American Economic Journal: Applied Economics 2023, 15(2): 184–217 https://doi.org/10.1257/app.20200762

Natural Resource Booms, Human Capital, and Earnings: Evidence from Linked Education and Employment Records†

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Using administrative panel data on the universe of Texas public school students, I analyze how shocks to local economic conditions affect education and employment decisions. I find that high school students at the bottom of the academic ability distribution worked and earned more in response to the fracking boom and that these earnings gains persisted through ages 24–25 despite the fact that the same students also became less likely to attend classes and graduate from high school. My results suggest that the opportunity cost of education is large for these students. (*JEL* H75, I21, I26, J24, J31, R23)

High school students face an important trade-off between working today and investing in skills and education that can increase future earnings. Local economic booms can affect this trade-off by leading to higher wages, which increase the opportunity cost of staying in school. Past literature has shown that these improvements in local economic conditions generally lead to lower educational attainment.[1] This can benefit students who choose to work rather than to pursue education through higher earnings in the short run but can potentially hurt these students if reduced educational attainment leads to lower earnings later in life. Whether forgoing education to enter the work force in response to improved local economic conditions ultimately helps or harms students is an empirical question and is likely to depend on student ability. While understanding how economic conditions affect educational attainment decisions has important policy implications, the lack of panel data tracking both education and labor market outcomes for individuals has limited the ability of past work to speak to this question directly.

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†Go to https://doi.org/10.1257/app.20200762 to visit the article page for additional materials and author disclosure statement(s) or to comment in the online discussion forum.

[1] For example, see Black, McKinnish, and Sanders (2005); Edmonds, Pavcnik, and Topalova (2010); Atkin (2016); and Charles, Hurst, and Notowidigdo (2018).

In this paper, I use unique administrative panel data covering the universe of students in the public education system of Texas to analyze how academic performance and labor market outcomes respond to changes in local economic conditions in both the short and long run. My research design exploits the fact that different areas had heterogeneous exposure to the oil and gas fracking boom, which led to plausibly exogenous variation in local labor market conditions. I find that high school students with greater exposure to fracking had better short-run labor market outcomes, but that these came at the expense of worse educational outcomes and that these differences were driven by students at the bottom of the ability distribution. The gains in earnings for these low-ability students relative to their peers in nonfracking areas persist through at least ages 24–25, suggesting that the decision to forgo education does not appear to be harmful to them even later in life.

I begin by showing how the fracking boom had a geographically heterogeneous effect on local economic conditions in Texas. I exploit regional variation in predetermined geological endowments of unconventional oil and gas deposits contained in shale formations. These deposits lie deep below the ground and—until the widespread use of horizontal drilling, hydraulic fracturing, and other techniques, combined with high oil and gas prices in the early 2000s—were considered economically and technologically infeasible to extract. In other words, these resources went from having essentially no real value to becoming extremely valuable in a very short period of time. I use detailed oil and gas data and information on shale reserves to measure geographic variation in fracking exposure. I combine this geographic variation with the timing of the onset of the fracking boom and estimate difference-in-differences and event study models, which allow me to assess the evolution of relative outcomes while controlling for fixed differences across local labor markets and cohorts of students.

As shown in past work such as Feyrer, Mansur, and Sacerdote (2017) and Winters et al. (2019), the benefits of the fracking boom for local labor markets were not confined to the oil and gas sector. The gains in employment and wages in these areas were also found in low-skill service sectors such as construction, hospitality, transportation, and retail services. This created labor market opportunities through higher wages and more job openings, particularly for the types of jobs that would be available for high school students, which would raise the opportunity cost of attending school. To the extent that these benefits were larger for areas with greater exposure to fracking, these areas would be expected to induce more students to substitute employment for education.

To test this question empirically, I use administrative panel data on student education and labor market outcomes from the state of Texas. The data are highly detailed and allow me to track individuals from the time they enter kindergarten through middle school, high school, and college. Furthermore, the educational data are merged with earnings records derived from unemployment insurance files, allowing me to track labor market outcomes for the same individuals. These records cover the universe of more than 20 years of high school cohorts and include rich information about student attendance, performance on standardized tests, college enrollment, graduation, employment, and earnings. These data allow me to track both short- and long-run outcomes to determine whether student decisions to enter the labor force during booms ultimately benefit them and whether these decisions vary across the academic ability distribution.

I find that the fracking boom had a large impact on both educational and labor market outcomes for high school students. In the labor market, outcomes were positive: high school students experienced significant increases in earnings and employment. The magnitudes of these gains were similar for both men and women and were concentrated in the retail and food service industries.[2] This improvement in local labor market conditions increased the opportunity cost of attending school. I estimate that exposure to the fracking boom led to 0.2 percentage point higher absence rates, 1 percentage point higher grade repetition rates, and 1.1 percentage point lower high school graduation rates. However, these numbers mask substantial heterogeneity across the academic skill distribution. Across all of these measures, students at the bottom of the ability distribution—who were also the group that saw the largest increases in employment and earnings—drove the deterioration in overall educational outcomes, while students at the top of the distribution were not affected. These results suggest that students who responded to the fracking boom by substituting work for school were primarily the students closest to the margins of attendance and graduation.

I then link student high school records to administrative college and unemployment insurance records to examine their educational and labor market outcomes in the long run. I show that the earnings gains experienced by students likely to drop out of high school persist through at least ages 24–25 but that they also depend on the economic conditions later in their lives. In particular, the effects on earnings are largest during periods of high oil prices, suggesting that the benefits of forgoing education to enter the workforce depend in part on the expected duration of the boom. However, labor market outcomes for the cohorts at the tail end of the boom were no worse off later in life than those of their counterparts in nonfracking areas despite reductions in educational attainment, suggesting that the decision to invest less in schooling on the part of low-ability students is at least partially justified by improvements in their outside options. Last, I show that the fracking boom is not associated with any significant change in college enrollment, which suggests that the increased high school dropout rates were driven by students who would not have attended college in the absence of the fracking boom. Because the earnings premium for a terminal high school degree is much smaller than for a college degree, this means that these students were forgoing far less income by dropping out than a student likely to go on to college.

While the decision to drop out of high school is likely based on a wide variety of factors, I find that the increased opportunity cost of schooling caused by improved labor markets is the most important mechanism through which the fracking boom affected educational outcomes. I investigate several other potential channels, but ultimately, I find that returns to education and changing school budgets are unable

[2] This is in line with findings from recent literature that does not directly look at students but finds large employment and earnings benefits associated with the fracking boom among workers employed outside the oil and gas industry (Feyrer, Mansur, and Sacerdote 2017; Winters et al. 2019). However, earlier research on the labor market effects of natural resource booms, such as coal booms, found that the direct employment effects were much larger than indirect effects on other industries (Black, McKinnish, and Sanders 2005).

to account for my results. I also show that the main findings are robust to alternative model specifications and assumptions regarding fracking exposure and are not driven by selective migration, since I only focus on the pre-existing student population.

This paper contributes to an extensive literature analyzing the impact of economic and labor market shocks on schooling decisions. These studies consider trade shocks in Mexico (Atkin 2016), infrastructure programs in India (Adukia, Asher, and Novosad 2020), oil price shocks in Canada (Emery, Ferrer, and Green 2012; Morissette, Chan, and Lu 2015), housing bubbles in the United States (Charles, Hurst, and Notowidigdo 2018), and coal booms in Appalachia (Black, McKinnish, and Sanders 2005). My results are consistent with these studies and provide further evidence that improved economic opportunities may lead to reduced educational attainment.

My findings also contribute to the literature analyzing heterogeneity in returns to schooling. Examples include Zimmerman (2014), who analyzes four-year colleges, and Andrews, Li, and Lovenheim (2016) and Mountjoy (2021), who look at community college. My paper builds on this literature in several ways. First, while past work has largely focused on the effects of supply-side factors like admissions, I instead consider the effects of demand-driven changes in educational attainment decisions caused by improved labor market conditions. Second, I focus on the earnings impact of high school, rather than college, attendance decisions. My results suggest that students at the low end of the skill distribution—most of whom are unlikely to ever attend college—experience the largest reduction in educational attainment in response to the fracking boom. However, relative to similar students without exposure to fracking, the same students experience earnings that are higher in the short run and no worse in the long run, which suggests that these are students for whom the financial returns to education are low.

Finally, this paper contributes to a smaller but growing literature on the role of the fracking boom in human capital decisions. This paper is the first to use linked longitudinal K–12, college, and employment data to analyze the effects of a natural resource boom on the entire human capital accumulation process from high school through college and into the workforce. This allows me to extend the existing literature on the contemporaneous effects of fracking on high school students by analyzing postsecondary schooling and longer-term labor market outcomes for the same individuals. My paper is most closely related to the literature studying the educational response to the fracking boom in the United States, which includes Weber (2014); Zuo, Schieffer, and Buck (2019); and Cascio and Narayan (2022). The paper closest to this one is Marchand and Weber (2020), who also analyze the effects of the fracking boom on educational outcomes in Texas. My results confirm most of their findings, including for attendance rates, teacher credentials, earnings, and local finances.[3]

[3] Our papers use different methodologies, measures of fracking activity, and time horizons, which leads to slightly different results for teacher experience and high school completion, but I obtain results that are qualitatively similar when I adjust my methodology to more closely match theirs. A more detailed breakdown comparing our results can be found in online Appendix B.

While previous work mainly focused on educational attainment and enrollment at high levels of geographic aggregation, I observe more detailed measures of human capital such as standardized test scores, absence rates, and grade repetition. Furthermore, I can track individuals throughout high school, college, and the labor market. These outcomes provide a more complete picture of how economic conditions affect students' paths at different stages of their educations. In addition, most prior work examining educational response to the fracking boom had limited information about student mobility over time. This paper overcomes this challenge by studying the universe of students in the public school system of Texas, which lets me distinguish directly between newly arrived migrants and pre-existing student populations. This represents an important improvement on prior work, as it allows me to rule out fixed characteristics of incoming migrant workers and their families from explaining my results.[4] Last, having panel data allows me to determine which types of students were most affected—both in terms of demographic characteristics and prior academic ability—and thus is crucial for policymakers seeking to make informed decisions when evaluating the consequences of fracking. Understanding the role of boom-driven labor market opportunities in student educational attainment decisions can help identify policy responses that may mitigate the potential negative consequences of these decisions.

The rest of the paper is organized as follows. Section I provides background information on the fracking boom. Sections II and III describe the data and research design. Sections IV and V present main results and robustness checks. Section VI discusses potential mechanisms, and Section VII concludes.

I. Background: Fracking Boom

The interaction of technological innovations and increased energy prices fueled massive shale oil and gas booms in the early 2000s.[5] Shale is a sedimentary rock that sits miles beneath the ground and contains large quantities of oil and natural gas. Unlike conventional deposits, which are found in pockets, shale oil and gas are dispersed throughout the formation in thin layers, and therefore conventional vertical drilling is typically not considered to be a feasible method of extracting resources from shales. However, advancements in hydraulic fracturing (known colloquially as "fracking") and directional drilling made it economically and practically feasible to extract resources from previously inaccessible formations. This is done by injecting water, sand, and chemicals at high pressure into a directionally drilled well to create small fractures and release trapped oil and gas. These techniques, combined with high oil and gas prices in the early 2000s, generated localized fracking booms across many areas of the United States.[6]

[4] Existing work, such as Wilson (2022) and others, documents a sizable migration response in the fracking areas.

