Does Money Still Matter? Attainment and Earnings Effects of Post-1990 School Finance Reforms

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In two 1992 papers, Card and Krueger used labor market outcomes to study the productivity of school spending. Following their lead, we examine the effects of post-1990 school finance reforms on students' educational attainment and labor market outcomes. Using a state-by-cohort panel design, we find that reforms increased high school completion and college-going, concentrated among Black students and women, and raised annual earnings. The reforms also increased the return to education, particularly for Black students and men, driven by the return to high school.

I. Introduction

The Coleman Report (1966), the first large-scale quantitative analysis of education in the United States, found little relationship between school spending and student achievement. A long line of similar observational studies has confirmed and updated this lack of correlation (for reviews, see Hanushek 1986, 1997, 2006). On the basis of this result, many have argued that school

spending is unproductive, at least at the margin, and that additional resources are not an effective way to increase student achievement (e.g., Burtless 1996; Hanushek 1997; Hanushek and Lindseth 2009).

These arguments were first made at a time when many students in the United States were exposed to shockingly low levels of school resources. The Coleman Report came out just 12 years after the *Brown v. Board of Education* decision and found that "the great majority of American children attend schools that are largely segregated." Two-thirds of Black students attended schools that were more than 90% Black. As of the early 1940s, Black students in the South had class sizes about 25% larger than whites, shorter school terms, and teachers who were paid about 40% less (Card and Krueger 1992b). Although these gaps closed substantially by the mid-1960s, dramatic inequities were at best in the very recent past. It is difficult to believe that reductions in average pupil-teacher ratios from around 60 to around 30, as Card and Krueger (1992b) document for Black students in the South between 1915 and 1966, were not important to improving school quality.

The Coleman Report and its successor studies were purely observational and subject to many potential biases (Krueger 2003). In particular, some of the variation in school resources was surely compensatory: insofar as policy makers directed additional resources to students with greater needs, this would bias the estimated effect of school resources downward.

A major limitation to the use of modern causal inference strategies in the study of education has been a lack of adequate data. Because education has been considered a state responsibility, with little federal role, systems to measure student outcomes have differed wildly across states. This has made it hard to construct credible natural experiments to study the impact of school resources.

Card and Krueger (1992a, 1992b) were among the first to bring a modern approach to causality to the literature on school resources. They brought two important innovations. First, they use labor market outcomes—wages of adult workers—rather than test scores to measure human capital. This is intuitively appealing to economists; there are many ways that tests can fail to capture what schools are actually teaching, but wages capture one of the prime outcomes that higher test scores are meant to enable.[1] Particularly given persistent concerns about bias in tests, it is useful not to need to rely on them to measure differences in educational outcomes of students from different groups. The use of wages as outcomes also enabled Card and Krueger's second innovation: they identify the effects of school resources by examining across-state, over-time differences in educational quality rather than differences among schools or districts. Shifts in state education policy, particularly

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[1] As Card and Krueger (1992a) note, earlier work had consistently found that school quality was positively associated with earnings, if not with test scores. See, e.g., Welch (1966).

those driven by desegregation and civil rights imperatives in the South in the Jim Crow era (the focus of Card and Krueger 1992b), are unlikely to respond endogenously to other determinants of students' human capital, so estimates of the effect of school quality identified from these shifts are more credibly causal than observational estimates at the school or district level.[2] But it was not then possible to use state-level research designs to study academic achievement, as testing regimes are set at the state level and there were no nationally comparable representative data on student test scores.

In contrast to the earlier observational literature, Card and Krueger found that school resources (which they, writing before the modern attention to outcome-based measures of school effectiveness, refer to as "school quality") were productive. Card and Krueger (1992a) found that men who were educated in states with better-resourced schools had higher returns to education than those educated in states that invested less in education, indicating that the additional spending made time spent in school more productive. Card and Krueger (1992b) found that improvements in resources at segregated Black schools in the South led to reductions in the Black-white earnings gap, accounting for 20% of the overall progress on closing this gap between 1960 and 1980.

These papers were enormously controversial (see, e.g., Burtless 1996) but have stood the test of time. The modern education literature no longer attaches much weight to observational, design-free estimates of the effects of school resources, recognizing the potential for substantial biases (Krueger 2003). But state policies offer an opportunity for a causal analysis. Research across a range of literatures has adopted and extended state-level panel data analyses to identify the effects of policies ranging from minimum wages (Cengiz et al. 2019) to safety net programs (Levine and Schanzenbach 2009; Goodman-Bacon 2018; Currie and Duque 2019) to early childhood education (Cascio and Schanzenbach 2013).

A recent literature has extended the state panel strategy to identify the effects of school finance reforms (SFRs) on student outcomes (Card and Payne 2002; Sims 2011; Jackson, Johnson, and Persico 2016; Lafortune, Rothstein, and Schanzenbach 2018). These reforms are designed to achieve more equitable or more adequate distributions of school resources across districts within each state and are often mandated by court orders at the end of long judicial proceedings. This makes the timing of reforms plausibly exogenous with respect to student outcomes, and they can be seen as "natural experiments" that support strong causal interpretations of panel data analyses that exploit this timing. Moreover, in contrast to purely state-level analyses, the

[2] Hanushek, Rivkin, and Taylor (1996) note that there can be omitted variables at the state level as well as at the district level and that in theory the bias could be larger or smaller. They do not provide evidence in support of the view that there is substantial omitted-variables bias in state-level panel analyses, however.

new SFR studies identify the effect of additional resources specifically in high-need districts, where resources are often relatively low prior to the reforms. This means that the treatment effects that they identify are highly policy relevant—they identify the effects of resources spent where and how they would be under the most plausible prospective policy changes.

However, it is not clear that the effects of additional resources at the margins identified by finance reforms, particularly more recent ones, will be as productive as in the period studied by Card and Krueger (1992a, 1992b). Baseline resource levels are much higher today, so if there are declining marginal returns we would expect a lower bang for the buck. Moreover, where in the 1950s and 1960s additional resources in Black schools in the South almost certainly went to hiring more and better teachers, today districts may divert additional resources to noninstructional purposes that may be less productive. These concerns are especially serious for more recent reforms: reforms in the 1970s and 1980s addressed many of the most severe inequities in educational spending, and reforms in the 1990s and 2000s may have occurred on a flatter part of the curve, where potential returns are smaller and opportunities for diversion of resources larger.

In this paper, we extend the new SFR literature to consider the question first taken up by Card and Krueger (1992a, 1992b): do increased school resources lead to better labor market outcomes for the students who are exposed to them? We extend the quasi-experimental strategy of Lafortune, Rothstein, and Schanzenbach (2018) to consider the effect of post-1990 "adequacy"-based reforms on educational attainment, earnings, and returns to education of the affected cohorts. Jackson et al. (2016) found substantial effects of the pre-1990 "equity" reforms on students' adult outcomes. But these may have captured the lowest-hanging fruit, leaving less opportunity for impacts of further spending increases. Our earlier work (Lafortune, Rothstein, and Schanzenbach 2018) found that the post-1990 adequacy reforms led to increases in absolute and relative student achievement in low-income districts within the reforming states. However, although the reforms generally led to increases in total spending, we did not find statistically detectable effects on average achievement in the state. Our turn here to labor market outcomes allows us to use larger samples and gives us more ability to detect state-level effects.[3]

We find that SFRs lead to increases in educational attainment and in mean earnings. These results hold when we consider the full state population, but we generally find larger effects for Black than for white students, consistent with the results from our earlier work that Black students are (somewhat)

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[3] The National Assessment of Educational Progress (NAEP) sample used by Lafortune, Rothstein, and Schanzenbach (2018) is representative at the state and national levels, but because it is a clustered sample with schools as clusters, it may not closely match the population in smaller areas.

disproportionately exposed to increased spending following reforms. We also find some evidence that effects are larger for female students.[4]

Following Card and Krueger (1992a), we examine whether finance reforms led to increases in the return to education. If increased resources translate into more student learning, we might expect this to translate not just into more education but also into higher labor market returns per year of high school education. We estimate state-by-cohort returns to high school graduation, and we find evidence that these increase modestly for cohorts affected by SFRs. These effects are also larger for Black than for white students, but unlike our attainment results these are larger for males than females.

II. School Finance Reforms

Our study examines the impact of what are known as adequacy-based SFRs, implemented since 1990. These represent the most recent of three waves of reforms. The history is important to understanding how our evidence relates to studies of other reforms (e.g., Jackson et al. 2016). We draw on Koski and Hahnel's (2015) more thorough review.

Schools in the United States are a state responsibility. Although the federal government provides some funding, it is under 10% of the total, and the organization of schools is left entirely to the states (US Department of Education 2021). Most states further delegate this responsibility to local school districts. Traditionally, these districts have levied local property taxes that they used to finance their operations. This local funding creates large inequities: districts with large property tax bases can more easily fund themselves, with lower tax rates, than can districts with lower property values. Tax bases correlate, albeit imperfectly, with local income, and historically districts with lower family incomes have spent substantially less than districts with higher incomes.

Beginning in the 1960s, advocates and legal scholars began questioning the local funding of schools, arguing that it creates inequality in access to public services.[5] There have been three waves of challenges to states' school funding systems. The first, brief wave challenged these systems under the federal right to equal protection under the law. This was quickly quashed by the US Supreme Court in *San Antonio Independent School District v. Rodriguez* (411 US 1, 1973), which noted that the US Constitution does not mention education and held that unequal and inadequate school funding did not raise federal constitutional concerns (Sutton 2008).

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[4] The evidence on gender differences in school quality is mixed. Autor et al. (2016) find that males are more sensitive to school quality, as measured by school average test score gains, but Hastings, Kane, and Staiger (2006) and Deming et al. (2014) find that females benefit more from attending their first-choice schools.

[5] Our discussion draws on Koski and Hahnel (2015).

Following *Rodriguez*, the second wave consisted of state court challenges. Many state constitutions contain clauses that guarantee equal access to public services or that require equitable systems of public education. Advocates noted that under local finance, high-tax-base districts could set lower tax rates and nevertheless wind up with more revenues to spend than did their lower-tax-base neighbors. Many courts found this to be unconstitutional and ordered states to adopt more equitable finance systems. In many other states, legislatures voluntarily adopted reforms without court orders. Some states provided state funding to low-tax-base districts (known as flat or variable grants), while others provided partial state matches to attempt to equalize the relationship between the tax rate and the resulting revenues (power equalization).

