (2007) and Alesina and Tabellini (2008) and evaluation in Che, Chung, and Lu (2017).

4. Some states are doubling or even tripling annual statewide appropriations for high school CTE (ACTE 2016).

12 segments), concentrators (7-11 segments), or participants (fewer than seven segments).[5] Local administrators determined the appropriate number courses in the program and number of segments covered in each course.[6]

2.1 CTE Funding Increase and Formula Change

Since CTE courses can be more expensive than general education classes, the state provides "added-cost funds" to defray additional expenses. The first 40% of these funds were allocated across Career Education Planning Districts (usually county ISDs) based on their share of CTE enrollment. These funds were *discretionary* and could be given to any constituent district. The other 60% of these funds were given directly to the districts operating programs based on both enrollment rates and a ranking of CTE programs' career prospects.

Michigan made a number of changes to the funding system in the mid-2010s. First, the state increased total expenditures on CTE by 38% starting in the the 2014-15 school year. At the same time, the state made changes to the funding formula that would take effect in 2016-17 based on student course-taking in 2015-16. These changes were not intended to affect student or administrator behavior or to serve as accountability measures; rather the intent was to simplify reporting. In fact, (absent behavioral changes) the new formula was calibrated to result in equivalent allocations of funds, not to alter them.

The most important change was providing increased funding for students who advanced through their CTE program. Whereas the previous formula used instructional hours to measure CTE enrollment for both the 60% formula funding and the 40% discretionary funding, the new formula reweighted enrollments using a notched schedule based on curricular units called "segments." For both types of funding, students who completed a program (all 12 segments) had a reimbursement weight of 10, concentrators (7-11 segments) a weight of 5, and participants (fewer than 7) a weight of 1. The 60% of funds given directly to districts continued to provide larger reimbursements to more expensive programs and to programs in "high-wage, high-demand" occupations. Appendix Figure A.1 illustrates how the number of segments completed, costs, and potential economic returns influenced the reimbursement rate. Appendix B provides a detailed description of the old and new funding systems.[7]

5. To complete a segment a student must have a GPA of 2.0 or higher in the course covering that unit. Completers were also required to take a corresponding CTE assessment in some programs of study.

6. For example, two different schools might offer business programs. One could have four courses with three segments each, and the other could have two courses, one with eight segments and the other, four.

7. Although the major change to the 40% and 60% funding was the change from instructional hours to curricular segments, there were two smaller changes that slightly affected funding. First, the state used

2.2 Administrative Data

The data used in this analysis are drawn from student-level longitudinal data files for Michigan provided by the Michigan Department of Education, its Office of Career and Technical Education, and the Center for Educational Performance and Information. We analyze a sample of first-time ninth graders in Michigan public schools for the expected graduating cohorts between 2010 and 2019. We link students to their demographic and achievement data and statewide CTE enrollment records. We drop 0.7% of students who attend state and county schools for whom the educational incidence of CTE funding is not well defined, leaving us with 1,138,078 unique student records.

Appendix Figure A.2 plots student progression rates in CTE across high school graduation cohorts. Averaged across all CTE programs, the participation rate (those taking CTE whether or not becoming a concentrator or completer) remained close to 53% before and after the funding formula change. By contrast, concentration and completion rates trended upward after 2014.[8] Given that students take CTE courses throughout their high school years, cohort exposure to the new formula increased from 2015 to 2018. For the 2015 cohort, the new law could only have influenced their course-taking during their senior year, whereas the 2018 cohort spent their entire high school experience under the new formula.

3 Quantifying the Effects of the Funding Change

To assess the equilibrium impact of the funding change, we estimate pre-post and event-study regressions tracking student outcomes before and after the reform.[9] We model the outcome of student i as a function of cohort indicators (omitting 2014):

updates their ranks of high-wage, high-demand occupations every 3-5 years based on economic trends. One of these updates occurred in 2015 in proximity to the funding change (there were also changes in 2012 and 2019), slightly changing the reimbursement weights for different programs before and after. Second, rather than allocate 60% funds beginning with the program of study with the highest ranked career prospects and proceeding down the list until funds were exhausted, the revised formula gave "rank factor" weights to ensure that the 20 highest-ranked programs got some funding (see Appendix Table B2). This democratized the number of programs receiving some support, but may have slightly reduced reimbursements to a few marginal programs.

8. Note that we use these groups inclusively. All completers also achieve concentrator and participant status and all concentrators are also counted as participants.

9. Although "event study" traditionally refers to regressions estimated with indicators for lead and lag periods, more recent use assumes treated and untreated units. This is not the case in the student-level Michigan data, but is true for our cross-state comparison below.

$$y_i = \sum_{k \in \mathcal{K}} \tau_k \mathbb{1}[\text{cohort}_i = k] + \beta X_i + \psi_{s(i)} + u_i$$

where $\mathcal{K} \in \{2012, 2013, 2015 \ldots 2019\}$. We control for school fixed effects, $\psi_{s(i)}$, and student-characteristics, X_i to adjust for any compositional changes over the time period.[10] Standard errors are clustered by school. Interpreting τ_k as the causal effect of the policy change requires a stationarity assumption that absent the funding change participation, concentration, and completion would remain at their 2014 levels.

Panel (a) of Figure 1a reveals dramatic changes in CTE concentration and completion. The figure depicts the event-study coefficients and 95% confidence intervals by high-school cohorts along with vertical lines indicating when the funding formula change was announced (which also coincided with an increase in state funding for CTE) and when the new formula was applied. After 2014, completion rates increased nearly 14 percentage points–over 84%–and concentration rates increase by 10 percentage points—over 33%. Participation rates, however, do not change.

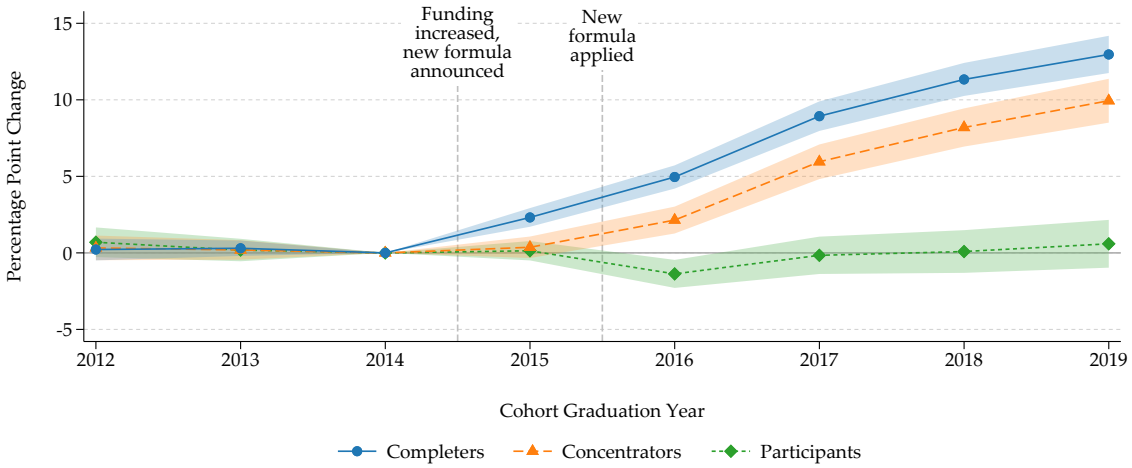
Although the flat pre-trends would be consistent with our identifying assumption, other changes in the CTE environment could bias estimates. We consider three sets of possible issues with this assumption. The first is an issue of interpretation rather than identification. The policies examined in this paper include a set of combined changes. The increase in CTE funding, a change to reimburse districts based off of students' curricular progress, and a few small tweaks to the career-based program rankings. Although we present evidence that the curricular progress was the main component generating the effects we find, the strict econometric interpretation of our results should be the effect of the full set of funding change policies.

Second, we think it is unlikely that other state or local changes are driving these results. Conversations with administrators confirm that the absence of explicit policies of this sort; furthermore, by 2014 the educational and demographic disruptions caused by the Great Recession in Michigan had subsided. Regarding federal legislation, new CTE policy (Perkins V) was not signed until 2018. Although the 2015 *Every Student Succeeds Act (ESSA)*, could potentially have influenced high school course-taking, Section 5 finds no evidence of changes on this margin.

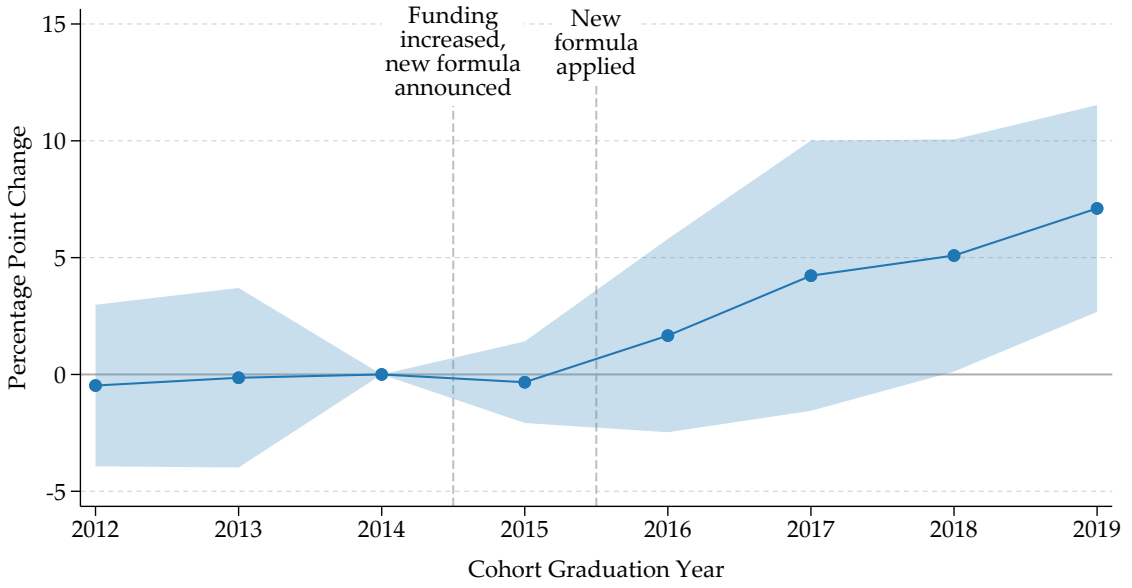
Third, to rule out federal policy or other nationwide secular trends, Panel (b) of Figure 1b compares concentration rates in Michigan to other states in the Career Technical

10. Specifically we control for student sex, race (Black Non-Hispanic, Hispanic, Other Non-White Non-Hispanic), special education status, English language learner status, free or reduced price lunch eligibility, eighth grade achievement (average of math and reading), eighth grade attendance, and imputation flags for missing tests and attendance.