[5] Other factors that led to the fracking boom in the United States include private land and mineral rights ownership, market structure, favorable geology, water availability, and private entrepreneurship. For a detailed discussion see Wang and Krupnick (2015).

[6] In December 2018 the Energy Information Administration estimated that hydraulically fractured horizontal wells accounted for most new oil and natural gas wells (Today in Energy, EIA: https://www.eia.gov/todayinenergy/detail.php?id=37815).

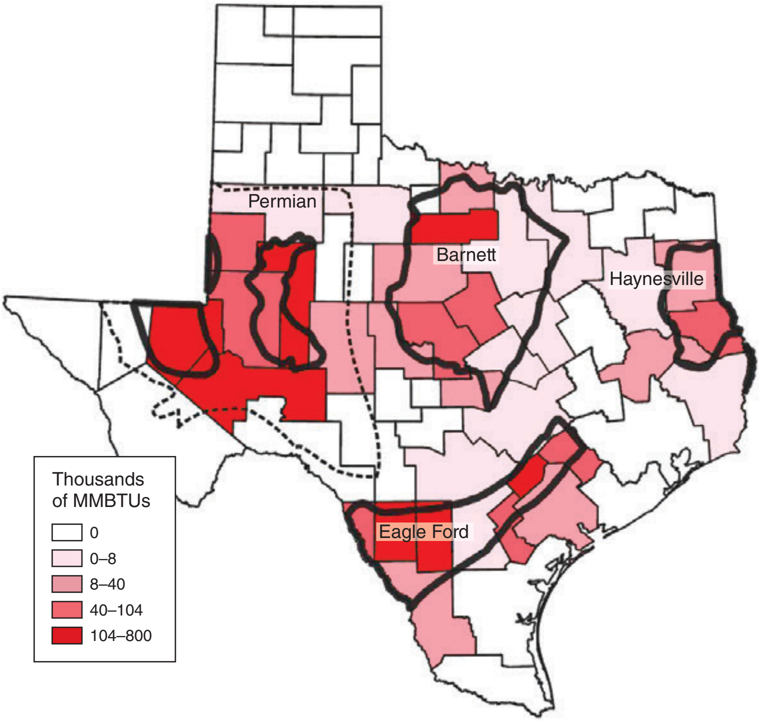

Figure 1. Predicted Shale Oil and Gas Reserves per Capita

Notes: This figure reports predicted shale oil and gas reserves divided by 1995 population for each commuting zone in Texas. Estimates of shale oil and gas reserves were calculated by overlaying shapefiles of shale plays with shapefiles of commuting zones and allocating estimates of play reserves to commuting zones based on the fraction of each play that they contain. The solid lines denote the boundaries of shale plays; the dotted line denotes the Permian basin. The data are from the U.S. Energy Information Administration and the U.S. Census Bureau.

Texas is a major player in the energy market and sits on top of four major shale formations (Figure 1). Due to high prices and new extraction technology, the oil and gas deposits contained in shale formations went from having essentially no real value to becoming extremely valuable in a very short period of time. This resulted in record-high levels of drilling: panel A of online Appendix Figure A.1 shows that the number of new unconventional wells drilled in areas lying on top of shale increased by more than 700 percent by 2014, whereas the number of conventional wells remained stable over the entire period (panel B).[7] Typically, after the wells are drilled and the shale is fractured, the wells are placed into production. As shown in panel C, increased drilling resulted in unprecedented levels of crude oil and natural gas production, which more than tripled between 2008 and 2017.[8]

[7] Following prior research, I count horizontal and directional wells as "unconventional" or as drilled on a shale and vertical wells as "conventional."

[8] Texas generates more than 40 percent of total US crude oil production and has more than one-third of US oil reserves. It is also one of the top natural gas–producing states, holding one-fourth of total gas reserves and generating 30 percent of total US natural gas production (Energy Information Administration 2018).

The oil and gas extraction booms that followed these technological developments had substantial effects on local labor markets both directly, through employment in the oil and gas industry, and indirectly, via spillover effects to other industries such as transportation, construction, trade, and hospitality (Allcott and Keniston 2018; Maniloff and Mastromonaco 2017; Cai, Maguire, and Winters 2019). For example, Feyrer, Mansur, and Sacerdote (2017) estimate that 40 percent of wage income generated by the fracking boom is attributable to workers outside the oil and gas industry. Panel D of online Appendix Figure A.1 shows that the share of workers employed in the oil and gas industry evolved similarly in both shale and nonshale areas of Texas until around the mid-2000s but grew substantially in areas that sit on top of shale starting from around 2005, consistent with the expansion of drilling. Similar patterns are observed in panels E and F, which display employment share in the transportation and wholesale trade industries. Prior work has also documented that labor demand shocks were particularly large for workers with low levels of education. For example, Modestino, Shoag, and Ballance (2016) show that employers cut skill and experience requirements in response to tightening labor markets due to fracking. A more detailed literature review on the labor market effects of fracking can be found in Marchand and Weber (2018).

Because shale resources were inaccessible until very recently, they were unlikely to influence economic development prior to the early 2000s and can plausibly be thought of as being exogenous with respect to local economic conditions up until that point.[9] Furthermore, Texas is a very large state with substantial shale deposits, and the effect of the boom on labor markets was sufficiently large and far-reaching to be visible even for the range of jobs available to high school students. Texas maintains rich data covering the universe of students in the state public school system that allows me to track students from elementary school through college and into the labor market. Together, these factors make this an ideal setting to analyze the effects of shocks to local economic conditions on human capital and earnings.

II. Data

The data used in this project come from several administrative registries maintained by the Texas Education Research Center (ERC).[10] My main sample consists of about 5.3 million individual observations across 21 cohorts of students who attended middle school in Texas and enrolled in high school in the state between 1996 and 2016. I define cohorts by the academic year in which students first entered grade nine, and I associate students with the school district in which they were enrolled in grade six.[11] These records come from the Texas Education Agency (TEA) and include data on student enrollment, attendance, test scores on standardized exams, high school graduation, and demographic information such as gender, age, race, free lunch, and special education status. I link these students to administrative college

[9] In Section III I provide more formal evidence for this assumption.

[10] Access to the data was obtained through a restricted-use agreement with the Texas ERC, a research center and data clearinghouse of the University of Texas at Austin.

[11] In Section V I show that my results are robust if I restrict my sample to students who had lived in Texas since at least elementary school.

enrollment and graduation records maintained by the Texas Higher Education Coordinating Board (THECB). Finally, these data are also matched to quarterly earnings records from the Texas Workforce Commission (TWC) that cover all employees in Texas subject to the state unemployment insurance system.[12]

I consider several academic outcomes. First, I look at high school student absences, grade repetition, and graduation. I calculate absence rates as the ratio of the number of days a student is absent to the total number of days taught. I define a student as a grade repeater if they are enrolled in the same grade or course for two consecutive years during high school. To measure high school graduation for each student, I link their enrollment records in ninth grade with their respective graduation records up to four years later. Second, I use sixth-grade test scores as a proxy for student academic ability in order to examine heterogeneous effects of the boom at different parts of the skill distribution. The test score data come from state standardized exams for mathematics and English.[13] I transform raw scores on each test into z-scores with mean zero and unit standard deviation by cohort.[14] I create a composite score from a student's mathematics and English test scores and then classify each student into quartiles based on their rank in the cohort-specific test score distribution. Last, the ability to link TEA records to postsecondary educational outcomes allows me to analyze the impact of the fracking boom on previously understudied outcomes such as college enrollment and completion. I examine these outcomes separately for community colleges and public four-year universities.

I also consider several labor market outcomes. First, I create a measure of quarterly earnings for each high school student in my main sample at ages 14 to 18. I average and take the natural log of nonmissing quarterly earnings for each student over four years of high school and deflate them by the consumer price index (CPI).[15] I also consider a measure of quarterly earnings that assigns zeros to quarters in which no earnings are observed. Second, I create indicators for being employed overall and split by industry. Finally, I examine earnings six to seven years after expected high school graduation, at roughly ages 24–25, which are the most recent records currently available for most cohorts in my sample.

I supplement education and earnings records with information on oil and gas drilling and production from Enverus, a private company that provides data and analysis to the energy sector.[16] I aggregate well-level records for the daily number of new wells to county-year level. These data can be split by well type (horizontal, directional, vertical, and unknown), and as in prior work, I categorize drilling from horizontal and directional wells as unconventional or produced by fracking (Feyrer, Mansur, and Sacerdote 2017). I use shapefiles of shale plays and estimates of shale

[12] Unemployment insurance records cover employers who pay $1,500 or more in total gross wages in a calendar quarter or have at least one employee during 20 different weeks in a calendar year regardless of the wages.

[13] The Texas Assessment of Academic Skills (TAAS) exam was administered until 2002, when it was replaced by the Texas Assessment of Knowledge and Skills (TAKS) exam. The most recent state exam, the State of Texas Assessments of Academic Readiness (STAAR), was implemented in 2012.

[14] I focus on students' first-time test scores, and I exclude scores of students who were recorded as zero due to illness or cheating or who received a special education waiver or a limited English proficiency exemption.

[15] All earnings are in 2013 US dollars.

[16] I obtained access to the data through a special agreement between Enverus (formerly DrillingInfo) and the University of Texas at Austin.

oil and gas reserves from the Energy Information Administration (EIA), and I incorporate oil and gas production data from the Texas Railroad Commission. Last, I use demographic, economic, and migration data from the U.S. Census Bureau, the Bureau of Labor Statistics, and the Internal Revenue Service (IRS) SOI Tax Stats for supplemental analyses.

Columns 1 and 2 of online Appendix Table A.1 report summary statistics of baseline observable characteristics for students in my main sample. The average absence rate is 5 percent, and the share of students in the sample who repeat at least one grade during high school is 19 percent. About 66 percent of students work during high school for at least one quarter, and they earn approximately $1,500 per quarter, on average. Seventy-six percent of students graduate from high school in four years, and 22 percent and 39 percent of students enroll into four-year and two-year colleges, respectively, in the two years after their expected high school graduation.

III. Research Design

A. *Measuring Exposure to the Boom*

One of the main challenges in estimating the relationship between the fracking boom and educational or employment outcomes is that the decision to extract oil and gas by companies (or to permit drilling activities by local communities) may be endogenous. For example, struggling communities may be more willing to accept fracking in order to boost employment or tax revenue. Likewise, drilling companies may choose to operate in areas with more favorable labor markets or legal environments. Therefore, using actual drilling or production to measure exposure to the boom can introduce omitted variable bias if the same characteristics that ultimately led to extraction of oil and gas reserves also affect individual education decisions.