Equity reforms were highly controversial. There were three lines of criticism. First, some argued, following on the old Coleman Report analysis, that the additional revenues that low-tax-base districts received under these reforms were wasted or at least not productive at raising student achievement.[6] Second, other critics argued that these reforms raised the "local tax price" of public spending, weakening the connection between local tax revenues and local spending and leading voters to choose lower levels of spending overall (Hoxby 2001). This argument drew heavily on the California experience and on a view that there was a causal connection between the California *Serrano v. Priest* decision (5 Cal.3d 584, 1971; 18 Cal.3d 728, 1976; 20 Cal.3d 25, 1977), which mandated a strict form of finance equalization, and the state's Proposition 13, which dramatically reduced the amount of available revenue (Fischel 1989, 1996). Other, more comprehensive studies do not find evidence of this "leveling down" (Corcoran and Evans 2015).

The third line of criticism focused on the emphasis on local property tax bases in these discussions. The size of the tax base varies with things like the composition of local land use, with large tax bases in districts that contain large commercial sectors. As a consequence, it does not correlate very closely with measures of student disadvantage, and reforms aimed at reducing spending gaps between high- and low-tax-base districts may not have led to additional spending in districts serving low-income or Black or Hispanic students (Hanushek 1991).

The third wave of finance reforms built on this idea and focused more specifically on the adequacy of funding in the most disadvantaged school districts. This wave began with the 1989 *Rose v. Council for Better Education* (790 SW 2d 186, Ky 1989) decision in Kentucky. By this time, many of the greatest inequities in school funding had been addressed, and it could be

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[6] Hanushek (1991), e.g., writes that "such added funds [as come from SFRs] will on average be dissipated on things that do not improve student achievement—at least unless other, larger changes are also made" (443).

argued that even low-income districts already had enough resources to provide minimal education quality. The Kentucky Supreme Court concluded, however, that gross inequalities in educational outcomes between high- and low-income districts was prima facie evidence of inadequate resources in the latter. The Kentucky Constitution, like many others, requires an "efficient system" of public schools, and the court ruled that this required that "[e]ach child, *every child* . . . be provided with an equal opportunity to have an adequate education" (emphasis in original). The court held that equal funding was not sufficient and instead ordered the state to provide adequate funding in low-income districts to enable students from those districts to achieve comparable academic and labor market outcomes to those seen elsewhere. The resulting Kentucky Education Reform Act of 1990 (KERA) substantially increased spending in low-income districts (Clark 2003; Flanagan and Murray 2004).

Following KERA, courts in many other states have ruled that their own constitutions also require adequacy in school funding. Unlike the earlier equity reforms, the adequacy-based reforms emphasized spending levels in the most disadvantaged school districts and in many cases aimed to lift spending in these districts above the state average to compensate for the increased costs of educating children from disadvantaged backgrounds. This made them vulnerable to the criticism, even more so than were the earlier equity reforms, that the additional funds were not strictly necessary and would not be used productively.

Lafortune, Rothstein, and Schanzenbach (2018) catalog major SFRs during the adequacy era. They identify 64 reforms in 26 states between 1990 and 2011, of which 39 followed court orders and 25 originated in legislative actions (although often in the shadow of ongoing or future litigation). We rely on the same database here; see Lafortune, Rothstein, and Schanzenbach (2018) for details.

These reforms cumulatively had a large impact. Lafortune, Rothstein, and Schanzenbach (2018) show that in 1990, average spending per pupil in the lowest-income school districts was more than $1,000 lower than in the highest-income districts. Figure 1, reproduced from Lafortune, Rothstein, and Schanzenbach (2018), shows the trend in spending in the one-fifth of districts in each state that have the lowest mean family incomes (labeled Q1) and the one-fifth with the highest family incomes (Q5). It indicates that overall, low-income districts achieved rough parity with high-income districts around 2001. As Lafortune, Rothstein, and Schanzenbach (2018) show, this was driven by the states that had reforms. In these states, the gap was reversed: by the onset of the Great Recession and the resulting state fiscal crisis, average spending per pupil in these states was about $700 higher in the lowest-income than in the highest-income districts. By contrast, in states that did not implement reforms, low-income districts continued to lag well behind their higher-income neighbors.
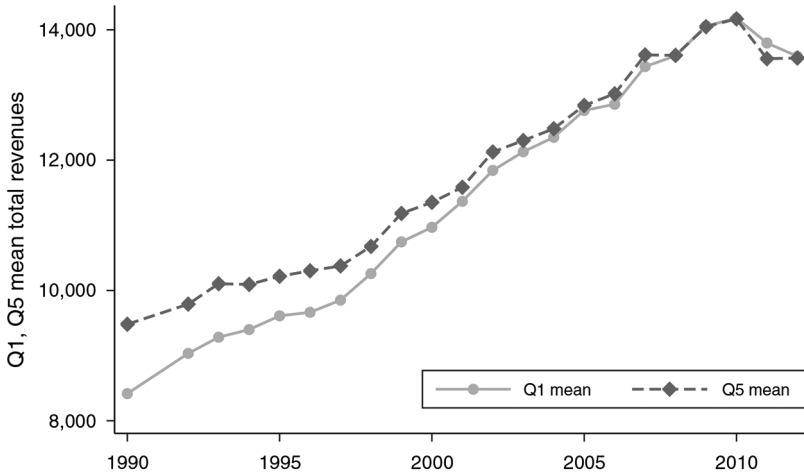
F<small>IG</small>. 1.—Mean revenues per pupil for highest and lowest income school districts, 1990–2012. Reproduced from Lafortune, Rothstein, and Schanzenbach (2018). Highest (lowest) income districts are those in the top (bottom) 20% of their states' district-level distributions of mean household income in 1990 and are labeled as Q5 and Q1, respectively. Revenues are expressed in real 2013 dollars. Districts are averaged within states, weighted by log district enrollment; states are then averaged without weights. Hawaii and the District of Columbia are excluded. A color version of this figure is available online.

Several recent studies have examined the effects of SFRs on student achievement. The two studies most similar to ours are Jackson, Johnson, and Persico (2016) and Lafortune, Rothstein, and Schanzenbach (2018). Jackson et al. study the earlier, equity-oriented reforms and use data from the Panel Study of Income Dynamics to trace students who lived in districts that benefitted from these reforms into adulthood. They find that exposure to a reform raised students' eventual education and earnings and reduced the incidence of adult poverty. Lafortune, Rothstein, and Schanzenbach (2018) use student achievement data from the NAEP to study the shorter-run impacts of post-1990 adequacy reforms on student test scores, finding sizeable increases in absolute and relative achievement in the lowest-income districts. Lafortune, Rothstein, and Schanzenbach (2018) also estimate effects of reforms on state average test scores but do not find statistically significant effects. We extend the Lafortune, Rothstein, and Schanzenbach (2018) research design for the study of post-1990 reforms to examine labor market outcomes, as in Jackson, Johnson, and Persico (2016). As noted earlier, the later reforms occurred in an environment of higher baseline spending levels, amid much criticism of the inefficiency of school spending. It is quite plausible that the large effects that Jackson, Johnson, and Persico (2016) find would be smaller at the margins impacted by later reforms.

III. Data

We use data from the 2000–2018 American Community Survey (ACS), a large, annual, nationally representative survey (Ruggles et al. 2021). We restrict the sample to those born in the United States who were expected to graduate from high school in the years 1992 through 2010, calculated as 13 years after they were expected to start kindergarten (assuming a school entry age cutoff of September 30) and thus including those born in the fourth quarter of 1973 through the third quarter of 1992. We measure educational attainment at age 26 and capture earnings outcomes in early adulthood between ages 26 and 39. We do not observe the state in which an individual attended school and impute this with the state of birth.[7]

Summary statistics are presented in table 1. Overall, the sample is 73% white and half female. On average, individuals have 13.8 years of completed education, and 93% have a high school diploma or more education. Average earnings are approximately $34,000 per year, and 81% have positive earnings. One quarter of the sample was exposed to an SFR, and on average these SFRs occurred 6 years before the individual would have graduated high school. Columns 2 and 3 report separate summary statistics for the white and Black subsamples. Black respondents on average have less completed education, have lower earnings, and are less likely to have positive earnings than whites do. Black respondents are also somewhat less likely to be exposed to an SFR. This is explained by the geographic pattern of SFRs, which are less common in the South. Columns 4 and 5 report statistics separately for males and females. Females have more years of completed education than males do, but they also have lower earnings and are less likely to have positive earnings.

We use the tabulation of major SFRs between 1990 and 2011 compiled by Lafortune, Rothstein, and Schanzenbach (2018), who reconciled and updated earlier tabulations from Corcoran and Evans (2015) and Jackson, Johnson, and Persico (2016). As Lafortune, Rothstein, and Schanzenbach (2018) document, these reforms are widely spread across the United States, in every region except the deep South.

Lafortune, Rothstein, and Schanzenbach's (2018) tabulation includes both court-ordered reforms and those initiated by legislatures, and in many cases it includes several events in the same state. In some cases these represent separate incremental reforms, but more commonly they represent several court orders that culminated in a single reform when the legislature finally complied. When there were multiple events, they were usually closely spaced—60% were three or fewer years apart. Lafortune, Rothstein, and Schanzenbach (2018) describe the empirical selection of a single event in each state that is associated with the largest change in realized school spending. This yields

[7] In the 2000 census, 19.1% of 6–18-year-olds who were born in the United States were living in a state other than their birth state. We exclude individuals born outside the 50 states plus the District of Columbia.