Figure 1. CTE Completion Increases after the Funding Change



(a) CTE Participation, Concentration, and Completion, Concentration in Michigan



(b) CTE Concentration in Michigan Relative to Other States

Notes. Figure (a) presents the main event study estimates described in the text. Figure (b) presents estimates from a student-weighted, state-cohort level regression of CTE concentration rates using data from the Career & Technical Education Policy Exchange (Goldring et al. 2021) and standard errors clustered by state, as described in the text.

Education Policy Exchange. The analysis compares cohort concentration rates in Michigan with those in Massachusetts, Tennessee, and Washington. Reassuringly, Michigan's trend in concentration rates was identical to other states' prior to the funding change, but after, concentration rates in Michigan diverge. The magnitude of the increase (8 percentage points) is similar to and statistically indistinguishable from those shown in Panel (a) (about 10 percentage points). These results provide additional reassurance that the estimates described above reflect the causal impact of the funding change on CTE coursetaking patterns in Michigan.

As an additional reliability check, we examine changes by program reimbursement potential. As noted in Appendix B concentrators and completers in certain programs of study were reimbursed 2.5, 5, or 10 times more than those in others (again see Appendix Figure A.1). If changes in CTE concentration/completion rates were caused by changes to the funding formula, we would expect rates to increase the most in programs with higher reimbursement potential in the 60% formula funding. Panels (a) and (b) of Appendix Figure A.3 separate out changes in concentration and completion by the program-specific reimbursement weights. We see that completion rates increased roughly 8 percentage points among programs with a reimbursement weight of 10 compared with only 2-4 percentage points among programs with lower weights.[11] Interestingly, while programs were also partially reimbursed based on costs, Panel (b) of Figure A.3 shows that responses are larger in programs with lower costs. While consistent with a causal interpretation of the results, the simple equilibrium estimates do not reveal the underlying behavioral mechanisms, whether they are operating on the supply-side or demand-side of the market, or their resulting implications for the incidence of CTE funding.

4 Behavioral Responses and the Incidence of Loopholes

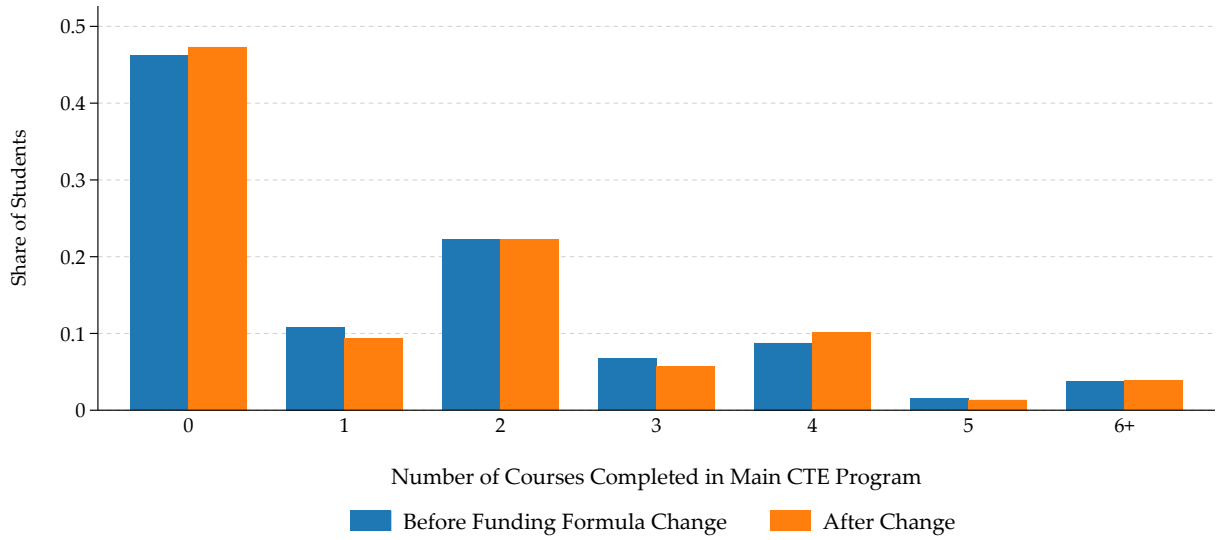
4.1 Administrator Behavior and Curricular Rearrangement

Knowing that the funding change increased equilibrium CTE completion rates, we now explore whether these reflect real coursetaking effects on the demand side or supply-side adjustments by administrators. Figure 1a shows that the fraction of students taking any CTE courses (i.e., the participation rate) did not change substantially following the reform. In addition, Figure 2 shows that the the *number* of CTE courses students took did not change after the reform. The average change in the post period relative to 2014 is an

11. Note that because the outcome for these regressions is an indicator for whether a student completed a CTE program with rank factor $R \in \{1, 2.5, 5, 10\}$, the four estimates' sum is slightly larger than the total effect because students may concentrate in or complete multiple programs with different rank factors.

increase of 0.02 courses with a standard error of 0.02. Student behavior is almost identical after the funding change with no increases in CTE participation rates (on the extensive margin) or CTE coursetaking intensity (the intensive margin).[12]

Figure 2. Course Completion Before and After the Funding Formula Change



Notes. The graph shows the share of students taking the specified number of courses in their most intensive CTE program. Before the funding formula change includes SY 2011-12 to SY 2013-14; after the change includes SY 2014-15 to SY 2018-19.

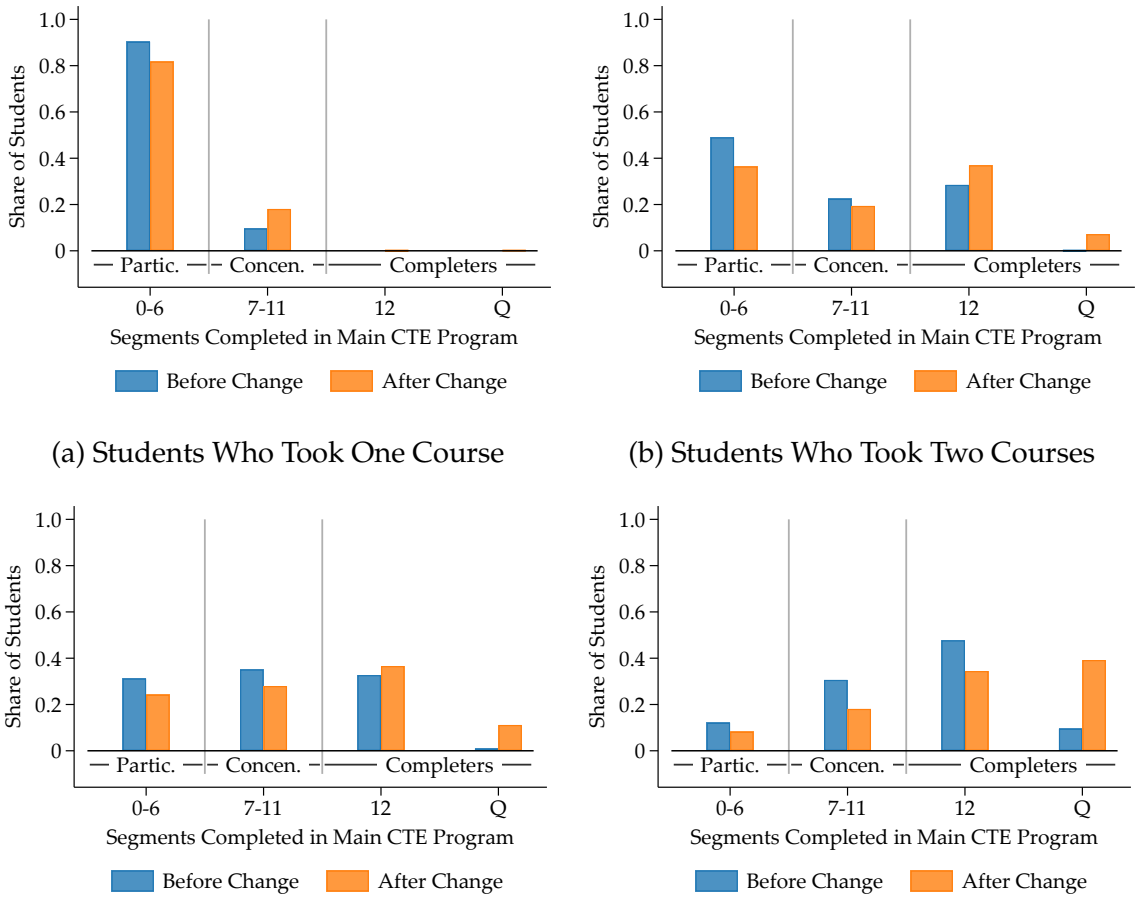
In contrast, we find noticeable changes in how administrators allocated the curricular units (called segments) across courses within CTE programs. Recall that although the state defined the 12 segments for each program of study, local administrators had flexibility to allocate these curricular units across courses as they saw fit. Originally, student learning was the only consideration in this decision, but by basing reimbursements on notches in segment completion, the funding change introduced other incentives. Figure 3 presents evidence that segments were rearranged around the notches in the reimbursement-rate formula. The figure plots the share of students (y-axis) who completed various numbers of segments (along the x-axis) separately by the number of courses they took.[13] Segment

12. One alternative explanation of increased completion with constant course taking is that students are substituting towards programs that take fewer courses to complete, but we find no differential changes in participation rates between programs in high- and low-completion rate clusters (we reject decreases greater than 1.7 percentage points in either).

13. Rather than comparing segments earned by students as a function of courses taken by students, the ideal comparison would be to compare the number of segments offered by the same course over time. Unfortunately, while the data clearly connect programs over time within school, course identifiers frequently change, making the ideal comparison impossible in the full sample.

"Q" designates instruction given after the 12 required segments, so students in segment Q generate the maximum reimbursement rate (and can do so over multiple years).

Figure 3. Increased CTE Program Completion Stemmed from Curricular Reshuffling



(a) Students Who Took One Course

(b) Students Who Took Two Courses

(c) Students Who Took Three Courses

(d) Students Who Took at Least Four Courses

Notes. Segments are state-defined groupings of content standards for each CTE program of study. Segment Q covers advanced content beyond the 12 segments required to complete a CTE program. "Before Change" refers to the period before the funding formula change and includes school year (SY) 2011-12 to SY 2013-14; "After Change" covers SY 2014-15 to SY 2018-19. "Partic." are CTE program participants who earned at least one segment, "Concen." are concentrators who earned at least seven segments, and completers earned all 12 segments.

Conditional on the number of courses taken, the distribution of segments shifts to the right across the curricular notches so that students were much more likely to become concentrators or completers after the funding change. For example, among students who take only one CTE course, the share of students who completed seven or more segments increased by 8.6 percentage points (89%—Panel (a)). Among those who took two courses the increase was 12.6 percentage points (25%—Panel (b)). Conditional on coursetaking,

the share of students earning twelve segments and any segment Q credits expanded dramatically. For example, the proportion of students who completed twelve or more segments increased by 15.7 percentage points among students who took two courses (55%—Panel (b)), and the share of students with segment Q credits increased by 7.2, 10.2, and 29.7 percentage points among those taking two, three, or four or more courses (110,000%, 1070%, and 311%—Panels (b), (c), and (d)).[14]

There are several ways in which these curricular changes may have occurred, each with different implications for student social welfare. On one hand, curriculum-based reimbursements could function as an accountability measures, helping administrators promote learning and cut instructional "fluff." Like performance-based funding in higher education, we would expect this type of response to have modest positive effects on welfare-relevant student outcomes (Ortagus et al. 2020).[15] On the other hand, if the notched reimbursement rates distort the efficient distribution of curriculum across courses, the curricular reshuffling could actually harm student learning. Given that coursetaking is unchanged, it seems likely that in either case the largest effects would be on CTE-content mastery and that other outcomes would only be less affected.