I instead use shale oil and gas reserves per capita as a measure of the fracking potential of an area, following the approach of Michaels (2010) and Cascio and Narayan (2022).[17] I define a local area for my analysis as a commuting zone, guided by the fact that fracking has been shown to generate shocks to local labor markets that extended beyond county and school district boundaries (Feyrer, Mansur, and Sacerdote 2017).[18] To construct my reserves measure, I use data on maximum reported reserves (separately for oil and gas) contained in each shale from the EIA.[19] To assign these reserves to commuting zones, I overlay shale maps with commuting zone boundary shapefiles and allocate oil and gas reserves to commuting zones based on the share of each shale that they represent. I then convert these predicted reserves into one common metric defined by millions of British Thermal

[17] A detailed comparison of my methodology with existing papers can be found in online Appendix B.

[18] Commuting zones are geographic units intended to approximate local labor markets and are constructed based on where people live and work (Tolbert and Sizer 1996). Another advantage of using commuting zones is that unlike metropolitan statistical areas, they also include rural areas, which is important in my setting because these areas often lie on top of shales. I use the commuting zone shapefile produced by Chetty et al. (2016) and the county commuting zone crosswalk from Autor and Dorn (2013b).

[19] This information can be accessed at https://www.eia.gov/naturalgas/crudeoilreserves/.

Units (MMBTUs), which represents energy content, and divide it by baseline population in 1995.[20]

Figure 1 displays geographic variation in the fracking potential across commuting zones in Texas as measured by the shale oil and gas reserves per capita. There is significant variation in predicted reserves across the state, with clusters of high-reserve areas found in the west and south. My research design relies on the assumption that reserves are a good proxy for drilling activity and, ultimately, the extent of the local labor market boom that results. To show that this assumption is valid, I regress the number of newly drilled wells in each commuting zone-by-year cell on interactions between reserves per capita and year indicators as well as year and commuting-zone fixed effects. I plot regression coefficient estimates in Figure 2. Areas with high fracking potential saw significant increases in oil and gas wells, suggesting that underlying reserves are a good proxy for subsequent drilling. The number of wells starts to increase around 2005 and reaches a peak in the early 2010s; in contrast, prior to the start of the boom, the coefficients are precisely estimated zeros.

B. *Empirical Framework*

My main specification is a difference-in-differences model in which I compare changes in educational and labor market outcomes across cohorts of high school students with high exposure to the fracking boom to changes in outcomes across cohorts with lower exposure. In line with past work, I date the start of the boom in Texas to 2005.[21] I estimate the following equation:

$$y_{icj} = \sum_{k \neq 2001} \beta_k \times \mathbf{1}\{k = c\} \times Reserves_j + X_{icj}\theta + \gamma_j + \delta_c + \lambda_c \times Z_j^{pre95} + \epsilon_{icj}, \tag{1}$$

where y_{icj} is an outcome of interest for student i in cohort c living in commuting zone j. I normalize predicted shale reserves per capita, $Reserves_j$, by the average nonzero reserves in my sample for ease of interpretation.[22] The term $\mathbf{1}\{k = c\}$ represents a set of dummy variables that are equal to one if cohort c was in ninth grade in year k. I normalize β_{2001} to zero, so all coefficients can be interpreted as changes relative to the cohort that started high school in 2001, i.e., the last "never treated" cohort. Cohorts of students who enrolled in ninth grade in the years 2002–2004 are "partially treated," since they were already in their sophomore, junior, or senior years of high school when the fracking boom began. "Fully treated" cohorts—students who enrolled in ninth grade in the first year of the fracking boom or later—correspond to $k \geq 2005$. Therefore, each estimate of β_k provides the

[20] I use conversion factors reported for 2017 by the EIA (https://www.eia.gov/totalenergy/data/monthly/pdf/sec12.pdf): 1,036 BTUs per cubic foot of gas and 5.723 MMBTUs per barrel of oil.

[21] The figures described earlier in this section support this choice, as it is clear that extraction activity and employment were largely unchanged until the mid-2000s. In Section V I show that my results are robust to alternative assumptions about the timing of the boom.

[22] This transformation implies that a one-unit change in reserves per capita corresponds to going from a commuting zone with no shale reserves to a commuting zone with average reserves.

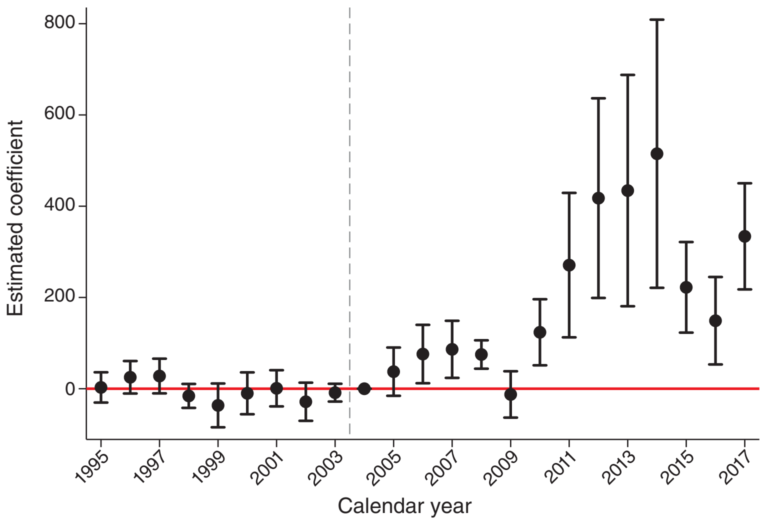

Figure 2. The Effect of the Fracking Boom on Oil and Gas Drilling

Notes: This figure reports estimated coefficients on interactions between year indicators and predicted shale oil and gas reserves per capita (β_k) from regression equation (1). The dependent variable is the number of newly drilled oil and gas wells per population of 100,000. All estimates are relative to the last year (2004) before the boom. Ninety-five percent confidence intervals for standard errors, clustered at the commuting-zone level, are displayed around each point estimate. The data are from Enverus and the U.S. Energy Information Administration.

difference in outcome for cohorts that start ninth grade in year k between the average reserve and zero-reserve areas, as compared to the last nontreated cohort.

I include commuting-zone fixed effects, γ_j, to control for time-invariant differences between commuting zones such as land area or preferences for education, and cohort fixed effects, δ_c, to capture area-invariant differences between cohorts of high school students such as statewide employment shocks. I also control for individual-level covariates, X_{icj}, which include race, ethnicity, gender, and indicators for special education, English proficiency, and free lunch status. The standard errors are clustered at the commuting-zone level.

I also consider a modified version of a difference-in-differences model above, which replaces year dummies with two indicators for being fully and partially treated. The exact specification is

$$(2) \quad y_{icj} = \beta_1 \left(Reserves_j \times Partial_c\right) + \beta_2 \left(Reserves_j \times Full_c\right) + X_{icj}\theta + \gamma_j + \delta_c + \lambda_c \times Z_j^{pre95} + \epsilon_{icj},$$

where $Partial_c$ equals one if a student was in ninth grade between 2002 and 2004, and $Full_c$ equals one if a student was in ninth grade in 2005 or later. All other variables remain the same.

The key identifying assumption is that the trends in student outcomes in commuting zones with different levels of fracking potential would continue to move in parallel in the absence of the boom, conditional on controls and fixed effects. The event study specification in equation (1) helps formally assess pre-trends by looking at estimates of β_k in the prefracking period. In the next section, I show that these estimates are indistinguishable from zero, confirming that there were no underlying trends in outcomes that differed across commuting zones with different levels of treatment.

The identifying assumption would also be violated if there are time-varying shocks specific to areas with high or low fracking exposure and that are correlated with student outcomes. Columns 1 and 2 of online Appendix Table A.1 show that counties with high shale reserves are generally similar to other areas in 1995. They are less populous and have slightly lower median household incomes, although none of these differences are statistically significant (and are captured by commuting-zone fixed effects). In columns 4 and 5, I show changes in student and commuting zone characteristics between 1995 and 2001. I do not find any economically meaningful differences in trends across regions, and only a few characteristics show p-values below 0.05. In order to control for possible differences in trends across areas that may be spuriously correlated with the fracking boom, I flexibly control for commuting-zone baseline characteristics, Z_j^{pre95}, by interacting them with cohort fixed effects, δ_c in all models.[23] I am not aware of any other policies or shocks that coincided with the timing and geographic variation as the fracking boom, and in Section V I show that there was no evidence of demographic shifts in student cohort composition associated with the boom. Taken together, these exercises provide support for my assumption that the scale of each area's fracking boom was driven largely by factors exogenous to local economic conditions and student educational outcomes.

IV. Main Results

A. *Labor Market Outcomes*

I begin by documenting that the fracking boom led to increased employment and earnings for high school students. Past work has shown that fracking exposure led to aggregate increases in job opportunities for low-skilled workers, but without student-level data these studies have been unable to directly observe how these changes affect students. This data problem is not unique to my particular research question; more broadly, evidence on the determinants of employment while in school is remarkably scarce. Thus, by directly linking student and employment outcomes, my work not only improves on the existing literature by precisely identifying the link between fracking-driven improvements in labor markets and educational attainment decisions but also sheds light on the factors that cause students to seek employment more generally.

Employment is quite common for high school students in Texas.[24] As shown in online Appendix Table A.1, nearly 79 percent of youth ages 14 to 18 are employed

[23] In online Appendix Figures A.2, A.3, and A.4, I show that none of my main results change when I exclude these interactions.

[24] This is due in part to the state's flexible child labor laws. Minors ages 14 to 15 are restricted to working a maximum of 48 hours per week (with no more than 8 hours in one day), and the state imposes no minor-specific restrictions starting at age 16. In addition, individuals between ages 14 and 17 cannot work in jobs that have

for at least one quarter during high school. Moreover, 55 percent of students are reported to have "meaningful employment," which I define as having quarterly earnings equal to working at the prevailing 2005 minimum wage of $5.15 for at least ten hours per week (roughly $600 per quarter). The majority of employed students work in the food service, retail, or entertainment sectors.

Figure 3 presents event study estimates from equation (1) for the effect of the fracking boom on the employment and earnings of adolescents at ages 14 to 18. All estimates are calculated relative to the last untreated cohort of students who started ninth grade in 2001. Partially treated students (i.e., those who were in their sophomore, junior, or senior year of high school when the boom started) are represented in the region between the dashed lines. Cohorts who started high school in 2005 or later are considered fully treated. The estimates in the preboom period do not show differential pre-existing trends for any of the outcomes I consider, which provides support for the validity of my identifying assumptions.

The postboom estimates for quarterly earnings (shown in panel A) and probability of being employed (shown in panel B) display a strong positive trend, with the effects becoming particularly large and significant in the late 2000s, consistent with the gradual expansion of the boom.[25] Since the reserves variable is normalized to the average reserve volume across all regions with positive reserves, students in commuting zones with average reserves would be estimated to experience a 6 percent increase in quarterly earnings and a 5 percentage point increase in the probability of employment (a 6 percent increase when evaluated at the preboom mean of 55 percent) in 2010 relative to a commuting zone with no reserves. These effects are much larger for labor markets at the right end of the reserve distribution: for example, students in commuting zones with reserves at the ninetieth percentile experience increases in earnings and employment of 17 percent and 20 percent, respectively. In panels C and D of Figure 3, I show that the employment response was particularly large in the food service and retail trade sectors.[26] This is not surprising, since these industries historically tend to employ large shares of adolescents, and—as discussed earlier—these are also the industries that indirectly benefited from the fracking boom. Last, the employment effect in the oil and gas sector presented in panel E is positive, but it is much smaller and noisier, partly due to the very small number of high school students working in this sector.