Table 1
Summary Statistics

	Overall (1)	White (2)	Black (3)	Male (4)	Female (5)
White	.73	1.00	.00	.74	.73
Black	.11	.00	1.00	.11	.11
Hispanic	.10	.00	.00	.10	.10
Asian, Pacific Islander	.02	.00	.00	.02	.02
Female	.50	.50	.51	.00	1.00
Potential experience (years)	11.7	11.5	12.4	11.9	11.4
Education (years)	13.8	14.0	13.0	13.5	14.0
High school diploma or more	.93	.94	.86	.91	.94
Some college or more	.69	.72	.55	.63	.74
College graduate or more	.36	.40	.20	.31	.40
Annual earnings ($)	34,060	36,599	21,996	40,172	28,016
Annual earnings (no 0s; $)	42,040	44,224	30,207	47,972	35,768
Average ln(earnings)	10.2	10.3	9.9	10.4	10.1
Earnings >0	.81	.83	.73	.84	.78
% exposed to SFR	.26	.25	.22	.26	.25
Years exposed to SFR if >0	5.91	5.92	5.83	5.93	5.90
Sample size	4,861,552	3,565,537	544,323	2,417,235	2,444,317

SOURCE.—2000–2018 ACS.
NOTE.—The sample includes those born in the United States from birth cohorts with predicted high school graduation between 1992 and 2010. Education outcomes are measured at age 26. Potential experience is defined as age minus education minus 6. Years of exposure to SFR represents the number of years elapsed from the date of the reform to the predicted graduation year, up to a maximum of 13. Sample sizes are for earnings outcomes; samples for education outcomes are smaller.

a list of a single primary SFR in each state, as shown in table A1. We use these for our analysis here.

Some of the reforms in the Lafortune, Rothstein, and Schanzenbach (2018) database included governance, curriculum, or accountability changes in addition to changes in funding formulas. Thus, impacts of the reforms may combine impacts of spending increases with impacts of accompanying policy changes. These are arguably the policy-relevant effects, since policy makers are unlikely to add additional school resources without measures to ensure they are spent well. In any case, Lafortune, Rothstein, and Schanzenbach's (2018) analysis of impacts of these reforms on test scores found little difference in their effects in states that did and did not have strong accountability regimes, suggesting that it is the spending and not the other policies that drive their impacts.

IV. Analytic Approach

To identify the causal effect of SFRs, we leverage variation in the timing of state reforms in an event study framework. The strategy builds on the idea that states without finance reform events in a particular year are a useful counterfactual for states with them, after accounting for fixed differences between the states and for common time effects.

We examine adult outcomes for students in states that implemented SFRs in time for those students to be exposed (i.e., before they graduated high school). We focus on cohorts as the unit of analysis, indexing them by their predicted high school graduation date. We expect that the effect of an SFR on a student's adult outcomes will be larger for a student exposed early in his or her educational career than for a student who is exposed only at the end of his or her time in school. This leads us to expect that any impact on outcomes will develop gradually over time as students have increasing exposure to the SFR.

The first cohort potentially affected by an SFR is the one that graduates in the year following the SFR, but we expect effects to grow for each of the following cohorts. To account for this pattern, we define a measure of years of exposure to the reform: graduating cohort g is exposed to a reform that occurs in year g^* for $(g - g^*)$ years, up to a maximum of 13.[8] Our main estimating equation is

$$E_{isgt} = \alpha_s + \delta_g + \kappa_t + 1(g > g_s^*)\beta^{\text{jump}}$$

$$+ 1(g > g_s^*)\min(13, g - g_s^*)\beta^{\text{yrs\_exposed}} \qquad (1)$$

$$+ (g - g_s^*)\beta^{\text{trend}} + X_{isgt}\gamma + \varepsilon_{isgt}.$$

Here, E_{isgt} is a measure of earnings for individual i from birth state s in predicted high school graduating cohort g in year t. The terms α_s, δ_g, and κ_t represent state of birth, predicted high school graduation cohort, and year effects, respectively.

When we examine educational attainment, we use the same model as a linear probability model, limiting the sample to those aged 26. This makes t and g perfectly collinear ($t = g + 8$), so we omit κ_t. For labor market outcomes, we follow the cohort across multiple ages.

We include in equation (1) three terms measuring the cohort's high school graduation year relative to the state's SFR. These terms are all set to zero in states that did not have a reform. The first parameter, β^{jump}, allows for a discrete change in outcomes after an SFR is enacted. The second, $\beta^{\text{yrs\_exposed}}$, measures the impact of years of the cohort's exposure to the SFR. The third, β^{trend}, is a linear trend variable, which captures preexisting trend differences

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[8] This reflects the fact that students are in school for 13 years, so a reform that occurs more than 13 years before a cohort's graduation year is already in effect when the students start kindergarten. There are very few cases in our sample where $g - g^* > 13$. Following Lafortune, Rothstein, and Schanzenbach (2018), we measure g^* by the calendar year of the reform, where g is indexed by the spring of the academic year. By allowing effects only when $g - g^* > 0$, we rule out the possibility that reforms that take place early in a calendar year can affect outcomes for students graduating that June.

between states that do and do not implement SFRs in a particular year. The vector X_{isgt} includes indicators for the individual's race and gender and the state's annual unemployment rate. In models for earnings outcomes, it also includes linear and squared terms in potential experience (age minus years of education minus 6) as of when the earnings measure is taken.[9] The usual error term is ε_{isgt}. The parameter of interest is $\beta^{yrs\_exposed}$, which captures changes in outcomes that grow linearly with the number of years a high school graduating cohort was exposed to the state's SFR.[10] In some specifications, we replace the three event-time controls with a full set of indicators for the distinct values of $g - g^*$. In these "nonparametric" specifications, we are interested in the pattern of β_{g-g^*} coefficients across positive values of $g - g^*$ as cohorts grow in exposure to the SFR.

In our earlier work (Lafortune, Rothstein, and Schanzenbach 2018), we used district-level data on finances and student test scores, which allowed us to compare districts in the top (Q5) and bottom (Q1) quintiles by average family income in the state. We showed that the exact timing of events is unrelated to trends in spending or achievement (i.e., that the β^{trend} coefficients in specifications like eq. [1] are near zero), consistent with the view that this timing is as good as random and enabling us to interpret the β^{jump} and $\beta^{yrs\_exposed}$ coefficients as causal.

Our main findings from that work are summarized in table 2. We find that after the state's main SFR event occurs, state revenues increase in the bottom quintile by $954 per pupil per year (in 2013 dollars), as shown in panel A. This does not come at the expense of higher-income districts; in the top quintile, districts revenues increase by $351 per pupil per year (not significant, although Lafortune, Rothstein, and Schanzenbach [2018] find significant effects in alternative specifications). Across all districts, average annual state revenues per pupil increase by $672 in response to finance reforms, while relative funding in Q1 versus Q5 districts increases by $606. Although we show only the β^{jump} estimates, the specifications also included $\beta^{yrs\_exposed}$ and β^{trend} parameters; these were near zero for revenue outcomes.

As noted earlier, some have argued that increases in state funding reduce the incentive for districts to raise local revenues (Hoxby 2001) and induce tax revolts that have the effect of reducing overall spending. We do not find that this occurred following the SFRs in our sample. As shown in panel B, total

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[9] Because SFRs affect education, potential experience may be an intermediate outcome of the SFRs. We have also estimated models that use age and age squared, with similar results.

[10] We use predicted high school graduation cohort and consider this an intention-to-treat estimate. Of course, if a student dropped out of high school before the twelfth grade, he or she may actually be exposed to fewer postreform years than we would have predicted, which would attenuate our results. Our results are similarly somewhat attenuated because of our use of reforms in the state of birth in place of the state of residence while in school.

Table 2
SFR Effects on School Finance and Student Test Scores

	Q1 (1)	Q5 (2)	Q1 − Q5 (3)	All Districts (4)
	A. State Revenue per Pupil			
Postevent	954	351	606	672
	(302)	(325)	(231)	(320)
	B. Total Revenue per Pupil			
Postevent	1,164	471	696	839
	(287)	(277)	(243)	(269)
	C. Student Test Scores			
Postevent × years elapsed	.007	−.001	.008	.004
	(.003)	(.003)	(.004)	(.003)

NOTE.—This table reports the coefficient of interest in the three-parameter model in Lafortune, Rothstein, and Schanzenbach (2018). Panel A is drawn from table 3, panel B; panel B is drawn from table 3, panel D; and panel C is drawn from table 5, cols. 3–5, and from table 8. Panels A and B report effects on school finances measured in 2013 dollars per pupil. Panel C reports effects on NAEP z-scores standardized by the mean and standard deviation in the first year of data for the subject and grade.

revenues rose by more than state revenues in both Q1 and Q5 districts, indicating increases in local effort. Total school revenues increase by $839 on average across districts in states that have SFRs.[11] In semiparametric specifications that allow the effect to vary freely by time since the expenditure, Lafortune, Rothstein, and Schanzenbach (2018) find that the increase in funding was not immediate but was phased in fairly quickly, within about 3 years after the date of the reform, and persisted for many years after the reforms.

In panel C of table 2, we reproduce the Lafortune, Rothstein, and Schanzenbach (2018) results for student achievement measured by 1990–2011 fourth- and eighth-grade NAEP math and reading scores—nationally representative tests with a consistent scoring scale across subjects, grades, and years. We standardize NAEP scores to have mean 0 and standard deviation 1 in the first year each test was given in the grade and subject. As we show in our earlier work, there is a trend break, but not a discrete increase, in test scores when SFRs are enacted. Thus, we report here the interaction between the SFR indicator and a trend variable, analogous to $\beta^{\text{yrs\_exposed}}$ in equation (1). We find that for those in the bottom quintile of the income distribution, 10 years after the SFR test scores increase by 0.07 standard deviations, and

[11] Our revenue data exclude funds that do not flow through the district's accounts, such as those raised by parent-teacher associations or local nonprofits that may fund school expenses directly. While there has been growth in this kind of funding over time, it is not quantitatively meaningful relative to the funds included in any but a very few wealthy districts (Nelson and Gazley 2014).

the gap between low- and high-income districts closes by 0.08 standard deviations.

Our earlier work emphasized effects on the relative achievement of students in low-income districts, who were exposed to larger increases in school spending following SFRs than were their peers in higher-income districts. Although we estimated the effect of SFRs on average achievement statewide, the results were imprecise: we estimate that average test scores increased by 0.04 standard deviations 10 years following an SFR, but the standard error on this is 0.03. Note that the increase in average expenditures per pupil in the Q1 districts was about 50% larger than that in the state as a whole, so if additional spending has the same impact across the distribution we would expect the statewide effect on educational production to be only two-thirds as large as in the Q1 districts. (If lower-income students are more sensitive to school expenditures, we would expect an even smaller ratio.) This is well within our confidence interval.