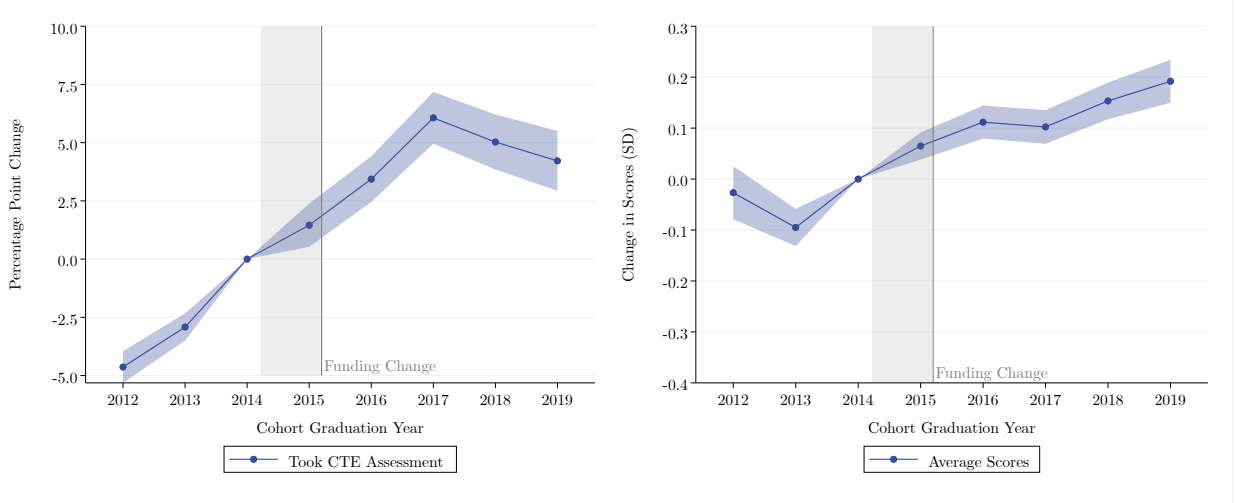
Data limitations prevent a compelling examination of these specific hypotheses. The closest measures we have for CTE content mastery are CTE assessments offered in select programs. Unfortunately, these assessments were being rolled out in the years surrounding the funding change. For these seven programs, an assessment was required for students to attain "completer" status from 2014–2017, introducing enormous compositional changes in testers. With these limitations in mind, Figure 4 reports the share of students in these programs taking these assessment (left panel) and the scores on the exams (right panel). With limited pre-treatment years trends should be interpreted with caution, nonetheless patters remain relatively stable to pre-existing trends, suggesting that the funding changes and subsequent curricular reorganization did not impact either testing or student learning (for better or worse).[16] Looking at other outcomes such as graduation rates or community college enrollment are further complicated by a contemporary change in Michigan's compulsory schooling age.

14. Because students have to earn a passing grade to complete a segment, grade inflation could be another possible margin of response. We find no evidence of this: Pass rates in CTE courses are high and fairly stable, climbing from 87.5% in 2010 until leveling off around 89.5% for 2014-2019.

15. Ortagus et al. (2020) also note that performance-based funding can sometimes lead to formula gaming and other unintended consequences.

16. We do find that despite the 50% increase in test taking from 2014-2017, the average eighth-grade test scores among students taking the tests do not change by more than 0.02 SD. Although this suggests that the 0.15 SD increase in CTE scores is not due to compositional changes in the student taking tests, the steep pre-trends make it unclear whether this is a result of the funding change.

Figure 4. Trends in CTE Assessments



Note: This figure shows the rates of assessment and average scores among students who participated in the seven programs of study that required assessments for completion in 2014-2017. The relevant cipcodes are 43.0100 (Criminal Justice), 47.0603 (Collision Repair), 47.0604 (Auto-Tech), 47.0613 (Truck Technician), 51.0000 (Health Services), 52.0299 (Business Administration), 52.0800 (Accounting), and 52.1999 (Sales and Marketing). Note that the rate of test-taking falls in 2018 when it was no longer required for completion.

Taken together these results suggest that on average the funding change did not affect student coursetaking and likely had minimal effects on learning on average. That is not to suggest, however, that no students were affected. Both the changes in completion rates and the curricular realignments indicate that some—but not all—districts responded to the funding change by reorganizing CTE program curricula. To the extent that these behavioral responses are correlated with other district characteristics, these behavioral responses will shift the incidence of state CTE funding toward more responsive districts, their CTE programs, and their students.

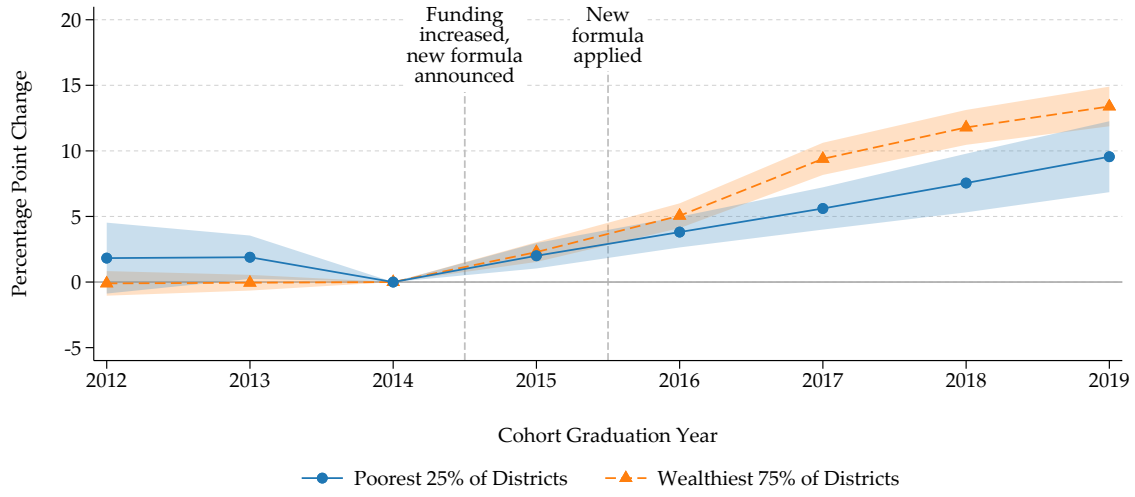
4.2 Implications for Incidence

Understanding how supply-side responses shape the incidence of CTE spending requires understanding how different district administrators responded to the funding change. To do this, we estimate the event study models described in Section 3 separately by district type. Across a variety of specifications, we find consistent evidence that urban districts and districts with the highest poverty rates responded *less* than schools in more affluent communities and non-urban locations. Figure 5 illustrates this pattern. In both Panel (a) and (b) we see that completion rates increased slightly for all groups after the announcement of the new formula, funding increase, and subsequent funding change.

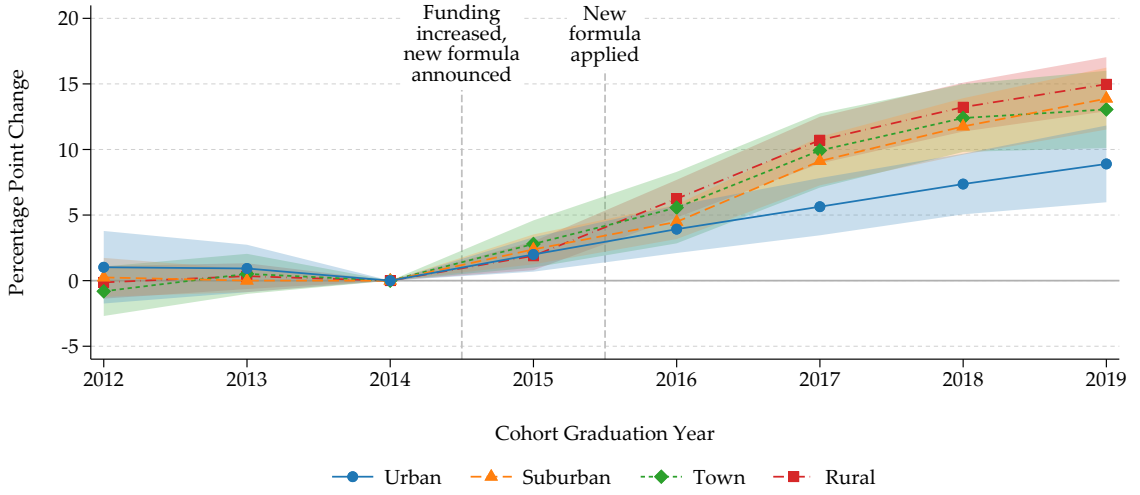
Although changes are similar in 2015 and 2016, completion rates soon begin to grow more rapidly in districts with lower poverty rates (Panel (a)) and in non-urban districts (Panel (b)). As with the statewide results discussed above, we find that the changes in CTE completion rates across district types result from curricular reshuffling as opposed to changes in student behavior or learning. Specifically, we confirm that there were no substantial changes in the number of CTE courses students completed post reform in any of the district types.

Figure 5. Completion Rates Increase Less in Poor and Urban Districts

(a) Changes by District Poverty



(b) Changes by District Urbanicity



Notes. Figure (a) presents the event study estimates described in the text by district poverty. Figure (b) presents event study estimates by district urbanicity.

To measure the economic incidence of these behavioral responses, we estimate event-study effects using a district-year level dataset of CTE funding. For each year we sum up the the total reimbursements to each local district[17] and calculate the number of dollars per high school student (regardless of whether they enrolled in CTE). We then estimate enrollment-weighted, district-level event-study regressions analogous to those in Section 3.[18]

Figure 6 shows how per-student CTE reimbursements changed around the funding change. Across the state, average funding per student increased from $51 in 2013-2014 to $76 in 2018-19. Panel (a) shows that although both higher- and lower-poverty school districts received more funds in 2015 when the overall level of state funding increased, the gains to high-poverty districts eroded by 15-40% in subsequent years.[19] This erosion corresponds to the disproportionate increase in completion rates in lower-poverty districts depicted in Figure 5. Because the total state budget for CTE remains fixed within a given year, the behavioral responses in lower-poverty districts generated direct transfers of state dollars to these districts from higher-poverty districts. After accounting for behavioral responses, districts in the top quartile of student poverty saw increases of $12 per pupil in the three years after the change compared with $25 for all other districts, a loss of $133 per full-time equivalent enrollment in CTE. The ratio of per-student spending between poorer and wealthier schools also shrunk from 0.58 in 2015 to 0.49 in the next three years.[20] Panel (b) reveals similar reductions in CTE funding to urban school districts. Districts located in small towns gained of $39 relative to $22-$29 in rural and suburban areas and less than $18-22 in urban areas.