In summary, these results suggest that the fracking boom led to substantial increases in the employment and earnings of high school students and that these increases were concentrated in service industries typically associated with youth employment. To provide some context to these employment numbers, they can be compared to past work analyzing changes in the minimum wage, which is one of the few topics that directly considers employment outcomes for teenagers. Neumark and Wascher (1992) show that a 10 percent increase in the minimum wage leads to

been explicitly deemed to be too hazardous (e.g., jobs involving exposure to radioactive substances, roofing operations, coal mining, etc). For more details on child labor laws in Texas, see: https://twc.texas.gov/jobseekers/texas-child-labor-law.

[25] The results are very similar if I exclude quarters that include summer months, and therefore the estimates are not driven by increased summer employment of high school students.

[26] Online Appendix Figure A.5 provides employment results for all major industries.

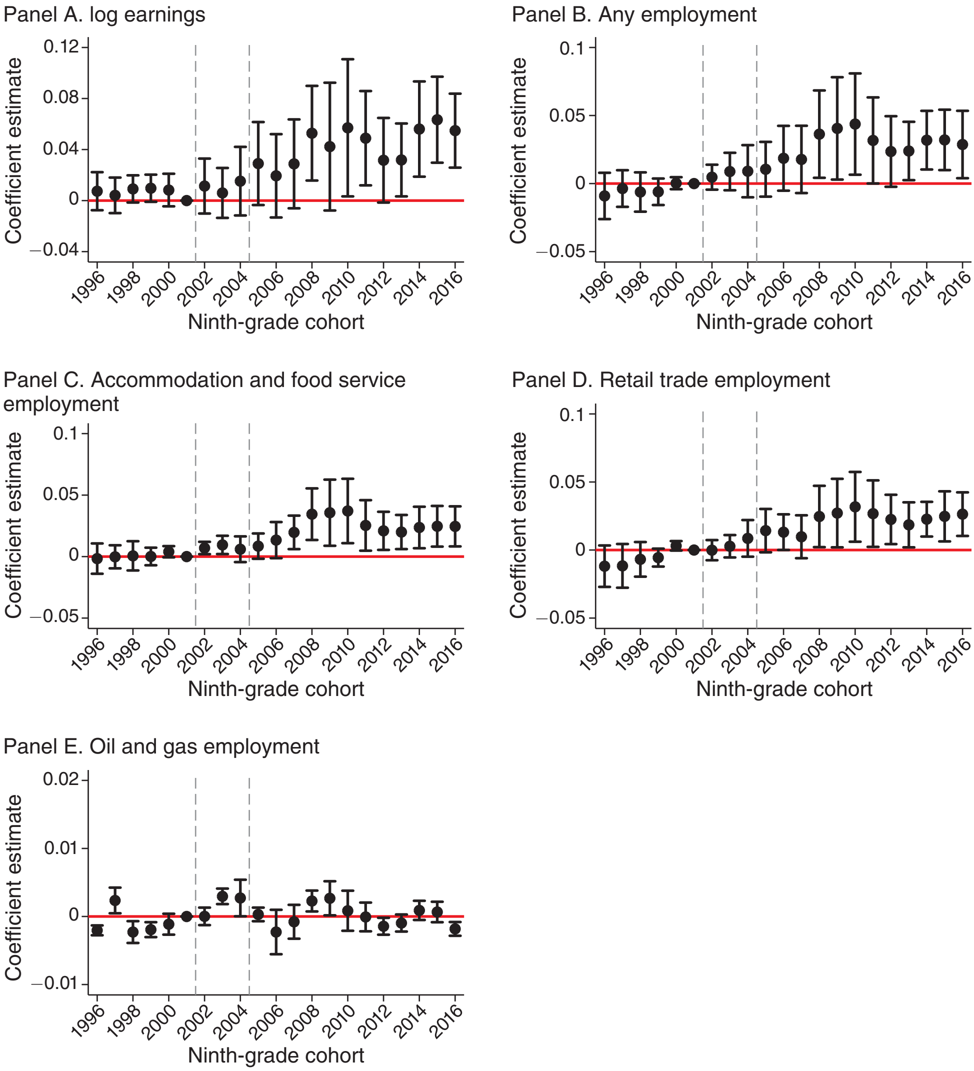

FIGURE 3. THE EFFECT OF THE FRACKING BOOM ON STUDENT EMPLOYMENT AND EARNINGS, AGES 14–18

Notes: This figure reports estimated coefficients on interactions between year indicators and predicted shale oil and gas reserves per capita (β_k) from regression equation (1). The dependent variables are the log quarterly earnings (panel A), probability of being employed for at least one quarter in any industry (panel B), in accommodation and food service (panel C), in retail trade (panel D), and in oil and gas (panel E). Cohorts that begin grade nine in 2001 are the omitted category. Cohorts of students that begin high school in 2005 or later are considered fully treated, while cohorts that begin high school before 2001 are considered untreated. The region between two dashed vertical lines represents cohorts that are partially treated. The regression also includes individual-level demographic controls, cohort fixed effects, commuting-zone fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects. Ninety-five percent confidence intervals for standard errors clustered at the commuting-zone level are displayed around each point estimate. The data are from the Texas Education Agency and the Texas Workforce Commission, provided by the Texas Education Research Center.

a decline in employment of roughly 1–2 percent, suggesting that my employment effects are economically significant.

The results from a more restrictive difference-in-differences specification, described by equation (2), appear in column 1 of Table 1 and are consistent with the findings from event study models above. The magnitudes of the effects are similar to other studies examining the labor market effects of the fracking boom in the US overall and in Texas in particular (Lee 2015; Krupnick and Echarte 2017; Bartik et al. 2019; Cai, Maguire, and Winters 2019). In panel B I report the effect on average quarterly earnings, which also includes quarters with zero earnings. It shows that cohorts in areas with average exposure to the boom earn about 6 percent more per quarter when evaluated at the preboom mean of $490.

Next, I examine whether the fracking boom had heterogeneous effects based on student gender and proxy for prior academic ability. The estimates reported in columns 2 and 3 are generally similar across gender. Students at the bottom of the ability distribution, who are likely to be on the margin of school attendance, may be more attracted by improved job opportunities than their high-performing peers. To test this hypothesis, I approximate student academic ability by calculating their composite score on math and English standardized tests in sixth grade and divide this measure into quartiles. The results from separately estimating equation (2) for each group of students are presented in columns 4–7 of Table 1. There are some stark differences by student ability: both employment and earnings increased considerably for students at the bottom of the skill distribution, while neither outcome changed for students in the top quartile. The next section builds on this observation by further exploring the link between student ability and educational outcomes.

B. *High School Performance and Completion*

In this section, I directly link students with their academic outcomes to examine whether the increase in student employment following the fracking boom affected their academic performance. A key channel through which the fracking boom could affect educational outcomes is through an increased opportunity cost of schooling. As local labor market conditions improve, the total value of earnings forgone by attending school—which represents the opportunity cost of schooling—goes up. For many high-ability students, this effect is likely to be inconsequential relative to the long-run earnings benefits of graduating high school and attending college. However, for many lower-ability students who are unlikely to attend college, having more attractive employment options in high school may have a much larger impact on schooling decisions. This suggests that understanding the consequences of the fracking boom depends not only on the average employment effects but also how they differ across the student ability distribution.

Although some prior work has documented that there is a decrease in educational attainment in the labor markets affected by fracking, data limitations have prevented these papers from analyzing the relationship between educational and labor market outcomes. Directly establishing this link allows me to determine which types of students respond to local labor market shocks. In the following paragraphs I examine whether the shale oil and gas boom differentially affected high school absence rates, grade repetition, and graduation in areas with high reserves. While I briefly discuss the magnitudes of some of my estimates in the

Table 1—The Effect of the Fracking Boom on Student Employment and Earnings, Ages 14–18

				Quartile of grade 6 test score distribution			
	Full sample	Men	Women	Q1 (Bottom)	Q2	Q3	Q4 (Top)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Log quarterly earnings							
Fully treated	3.706	3.985	3.430	4.128	3.706	3.205	3.433
	(1.553)	(1.705)	(1.406)	(1.155)	(1.550)	(1.574)	(2.071)
Partially treated	0.435	0.921	−0.051	0.214	0.208	0.773	0.783
	(0.898)	(1.084)	(0.760)	(1.208)	(1.026)	(0.637)	(1.068)
Observations	3,482,389	1,718,182	1,764,207	832,945	889,486	896,446	863,512
Panel B. Quarterly earnings, including zeros							
Fully treated	30.538	32.298	28.556	39.236	33.193	20.659	20.662
	(15.110)	(17.262)	(13.238)	(15.496)	(15.687)	(14.548)	(16.758)
Partially treated	17.403	21.349	13.228	23.200	17.424	10.678	18.744
	(12.276)	(14.341)	(10.519)	(14.555)	(12.629)	(10.968)	(13.153)
Baseline mean	490.4	511.9	469.7	474.7	506.2	512.8	468.5
Panel C. Any employment							
Fully treated	3.243	3.193	3.267	3.386	3.295	3.037	2.904
	(1.660)	(1.753)	(1.561)	(1.411)	(1.537)	(1.738)	(2.025)
Partially treated	1.169	1.415	0.899	0.913	1.518	1.145	1.129
	(1.066)	(1.124)	(1.029)	(1.133)	(0.960)	(1.010)	(1.264)
Baseline mean	63.7	64.3	63.1	60.0	65.1	66.1	63.5
Observations	5,357,850	2,664,414	2,693,436	1,339,456	1,339,464	1,339,461	1,339,469

Notes: This table reports difference-in-differences estimates of the effect of the fracking boom on high school student employment and earnings at ages 14–18. The unit of analysis is at the student cohort–commuting zone level. In columns 4–7, the "ability" quartiles are assigned based on sixth-grade test scores on the state standardized math and English exam. "Partially treated" and "Fully treated" rows report coefficients on the interaction terms between predicted shale reserves and an indicator variable for entering high school in 2001–2004 and an indicator variable for entering high school in 2005 or later, respectively. Commuting-zone fixed effects, cohort fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects are included in all specifications. Coefficient estimates in panels A and C are multiplied by 100 for readability. Standard errors, shown in parentheses, are clustered at the commuting-zone level.

context of the existing literature here, a more detailed comparison can be found in online Appendix B.

Absence Rates.—First, I examine the effect of the fracking boom on high school student absence rates. I calculate absence rates for each student by taking the ratio of days absent to total number of days taught in each year and then take the average across grades 9 through 12. Figure 4, panel A reports year-specific coefficients, β_k, from equation (1) along with 95 percent confidence intervals. There was no evidence of pre-existing trends between areas with different fracking potential prior to the boom. After the beginning of the boom, however, students in commuting zones with high fracking potential experienced a gradual and persistent increase in absence rates.