V. Education and Earnings Results

In the ACS data we use for the current analysis, we cannot observe which school district an adult attended. Our analysis of long-run outcomes focuses on average effects across all students in a cohort, as in column 4 of table 2. Fortunately, because of its large sample size the ACS data give us more power for this type of analysis than the NAEP.

We begin by estimating the impact of exposure to a state SFR on education outcomes measured at age 26. Figure 2 and table 3 present results. Each cell of the table represents a separate regression, and we report only the coefficient $\beta^{\text{yrs\_exposed}}$ on the variable of interest, years of exposure to the state's SFR.[12] Other variables controlled include the individual's race and gender (where appropriate), state of residence unemployment rates, fixed effects for state of birth and cohort, a linear control for years relative to the first cohort affected by the SFR, and an indicator variable for whether the individual was in a cohort exposed to any SFR. Figure 2, discussed at greater length below, shows results for the full sample models for high school graduation and college enrollment graphically, with all three of the β coefficients as well as nonparametric models that allow the SFR effect to vary freely with the event time.

SFR exposure increases high school graduation and college enrollment overall, especially for Blacks and females. We would expect SFRs, which affect spending in K–12 schools but do not generally affect state higher education systems, to have their primary effects on high school completion, but perhaps also to affect the share of high school graduates who are prepared to attend college. As shown in panel A, 10 years of exposure to an SFR raises

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[12] Throughout the paper, tables report only the $\beta^{\text{yrs\_exposed}}$ coefficient of interest. Full results are reported in the appendix; the full results for our attainment models are provided in tables A3–A5.

high school graduation rates by 2.0 percentage points and raises the share of students who attend at least some college by 1.4 percentage points. College graduation outcomes are not impacted. Continuous education increases by 0.06 years, but the estimate is not statistically significant.

As shown in panels B and C of table 3, SFRs have larger effects on Black students' outcomes than on those of white students. For Black students, the implied effect after 10 years is a 3.4 percentage point increase in high school graduation and a 6.7 percentage point increase in the likelihood of attending some college. By contrast, effects on each measure are smaller for white students, and only the impact on the likelihood of completing high school is statistically significant.

Panels D and E show that education impacts are also larger for females than males. After a decade, female high school graduation rates increase by 3.2 percentage points, and the likelihood of attending some college increase by 2.5 percentage points. None of the estimates are statistically or substantively significant for males.[13]

Figure 2 displays coefficients from event study regressions, where the dependent variable is an indicator for whether the individual graduated from high school (fig. 2A) or has attended some college (fig. 2B) by age 26. We present several plots following a standard form. The long-dashed line shows the parametric specification from equation (1). The solid line represents estimates from a nonparametric event study specification that does not constrain the phase-in and prior trend effects to be linear. The effects are measured relative to the year of the SFR (which is excluded), and we limit the coefficients to the timeframe between 5 years prior and 12 years after the SFR. Short-dashed lines show pointwise 95% confidence intervals on the nonparametric estimates.

Figure 2A shows the overall impact on high school graduation. There is a slight downward trend in high school graduation rates prior to an SFR, but it is not statistically significant in the parametric or nonparametric specification. Following the reforms, high school graduation rates continue to increase, by 2% by the end of the sample period. Figure 2B shows a similar overall pattern for some college, with a 1% increase in college attendance by the end of the sample period. There is perhaps some indication that effects on high school graduation are larger than the linear specification implies in the first years following a reform, but this is far from statistically significant, and overall the linear form seems to fit quite well. Parallel event study graphs for the Black and female subsamples are shown in figures A1 and A2. These also demonstrate a lack of pretrends as well as stronger positive impacts on educational attainment consistent with table 3.

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[13] This contrasts with Autor et al.'s (2016) finding that male students are more sensitive to school quality than are females, although as noted above evidence on this point is mixed.
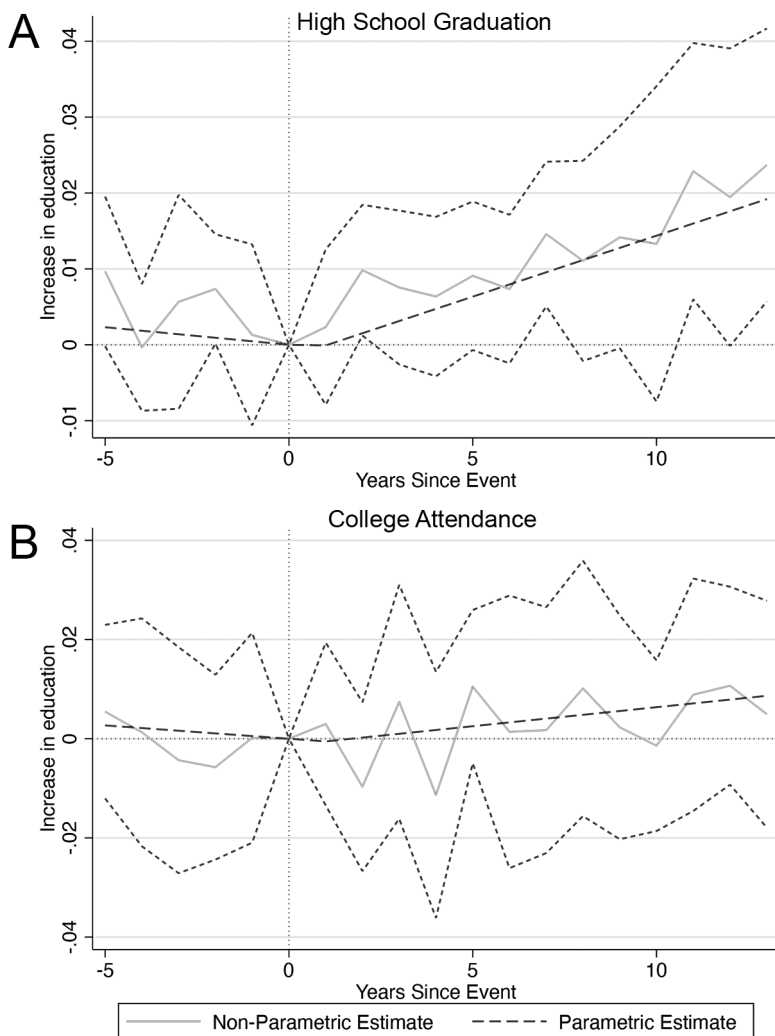
FIG. 2.—*A*, Event study estimate of effects of SFRs on high school graduation. *B*, Event study estimate of effects of SFRs on college attendance. Each panel displays coefficients from event study regressions. The dependent variables are indicators for graduating high school or attending some college by age 26. The long-dashed lines show the three-parameter parametric model (eq. [1]). The solid lines show nonparametric results with the event year (indicated as zero) as the excluded category; short-dashed lines represent 95% confidence intervals. Standard errors are clustered at the state of birth level. In *A*, the *p*-value for the omnibus hypothesis test of zero preevent effects in the nonparametric model is .132; the *p*-value for zero postevent effect is .003. In the parametric model, the preevent trend is –0.000 (SE = 0.000); the postevent jump is –0.002 (SE = 0.004), and the change in trend following the event is 0.002 (SE = 0.001). The *p*-value for the hypothesis that

Table 3
Effects of Exposure to SFRs on Completed Education

	High School Graduation or Higher (1)	Some College or Higher (2)	College Graduate or Higher (3)	Education (Continuous Years) (4)
	A. Overall Population			
Years exposed to SFR	.0020**	.0014*	.0000	.0062
	(.0008)	(.0007)	(.0006)	(.0040)
Observations	456,656	456,656	456,656	456,656
	B. White Respondents Only			
Years exposed to SFR	.0013*	.0013	−.0004	.0020
	(.0007)	(.0009)	(.0008)	(.0033)
Observations	325,297	325,297	325,297	325,297
	C. Black Respondents Only			
Years exposed to SFR	.0034***	.0067**	−.0002	.0160
	(.0012)	(.0033)	(.0021)	(.0105)
Observations	52,211	52,211	52,211	52,211
	D. Male Respondents Only			
Years exposed to SFR	.0008	.0002	.0007	.0062
	(.0008)	(.0011)	(.0009)	(.0047)
Observations	226,598	226,598	226,598	226,598
	E. Female Respondents Only			
Years exposed to SFR	.0032***	.0025**	−.0007	.0060
	(.0010)	(.0010)	(.0008)	(.0053)
Observations	230,058	230,058	230,058	230,058
State of birth fixed effects	X	X	X	X
Cohort fixed effects	X	X	X	X
Demographics	X	X	X	X

Source.—2000–2018 ACS.

Note.—The sample includes 26-year-olds who were born in the United States and were predicted to graduate from high school during the period 1992–2010. Years of exposure to SFR is capped at 13. Reported coefficients represent the impact of the state's main SFR event interacted with time since the reform. Standard errors clustered on the state of birth are in parentheses.

* $p < .10$.
** $p < .05$.
*** $p < .01$.

the postevent jump and change in trend are both zero is .020. In B, the p-value for the omnibus hypothesis test of zero preevent effects in the nonparametric model is .403; the p-value for zero postevent effect is .001. In the parametric model, the preevent trend is 20.001 (SE = 0.001); the postevent jump is 20.001 (SE = 0.005), and the change in trend following the event is 0.001 (SE = 0.001). The p-value for the hypothesis that the postevent jump and change in trend are both zero is .149. A color version of this figure is available online.