As a robustness check, Appendix B discusses the funding change in more detail and presents evidence that these effects are driven by behavioral responses to the funding formula consistent with our understanding of the incidence. For example, Appendix Figure B.1 compares the changes in funding between formula-based and discretionary funding, showing much more substantial effects in the former. These patterns are consistent with

17. For programs operated by ISDs, which include county-based career tech centers, we assign funds proportional to the share of the ISD's of total high-school students in each district.

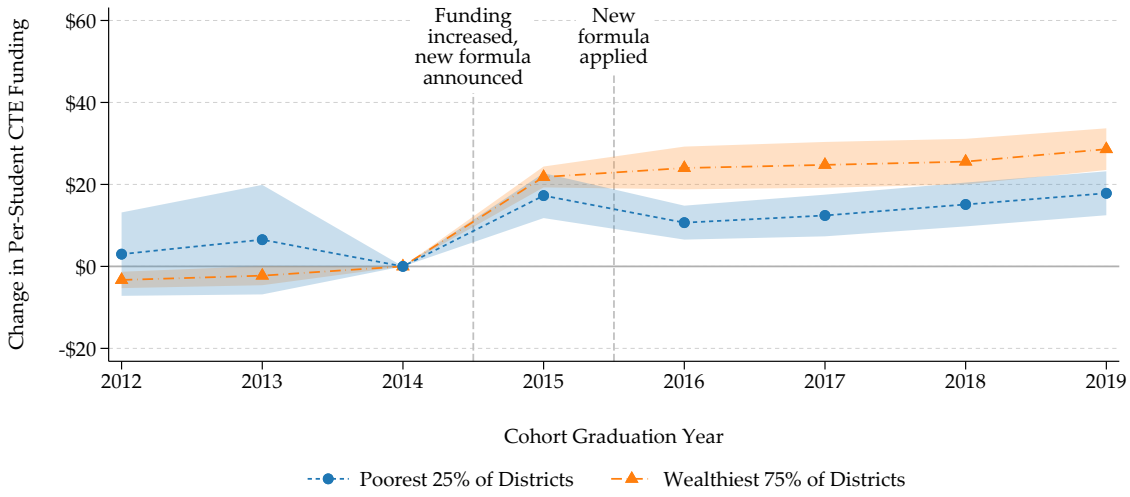
18. Note that whereas the earlier analyses used cohort graduation years, the funding numbers represent academic/fiscal years, e.g. SY 2016-17 is 2017. We include district fixed effects and cluster standard errors by district.

19. An additional increase in funding in 2018-19 (See Appendix Table C.3) offsets most of this erosion but further widens the gap between high- and lower-poverty schools.

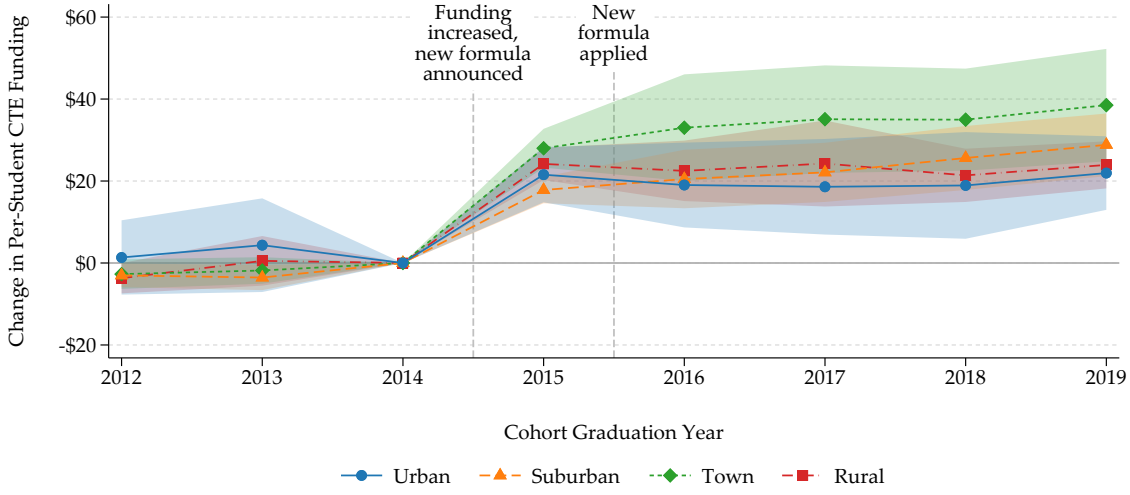
20. Although the differences are statistically imprecise, visual inspection of Panel (a) seems to suggest that the absolute gap in per-student funding between poor and wealthier districts in the last few years, this comparison is complicated by an additional increase in funding in 2019. Relatedly, note that the growth in completion rates in Figure 5 is not faster in poor districts than in wealthier districts in any year. This suggests that the difference in incidence is fairly permanent rather than the result of wealthier districts adjusting more quickly until incidence is equalized by poor districts catching up.

Figure 6. Poor and Urban Districts Bear the Burden of Curricular Rearrangements

(a) Change in CTE Funding by District Poverty



(b) Change in CTE Funding by District Urbanicity



Notes. Figure (a) presents event study estimates showing how per-student funding evolved over time by district poverty. Figure (b) presents similar estimates by district urbanicity.

administrators in more affluent districts responding more to the new funding formula.[21] Furthermore, Appendix Figure B.1 shows that the small changes in discretionary funds are generated by higher-poverty CEPDs receiving fewer funds under the new formula rather than CEPD administrators choosing to fund programs in higher-poverty schools less. As noted in Appendix B, one small change to the CEPD discretionary funding system had the potential to reduce funds to large districts with low CTE enrollment. The results in Appendix Figure B.1 also reveal that this is not driving our incidence results. Together these facts offer confirmatory evidence that administrator responses to the funding change shaped the incidence of CTE funding in Michigan.

4.3 Mechanisms: Differential Responses across Districts

The disparate impact of the CTE funding formula could be explained by two main sets of factors. One one hand, there may be institutional differences in the number and types of programs districts operate. If some districts disproportionately operate highly reimbursed programs or already have a large number of students participating in CTE, they would find it disproportionately beneficial to manipulate completion rates. The other set of explanations involve administrator capacity. If some districts have more centralized administrative capacity, have individual administrators more experienced with CTE financing, or feel less compunction about curricular rearrangement, these districts may be more disposed to develop and implement curricular changes to increase completion rates.

To explore the role of these factors, we create a data set with one observation for each CTE program in each school building (called PSNs by the state) in each year. Our key outcome is the change in the completion rate from the three years prior to the funding change (i.e., 2012-2014) to after the reform (i.e., years 2017-2019).[22] Unlike the student-level analyses above, the completion rates we create include only students who took at least one course, and can be thought of CTE completion rates conditional on participation. Our final dataset includes 1,645 continuously operated programs spanning 47 fields of study (identified by CIPcode) across 226 districts. We predict changes in completion rates

21. Note that the available data reflects the revenue *generated* by each program. According to state officials, local CTE administrators have the flexibility to allocate revenue across programs as they see fit within their agency. For example, an administrators may choose to use some of the money generated by a lucrative business program to subsidize a less popular agriculture program. To explore whether such reallocation influences our analyses, we also conduct the analysis at the CEPD (i.e., CTE Planning District) level because there is no mechanism to reallocate funding across CEPDs. Appendix Figure B.2 shows these results. While the differences across district characteristics are more muted because of the aggregation, the pattern of greater revenue going to more advantaged districts remains the same.

22. In contrast to the event study, we omit 2015 and 2016 to focus on the impact once the additional funding and new formula were in place. Results with all years are qualitatively similar.

with program and district characteristics and present the results in Table 1. Observations are weighted by number of CTE participants prior to the reform and standard errors are clustered by district.

Table 1. Determinants of District Heterogeneity in Response to Funding Formula Change

Dependent Variable: Change in CTE Completion Rate				
	(1)	(2)	(3)	(4)
ISD Operated Program	6.25*	7.14*	7.62*	0.21
	(2.49)	(2.76)	(3.39)	(4.53)
Urban (%)			-1.54	-1.06
			(3.80)	(3.90)
Town (%)			-1.61	-3.60
			(3.49)	(4.70)
Rural (%)			0.49	1.16
			(3.71)	(4.25)
Economically disadvantaged (%)			-1.46	-3.60
			(6.19)	(7.25)
Enrollment (1000s Pre-Change)			-0.06	0.06
			(0.07)	(0.08)
Adjusted R-squared	0.015	0.063	0.061	0.169
CIP Code Fixed Effects		x	x	x
CEPD (Region) Fixed Effects				x

Notes. This table reports results of regressions with one observation per CTE program. The total number of observations is 1,645. The mean (standard deviation) of the outcome, the change of the CTE program completion rate, is 14.8 percentage points (23.0).
* $p = 0.05$

We draw three main conclusions from the results. First, completion rates increase more in more centrally provided programs. The model shown in column 1 includes an indicator for intermediate school districts (ISD). In Michigan, ISDs are regional level units that operate larger CTE programs that serve students across multiple districts. For example, countywide “career tech" centers are typically operated by ISDs as opposed to local school districts. We find that completion rates increased 6.2 percentage points (40%) more in programs operated by ISDs relative to those operated by regular districts. As ISDs have greater experience operating CTE programs and navigating CTE financing, this suggests the importance of administrative capacity, reminiscent of similar results in health insurance (Dafny 2005) and tax evasion (Alstadsæter, Johannesen, and Zucman 2019). ISDs also have a greater incentive in maximizing CTE funding because it constitutes a larger

share of their overall budgets, as in other contexts (Dafny and Dranove 2009).[23]

Second, we show that the large changes in ISD-operated programs are not driven by heterogeneity in CTE composition or other district characteristics. In column 2, we include a full set of fixed effects for CTE field of study (i.e., cipcode). The inclusion of these controls increases the adjusted R-squared of the model from 0.015 to 0.062, but does not meaningfully affect the size of the estimate for ISD provision. These changes indicate that while the mix of programs offered by a district is associated with the change in completion rates, these patterns are unrelated to ISD provision, reinforcing the importance of administrative capacity. In column 3, we include controls for district urbanicity shares (city, town, or rural with suburb omitted), district poverty rate, and number of high-school students in the district because ISD-operated programs are more prevalent in more rural areas and in areas with above-average poverty rates and these factors could proxy for district capacity. Conditional on ISD provision, however, none of these variables are significant predictors of district responses to the funding change.[24]

Finally, we show that the responses at ISD-operated programs are highly geographically correlated. In column 4, we include fixed effects for the regional CTE education planning districts (CEPD).[25] CEPD administrators can exert considerable influence over CTE operations within their jurisdiction, including whether programs tend to be offered at the ISD level and how to structure programs. As such, fixed effects allow us to compare ISD-operated programs to locally-operated programs overseen by the same administrators. The regional effects nearly triple the explanatory power of the model, but within CEPDs, ISD-operated programs respond identically to similar locally-operated programs. This highlights an important spacial component to the behavioral responses and reveals that the same CEPDs that tend to have centralized provision (i.e., ISD operated programs) see the biggest behavioral responses. This geographical heterogeneity is similar to that observed in tax evasion and tax cheating papers (Chetty, Friedman, and Saez 2013; Boning et al. 2020) and is suggestive of learning networks connected with CEPD administration.