Corresponding estimates from the more concise model in equation (2) are shown in Table 2 and confirm the results of the event study model. Each column in this table reports estimates from running a separate regression. Students in labor markets

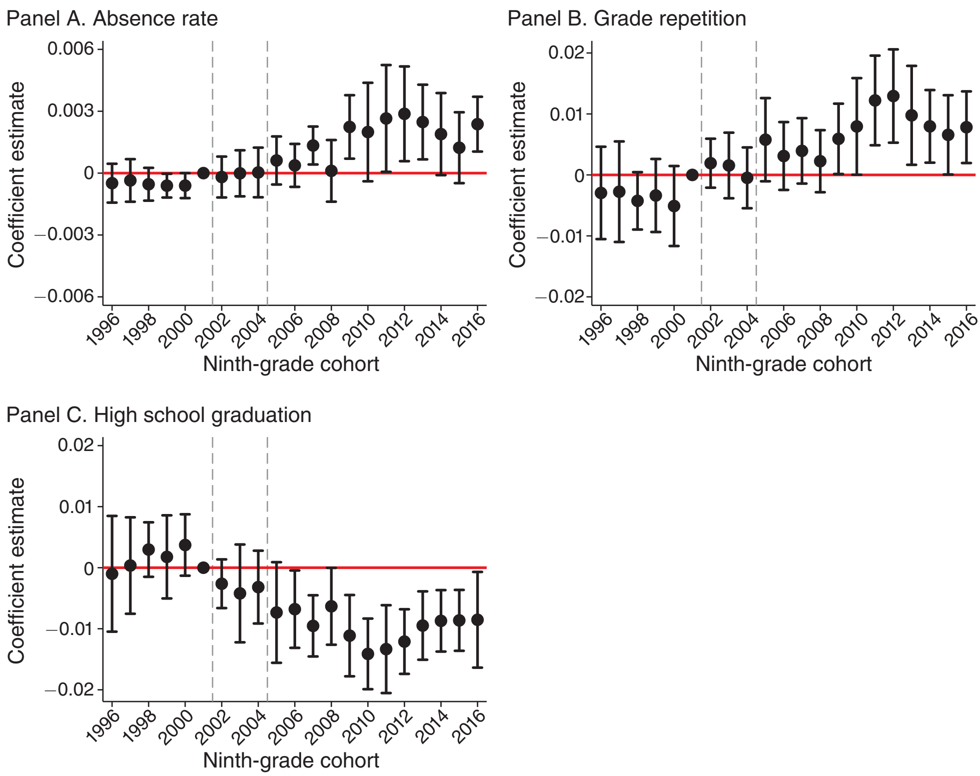

Figure 4. The Effect of the Fracking Boom on High School Outcomes

Notes: This figure reports estimated coefficients on interactions between year indicators and predicted shale oil and gas reserves per capita (β_k) from regression equation (1). The dependent variables are the absence rate in high school (panel A), grade repetition in high school (panel B), and high school graduation (panel C). Cohorts that began grade nine in 2001 are the omitted category. Cohorts of students that began high school in 2005 or later are considered fully treated, while cohorts that began high school before 2001 are considered untreated. The region between two dashed vertical lines represents cohorts that are partially treated. The regression also includes individual-level demographic controls, cohort fixed effects, commuting-zone fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects. Ninety-five percent confidence intervals for standard errors clustered at commuting-zone level are displayed around each point estimate. The data are from the Texas Education Agency, provided by the Texas Education Research Center.

with average reserves experienced a 0.2 percentage point increase in absence rates. These point estimates imply that students missed an additional half-day of school, contingent on a standard 180-day school year. While the effects were similar for both males and females, the average effects mask substantial heterogeneity across students of different academic ability. The effect is largest for students at the bottom of the skill distribution (0.3 percentage points) and is not statistically different from zero for the top quartile. This heterogeneity accords with the employment and earnings estimates in the previous section, which were strongest for the same group of students. These effects are economically significant given that Head Start, a program that directly targeted educational outcomes, was shown by Ludwig and Miller (2007) to have no significant effect on absence rates. The magnitudes I estimate are smaller, though more persistent, than the effects of other events such as school shootings (Cabral et al. 2021) or police violence (Ang 2021) on absence rates.

Table 2—The Effect of the Fracking Boom on Academic Outcomes in High School

				Quartile of grade six test score distribution			
	Full sample	Men	Women	Q1 (Bottom)	Q2	Q3	Q4 (Top)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Absence rate							
Fully treated	0.215	0.250	0.180	0.305	0.192	0.141	0.071
	(0.089)	(0.097)	(0.085)	(0.113)	(0.091)	(0.078)	(0.063)
Partially treated	0.038	0.055	0.023	0.069	0.040	−0.004	−0.011
	(0.060)	(0.066)	(0.060)	(0.077)	(0.070)	(0.073)	(0.029)
Baseline mean	5.8	5.6	6.1	8.0	6.3	5.1	3.9
Panel B. Grade repetition							
Fully treated	1.041	1.181	0.905	1.379	0.866	0.625	0.430
	(0.441)	(0.588)	(0.319)	(0.645)	(0.526)	(0.342)	(0.188)
Partially treated	0.413	0.532	0.299	0.475	0.432	0.122	0.157
	(0.309)	(0.349)	(0.284)	(0.573)	(0.259)	(0.355)	(0.152)
Baseline mean	21.0	22.6	19.6	36.5	23.0	15.3	10.1
Panel C. High school graduation							
Fully treated	−1.102	−1.382	−0.822	−1.822	−0.682	−0.669	−0.269
	(0.394)	(0.499)	(0.305)	(0.649)	(0.483)	(0.278)	(0.201)
Partially treated	−0.465	−0.785	−0.147	−1.015	−0.117	0.066	0.075
	(0.457)	(0.512)	(0.418)	(0.552)	(0.311)	(0.399)	(0.151)
Baseline mean	74.7	72.0	77.3	56.4	72.4	81.2	87.9
Observations	5,357,850	2,664,414	2,693,436	1,339,456	1,339,464	1,339,461	1,339,469

Notes: This table reports difference-in-differences estimates of the effect of the fracking boom on high school student academic outcomes. The unit of analysis is at the student cohort–commuting zone level. In columns 4–7 the "ability" quartiles are assigned based on sixth-grade test scores on the math and English state standardized exam. "Partially treated" and "Fully treated" rows report coefficients on the interaction terms between predicted shale reserves and an indicator variable for entering high school in 2001–2004 and an indicator variable for entering high school in 2005 or later, respectively. Commuting-zone fixed effects, cohort fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects are included in all specifications. Coefficient estimates are multiplied by 100 for readability. Standard errors, shown in parentheses, are clustered at the commuting zone level.

Grade Repetition.—I next examine whether exposure to the fracking boom resulted in higher incidence of grade repetition, which I define as a student's enrollment in the same grade or course for two consecutive years at any time during high school.[27] The difference-in-differences results shown in Table 2, panel B indicate that students in a commuting zone with average level of shale reserves per capita experienced a 1 percentage point higher likelihood of grade repetition (4.8 percent increase when evaluated at the mean of 21 percent). The event study plot in panel B of Figure 4 confirms that the increase in grade repetition corresponds to the timing of the start of the boom and appears to be persistent. Notably, the preboom

[27] My calculation of grade repetition rates differs somewhat from the statistics calculated from the TEA. In both of our measures, students who fail to earn credit in one course are classified as being at the same grade level the next year even if they only have to retake a single class and pass all others. However, my measure of grade repetition rates is calculated as the percent of students who ever repeat at least one grade, whereas the official statistics reported by the TEA are calculated annually as the percentage of students in each year who repeat a grade. This means that my repetition rates will be mechanically higher than those reported by the TEA even though they are based on the same underlying data.

coefficients are close to zero and statistically indistinguishable from the base year. As with absence rates, the effects on grade repetition are similar across males and females but are concentrated at the bottom of the ability distribution.

High School Graduation.—Having shown that absences and grade repetition increase as a result of the boom, I now consider whether it may have also affected high school completion. The event study plot in Figure 4 shows no discernible pre-trend in high school graduation. However, shortly after the beginning of the boom, we see a significant decrease in the probability of graduation. As before, the treatment effects appear to grow over time, with the boom having a larger effect on fully treated cohorts that begin high school after 2009, when the fracking boom was in its most intense phase.

Table 2, panel C presents results from a difference-in-differences model outlined in equation (2). The estimates in column 1 indicate that students in an area with average fracking potential experienced a 1.1 percentage point decrease in the probability of high school graduation.[28] Evaluated at the mean graduation rate of 75 percent, this represents a 1.5 percent decline. Men experience a slightly higher decrease in the probability of graduation (1.9 percent) than women (1.1 percent). In the remaining columns, I examine whether the effects differ by students' academic ability. The effect is almost five times larger among the least academically prepared students (1.8 percentage points) than the top students (0.3 percentage points). This is what one would expect if these students were on the margin of dropping out of high school.

Two related papers—Black, McKinnish, and Sanders (2005) and Cascio and Narayan (2022)—each estimate the effect on high school enrollment of a 10 percent increase in earnings: Black, McKinnish, and Sanders (2005) find that this increase leads to a decline in high school enrollment rates of 5–7 percent, while Cascio and Narayan (2022) find a more modest decrease of 1.9 percent. Because I do not directly analyze enrollment as an outcome, in order to facilitate comparison with these papers, I assume that fracking causes the same percentage change in high school enrollment as it does in high school graduation. I estimate that exposure to the boom leads to an increase in male earnings of 4 percent and a decrease in graduation rates of 1.92 percent. From these numbers, a back-of-the-envelope calculation suggests that a 10 percent increase in earnings leads to a 4.8 percent decline in graduation rates. Thus, my results are larger than past studies analyzing the fracking boom and similar to the low end of the range of estimates calculated from the coal boom.[29]

Taken together, these results suggest that the preboom estimates are indistinguishable from zero and that there are trend breaks in educational outcomes shortly after the beginning of the boom. The heterogeneous results by proxy for ability align with the predictions for which types of students we would expect to respond most:

[28] These estimates reflect on-time high school graduation—i.e., in the next four years after enrollment. The estimates are qualitatively similar if I consider five- and six-year high school graduation rates instead.

[29] A more detailed comparison, including for many other outcomes I consider, can be found in online Appendix B.

students already on the margin of school attendance or dropping out. Moreover, it is clear that students who decreased their educational investment are exactly the ones who experienced increased earnings and participation in the labor market.

C. *College Enrollment and Graduation*

The choices that students make during high school may have an impact on their college plans and career trajectories later in life. The results so far indicate that students who experience increased labor market opportunities during high school invest less into their human capital in the short term. In this section, I consider whether students in areas affected by the shale boom during high school changed their enrollment and graduation from postsecondary institutions.