Table 4 extends the results to earnings outcomes. We measure annual earnings in inflation-adjusted 2018 dollars, and we include observations on cohorts between ages 26 and 39. In addition to the controls included in table 3, the specifications in this table also include controls for calendar year fixed effects, predicted experience, experience squared, and unemployment rate. SFRs increase a number of earnings outcomes. On average, as shown in panel A, a year's additional exposure to an SFR increases annual earnings by $164 when

Table 4
Effects of Exposure to SFRs on Earnings

	Earnings (1)	Earnings (No 0s) (2)	ln(Earnings) (3)	Positive Earnings (4)
	A. Overall Population			
Years exposed to SFR	164.4**	198.6**	.0036**	.0000
	(65.4)	(82.5)	(.0015)	(.0004)
Observations	4,861,552	3,938,749	3,938,749	4,861,552
	B. White Respondents Only			
Years exposed to SFR	111.9	139.8	.0018	−.0002
	(75.2)	(95.9)	(.0011)	(.0003)
Observations	3,565,537	2,950,794	2,950,794	3,565,537
	C. Black Respondents Only			
Years exposed to SFR	108.2**	118.2**	.0011	.0010**
	(47.1)	(55.5)	(.0019)	(.0004)
Observations	544,323	396,357	396,357	544,323
	D. Male Respondents Only			
Years exposed to SFR	193.2*	207.3*	.0030	.0002
	(98.4)	(114.2)	(.0020)	(.0004)
Observations	2,417,235	2,024,186	2,024,186	2,417,235
	E. Female Respondents Only			
Years exposed to SFR	131.5***	183.6***	.0043***	−.0002
	(43.4)	(55.5)	(.0012)	(.0005)
Observations	2,444,317	1,914,563	1,914,563	2,444,317
State of birth fixed effects	X	X	X	X
Cohort fixed effects	X	X	X	X
Year fixed effects	X	X	X	X
Unemployment rate	X	X	X	X
Experience, exp^2	X	X	X	X
Demographics	X	X	X	X

Source.—2000–2018 ACS.
Note.—The sample includes those aged 26–39 who were born in the United States and were predicted to graduate from high school during the period 1992–2010. Years of exposure to SFR is capped at 13. Reported coefficients represent the impact of the state's main SFR event interacted with time since the reform. Earnings are in 2018 dollars adjusted for inflation using the consumer price index research series using current methods (CPI-U-RS). Standard errors clustered on state of birth are in parentheses.
 * $p < .10$.
 ** $p < .05$.
 *** $p < .01$.

we include in the sample those with zero earnings and by $199 when non-workers are omitted. Log earnings (col. 3) increase by 0.0036, implying a 3.6% increase in earnings for an additional 10 years of exposure relative to the immediate postreform cohorts. We find no impact on the likelihood of having positive earnings (col. 4).

An event study plot of the log earnings model is shown in figure A3. There is a small negative pretrend, although this is only marginally statistically significant. More importantly, the parametric model indicates a statistically significant decline in earnings for the first postpolicy cohort, followed by the increasing trend seen in table 4. Inspection of the nonparametric model suggests that this is driven by a nonlinear pattern in the posttreatment series, with near-zero treatment effects for the first posttreatment cohorts and increases beginning around event time 4. This is consistent with the idea that schools take a few years following SFRs to begin using resources effectively to raise graduates' human capital. When we modify equation (1) to allow for a trend break at event time 4, the immediate postevent decline shrinks and becomes statistically insignificant, the early postreform trend is flat, and there is a strong positive trend after event time 4.

As shown in panels B and C of table 4, impacts on earnings are similar across our Black and white subsamples, although the estimates for the Black subsample are more precise. Each year of exposure to an SFR increases the average Black respondent's earnings by $108 (or by $118 if those with zero earnings are excluded). There is also a statistically significant effect on the likelihood of having positive earnings. For whites, none of the effects are significant, although magnitudes of the earnings estimates are a bit larger.

Panels D and E show results separately for males and females. Both groups have higher earnings when they are exposed to SFRs. Effects are slightly larger for males, but differences between the groups are well within confidence intervals. Point estimates indicate that men's earnings increase by an average of $193 per year of exposure to SFR, while women's increase by $132. However, the log earnings model indicates a 0.0043 increase for women and a smaller, statistically insignificant 0.0030 effect for men. There is no evidence of employment effects for either group.

VI. Impacts on the Returns to Education

Insofar as SFRs lead to increased resources for schools and those resources are used to improve student learning, the rate of student human capital accumulation during school should increase. This means that students who remain in school for longer should benefit more, at least through the end of high school.

To assess this, we follow Card and Krueger (1992a) and examine whether SFRs lead to increases in the labor market return to education. A contrast from their application is that most students in our sample continue in school after high school graduation—67% have some college or more. It is not clear

that higher spending in K–12 schools should lead to increases in the return to college (although we showed above that it does lead to more students being ready to attend college and thus to a higher college-going rate); it is only the return to precollege education that we expect to increase. To assess this, we fit a Mincer-style earnings function, separately for each state and cohort:

$$\ln E_{isgt} = \delta_{sg} + \mathrm{HS}_{isgt}\theta_{sg}^{\mathrm{HS}} + \mathrm{SCol}_{isgt}\theta_{sg}^{\mathrm{SCol}} + \mathrm{BA}_{isgt}\theta_{sg}^{\mathrm{BA}}$$

$$+ \left(t - g - (S_{isgt} - 12)\right)\gamma_{sg}^1 + \left(t - g - (S_{isgt} - 12)\right)^2\gamma_{sg}^2 \quad (2)$$

$$+ Black_{isgt}\pi + Female_{isgt}\rho + u_{isgt}.$$

Here, HS_{isgt}, SCol_{isgt}, and BA_{isgt} are indicators for completing high school, for some college, and for completing college, respectively. These are specified cumulatively: an individual who completes college will have $\mathrm{HS}_{isgt} = \mathrm{SCol}_{isgt} = \mathrm{BA}_{isgt} = 1$. We control for a quadratic in potential labor market experience, $(t - g - (S_{isgt} - 12))$: the number of years elapsed between the cohort's high school completion year (g) and the date that earnings are measured (t), adjusted by the individual's years of education S_{isgt} relative to high school completion. We also include indicator variables for whether the individual is Black or female. We limit the sample to cohorts graduating high school in 2008 or earlier in order to observe enough years of wages for each included cohort.

The θ coefficients represent returns to each level of schooling, relative to stopping at the previous level, while the γ coefficients generate a quadratic return to potential experience. Each is allowed to vary freely across states and cohorts. Note that in this specification the returns to high school are identified from the contrast between those who did not finish high school and those who did, the returns to some college are identified from the contrast between college-goers and high school graduates, and the returns to a BA are identified from the contrast with college-goers who did not complete. Note also that we assign all respondents to their state of birth, s, so immigrants—a disproportionate share of the less-than-high-school population—are excluded. Because there are relatively few high school dropouts in our sample (just 6.3%), our estimates of $\theta_{sg}^{\mathrm{HS}}$ are quite imprecise at the state-by-cohort level.

We expect that SFRs may raise the returns to high school, $\theta_{sg}^{\mathrm{HS}}$, but should not affect the additional returns to college ($\theta_{sg}^{\mathrm{SCol}}$ and $\theta_{sg}^{\mathrm{BA}}$). We assess this by using the $\hat{\theta}_{sg}$ estimates from equation (2) in second-stage regressions akin to equation (1). The specification for the return to high school is thus

$$\hat{\theta}_{sg}^{\mathrm{HS}} = \alpha_s + \delta_g + 1(g > g_s^*)\beta^{\mathrm{jump}} + 1(g > g_s^*)(g - g_s^*)\beta^{\mathrm{yrs\_exposed}}$$

$$+ (g - g_s^*)\beta^{\mathrm{trend}} + \eta_{sg} + \nu_{sg}. \quad (3)$$

To correspond to the earlier analyses, we weight this analysis by the working population in the s-g cell. It is worth noting that the two-step estimator

effectively controls for years of education, themselves impacted by SFRs. We expect that the resulting intermediate outcome problem is small here, as the impact of SFRs on attainment is too small to greatly change the estimated return to education.

The composite error term in equation (3), $\eta_{sg} + \nu_{sg}$, includes sampling error in $\hat{\theta}_{sg}$, $\eta_{sg} \equiv \hat{\theta}_{sg} - \theta_{sg}$, as well as any unmodeled variation across states and cohorts in the return to education. As in other specifications, we cluster at the state level to account for both dependence and heteroskedasticity.

Estimates of equation (3) are displayed in figure 3. This shows a small, statistically insignificant ($p = .74$) decline in the return to high school completion in the years leading up to an SFR. Following the SFR, the return to
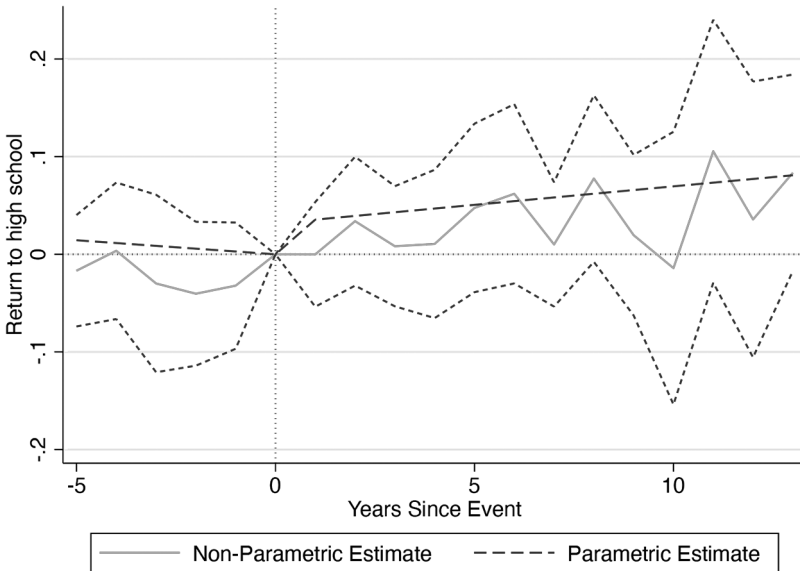

FIG. 3.—Event study estimate of effects of SFRs on return to high school. The graph displays coefficients from event study regressions. The dependent variable is the coefficient on high school graduation in a log earnings regression estimated separately by cohort and state of birth, controlling for some college, college plus, predicted experience and its square, and indicators for Black and female. The long-dashed line shows the three-parameter parametric model (eq. [1]). The solid line shows nonparametric results with the event year (indicated as zero) as the excluded category; short-dashed lines represent 95% confidence intervals. Standard errors are clustered at the state level. The p-value for the omnibus hypothesis test of zero preevent effects in the nonparametric model is .729; the p-value for zero postevent effect is <.001. In the parametric model, the preevent trend is -0.003 (SE $= 0.004$); the postevent jump is 0.032 (SE $= 0.020$), and the change in trend following the event is 0.007 (SE $= 0.004$). The p-value for the hypothesis that the postevent jump and change in trend are both zero is .094. A color version of this figure is available online.