5 Conclusion

This paper shows how heterogeneous responses to loopholes in a CTE funding formula shaped the incidence of the resulting public services. Because wealthier districts with more

23. It is also possible that because of the centralization, ISDs are able to use their 40% funds in ways that enable them to generate more 60% funds.

24. It is worth noting that the estimates are not sufficiently precise to rule out some moderate relationships.

25. In more densely populated regions of the state, CEPDs coincide closely with ISDs. In more rural areas of the state, CEPDs include multiple ISDs.

administrative acumen were more likely to reorganize curricular units around notches in the new funding formula, they were able to gain a greater share of the statewide funding increase. The quantitative results presented above were confirmed by anecdotes from local and state administrators discussing the complexity of the state funding formula and the difficulty that high-poverty and urban districts often have in recruiting and retaining administrative staff required to interact with these systems. We conclude by considering three implications for policy and practice.

At the most general level, these results are important because they demonstrate the importance of both supply-side responses to loopholes for the incidence of public services. Given the extensive understanding that that regulator incentives affect public services as diverse as healthcare, electrical utilities, and education, our results suggest that policymakers should consider not only the potential for adverse incentives but also the distributional consequences that could result from differential responses to these incentives. In this regard our results reinforce understanding from the optimal tax and tax systems literature that behavioral responses can undermine distributional goals and overall tax progressivity (Alstadsæter, Johannesen, and Zucman 2019; Rubolino 2023; Boning et al. 2023). We show how the same considerations are true for the incidence of public goods and services.

Additionally, our paper provides a cautionary tale for education finance, which weaves together complex funding systems to achieve an assortment of goals. Even well designed policies can result in perplexing behavioral responses (e.g., Cullen 2003; Kwak 2010). Furthermore, district responses to the new funding formula illustrates how the discretion can enable local actors to game national reporting standards.[26]

Finally, in regards to supporting CTE, our results also suggest that even when administrators support the objective of increasing CTE concentration rates, doing so is difficult. Districts face a limited supply of trained instructors and both students and schools are relatively unresponsive to changes in labor market demand for skills taught in CTE courses (Carruthers et al. 2023). As such, district administrators may have had little leverage to change these outcomes regardless of the incentive structure.

26. This is not unique to Michigan. The U.S. Department of Education, the primary funder of high school CTE, has left defining "concentrators" up to states, despite using concentration status as a key reporting indicator. See Carruthers et al. 2020 for an example of differences in definitions across select states.

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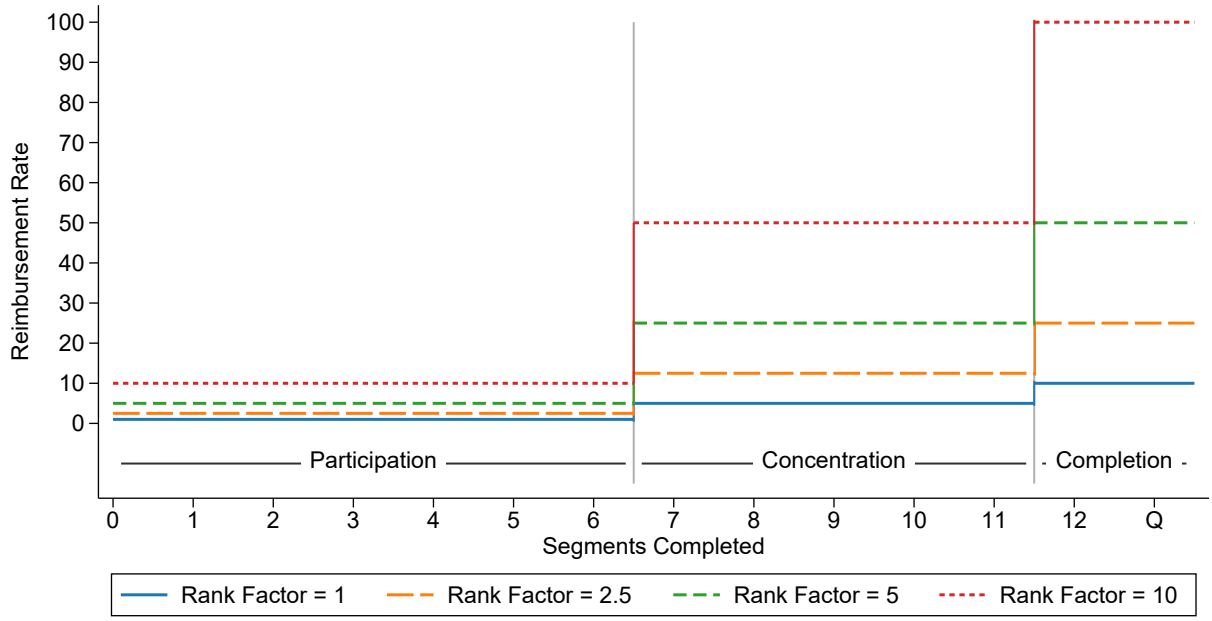
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Appendices

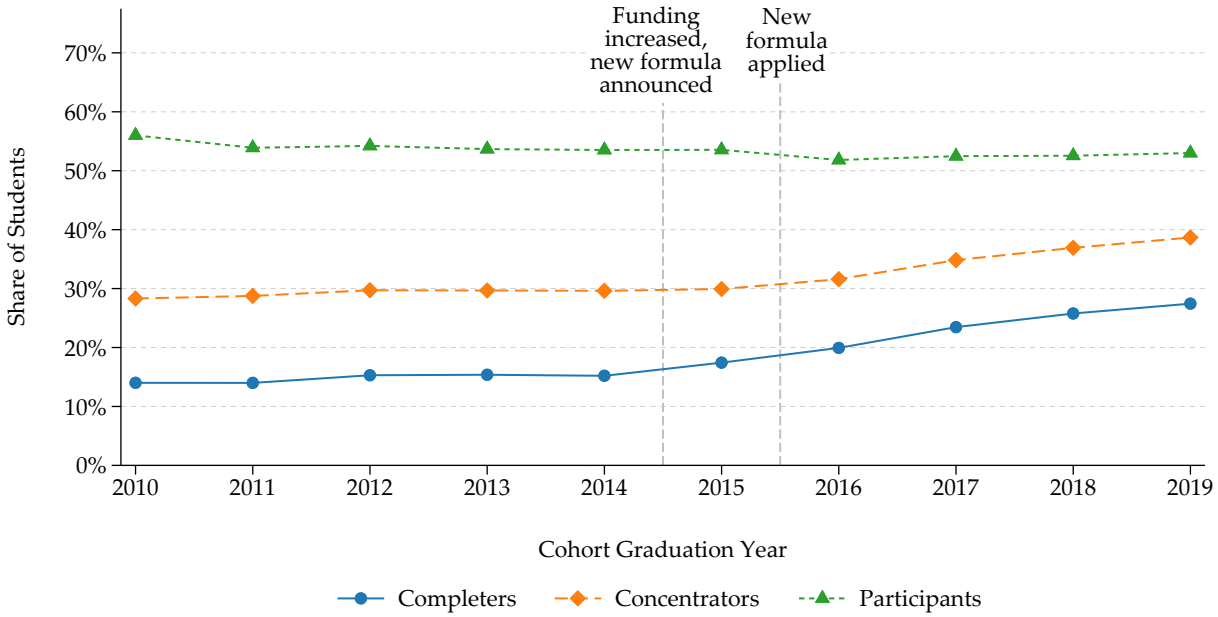
A Tables and Figures

Figure A.1. Notched Incentive Structure of New Funding Formula



Notes. The graph shows the funding reimbursement rates for CTE students after the new funding formula was introduced in SY 2015-16. The reimbursement rate is determined by the number of segments a student completes, the state rank factor, and the program cost factor, leading to a notched incentive structure. See Appendix B for more detail.

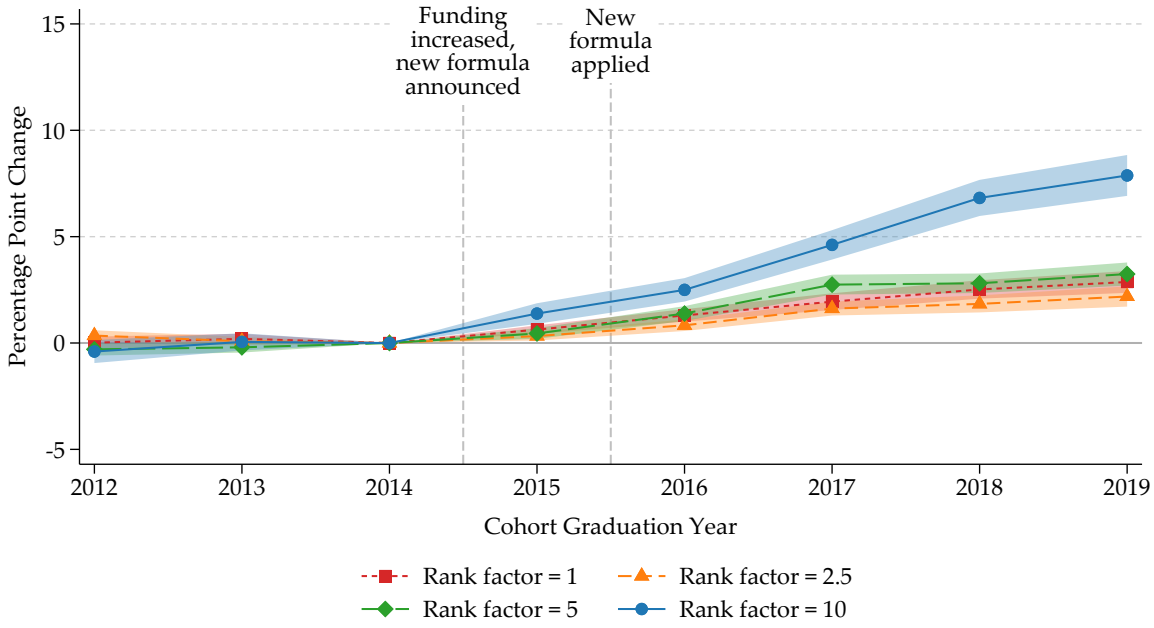
Figure A.2. Student Advancement Through Michigan CTE Programs by Cohort Graduation Year