The results for college enrollment in the next two years after expected high school graduation are reported in panels A and B of Table 3.[30] There appears to be little effect of exposure to the boom on students' likelihood of attending either a community college or a four-year public institution in Texas. The corresponding estimates from the event study model are presented in Figure 5 and are consistent with the results described above. In columns 4–7 I present estimates for college enrollment split by proxy for ability. The estimates are not statistically different from zero except for students in the top quartile of the skill distribution, who increase their college enrollment rate by 1.2 percentage points. One possible reason for why high-ability students would be more likely to go to college in response to the fracking boom would be if it increased family financial resources. This could give talented but financially constrained students opportunities to attend college that they would not otherwise have.[31] In contrast, students of lower ability who were unlikely to attend college regardless of local labor market conditions would not be expected to benefit from this effect; this is consistent with the fact that college enrollment rates were largely unchanged despite a significant increase in dropout rates.

Panels C and D of Table 3 explore the effect of the fracking boom on the probability of college graduation. Panel C reports results for graduation from community college in two years, and panel D shows estimates for graduation from a public university in six years after expected high school graduation. There does not appear to be a significant change in the probability of community college graduation. On the other hand, there is evidence of a small decrease in the probability of public university graduation. The estimate in column 1 implies that students who were exposed to the boom during high school are 0.36 percentage points less likely to graduate from a public four-year university. The corresponding event study estimates are reported in Figure 5. While these results could reflect similar underlying mechanisms to what I observe for high school students, they should be interpreted as suggestive due to the fact that I am not able to observe six-year graduation rates for six of the fully treated cohorts in my data.

In related work, Emery, Ferrer, and Green (2012) analyze the response of educational attainment to the fracking boom in Canada and find that some of these effects

[30] Looking at immediate college enrollment does not change the results.
[31] Unfortunately, this cannot be tested directly in my data due to the lack of detail about family income.

Table 3—The Effect of the Fracking Boom on College Enrollment and Graduation

	Full sample	Men	Women	Quartile of grade six test score distribution: Q1 (Bottom)	Q2	Q3	Q4 (Top)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Community college enrollment							
Fully treated	−0.138	−0.202	−0.073	−0.840	0.182	0.020	1.269
	(0.482)	(0.425)	(0.556)	(0.550)	(0.497)	(0.473)	(1.026)
Partially treated	−0.351	−0.579	−0.113	−0.904	−0.017	−0.113	0.459
	(0.360)	(0.293)	(0.450)	(0.388)	(0.337)	(0.356)	(0.756)
Baseline mean	39.5	36.1	42.7	24.1	37.7	45.9	49.6
Observations	4,724,806	2,342,470	2,382,336	1,181,195	1,181,203	1,181,200	1,181,208
Panel B. Public university enrollment							
Fully treated	−0.044	0.039	−0.133	−0.071	0.054	0.186	1.172
	(0.279)	(0.266)	(0.306)	(0.196)	(0.258)	(0.308)	(0.474)
Partially treated	0.080	−0.122	0.278	0.136	0.122	−0.126	0.659
	(0.262)	(0.257)	(0.374)	(0.157)	(0.196)	(0.286)	(0.536)
Baseline mean	19.5	17.8	21.2	3.7	11.2	22.9	39.3
Observations	4,724,806	2,342,470	2,382,336	1,181,195	1,181,203	1,181,200	1,181,208
Panel C. Community college graduation							
Fully treated	−0.099	−0.053	−0.140	0.063	−0.111	−0.153	−0.161
	(0.052)	(0.058)	(0.084)	(0.061)	(0.084)	(0.144)	(0.109)
Partially treated	−0.109	−0.103	−0.109	0.088	−0.089	−0.086	−0.324
	(0.049)	(0.083)	(0.046)	(0.070)	(0.070)	(0.067)	(0.070)
Baseline mean	1.3	1.1	1.4	0.6	1.2	1.6	1.7
Observations	4,724,806	2,342,470	2,382,336	1,181,195	1,181,203	1,181,200	1,181,208
Panel D. Public college graduation							
Fully treated	−0.363	−0.266	−0.456	−0.180	−0.253	−0.353	−0.234
	(0.147)	(0.125)	(0.234)	(0.061)	(0.144)	(0.256)	(0.308)
Partially treated	−0.132	−0.121	−0.143	−0.072	0.038	−0.049	−0.166
	(0.176)	(0.121)	(0.300)	(0.085)	(0.125)	(0.232)	(0.365)
Baseline mean	13.7	11.4	16.0	1.8	7.1	15.8	29.4
Observations	3,501,707	1,721,825	1,779,882	875,422	875,428	875,425	875,432

Notes: This table reports difference-in-differences estimates of the exposure to the fracking boom during high school on college enrollment and graduation. The unit of analysis is at the student cohort–commuting zone level. In columns 4–7 the "ability" quartiles are assigned based on sixth-grade test scores on the state math and English standardized exam. "Partially treated" and "Fully treated" rows report coefficients on the interaction terms between predicted shale reserves and an indicator variable for entering high school in 2001–2004 and an indicator variable for entering high school in 2005 or later, respectively. Commuting-zone fixed effects, cohort fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects are included in all specifications. Coefficients are multiplied by 100 for readability. Standard errors, shown in parentheses, are clustered at the commuting-zone level.

were only temporary. I cannot directly replicate their analysis because I am only able to see outcomes for a small subset of cohorts who were exposed to the boom at age 28. Nonetheless, in online Appendix B I show that high school and college attainment looks very similar at age 28 as it does at age 25. While it is still possible that these students may choose to pursue higher education later in life, my results suggest that the attainment effects appear to be persistent for students in my sample.

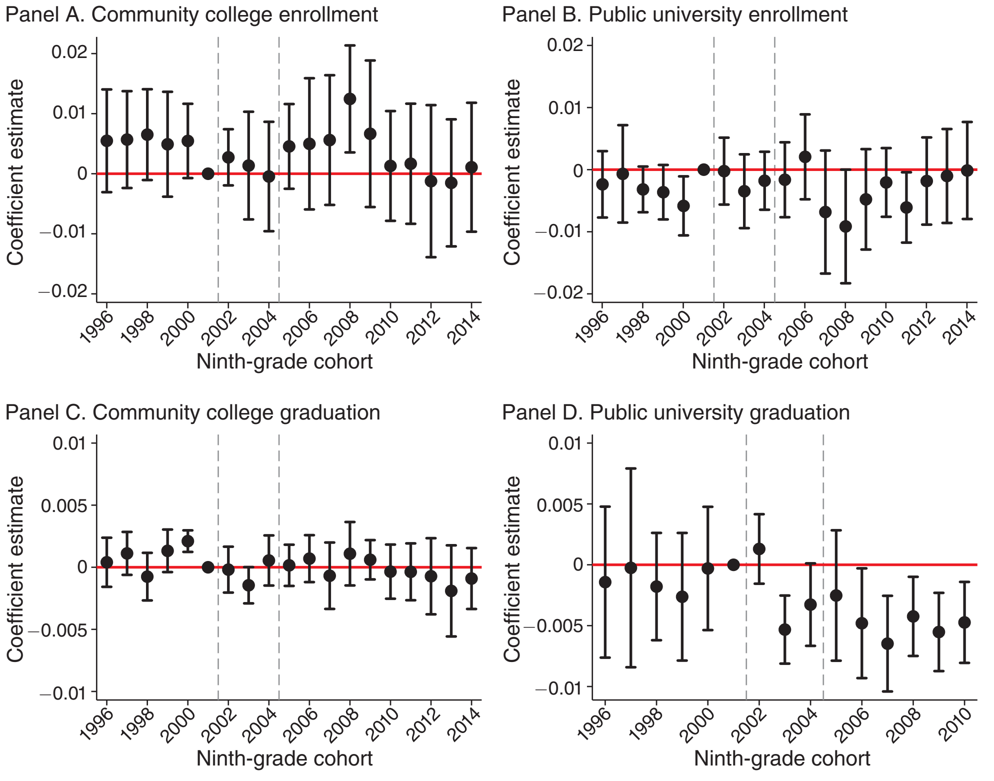

Figure 5. The Effect of the Fracking Boom on College Enrollment and Graduation by College Type

Notes: This figure reports estimated coefficients on interactions between year indicators and predicted shale oil and gas reserves per capita (β_k) from regression equation (1). The dependent variables are enrollment in community college in the next two years after expected high school graduation (panel A), enrollment in a four-year public university in the next two years after expected high school graduation (panel B), graduation from community college in two years (panel C), and graduation from a public university in six years (panel D). Cohorts that began grade nine in 2001 are the omitted category. Cohorts of students that began high school in 2005 or later are considered fully treated, while cohorts that began high school before 2001 are considered untreated. The region between two dashed vertical lines represents cohorts that are partially treated. The regression also includes individual-level demographic controls, cohort fixed effects, commuting-zone fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects. Ninety-five percent confidence intervals for standard errors clustered at commuting zone level are displayed around each point estimate. The data are from the Texas Education Agency and the Texas Higher Education Coordinating Board, provided by the Texas Education Research Center.

D. *Adult Earnings*

The question of whether low-ability students ultimately benefit from their decision to reduce educational attainment in response to the boom depends on how long the employment and earnings benefits are expected to persist. In this section I evaluate the effects of fracking on student earnings at ages 24–25.[32] I find that the earnings effects are positive, on average, for treated cohorts, suggesting that the

[32] I focus on earnings at ages 24–25 to allow for observations of cohorts across a broader range of economic conditions. In online Appendix Figure A.6, I show similar results for earnings for the much smaller set of cohorts that I can track until age 28.

labor market benefits of the fracking boom were relatively persistent. While these earnings effects were largest for cohorts with more exposure to high oil prices, even the cohorts who reached ages 24–25 when prices were at their postcrisis lows were no worse off than their counterparts in nonfracking areas despite having worse educational outcomes.

Table 4 presents results from estimating equation (2) for cohorts that were exposed to fracking during high school, where the outcome variables are quarterly earnings at ages 24–25.[33] In column 1 I focus on the level of average quarterly earnings including observations of zeros, and in columns 2–8 I use log earnings and exclude zeros. The estimate in column 2 implies that students who were in commuting zones with average reserves during high school experience a 1.7 percent increase in quarterly earnings at ages 24–25 compared to students who were not exposed to the fracking boom. To understand how the effect of the boom varies for students of different abilities, I split students into quartiles based on their sixth-grade standardized test scores. The estimates in columns 5–8 of panel A show that cohorts exposed to fracking had earnings that were between 1.1 and 2.5 percent higher at ages 24–25, with the largest effects occurring in the middle of the ability distribution.[34]

While my results suggest that the later-life earnings of these particular cohorts benefited from the fracking boom despite their reduced educational attainment, this effect is likely to be a function of the strength of the labor market. I investigate the role of labor markets in several ways. First, I analyze how labor market conditions evolved during the course of my analysis. I can first observe later-life (ages 24–25) earnings for students exposed to the fracking boom in high school beginning in 2012, when the unemployment rate in Texas was 6.7 percent.[35] As online Appendix Figure A.7 shows, it moved steadily downward over the next several years, reaching a low of 3.5 percent at the end of my sample in 2019. Thus, for most of the period in my analysis, the statewide unemployment rate was below its pre-Great Recession (1976–2007) average of 6.1 percent. This suggests that my earnings results were, on average, observed during a period of relative labor market strength. In online Appendix Figure A.8, I show that this labor market strength appeared in both fracking and nonfracking areas although, unsurprisingly, the changes relative to the preboom period were larger for areas lying on top of shales.