high school increases by 3 percentage points, and the trend also changes, increasing by 0.7 percentage points per year of exposure. This change in trend is marginally statistically significant ($p = .076$), as is the total change following the SFR ($p(\beta^{\text{jump}} = \beta^{\text{yrs\_exposed}} = 0) = .099$). By the 10th year after the SFR, the return to high school graduation has increased by about 10 percentage points relative to the pre-SFR trend. We also overlay on the graph a "nonparametric" set of estimates that allow the effects to vary freely with $(g - g_s^*)$. This also shows a gradual, but nosily estimated, increase in the return to high school following the implementation of an SFR; we can rule

Table 5
Effects of SFRs on Returns to Education

	High School (1)	Some College (2)	College (3)
	A. Overall Population		
Years exposed to SFR	.0067*	−.0004	−.0032
	(.0037)	(.0019)	(.0027)
Observations	826	826	826
	B. White Respondents Only		
Years exposed to SFR	.0107***	.0004	.0005
	(.0033)	(.0023)	(.0025)
Observations	824	824	825
	C. Black Respondents Only		
Years exposed to SFR	.0164**	−.0011	−.0070
	(.0081)	(.0042)	(.0047)
Observations	736	704	706
	D. Male Respondents Only		
Years exposed to SFR	.0120**	.0015	−.0072***
	(.0057)	(.0020)	(.0025)
Observations	826	826	825
	E. Female Respondents Only		
Years exposed to SFR	.0014	−.0019	.0007
	(.0069)	(.0026)	(.0033)
Observations	824	824	825
State of birth fixed effects	X	X	X
Cohort fixed effects	X	X	X

NOTE.—Dependent variables are coefficients on indicators for educational attainment (high school or more, some college or more, and 4-year college degree or more) in a log earnings regression estimated separately by cohort and state of birth, controlling for predicted experience and its square, and indicators for Black and female, aggregated to the state-by-cohort level, for cohorts predicted to graduate from high school during the period 1992–2008. The dependent variable in col. 1 is the coefficient on high school graduate (relative to dropout), in col. 2 it is the coefficient on some college, and in col. 3 it is the coefficient on a college degree; in each case, these are identified from the contrast to the next lower education level. The table presents estimates of the state's main SFR event interacted with time since the reform; other covariates (not shown) include a linear trend, an indicator for post-SFR, and cohort and state of birth fixed effects. Standard errors are clustered at the state level.

out (with $p < .001$) the hypothesis of zero change in the return following the SFR.

We further explore the SFR effect on returns to education in table 5. In addition to estimating the effect of SFRs on returns to high school in column 1, we also show the impact on returns to some college and college ($\theta_{sg}^{\text{SCol}}$ and θ_{sg}^{BA}, respectively) in columns 2 and 3. We view these as placebo tests, as there is no reason to expect that SFRs should increase the productivity of colleges. (Note that in our specification [2], any benefits that college-goers get from improved high schools is captured by θ_{sg}^{HS}.)

As shown in panel A, the returns to high school increase in the years after an SFR. This change is marginally significant. On the other hand, additional returns to some college or college do not vary with SFR exposure. In panels B and C we estimate returns separately for white and Black respondents, reestimating equation (2) by subgroup to obtain state-cohort-race education returns. Returns to high school for both white and Black respondents increase significantly following an SFR, with a larger effect for Blacks. Neither returns to some college nor college vary with SFR exposure, for either whites or Blacks. Panels D and E produce estimates separately for males and females. SFRs raise returns to high school for the male sample only. Recall that earlier we found no changes in male educational attainment but evidence of higher earnings for them. There is an unanticipated negative and significant coefficient on the returns to a bachelor's degree for males; while we do not have a good explanation for this, it (like the null results for returns to college for other subsamples) does suggest that SFRs are not associated with secular increases in the return to education that might bias our estimates of their effects.

Overall, we conclude that there is suggestive evidence that SFRs improve returns to a high school education.

VII. Conclusion

There has been a many-decades debate about whether "money matters" in education—about whether additional resources will lead to improved student outcomes or will be wasted because of inadequate incentives and/or poor management. This debate has largely turned on observational evidence regarding cross-sectional correlations between school resources and student achievement, but these correlations cannot be interpreted as causal.

Alan Krueger was one of the first to bring rigorous causal evidence to this debate. In early work with David Card, he used variation in state spending per pupil between states and over time as a source of variation in school resources that was unlikely to be driven by unobserved student factors that would bias the estimated return to resources. Card and Krueger (1992a, 1992b) found that increased resources translated into increased labor market returns to education and reduced Black-white earnings gaps.

Alan returned to this topic throughout his career. Most notably, he un-
covered a groundbreaking experiment that had been conducted in Tennessee
in which early elementary students were randomly assigned to small or
regular-size classes—a common use of additional school resources is to re-
duce class size—and then tested at the end of each year.[14] He found that
the students randomly assigned to small classes achieved higher test scores
(Krueger 1999) and better schooling outcomes more generally (Krueger
and Whitmore 2001). Smaller classes also narrow the test score gap between
Black and white students (Krueger and Whitmore 2002). Subsequent follow-
up evaluations have also found evidence that smaller classes in the early ele-
mentary grades cause higher educational attainment and earnings (Chetty et al.
2011; Dynarski, Hyman, and Schanzenbach 2013).

As the debate over school resources has continued, policy makers have
made substantial changes. Courts in many states have found that resources
do matter and that states are constitutionally required to adopt funding for-
mulas that provide for more equitable and higher levels of school funding.
Early studies found that equity-based reforms indeed reduced disparities
in school funding (Corcoran and Evans 2015), and Jackson, Johnson, and
Persico (2016) find that students exposed to this increased funding had better
life outcomes—more education, higher earnings, reduced poverty, and bet-
ter health. In earlier work, we found that the more recent adequacy-based
reforms led to higher funding and higher test scores in low-income districts.
Here, we show that that translates into higher educational attainment and
higher earnings, driven in part by an increase in the return to high school
completion. These effects phase in slowly in the years following a reform,
as successive cohorts of students are exposed to the improved levels of school
quality for longer.

It is helpful to compare the magnitude of the earnings impacts of SFRs to
their costs. Lafortune, Rothstein, and Schanzenbach (2018) find that SFRs
raise average spending by $839 per pupil (table 2) and that this increase takes
effect quickly after passage and persists approximately unchanged for many
years thereafter. At a 3% real discount rate, this means that a student who
enters school after the SFR will be exposed to total increased spending over
her schooling career, discounted to kindergarten, of $9,190. We find that stu-
dents exposed to the reforms obtain more education and higher earnings and
that these effects grow with the amount of students' schooling careers that
occurs after the SFR event. In table 4, we find that annual earnings at ages 26–
39 increase by $163 for each additional year that a student was exposed to
the SFR. Multiplying this by 13 for cohorts that entered school after the
SFR, we obtain a total earnings increase of $2,137 per year. Discounting this

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[14] Hanushek and Lindseth (2009) find that the number of teachers per pupil in-
creased by more than 60% from 1960 to 2000. See also Card and Krueger (1992b),
who use class size as a measure of school resources/quality.

to age 5 and summing over ages 26–39 implies a cumulative present discounted value of the earnings increase of $13,367 per student, or a benefit-cost ratio of 1.5 to 1.[15] Moreover, this assumes that earnings benefits evaporate when students turn 40; if we instead assume that they persist at the same real dollar value until age 62, the benefit-cost ratio doubles to 2.9 to 1. This is an extremely high rate of return; that the benefits are likely to be concentrated among students from low-income school districts and families means that the social return calculation is even more positive.

The new quasi-experimental evidence shows consistently that money matters in education. This does not mean that money can be spent with abandon or that it is always a good idea to increase funding. But it does indicate that at the margins we have been at in recent decades and with whatever limitations judges face in ensuring that their orders are carried out intelligently and productively, mandated increases in school funding are used productively and benefit students.

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[15] As noted in sec. V, the parametric model indicates a jump down in earnings following reforms. This is significant in the model for log earnings but not in the model for earnings levels that we use for the cost-benefit analysis. When we include this jump down in our calculation of the effects, the benefit-cost ratio declines to 1.12.

Appendix

FIG. A1.—*A*, Event study estimate of effects of SFRs on high school graduation: Black subsample. *B*, Event study estimate of effects of SFRs on high school graduation: females. The graphs display coefficients from event study regression on the 2000–2018 ACS sample covering those predicted to graduate from high school during the period 1992–2010, limited to Black and female respondents, respectively. In each case, the dependent variable is whether an individual graduated from high school