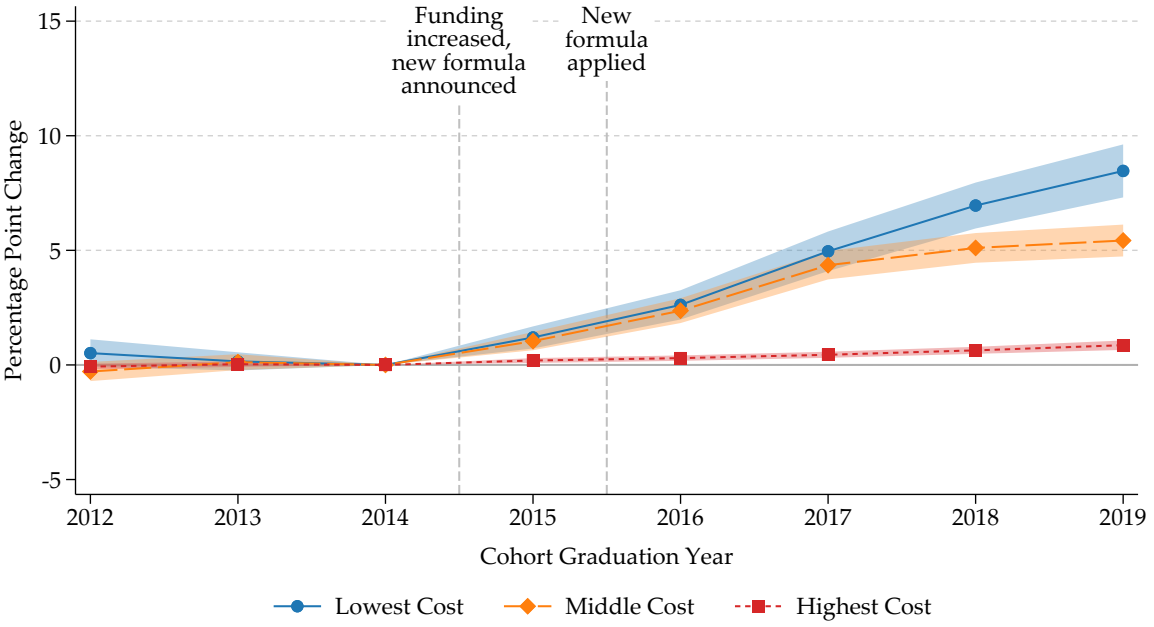
Notes. The cohort graduation year refers to spring of the school year in which a ninth-grade cohort would be expected to graduate on-time from high school. Michigan defines 12 segments, or groupings of content standards, for each CTE program of study. Completers earned all 12 segments in a CTE program, concentrators earned at least seven segments, and participants earned at least one segment.

Figure A.3. Completion Increases Most in Low-Cost and High-Reimbursement Programs

(a) By Reimbursement Rank



(b) By Average Program Cost



Note: This figure shows the changes in completion rates separately by program reimbursement rank and porgram costs. Panel (a) shows results by reimbursment rank factor. Completers in programs with a rank factor of 10 are reimbursed 10x more than programs with a rank factor of 1. Panel (b) separates programs by terciles of average costs.

B Added-Cost Funding for CTE Programs in Michigan

CTE in Michigan is funded by federal, state, and, in some cases, local dollars. State funding includes the basic foundation allowance that funds all public schools.[27] It also includes funds intended to defray the additional costs incurred in offering CTE programs (totalling $37 million in 2016). Federal funds under Perkins IV were allocated based on Michigan's share of the national population of children, its share of children with family incomes below poverty, and its share of children who were enrolled in public and private nonprofit secondary schools ($52 million). Additionally, about half of the municipalities statewide impose an additional local property tax to support CTE in their schools.

The state appropriates funds to cover the added-cost of operating CTE programs through Section 61a of the State Aid Act. The added-cost funds have typically been divided into two portions. The first portion, amounting to 60% of added-cost funds, is allocated to local fiscal agencies using (among other data components) a state ranking of CTE programs. The second portion, accounting for the remaining 40% of funds, is divided among Career Education Planning Districts (CEPDs), local CTE administrative units. In 2014, the state began planning for a new added-cost funding formula. Details of the proposed changes were shared with regional administrators in the fall of 2014 and the changes were signed into law in June 2015. Funding for school year (SY) 2015-16 was based on the former formula (using enrollment form 2014-15). In December 2015, OCTE distributed a funding simulation to administrators that compared funds based on the new formula to the actual SY 2015-16 amounts. Beginning in SY 2016-17, the state adopted the new added-cost funding formula (using enrollment form 2015-16).

B.1 The 60% Formula-Based Funds

Before the funding formula change, the 60% portion of added-cost funds was allocated among fiscal agencies (usually districts or ISDs) based primarily on three data components: student hours, a program-specific added-cost factor (i.e., a reimbursement rate), and a state rank list. The definition of a student hour was one student enrolled in one hour of CTE instruction per day, five days per week, for an entire year. This feature was cumbersome to report and resulted in audits and *ex-post* funding adjustments. The added-cost factor, which was capped at $400 per student hour, was based on a two-year average of statewide CTE and non-CTE median costs. For each program, the total student hours

27. State revenues used to fund CTE include taxes on property, commercial sales, corporate and personal income, and the state lottery.

was multiplied by the appropriate added-cost factor to determine the maximum allowable added-cost funding.[28] However, because the 60% portion of added-cost funds was insufficient to fund all programs, a state rank list was used to prioritize programs to be funded. The state rank list was based on employment opportunity data, median wage data, and program completer placements in related careers or postsecondary education; it was updated approximately every four years. The 60% portion of added-cost funds was allocated to programs according beginning with the most highly ranked and continuing down the state rank list, until funds were depleted.

Appendix Table B1 shows how the 60% portion of added-cost funds was allocated. Columns 1 and 2 show the allocation in SY 2013-14 before the funding formula change was announced. Each program was ranked according to the state rank list, with Business the highest ranked program. The top six ranked programs were fully funded and the seventh ranked program (Finance) was partially funded at 72% of its maximum allowable added-cost funding. Since the 60% portion of added-cost funds was depleted after funding the seven top-ranked programs, lower ranked programs were not funded with this portion of added-cost funds.

Under the changes to the funding formula in SY 2016-17, the 60% portion of added-cost funds was allocated based on student advancement, program cost factors, and the state rank list. Importantly, student hours was no longer included as a component in the formula. Instead, student advancement gave each student a higher weight the further they progressed through a program. Michigan characterized student progress was based on segments: participants or enrollees (fewer than seven segments), concentrators (seven to eleven segments), or completers (who passed courses that covered all twelve segments). Note that earning credit for a segment required earning at least a 2.0 GPA in the associated course. In the funding formula enrollees were assigned a weight of 1, concentrators a weight of 5, and completers a weight of 10. For each program, the 60% portion of added-cost funds was allocated via the following formula:

$$\text{Program Value}_{60\%} = (E + 5N + 10C) * M * R \tag{1}$$

where E, N, and C are the number of enrollees, concentrators, and completers respectively,

28. This statement ignores additional requirements specified for the complete formula. An enrollment reimbursement limit of 22 students per teacher applied at the course-section level, with the limit raised to 30 students per teacher for the Parenthood Education program. The Coop-Capstone program had a modified formula and reimbursement rate. Additionally, added-cost funds could not exceed 75% of the "added" cost of the program; the difference between the added-cost funds received and the total added costs was required to be paid by the local fiscal agency. There was also a spending requirement: at least 90% of added-cost funds received had to be used to support program improvement.

$M \in \{1, 5, 10\}$ is the program cost factor, and $R \in \{1, 2.5, 5, 10\}$ is the state rank factor. In the revised formula the program cost factor is based on terciles of average program costs. The rank factor is based off of a similar ordered list based on economic considerations as before the funding formula change. However, rather than fully funding programs in the order of the state rank list, the funding formula change the top 20 programs on the state rank list were funded proportionately to their program value as calculated in Equation 1. The new system gave the top seven programs a reimbursement rate of 10, the second seven a reimbursement rate of 5, and the next six a reimbursement rate of 2.5. Programs outside of the top 20 ranked programs had a reimbursement rate of 1 and received no 60% funds, but they could still receive some funding from the 40% portion.[29]

Appendix Table B2 shows the components that were entered into Equation 1 to calculate added-cost funding for the 60% portion of funds in SY 2016-17. The top seven ranked programs received a state rank factor of 10, programs ranked eight to 14 received a factor of 5, and programs ranked 15 to 20 received a factor of 2.5. Only two programs that were ranked in the top 20 programs on the state rank list received the maximum cost factor of 10: Mechatronics and Electrician/Power Transformer Installer. A further 14 programs received a cost factor of 10 but were ranked outside the top 20 programs by the state rank list and thus were ineligible to receive the 60% portion of added-cost funds. Therapeutic Services and Construction Trades received the highest funding from the 60% portion of added-cost funds after the funding formula change. Note that this includes both mechanical changes from reimbursements and the behvaioral changes of increase completion. Therapeutic Services in particular benefited from a high proportion of students completing the program. These patterns explain the increase in concentration and completion in high-rank, but low cost programs documented in Figure A.3.

In addition to changing how programs were funded, note that Michigan also increased the funding it provided for CTE by roughly $10 million the year before the funding change. But column 5 of Appendix Table 1 reveals that not all programs of study benefited proportionally by presenting the difference in the 60% portion of added-cost funds between SY 2013-14 (column 2) and SY 2016-17 (column 4). The funding formula change led to a drop in added-cost funding from the 60% portion of funds for the Business, Marketing, and Finance programs. Only programs ranked highly on the state rank list before the formula change experienced a drop in funding after the change. Fourteen programs started to receive some of the 60% portion of added-cost funds after the formula change, compared to receiving no funds from the 60% portion before the change.

29. Non-top 20 programs could receive 40% funding if the program was selected by the CEPD administrator for funding.

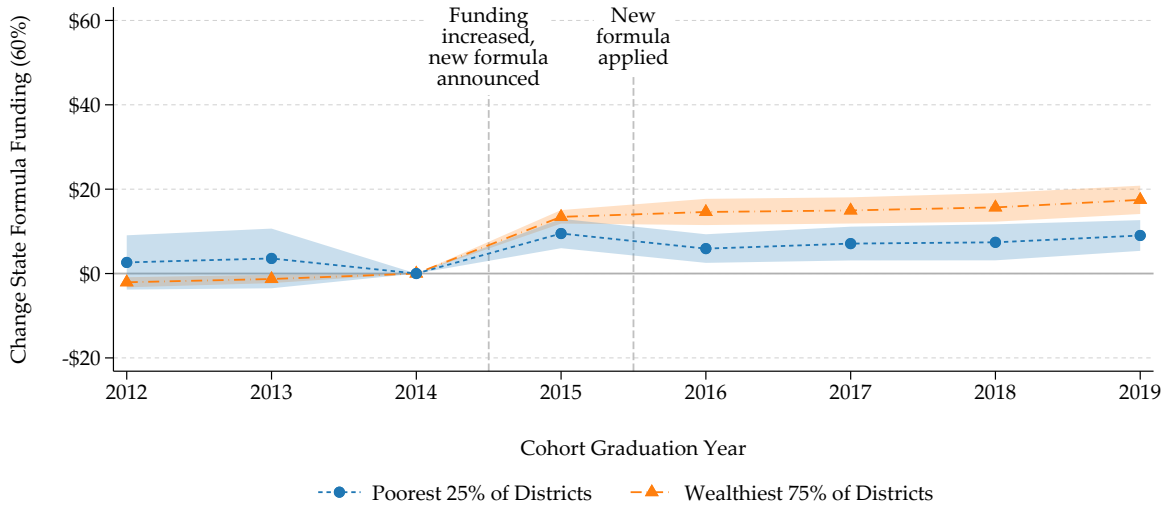
B.2 The 40% Discretionary Funds

The second portion of added-cost funds comprises the remaining 40% of appropriated Section 61a funds. Before the funding formula change, the 40% portion of funds was divided among regions according to the regional share of the state's students and of total student hours (reimbursed at the full-funded level).[30] Each regional administrator ranked their CTE programs in the desired priority order for funding, and the region's share of the 40% portion of added-cost funds was divided among the preferred programs.