Next, I consider how my earnings results respond to changes in oil prices. The intensity of the fracking boom was closely tied to oil and gas prices, meaning that a 25-year-old working when oil prices were near $100 per barrel in 2013 would be

[33] Because I only observe records for students who stay in Texas, it is important to make sure that the fracking boom did not change the probability that a student remains in the state. In online Appendix Figure A.9, I show that the probability of a student in my data having an employment record does not change in response to the fracking boom, suggesting that my results are not driven by selective migration.

[34] While the effects for these quartiles are likely driven by improved labor market opportunities associated with the boom, they may be partially explained by an increased share of people who don't graduate from high school and gain additional work experience. A back-of-the-envelope calculation suggests that the estimated change in graduation could explain at most 32 percent of the earnings effects. This is calculated under the conservative assumption that individuals in their early 20s earn zero while in high school and $3,200 per quarter—the average earnings for high school dropouts between the ages of 18 and 22 in my data—if they do not have a high school degree. The exact calculation is the following: $(1.102 \times 3{,}200)/111$, where 111 is an estimated increase in quarterly earnings.

[35] I focus on aggregate measures of labor market strength because my data do not allow me to observe where exactly individuals are employed in Texas.

Table 4—The Effect of the Fracking Boom on Quarterly Earnings at Ages 24–25

	Earnings including zeros	log earnings						
					Quartile of grade six test score distribution			
	All	All	Men	Women	Q1 (Bottom)	Q2	Q3	Q4 (Top)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Earnings at ages 24–25								
Reserves × Post	110.572	1.655	0.805	2.407	1.097	2.479	1.586	1.946
	(32.195)	(0.252)	(0.284)	(0.353)	(0.340)	(0.322)	(0.304)	(0.502)
Panel B. Earnings at ages 24–25 before versus during versus after 2014 oil price decline								
Reserves × Before oil decline	254.004	2.765	2.487	2.800	2.877	2.890	2.771	2.606
	(66.635)	(0.607)	(0.756)	(0.485)	(0.610)	(0.684)	(0.567)	(1.067)
Reserves × During oil decline	39.349	0.815	−0.079	1.755	−0.349	2.147	0.867	1.225
	(55.133)	(0.257)	(0.343)	(0.336)	(0.437)	(0.587)	(0.421)	(0.408)
Reserves × After oil decline	29.565	1.329	−1.102	2.677	0.776	2.385	1.014	1.312
	(49.034)	(0.525)	(0.601)	(0.649)	(0.495)	(0.730)	(0.778)	(0.469)
Observations	2,234,728	2,234,728	1,085,799	1,148,929	536,310	568,936	575,464	554,018

Notes: This table reports difference-in-differences estimates of the exposure to the fracking boom during high school on quarterly earnings at ages 24–25. The unit of analysis is at the student cohort–commuting zone level. In columns 5–8 the “ability” quartiles are assigned based on sixth-grade test scores on the state math and English standardized exam. In panel B the postperiod is divided into three subperiods. The “Before oil decline” term includes cohorts that started high school in 2002–2004 and who turned 24–25 in 2011–2013; “During oil decline” and “After oil decline” refer to cohorts that started high school in 2005–2007 and after 2008 and who turned 24–25 in 2014–2017 and 2018–2019, respectively. The sample in columns 2–8 includes individuals with nonmissing earnings in at least half of the quarters at ages 24–25. Commuting-zone fixed effects, cohort fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects are included in all specifications. The coefficient estimates in columns 2–8 are multiplied by 100 for readability. Standard errors, shown in parentheses, are clustered at the commuting-zone level.

expected to experience a larger benefit from the fracking boom than a 25-year-old working when oil prices had fallen to less than $50 per barrel in 2016. Table 4, Panel B splits the postperiod into three periods. The first is 2011–2013 (“Before oil decline”), when oil prices hovered near $100 per barrel. The second is 2014–2016, when prices fell to less than $50 per barrel (“During oil decline”). The third and final category covers 2017–2019, when prices rose to $65 per barrel (“After oil decline”). The first row shows that earnings were about 2.8 percent higher for 24–25-year-olds working during the oil price boom in 2011–2013. As oil prices declined, the earnings effects fell to roughly 0.8 percent. When prices rose again post-2016, the estimated earnings effects rose to around 1.3 percent, with the effect driven primarily by students in the bottom half and middle of the ability distribution.

Figure 6 shows this result in more granular detail by plotting an event study that shows the earnings at ages 24–25 for each cohort in my sample along with oil prices. In this figure, each cohort is referred to by the year it started high school, while earnings and oil prices are measured 10 to 11 years later. The effects are largest for the partially treated cohorts, who benefitted from oil prices that were close to $100 per barrel when they were around 25 years old. As oil prices dipped in 2015–2016 the effects became smaller, but both rose again in 2018–2019. Going forward, industry

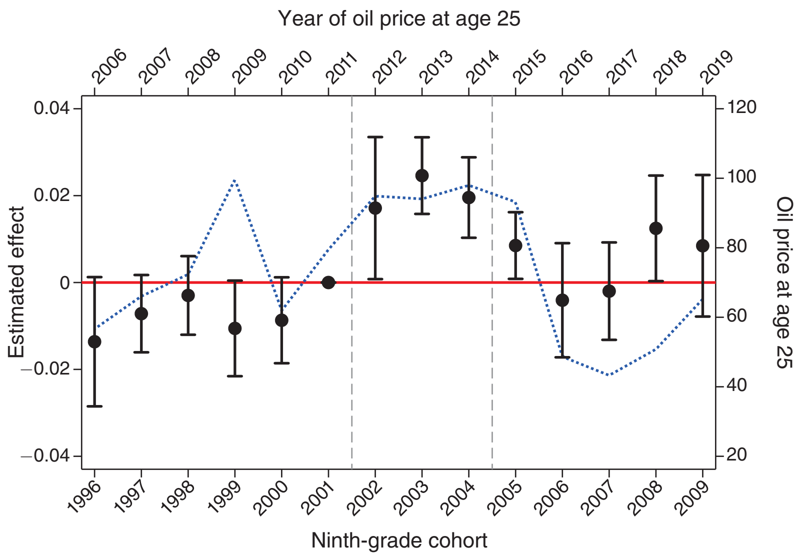

Figure 6. The Effect of the Fracking Boom on Quarterly Earnings at Ages 24–25

Notes: This figure reports estimated coefficients on interactions between year indicators and predicted shale oil and gas reserves per capita (β_k) from regression equation (1). The dependent variable is the natural logarithm of quarterly earnings at ages 24–25. Cohorts that began grade nine in 2001 are the omitted category. Cohorts of students that began high school in 2005 or later are considered fully treated, while cohorts that began high school before 2001 are considered untreated. The region between two dashed vertical lines represents cohorts that are partially treated. The regression also includes individual-level demographic controls, cohort fixed effects, commuting-zone fixed effects, and 1995 commuting-zone characteristics interacted with cohort fixed effects. The sample includes individuals with nonmissing earnings in at least half of the quarters at ages 24–25. The oil price is measured by the West Texas Intermediate (WTI) crude oil price and is plotted at age 25 for each cohort. Ninety-five percent confidence intervals for standard errors clustered at commuting-zone level are displayed around each point estimate. The data are from the Texas Education Agency, Texas Workforce Commission, and U.S. Energy Information Administration.

analysts currently project strong demand and forecast a range of between \$70–85 over the next several years,[36] which would be above the 2005–2019 average of just over \$70 per barrel and suggests these earnings effects may persist for recent cohorts. That the effects are more closely linked to oil prices than they are to broader labor market conditions can be explained in part by the fact that these broader measures include many jobs that require skills, certifications, and experience that make them inaccessible to the young adults in my sample.

There are two important conclusions to be drawn from these results. First, the positive medium-run earnings effects for high school students exposed to fracking appear to be a result of the fact that oil prices were, on average, high enough to boost economic activity in fracking areas during this period. Second, even when oil prices reached postcrisis lows and activity slowed, the earnings of cohorts exposed to fracking were not significantly less than their peers in nonfracking areas even though these cohorts had worse educational outcomes. This is consistent with the idea that the marginal value of schooling for these students was likely low. I do

[36] See https://www.nasdaq.com/articles/oil-prices-will-remain-high-for-years-to-come-2021-10-26.

not observe these students during periods of broader economic weakness, which suggests caution in extrapolating these results. Nonetheless, the fact that the earnings effects seem to be closely tied to oil prices and that they remain non-negative even during the largest oil price collapse of the postboom era suggests that student decisions to drop out in favor of entering the labor market are not necessarily myopic.

In online Appendix A I consider several extensions of my main results. First, I plot cohort fixed effects for each of my education and labor market outcomes in Figures A.11 and A.12. None of these coefficients, which show the average effects for each outcome in untreated areas for each cohort relative to the base year, are statistically significant during the boom, suggesting that the differential effects that I identify with my main specification are driven by changes in outcomes for students exposed to fracking. Next, in Figure A.13, I show my main education and labor market outcomes broken down by ability decile. The effects on educational outcomes are largest for students in the bottom half of the ability distribution, with the bottom decile experiencing particularly large effects on graduation and absence rates. This suggests that most of my education effects are driven disproportionately by much worse outcomes for low-ability students rather than slightly worse outcomes across the distribution. In contrast, I find the estimated magnitudes of the employment and earnings effects are more spread out across the entire distribution with larger estimates at the bottom and middle of the skill distribution, suggesting my labor market results are more broad based than the educational outcomes.

V. Robustness Checks

A. *Alternative Specifications*

The estimated impacts of the fracking boom on student academic and labor market outcomes are robust to a variety of alternative specifications. In panel A of online Appendix Table A.3, I report results from the baseline specification for reference. In panel B, I reestimate the main results without student-level controls and commuting-zone characteristics. Removing controls from the main specification has little effect on the coefficient estimates. Panel C restricts the sample to a set of commuting zones that have nonzero reserves per capita, thus limiting the variation in my analysis to areas that had the potential to benefit directly from extraction. The magnitude of these estimates is sometimes attenuated, but the precision and pattern of effects are very similar to the baseline sample. In panel D I consider different assumptions about the timing of the fracking boom. Instead of using 2005 as the first year of the boom for all shale plays, I follow Bartik et al. (2019) and use additional temporal variation in the fracking boom within Texas. This variation is shale specific and is based on the first date when the fracking potential became public knowledge. The estimates from this approach are very similar to the baseline specification. I also compare my estimates across oil and gas shale plays in online Appendix Table A.7 and find larger effects for both educational and labor market outcomes in oil-rich areas, which is consistent with the findings of Marchand and Weber (2020).

B. *Selective Migration*

One concern in studies that analyze impacts of economic shocks on educational outcomes with aggregate data is that the results could be biased by selective migration. Systematic migration into booming areas as a result of improved labor market opportunities has the potential to change the composition of population and lead to biased results. For example, if individuals who are more likely to be absent or drop out of high school relocate to booming areas for work, then these areas may be disproportionately experiencing higher rates of absences and lower graduation rates regardless of the behavior of the pre-existing local population. In my main analysis, I mitigate this concern directly by focusing on high school students who lived in the area since middle school, thus excluding potential migrants from my sample. I perform several additional tests to explore the issue of endogenous migration in more detail.