by age 26. The long-dashed lines show the three-parameter parametric model (eq. [1]). The solid lines show nonparametric results with the event year (indicated as zero) as the excluded category; short-dashed lines represent 95% confidence intervals. Standard errors are clustered at the state level. In A, the p-value for the omnibus hypothesis test of zero preevent effects in the nonparametric model is .141; the p-value for zero postevent effect is <.001. In the parametric model, the preevent trend is -0.002 (SE = 0.001); the postevent jump is 0.006 (SE = 0.013), and the change in trend following the event is 0.004 (SE = 0.001). The p-value for the hypothesis that the postevent jump and change in trend are both zero is .02. In B, the p-value for the omnibus hypothesis test of zero preevent effects in the nonparametric model is .824; the p-value for zero postevent effect is .003. In the parametric model, the preevent trend is -0.001 (SE = 0.000); the postevent jump is 0.001 (SE = 0.004), and the change in trend following the event is 0.003 (SE = 0.001). The p-value for the hypothesis that the postevent jump and change in trend are both zero is .003. A color version of this figure is available online.
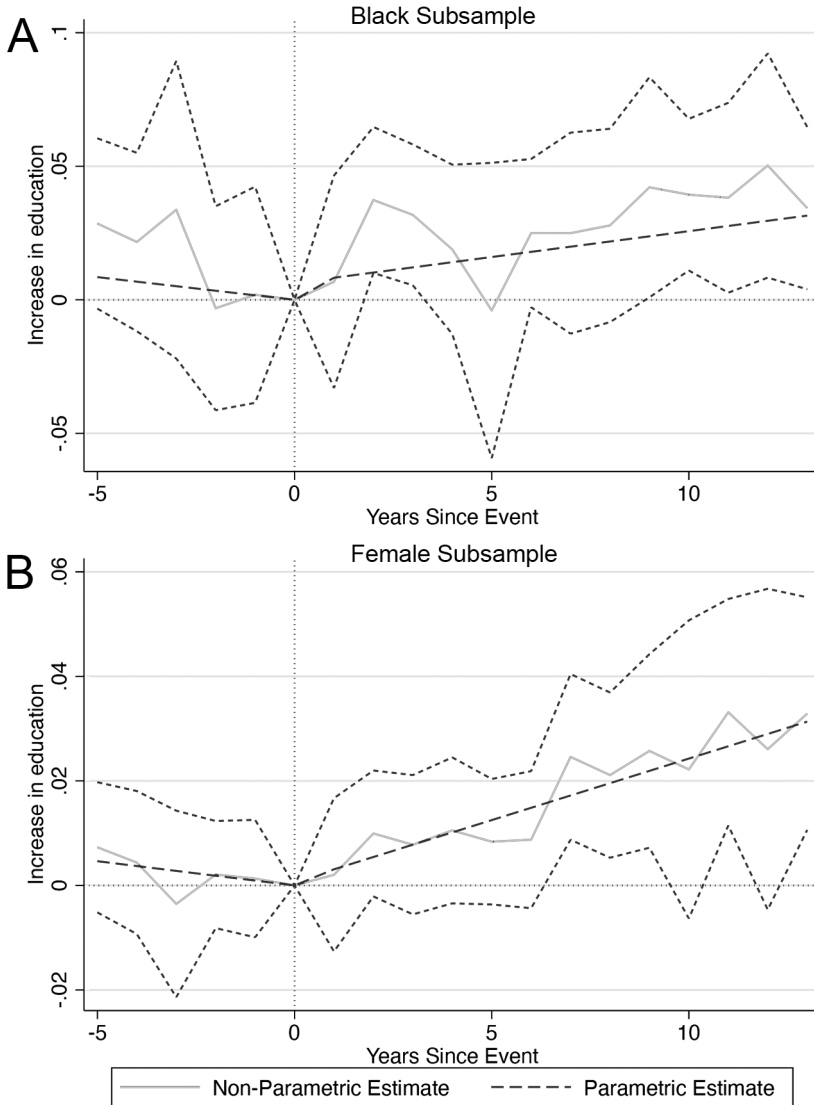
Fig. A2.—A, Event study estimate of effects of SFRs on college attendance: Black subsample. B, Event study estimate of effects of SFRs on college attendance: females. The graphs display coefficients from event study regressions on the 2000–2018 ACS sample covering those predicted to graduate from high school during the period 1992–2010, limited to Black or female respondents, respectively. In each case, the dependent variable is whether an individual graduated from high school by age 26. The long-dashed lines show the three-parameter parametric model (eq. [1]). The solid lines show nonparametric results with the event year (indicated

as zero) as the excluded category; short-dashed lines represent 95% confidence intervals. Standard errors are clustered at the state level. In *A*, the *p*-value for the omnibus hypothesis test of zero preevent effects in the nonparametric model is .294; the *p*-value for zero postevent effect is <.001. In the parametric model, the preevent trend is −0.001 (SE = 0.002); the postevent jump is 0.002 (SE = 0.013), and the change in trend following the event is 0.007 (SE = 0.003). The *p*-value for the hypothesis that the postevent jump and change in trend are both zero is .090. In *B*, the *p*-value for the omnibus hypothesis test of zero preevent effects in the nonparametric model is .384; the *p*-value for zero postevent effect is .007. In the parametric model, the preevent trend is −0.001 (SE = 0.001); the postevent jump is 0.002 (SE = 0.006), and the change in trend following the event is 0.002 (SE = 0.001). The *p*-value for the hypothesis that the postevent jump and change in trend are both zero is .033. A color version of this figure is available online.
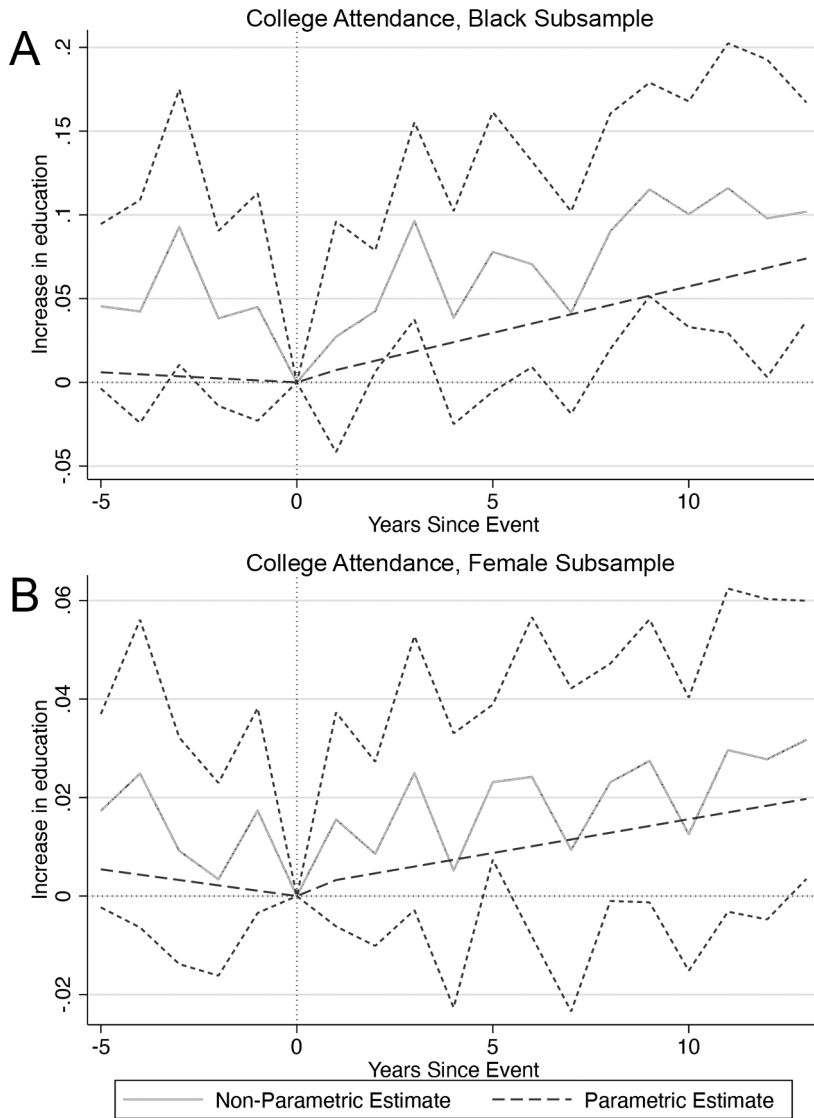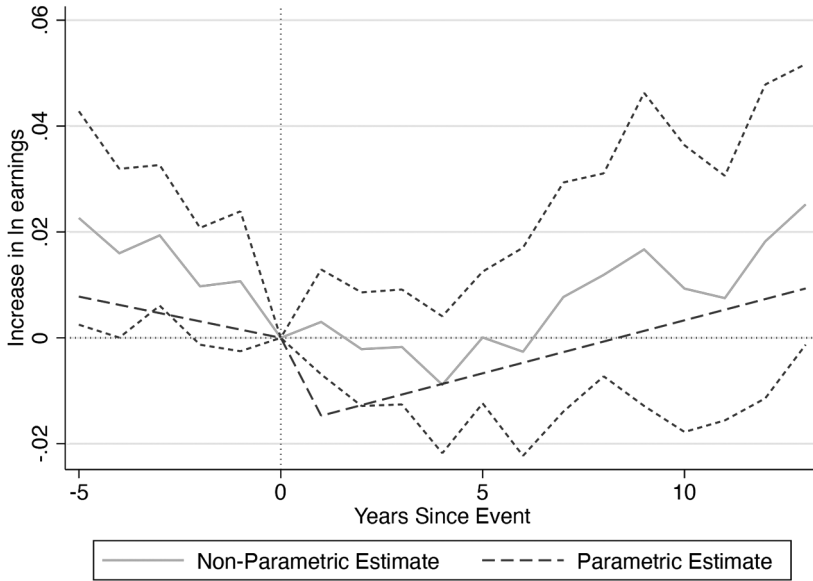
FIG. A3.—Event study estimate of effects of SFRs on log of earnings. The graph displays coefficients from event study regression. The dependent variable is the log of inflation-adjusted annual earnings from ages 26 to 39. The long-dashed line shows the three-parameter parametric model (eq. [1]). The solid line shows nonparametric results with the event year (indicated as zero) as the excluded category; short-dashed lines represent 95% confidence intervals. Standard errors are clustered at the state level. The p-value for the omnibus hypothesis test of zero preevent effects in the non-parametric model is .052; the p-value for zero postevent effect is .007. In the parametric model, the preevent trend is -0.002 (SE $= 0.001$); the postevent jump is -0.017 (SE $= 0.006$), and the change in trend following the event is 0.004 (SE $= 0.001$). The p-value for the hypothesis that the postevent jump and change in trend are both zero is .004. A color version of this figure is available online.

### Table A1
SFRs, by State

State	School Finance Event Year
Alaska	1999
Arizona	1998
Arkansas	2002
California	2004
Colorado	2000
Idaho	1993
Indiana	2011
Kansas	2005
Kentucky	1990

Table A1 (*Continued*)

State	School Finance Event Year
Maryland	2002
Massachusetts	1993
Missouri	1993
Montana	2005
New Hampshire	2008
New Jersey	1998
New Mexico	1999
New York	2006
North Carolina	1997
North Dakota	2007
Ohio	1997
Tennessee	1995
Texas	1992
Vermont	2003
Washington	2010
West Virginia	1995
Wyoming	2001

NOTE.—States without school finance events are Alabama, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois, Iowa, Louisiana, Maine, Michigan, Minnesota, Mississippi, Nebraska, Nevada, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Utah, Virginia, and Wisconsin, plus the District of Columbia.