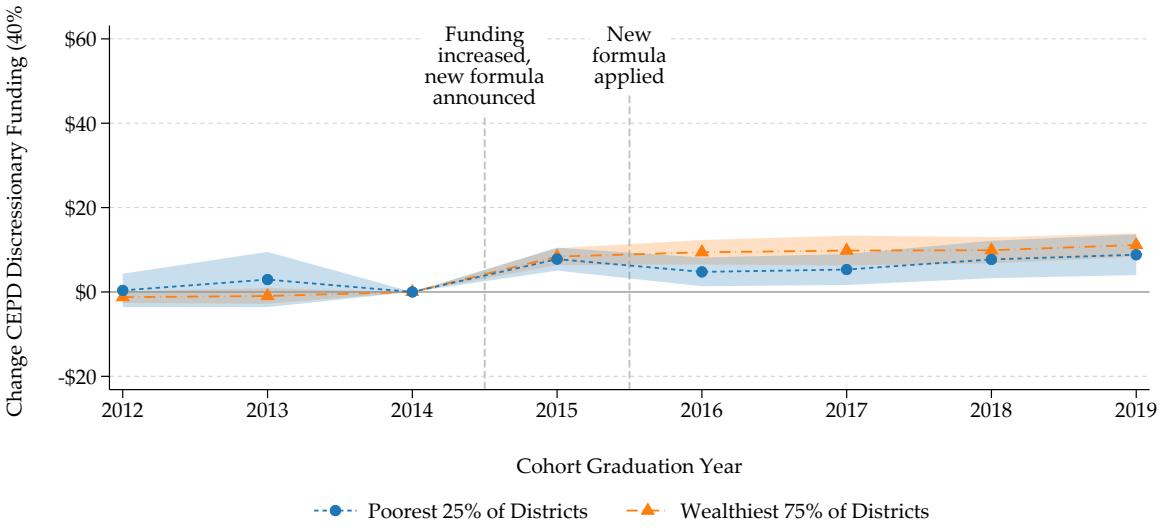
After the funding formula change, the 40% portion of funds was divided among regions according to the regional share of the state's total number of concentrators and completers. As before, each regional administrator selected programs they wished to receive a share of the 40% portion. The formula used to distribute the funds among the selected programs was identical to Equation 1, with the state rank list excluded as a formula component (i.e., R set to 1). The distribution of the 40% portion among CTE programs under the new formula in SY 2016-17 is shown in Appendix Table 2. Most programs that were not included in the top 20 ranked programs on the state rank list, and thus ineligible to receive any of the 60% portion of added-cost funds, did receive some funding from the 40% portion. However, Therapeutic Services, which received the highest share of the 60% portion of added-cost funds, also received the highest share of the 40% portion of funds. The second-highest share of 40% funds was allocated to the Collision Repair Technician program, which was ranked 24th on the state rank list and was thus ineligible to receive a share of funding from the 60% portion of added-cost funds.

30. These two features had equal weights: 50% on total number of 9-12 students and 50% based on CTE students.

Figure B.1. Reductions are Driven by State Formula Funding



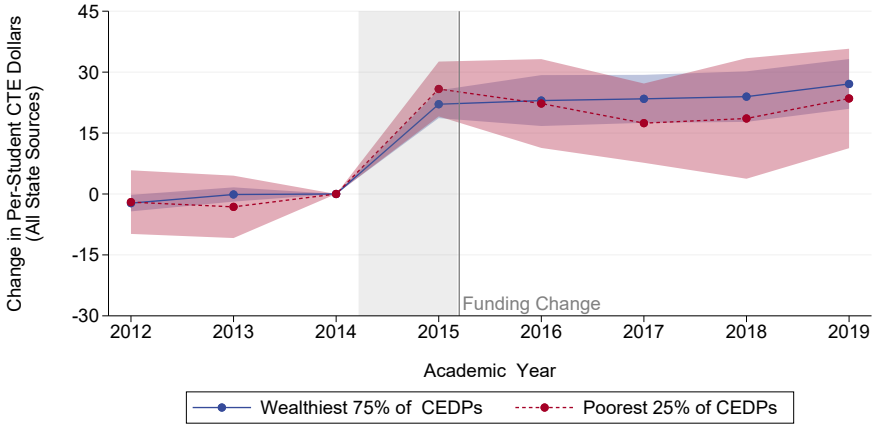
(a) State Formula Funding



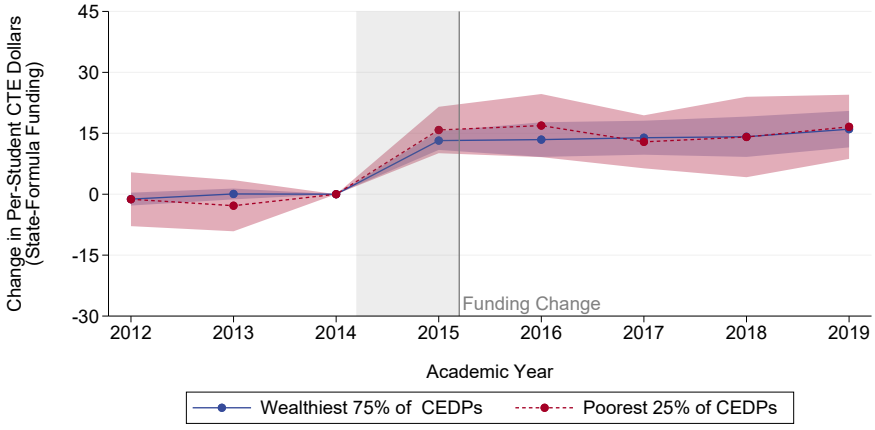
(b) CEPD Discretionary Funding

Note: This figure shows the changes in funding separately by source as described in Appendix B.

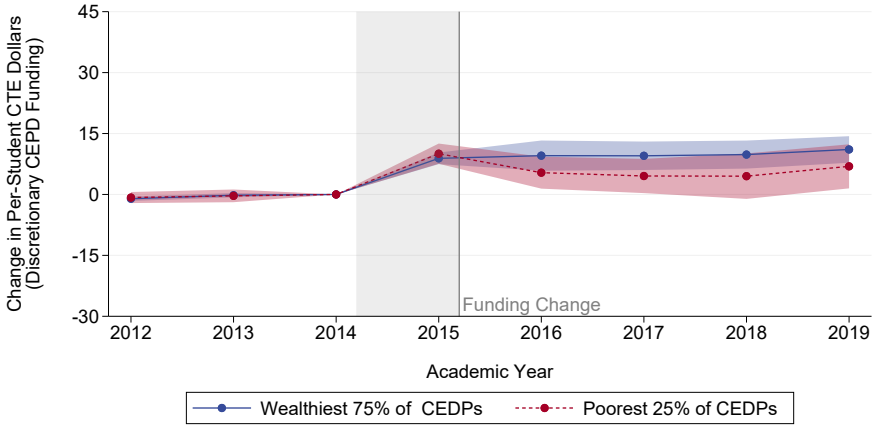
Figure B.2. CEPD-Level Event Study Results



(a) All Funds



(b) Formula Funds



(c) Discretionary Funds

Note: This figure shows the per pupil expenditures split by CEPD-level poverty quartile. Panel (a) shows all funds, Panel (b) shows Formula funds, and Panel (c) shows discressionary funds.

Table B.1. CTE Added-Cost Funding (60% Portion) Before and After the Funding Formula Change

		Before Change (SY14)		After Change (SY17)		
Program Name	CIP Code	State Rank	Funding ($)	State Rank	Funding ($)	Funding Diff. ($)
Business Admin Mgt & Operations	52.0299	1	3,173,712	5	1,294,506	-1,879,207
Marketing Sales and Services	52.1999	2	2,560,610	1	1,676,289	-884,320
Therapeutic Services	51.0000	3	4,912,879	4	7,931,695	3,018,816
Computer Syst Networking & Telecom	11.0901	4	750,675	8	381,877	-368,798
Construction Trades	46.0000	5	2,704,264	7	2,916,739	212,475
Child & Custodial Care Services	19.0700	6	296,846			
Finance & Financial Mgt Services	52.0800	7	1,065,504	10	372,374	-693,129
Education General	13.0000	8	0	11	714,837	714,837
Systems Administration/Administrator	11.1001	9	0	12	232,787	232,787
Computer Programming/Programmer	11.0201	10	0	6	374,069	374,069
Digital/Multimedia & Info Resources Design	11.0801	11	0	17	112,049	112,049
Public Safety/Protect Services	43.0100	12	0	3	1,254,792	1,254,792
Diagnostic Services	51.1000	13	0	25	0	0
Agriculture, Agric Operations and Related Sci	01.0000	14	0	2	669,815	669,815
Engineering Technology	15.0000	15	0	18	74,671	74,671
Cooking & Related Culinary Arts, General	12.9999	16	0			
Plumbing Technology	46.0503	17	0	22	0	0
Natural Resources and Conservation	03.0000	18	0	34	0	0
Elec/Power Trans Installer	46.0301	19	0	13	129,570	129,570
Automobile Technician (ASE Certified)	47.0604	20	0	15	670,976	670,976
Biotechnology Medical Services	26.0102	21	0	27	0	0
Graphics Communications	10.0301	22	0	26	0	0
Aero/Av/Aerospace Sci & Tech	49.0101	23	0	30	0	0
Electrical/Electronics Equip Installation Repair	47.0101	24	0	40	0	0
Applied Horticulture & Horticultural Operations	01.0601	25	0	37	0	0
Health Informatics	51.0707	26	0	38	0	0
Medium/Heavy Truck Technician (ASE Certified)	47.0613	27	0	32	0	0
Drafting/Design Technology	15.1301	28	0	19	46,520	46520
Machine Tool Technology/Machinist	48.0501	29	0	16	245,168	245,168
Heavy/Industr Equipment Maintenance Tech	47.0399	30	0	21	0	0
Collision Repair Technician (ASE Certified)	47.0603	31	0	24	0	0
Welding Brazing/Soldering	48.0508	32	0	20	377,313	377,313
Agricultural Business & Management	01.0101	33	0			
Biotechnology	26.1201	34	0	43	0	0
Cosmetology	12.0400	35	0	23	0	0
Radio & TV Broadcasting Tech	10.0202	36	0	31	0	0
Heating, AC & Refrigeration	47.0201	37	0	33	0	0
Animal Health and Veterinary Science	01.0903	38	0	41	0	0
Power Plant Tech (Aircraft)	47.0608	39	0	35	0	0
Airframe Technology	47.0607	40	0	42	0	0
Visual & Performing Arts	50.0101	41	0			
Fashion Design	19.0906	42	0	47	0	0
Woodworking General	48.0701	43	0	44	0	0
Army (JROTC)	28.0301	44	0	46	0	0
Insurance	52.1701	45	0	28	0	0
Mechatronics	14.4201	50	0	9	573,143	573,143
Mechanical Drafting	15.1306	51	0	29	0	0
Home Furn Equip Inst & Cons	19.0605	52	0	45	0	0
Small Engine & Rel Equip Repair	47.0606	53	0	39	0	0
Avionics Maintenance Technology	47.0609	54	0	36	0	0
Cooking & Related Culinary Arts, General	12.0500			14	1,437,586	1,437,586
Lineworker	46.0303			48	0	0
Cyber Security and Digital Forensics	11.1003			50	0	0