First, because in my dataset the same students are followed over time, I can directly explore whether there is evidence of endogenous migration within Texas. The first two rows of Table 5 show no statistically significant effect of fracking on the probability of moving across both school districts and commuting zones. I also show that my main results are robust to restricting my sample to students who had lived in the same commuting zone since elementary school. This sample is more restrictive due to a smaller number of cohorts, which I can track backward in time. Nevertheless, in online Appendix Table A.4 I show that the estimates are similar to the baseline sample.

Second, I consider whether student demographic characteristics are related to the fracking boom. In panel B of Table 5, I estimate the impact of fracking on student gender, race, gifted status, limited English proficiency, free lunch, and special education indicators. The estimates provide little evidence that the boom changed the composition of student cohorts, alleviating concerns about selective migration, demographic shifts, and other changes taking place at the same time as the boom.

Since my data do not allow me to track students who leave Texas, I cannot directly observe out-of-state migration. In principle, this could lead to bias in my estimation of dropout rates if students who leave the state are more likely to finish high school elsewhere. I explore this possibility in two ways. First, I create a flag for whether I can link a student to college or earnings records in my data and use it as a dependent variable in my main specification. In online Appendix Figure A.9 and panel A of Table 5, I show that there is no differential change in the probability of being observed in my data between the fracking and nonfracking areas. Second, I use county-level migration data from the IRS, which is based on year-to-year address changes reported on individual income tax returns. In online Appendix Figure A.10, I present results from estimating equation (1) with out-migration rate as the dependent variable. The estimates show no evidence of changing patterns of out-of-state migration, alleviating the concern that it may be affecting my results.

VI. Discussion

My main results show that the fracking boom caused a decrease in human capital investment among high school students. While I argue that the increased oppor-

TABLE 5—THE EFFECT OF THE FRACKING BOOM ON STUDENT MIGRATION AND DEMOGRAPHICS

	Baseline mean	Partially treated	Fully treated
Panel A. Migration			
Probability of changing school districts	13.3	−0.075	−0.145
		(0.143)	(0.150)
Probability of changing commuting zones	5.0	0.012	−0.092
		(0.074)	(0.056)
Probability of being observed in college or earnings records	89.3	0.644	0.771
		(0.787)	(0.993)
Panel B. Cohort composition			
Male	49.1	0.176	0.065
		(0.117)	(0.088)
White	56.5	−0.024	−0.337
		(0.231)	(0.493)
Hispanic	27.6	0.104	0.672
		(0.3009)	(0.612)
Black	13.5	−0.085	−0.081
		(0.153)	(0.148)
Special education	7.4	0.340	0.304
		(0.115)	(0.183)
Gifted	13.6	−0.404	−0.145
		(0.300)	(0.360)
ESL	1.8	−0.154	−0.518
		(0.156)	(0.377)
Free lunch	32.4	0.078	−0.902
		(0.273)	(0.724)

Notes: This table reports difference-in-differences estimates of the effect of the fracking boom on student migration and demographics. The unit of analysis is at the student cohort–commuting zone level. The sample for the probability of being observed in the records contains 3,210,374 observations; for all other outcomes it contains 5,357,850 observations. "Partially treated" and "Fully treated" columns report coefficients on the interaction terms between predicted shale reserves and an indicator variable for entering high school in 2001–2004 and an indicator variable for entering high school in 2005 or later, respectively. Coefficients are multiplied by 100 for readability. Standard errors, shown in parentheses, are clustered at the commuting-zone level.

tunity cost of education due to improved labor markets was a key driver, these reduced-form estimates could, in principle, also be affected by other changes caused by the boom. In this section, I discuss the importance of several other channels that may contribute to my findings.

Opportunity Cost and Returns to Schooling.—The results in Section IV showed that the fracking boom substantially increased the opportunity cost of schooling for both men and women of high school age and resulted in lower educational investment. However, if the fracking boom changed the expected labor market premium for high school graduates relative to high school dropouts, this effect could also be contributing to my findings.[37] In online Appendix Table A.5, I explore this possibility by taking advantage of my administrative records and comparing earnings of slightly older individuals in Texas (ages 18–22) with and without a high school degree. The dependent variable in this analysis is the difference in log quarterly

[37] For example, Bütikofer, Dalla Zuanna, and Salvanes (2018) find that the returns to academic versus vocational education dropped significantly in the high-oil regions of Norway in response to the oil boom in the 1970s.

earnings between these two groups in each commuting zone and year. The estimates indicate that the fracking boom did not substantially change the expected earnings gap between high school graduates and dropouts. Unlike students still enrolled in high school at the time of the boom, these slightly older students had already made their attendance decisions by the time fracking boosted local labor markets. To the extent that the labor market outcomes of these older students helped their younger peers form expectations about their options after graduating, however, they are a useful signal for evaluating the returns to education in early adulthood. While the recency of the boom limits my ability to analyze longer-term labor market outcomes, the fact that my results show no significant change in this earnings gap provides suggestive evidence that students were not choosing to drop out due to a reduction in the expected returns to education.

These findings have broader implications for policies that can affect teenage employment. The fact that the roughly 4 percent increase in high school employment I document in response to the fracking boom is larger than the 1.1 percentage point decline in graduation rates suggests that many of the students whom I observe working during school are still able to graduate. This increase in work experience can help explain the persistence of the earnings effects I document in Section IVD. This finding suggests that policies that encourage teenage employment may provide some longer-run benefits through increased work experience, particularly if this work experience does not come at the expense of educational outcomes. One such policy that is often thought to affect teenage employment is the minimum wage. To the extent that high school students have a marginal product of labor below the minimum wage, reducing it may benefit these students by allowing them to obtain valuable work experience.[38]

My results can also speak to the implications of policies that seek to promote college education in the presence of heterogeneity in student ability. I find that in response to the fracking boom, students at the low end of the skill distribution simultaneously experience both the largest reductions in educational attainment and substantial earnings gains that persist through their mid-20s. This suggests that there are students who may benefit more from policy interventions that support wages and job opportunities for positions that do not require college degrees rather than policies that uniformly encourage additional education. However, the presence of these students does not preclude the possibility that there are other low-ability students who might benefit from easing access to college. Past work, including Zimmerman (2014), has shown that these students can benefit financially from greater access to college, though Andrews, Li, and Lovenheim (2016) and Mountjoy (2021) have shown that this is not always the case. This strand of literature has emphasized the importance of taking heterogeneity in student ability into account when designing educational policies, and my work contributes to these papers by emphasizing the role of labor market opportunities in educational attainment decisions.

[38] The net effects of minimum-wage changes in this setting depend on several factors, including the students' marginal returns to education, the marginal disutility of labor, and the wage elasticity of demand for low-skill workers. If the wage elasticity of demand is low, then increases in the minimum wage could also induce high school students to increase their labor supply.

School Resources.—Changes in school resources associated with fracking can affect educational outcomes independently from the labor market. Oil and gas production in Texas is taxed at the state level through a single severance tax and at the local level through property taxes, which are levied on the value of a well's oil and gas resources. Since local property taxes provide more than a half of total revenue for schools, expansion of the local tax base may lead to higher school revenues and spending.[39]

Online Appendix Table A.6 presents estimates of the effect of fracking on school revenues and expenditures per student. School revenues experienced a 2.7 percent increase due to the boom in areas with average reserves compared to areas without any fracking potential. This was also reflected in school spending per student, which rose by 3.2 percent.[40] Given the evidence that higher school spending has either insignificant or positive effects on human capital formation (Jackson, Johnson, and Persico 2016; Hyman 2017), this would lead to better educational outcomes in areas with greater intensity of extraction activities. While this does not necessarily mean that improvements in school resources had no effect on the margin, it does suggest that any potential benefits to educational outcomes were offset by changes coming through other channels. This implies that future shocks or policies that induce high school students to substitute employment for education may have worse long-run outcomes if these shocks do not increase school funding.

Finally, I explore whether fracking could affect student outcomes via teacher quality using teacher-level data from the TEA, which include detailed outcomes such as experience, degree level, and earnings. The estimates in online Appendix Table A.6 suggest that fracking did not have a statistically significant impact on teacher quality as measured by the number of teachers in a commuting zone who have an advanced degree or fewer than five years of experience.[41] There was no significant change in earnings, either, which reflects the fact that teacher salaries are based on a variety of factors and will not always respond immediately to changes in tax revenue.[42]

VII. Conclusion

In this paper, I use the fracking boom in Texas as a natural experiment to study the short- and long-run effects of shocks to local labor markets on educational and employment outcomes for high school students. My analysis combines geological data on the distribution of shale resources with individual-level data for the universe

[39] While the evidence in some areas is mixed (for example, see Muehlenbachs, Spiller, and Timmins 2015 for results in Pennsylvania), Weber, Burnett, and Xiarchos (2016) find that the average housing values increased substantially due to shale development in Texas.

[40] These findings are in line with Newell and Raimi (2015), who document that most county and municipal governments have experienced net financial benefits from the fracking boom.

[41] Marchand and Weber (2020) find that the share of teachers with less than five years of experience increased in response to the fracking boom in Texas. This discrepancy can be explained by the differences in our methodologies and the timing of our samples. When I modify my approach to more closely match theirs, I find statistically significant but small positive effects on the share of teachers with low experience. More details can be found in online Appendix B.

[42] This is particularly relevant in the case of fracking, the revenue boost from which some areas may perceive to be transitory.

of public school students in Texas that allows me to follow students through high school, college, and into the labor market. I find that greater exposure to fracking led to increases in both earnings and the probability of employment for high school students, particularly for students at the bottom of the ability distribution, but that the same students also experienced worse educational outcomes as measured by absence, grade repetition, or graduation rates. In contrast, I find far smaller effects on both educational and labor market outcomes for high-ability students.

Despite their diminished educational attainment, I find that the earnings gains for these low-ability students—many of whom were on the margin of attending high school and would have been unlikely to attend college even in the absence of the fracking boom—persist through at least ages 24–25. These effects are strongest for young adults whose employment coincides with high oil prices, but they are estimated to be non-negative even for cohorts exposed to the 2015–2016 period when oil prices fell by more than 50 percent. These results offer novel evidence regarding the trade-offs between employment and education faced by young adults and, to my knowledge, they are the first long-term, individual-level responses of any sort that have been analyzed in response to fracking.

The results contribute to our understanding of how the returns to education can differ across the ability distribution. Past work has shown that many students at the margin of college attendance face financial or academic barriers to college attendance and that their outcomes can be improved by policies that ease these constraints. However, my findings suggest that there is also a substantial share of these students who are unlikely to ever attend college and for whom the opportunity costs of attending high school appear to be large. Many of these students gain financially from substituting employment for education not only in the near term but also later in life. Rather than programs designed to encourage college attendance, my results suggest that many of these students may receive greater benefit from programs that support higher wages and job opportunities that do not require degrees.

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