Table A2
Additional Coefficients for SFR Effects on School Finance and Student Test Scores (Table 2)

	Q1 (1)	Q5 (2)	Q1 − Q5 (3)	All Districts (4)
		A. State Revenue		
Postevent	954	351	606	672
	(302)	(325)	(231)	(320)
Trend	60	72	−10	68
	(50)	(56)	(25)	(50)
Years since SFR	−40	−84	42	−61
	(70)	(61)	(36)	(60)
		B. Total Revenue		
Postevent	1164	471	696	839
	(287)	(277)	(243)	(269)
Trend	16	9	9	9
	(39)	(32)	(24)	(32)
Years since SFR	−11	2	−14	−17
	(70)	(41)	(44)	(52)

NOTE.—This table reports coefficients of the three-parameter model in Lafortune, Rothstein, and Schanzenbach (2018). Panel A is drawn from table 3, panel B; panel B is drawn from table 3, panel D. School finances are measured in 2013 dollars per pupil.

Table A3
Additional Coefficients for Effects of Exposure to SFRs on Completed Education (Table 3)

	High School Graduation or Higher (1)	Some College or Higher (2)	College Graduate or Higher (3)	Education (Continuous Years) (4)
	A. Overall Population			
Years exposed to SFR	.0020**	.0014*	.0000	.0062
	(.0008)	(.0007)	(.0006)	(.0040)
Trend	−.0005	−.0005	−.0002	−.0032
	(.0004)	(.0007)	(.0005)	(.0027)
Post-SFR	−.0015	−.0015	−.0045	−.0306
	(.0037)	(.0054)	(.0060)	(.0346)
Observations	456,656	456,656	456,656	456,656
	B. White Respondents Only			
Years exposed to SFR	.0013*	.0013	−.0004	.0020
	(.0007)	(.0009)	(.0008)	(.0033)
Trend	−.0007	−.0014	−.0004	−.0041
	(.0005)	(.0009)	(.0007)	(.0034)
Post-SFR	−.0016	−.0025	−.0048	−.0313
	(.0032)	(.0064)	(.0072)	(.0315)
Observations	325,297	325,297	325,297	325,297
	C. Black Respondents Only			
Years exposed to SFR	.0034***	.0067**	−.0002	.0160
	(.0012)	(.0033)	(.0021)	(.0105)
Trend	−.0018	−.0012	.0014	−.0029
	(.0014)	(.0020)	(.0014)	(.0055)
Post-SFR	.0077	.0020	.0096	.0502
	(.0131)	(.0130)	(.0108)	(.0547)
Observations	52,211	52,211	52,211	52,211
	D. Male Respondents Only			
Years exposed to SFR	.0008	.0002	.0007	.0062
	(.0008)	(.0011)	(.0009)	(.0047)
Trend	−.0000	.0000	−.0016**	−.0061
	(.0007)	(.0010)	(.0007)	(.0041)
Post-SFR	−.0039	−.0045	−.0051	−.0318
	(.0053)	(.0063)	(.0057)	(.0314)
Observations	226,598	226,598	226,598	226,598
	E. Female Respondents Only			
Years exposed to SFR	.0032***	.0025**	−.0007	.0060
	(.0010)	(.0010)	(.0008)	(.0053)
Trend	−.0009**	−.0011	.0013*	.0002
	(.0004)	(.0008)	(.0007)	(.0027)
Post-SFR	.0009	.0017	−.0040	−.0297
	(.0038)	(.0065)	(.0096)	(.0462)
Observations	230,058	230,058	230,058	230,058

Table A3 (*Continued*)

	High School Graduation or Higher (1)	Some College or Higher (2)	College Graduate or Higher (3)	Education (Continuous Years) (4)
State of birth fixed effects	X	X	X	X
Cohort fixed effects	X	X	X	X
Demographics	X	X	X	X

SOURCE.—2000–2018 ACS.
NOTE.—The sample includes 26-year-olds born in the United States who were predicted to graduate from high school during the period 1992–2010. Years of exposure to SFR is capped at 13. Standard errors clustered on state of birth are in parentheses.
* $p < .10$.
** $p < .05$.
*** $p < .01$.

Table A4
Additional Coefficients for Effects of Exposure to SFRs on Earnings (Table 4)

	Earnings (1)	Earnings (No 0s) (2)	ln(Earnings) (3)	Positive Earnings (4)
	A. Overall Population			
Years exposed to SFR	164.4**	198.6**	.0036**	.0000
	(65.4)	(82.5)	(.0015)	(.0004)
Trend	−103.7*	−129.3*	−.0016	.0001
	(57.4)	(68.0)	(.0011)	(.0003)
Post-SFR	−475.5*	−559.3*	−.0169***	−.0020
	(250.2)	(307.7)	(.0056)	(.0013)
Observations	4,861,552	3,938,749	3,938,749	4,861,552
	B. White Respondents Only			
Years exposed to SFR	111.9	139.8	.0018	−.0002
	(75.2)	(95.9)	(.0011)	(.0003)
Trend	−63.0	−96.8	−.0010	.0004
	(65.8)	(82.6)	(.0010)	(.0003)
Post-SFR	−523.5	−543.4	−.0122*	−.0025
	(328.6)	(390.3)	(.0062)	(.0015)
Observations	3,565,537	2,950,794	2,950,794	3,565,537
	C. Black Respondents Only			
Years exposed to SFR	108.2**	118.2**	.0011	.0010**
	(47.1)	(55.5)	(.0019)	(.0004)
Trend	−103.4**	−104.8*	.0002	−.0005
	(43.9)	(54.1)	(.0017)	(.0005)
Post-SFR	−4.9	−225.8	−.0098	.0019
	(275.7)	(276.7)	(.0117)	(.0039)
Observations	544,323	396,357	396,357	544,323
	D. Male Respondents Only			
Years exposed to SFR	193.2*	207.3*	.0030	.0002
	(98.4)	(114.2)	(.0020)	(.0004)

Table A4 (*Continued*)

	Earnings (1)	Earnings (No 0s) (2)	ln(Earnings) (3)	Positive Earnings (4)
Trend	−128.0	−143.1	−.0012	−.0000
	(78.0)	(86.4)	(.0014)	(.0003)
Post-SFR	−416.8	−455.2	−.0158**	−.0019
	(384.4)	(413.1)	(.0061)	(.0016)
Observations	2,417,235	2,024,186	2,024,186	2,417,235
	E. Female Respondents Only			
Years exposed to SFR	131.5***	183.6***	.0043***	−.0002
	(43.4)	(55.5)	(.0012)	(.0005)
Trend	−77.1*	−108.6**	−.0020*	.0001
	(40.0)	(50.9)	(.0011)	(.0005)
Post-SFR	−487.7***	−652.5**	−.0172**	−.0015
	(164.9)	(253.5)	(.0078)	(.0019)
Observations	2,444,317	1,914,563	1,914,563	2,444,317
State of birth fixed effects	X	X	X	X
Cohort fixed effects	X	X	X	X
Year fixed effects	X	X	X	X
Experience, exp²	X	X	X	X
Demographics	X	X	X	X

SOURCE.—2000–2018 ACS.
NOTE.—The sample includes those aged 26–39 who were born in the United States and were predicted to graduate from high school during the period 1992–2010. Years of exposure to SFR is capped at 13. Earnings are in 2018 dollars adjusted for inflation using the consumer price index research series using current methods (CPI-U-RS). Standard errors clustered on state of birth are in parentheses.
* $p < .10$.
** $p < .05$.
*** $p < .01$.

Table A5
Additional Coefficients for Effects of SFRs on Returns to Education (Table 5)

	High School (1)	Some College (2)	College (3)
	A. Overall Population		
Years exposed to SFR	.0067*	−.0004	−.0032
	(.0037)	(.0019)	(.0027)
Trend	−.0029	−.0026	.0017
	(.0037)	(.0019)	(.0017)
Post-SFR	.0317	.0177	.0072
	(.0197)	(.0106)	(.0095)
Observations	826	826	826

Table A5 (*Continued*)

	High School (1)	Some College (2)	College (3)
	B. White Respondents Only		
Years exposed to SFR	.0107***	.0004	.0005
	(.0033)	(.0023)	(.0025)
Trend	−.0051	−.0020	.0002
	(.0039)	(.0024)	(.0021)
Post-SFR	−.0083	.0266**	−.0004
	(.0232)	(.0120)	(.0106)
Observations	824	824	825
	C. Black Respondents Only		
Years exposed to SFR	.0164**	−.0011	−.0070
	(.0081)	(.0042)	(.0047)
Trend	−.0138*	−.0005	−.0017
	(.0077)	(.0040)	(.0043)
Post-SFR	.1317**	−.0163	.0627**
	(.0611)	(.0325)	(.0257)
Observations	736	704	706
	D. Male Respondents Only		
Years exposed to SFR	.0120**	.0015	−.0072***
	(.0057)	(.0020)	(.0025)
Trend	−.0016	−.0057***	.0045**
	(.0050)	(.0019)	(.0021)
Post-SFR	.0051	.0320**	.0072
	(.0298)	(.0142)	(.0131)
Observations	826	826	825
	E. Female Respondents Only		
Years exposed to SFR	.0014	−.0019	.0007
	(.0069)	(.0026)	(.0033)
Trend	−.0026	.0005	−.0010
	(.0048)	(.0030)	(.0023)
Post-SFR	.0561**	−.0004	.0070
	(.0273)	(.0173)	(.0111)
Observations	824	824	825
State of birth fixed effects	X	X	X
Cohort fixed effects	X	X	X

Note.—Dependent variables are coefficients on indicators for educational attainment (high school or more, some college or more, and 4-year college degree or more) in a log earnings regression estimated separately by cohort and state of birth, controlling for predicted experience and its square, and indicators for Black and female, aggregated to the state-by-cohort level. The dependent variable in col. 1 is the coefficient on high school graduate (relative to dropout), in col. 2 it is the coefficient on some college, and in col. 3 it is the coefficient on a college degree; in each case, these are identified from the contrast to the next lower education level. Standard errors are clustered at the state level.

* $p < .10$.
** $p < .05$.
*** $p < .01$.

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