Table B.2. CTE Added-Cost Funding After the Funding Formula Change (SY 2016-17)

Program Name	CIP Code	State Rank	Rank Factor	Cost Factor	Participants	Concentrators	Completers	60% Funding	40% Funding	Total Funding
Marketing Sales and Services	52.1999	1	10	1	6443	4785	5941	1,676,289	382,261	2,058,550
Agriculture, Agric Operations and Related Sciences	01.0000	2	10	1	3813	2674	1859	669,815	260,357	930,172
Public Safety/Protect Services	43.0100	3	10	5	443	346	1130	1,254,792	307,157	1,561,949
Therapeutic Services	51.0000	4	10	5	2539	1846	7389	7,931,695	1,848,474	9,780,169
Business Admin Mgt & Operations	52.0299	5	10	1	7920	3699	4276	1,294,506	350,230	1,644,736
Computer Programming/Programmer	11.0201	6	10	1	1533	1139	1275	374,069	110,058	484,127
Construction Trades	46.0000	7	10	5	1815	1464	2202	2,916,739	731,686	3,648,425
Computer Syst Networking & Telecom	11.0901	8	5	5	328	330	618	381,877	231,491	613,368
Mechatronics	14.4201	9	5	10	352	348	403	573,143	340,489	913,632
Finance & Financial Mgt Services	52.0800	10	5	1	4547	1837	2606	372,374	194,892	567,267
Education General	13.0000	11	5	5	766	305	1298	714,837	306,587	1,021,424
Systems Administration/Administrator	11.1001	12	5	5	118	145	413	232,787	46,708	279,495
Elec/Power Trans Installer	46.0301	13	5	10	29	23	124	129,570	64,575	194,145
Cooking & Related Culinary Arts, General	12.0500	14	5	5	2802	1332	2210	1,437,586	653,358	2,090,944
Automobile Technician (ASE Certified)	47.0604	15	2.5	5	3056	2245	1457	670,976	972,916	1,643,893
Machine Tool Technology/Machinist	48.0501	16	2.5	5	638	473	755	245,168	306,468	551,636
Digital/Multimedia & Info Resources Design	11.0801	17	2.5	1	2972	1633	1280	112,049	126,829	238,878
Engineering Technology	15.0000	18	2.5	1	1307	735	1097	74,671	95,304	169,975
Drafting/Design Technology	15.1301	19	2.5	1	1013	725	530	46,520	71,961	118,481
Welding Brazing/Soldering	48.0508	20	2.5	5	558	871	1155	377,313	447,527	824,840
Heavy/Industrial Equipment Maintenance Tech	47.0399	21	1	10	182	43	118	0	139,613	139,613
Plumbing Technology	46.0503	22	1	10	7	5	35	0	44,587	44,587
Cosmetology	12.0400	23	1	10	395	417	411	0	925,141	925,141
Collision Repair Technician (ASE Certified)	47.0603	24	1	10	327	313	405	0	1,232,271	1,232,271
Diagnostic Services	51.1000	25	1	10	10	34	133	0	242,471	242,471
Graphics Communications	10.0301	26	1	1	1421	1076	1612	0	591,809	591,809
Biotechnology Medical Sciences	26.0102	27	1	10	33	106	35	0	102,007	102,007
Insurance	52.1701	28	1	5	7	67	40	0	36,414	36,414
Mechanical Drafting	15.1306	29	1	1	1509	1175	1375	0	449,240	449,240
Aero/Av/Aerospace Sci & Tech	49.0101	30	1	10	54	10	113	0	326,394	326,394
Radio & TV Broadcasting Tech	10.0202	31	1	1	1055	959	1272	0	472,806	472,806
Medium/Heavy Truck Technician (ASE Certified)	47.0613	32	1	10	93	124	125	0	207,605	207,605
Heating, AC & Refrigeration	47.0201	33	1	10	36	53	29	0	115,947	115,947
Natural Resources and Conservation	03.0000	34	1	1	141	90	40	0	8,020	8,020
Power Plant Tech (Aircraft)	47.0608	35	1	10	46	13	9	0	123,805	123,805
Avionics Maintenance Technology	47.0609	36	1	10	6	9	20	0	48,817	48,817
Applied Horticulture & Horticultural Operations	01.0601	37	1	10	72	108	116	0	532,425	532,425
Health Informatics	51.0707	38	1	5	4	4	11	0	0	0
Small Engine & Rel Equip Repair	47.0606	39	1	10	165	96	97	0	123,631	123,631
Electrical/Electronics Equip Installation Repair	47.0101	40	1	5	348	178	194	0	309,085	309,085
Animal Health and Veterinary Science	01.0903	41	1	5	181	51	223	0	114,375	114,375
Airframe Technology	47.0607	42	1	5	11	1	16	0	4,757	4,757
Biotechnology Medical Sciences	26.1201	43	1	10	5	3	49	0	33,617	33,617
Woodworking General	48.0701	44	1	1	680	290	504	0	149,397	149,397
Home Furn Equip Inst & Cons	19.0605	45	1	1	66	24	6	0	2,072	2,072
Army (JROTC)	28.0301	46	1	1	497	189	89	0	104,408	104,408
Fashion Design	19.0906	47	1	1	223	105	27	0	24,320	24,320
Lineworker	46.0303	48	1	5	7	5	18	0	10,160	10,160
Family & Consumer Sciences	19.0000	49	1	0	6407	0	0	0	0	0
Cyber Security and Digital Forensics	11.1003	50	1	0	0	2	52	0	0	0

Table B.3. Change in CTE Added-Cost Funding Before and After the Funding Formula Change (SY 2013-14 to SY 2016-17)

Program Name	CIP Code	Change in 60% Portion ($)	Change in 40% Portion ($)	Total Funding Change ($)
Agriculture, Agricultural Operations and Related Sciences	01.0000	669,815	-668,303	1,512
Applied Horticulture and Horticultural Operations	01.0601	0	487,558	487,558
Animal Health & Veterinary Science	01.0903	0	109,404	109,404
Natural Resources and Conservation	03.0000	0	-5,883	-5,883
Radio & TV Broadcasting Technology	10.0202	0	276,859	276,859
Graphics and Printing Technology and Communications	10.0301	0	-73,222	-73,222
Computer Programming/Programmer	11.0201	374,069	-118,665	255,404
Digital/Multimedia and Information Resources Design	11.0801	112,049	-608,265	-496,216
Computer Systems Networking and Telecommunications	11.0901	-368,798	231,491	-137,307
Systems Administrator/Administrator	11.1001	232,787	-137,132	95,655
Cosmetology	12.0400	0	805,924	805,924
Education General	13.0000	714,837	86,685	801,522
Mechatronics	14.4201	573,143	276,322	849,465
Engineering Technology	15.0000	74,671	-283,697	-209,026
Drafting and Design Technology	15.1301	46,520	-363,882	-317,362
Mechanical Drafting	15.1306	0	24,713	24,713
Home Furnishings Equipment Installers and Consultants	19.0605	0	2,072	2,072
Fashion Design	19.0906	0	21,411	21,411
Biotechnology Medical Services	26.0102	0	89,757	89,757
Biotechnology	26.1201	0	16,397	16,397
Army (JROTC)	28.0301	0	42,913	42,913
Public Safety/Protective Services	43.0100	1,254,792	-464,059	790,733
Construction Trades	46.0000	212,475	731,686	944,161
Electrical and Power Transmission Installation	46.0301	129,570	35,322	164,892
Plumbing Technology	46.0503	0	44,587	44,587
Electrical/Electronics Equipment Installation and Repair	47.0101	0	130,492	130,492
Heating, Air Conditioning, Ventilation and Refrigeration	47.0201	0	115,947	115,947
Heavy Industrial Equipment Maintenance Technologies	47.0399	0	125,373	125,373
Collision Repair Technician	47.0603	0	1,084,698	1,084,698
Automotive Technician	47.0604	670,976	-818,278	-147,302
Small Engine & Related Equipment Repair	47.0606	0	101,164	101,164
Airframe Technology	47.0607	0	4,757	4,757
Power Plant Technology (Aircraft)	47.0608	0	123,805	123,805
Avionics Maintenance Technology	47.0609	0	48,817	48,817
Medium/Heavy Truck Technician	47.0613	0	196,148	196,148
Machine Tool Technology/Machinist	48.0501	245,168	108,761	353,929
Welding, Brazing and Soldering	48.0508	377,313	-185,372	191,941
Woodworking General	48.0701	0	100,055	100,055
Aeronautics/Aviation Aerospace Science & Technology	49.0101	0	314,074	314,074
Therapeutic Services	51.0000	3,018,816	1,848,474	4,867,290
Diagnostic Services	51.1000	0	154,294	154,294
Business Administration Management and Operations	52.0299	-1,879,207	350,230	-1,528,977
Finance & Financial Management Services	52.0800	-693,129	-7,840	-700,969
Insurance	52.1701	0	36,414	36,414
Marketing, Sales and Service	52.1999	-884,320	382,261	-502,059

Table B.4. CTE Added-Cost Funding Amount in Michigan by School Year

School year	Added-Cost Funding
2007-08	30,000,000
2008-09	30,000,000
2009-10	27,000,000
2010-11	27,000,000
2011-12	26,611,300
2012-13	26,611,300
2013-14	26,611,300
2014-15	26,611,300
2015-16	36,611,300
2016-17	36,611,300
2017-18	36,611,300
2018-19	36,611,300
2019-20	37,611,300