Reversing the Natural Resource Curse: Coal Mine Closures and Poverty in Appalachia

David Nason*

Adam Scavette†

Heather M. Stephens‡

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Abstract

U.S. coal production has fallen sharply since its peak in 2008. Appalachia has disproportionately borne the impacts of this decline, experiencing significant reductions in coal production, mining employment, and mine operations. Previous research has linked coal mine closures to local economic downturns, as affected communities have experienced job losses, population decline, and reduced local tax revenues. However, the long-term implications remain uncertain, as some research suggests the presence of a natural resource curse in which regions dependent on resource extraction struggle with weak economic development. In this paper, we use quasi-experimental methods to examine the impact of mine closures on local poverty in Appalachia. Analyzing 65 counties with mine closures between 2005 and 2009, we find that, over a decade, mine closures led to at least a 4-6 percent average reduction (1-2 percentage points) in their county's poverty rate. We find suggestive evidence that local poverty reduction was driven by population decline (via net outmigration), wage increases, and rising educational investment (via employment and attainment). Overall, we find limited evidence of local economic decline in counties experiencing mine closures.

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*West Virginia University. Email: dhn0003@mix.wvu.edu.

†Federal Reserve Bank of Philadelphia. Email: adam.scavette@phil.frb.org

‡Regional Research Institute, West Virginia University. Email: heather.stephens@mail.wvu.edu

1 Introduction

Since its peak in 2008, U.S. coal production has declined amid the rise in affordability of natural gas, the closure of coal-fired power plants, and government regulations for cleaner air emissions. The impact of coal's recent decline has been borne disproportionately by Appalachia, where mines tend to be less productive than those in western minefields (Bowen et al., 2021). [1] Bowen et al. (2021) estimates that between 2005 and 2020, Appalachian coal production fell 65 percent (compared to 54 percent for the nation) and coal employment fell by 54 percent. Additionally, over half of Appalachia's coal mines have closed since the mid-2000s due to rising production costs (e.g., lower worker productivity, higher health and safety costs), slowing electricity demand, and falling natural gas prices (Berry, 2021; Watson et al., 2023).

The literature has documented the impacts of the 2000s coal shock and the resulting public policies. Some research suggests that the 2000s coal shock reduced population, employment, and earnings and increased the rate of government transfers (e.g., Medicaid, Medicare, SNAP) in affected areas (Michieka et al., 2022; Hanson, 2023; Krause, 2024). Additionally, there have been large indirect effects of the decline in coal demand documented across Appalachia since the 2000s, such as declines in household financial well-being (Blonz et al., 2023) and reductions in local revenues for public education (Kent, 2016; Welch & Murray, 2020). However, there appears to be little impact on education and training assistance (Hanson, 2023) or postsecondary education completion (Krause, 2024). These negative effects of the coal shock on their surrounding local economies have made Appalachian coal communities a target for place-based policies (CRS, 2023). Public policy efforts have attempted to remediate the losses from coal mine closures at the state level through reallocation funds (Kent, 2016), and at the federal level through efforts such as the Inflation Reduction Act, which offers place-based tax incentives for clean energy investments in communities with a coal mine or coal plant closure (UST, 2023).

[1] Additionally, technological change and increasing productivity in the coal industry has resulted in a long and slow decline in national coal employment since the late-1970s (Kolstad, 2017).

However, despite these ostensibly negative effects of the mine closures, the question is do the closures represent opportunities for coal mine communities to reverse the natural resource curse? The natural resource curse describes the paradox that areas gifted with natural resource assets tend to perform poorly in terms of economic development (van der Ploeg, 2011). Several studies find that coal mining employment in the U.S. is associated with negative long-term economic outcomes such as decreased population, decreased manufacturing activity (Matheis, 2016), decreased entrepreneurship (Betz et al., 2015), and higher poverty (Deaton & Niman, 2012; Partridge et al., 2013). However, many studies (Michaels, 2011; Aragón & Rud, 2013; Frederiksen & Kadenic, 2020) find evidence contradicting the natural resource curse, such that natural resource extraction leads to local income, employment, and population growth. If the natural resource curse is valid, will former coal communities economically benefit when mines shut down?

We contribute to the natural resource curse literature by examining the impact of coal mine closures on poverty in Appalachia. Despite the negative economic shock, we examine whether the closures helped reverse the natural resource curse. To do so, we identify 65 counties containing coal mines that closed between 2005 and 2009 using data from the U.S. Energy Information Administration. We match these counties with other Appalachian counties containing coal mines that did not close during our treatment period. We believe that this type of control group is appropriate since counties containing closed coal mines are likely to be similar to those containing mines that did not close along several factors (e.g. similar infrastructure, education level, wages). We then run difference-in-difference models on our treatment and control samples where the identifying assumption is that the control counties form a valid counterfactual for those counties with closing coal mines after conditioning on differences in preexisting trends, county fixed effects, and year fixed effects. We also use two alternative sets of controls that encompass the other counties of the Appalachian Basin (a geologic region containing coal) and the other counties within the Appalachian Regional Commission's service area, respectively.

Our results indicate that the poverty rate declines by 1 to 2 percentage points over ten years following a coal mine closure, providing some evidence of a reversal of the natural resource curse. To further explore the mechanisms driving this effect, we estimate a number of additional models and examine closely counties who experienced the highest and lowest drop in poverty. It appears that local poverty reduction was driven by population decline (via net outmigration), wage increases, and rising educational investment (via employment and attainment). Overall, we find limited evidence of local economic decline in counties that have experienced mine closures.

2 Background

2.1 Natural Resource Curse

The natural resource curse theory is based on the observation that places whose economies rely on natural resource extraction have worse economic outcomes. One source of the curse is that the high-paying jobs associated with natural resource extraction may reduce human capital formation and that places will underinvest in education (Cockx & Francken, 2016). While a larger literature has focused on national and state economic outcomes, James & Aadland (2011) were among the first to examine the impact of resource extraction on local U.S. economies. Several previous studies support a resource curse associated with coal mining in the U.S., finding that coal mining employment is associated with negative long-term economic outcomes including declining population and decreased industrial activity (Matheis, 2016), decreased entrepreneurship (Betz et al., 2015), and higher poverty (Deaton & Niman, 2012; Partridge et al., 2013).

At the same time, however, the results from other studies appear to contradict the natural resource curse. For example, Aragón & Rud (2013) show that growth in extractive industries in Peru is associated with increasing real income from the mining and non-mining sectors. Focusing on mine openings rather than closures, Frederiksen & Kadenic (2020) find positive employment effects, both in direct mining employment and multiplier effects that increase employment in other industries. Other research provides evidence that oil-abundant U.S. counties experienced higher population growth, higher per capita income, and developed better infrastructure in the latter half of the twentieth century. This paper points to one potential mechanism that communities can use to avoid the natural resource curse, investing in better infrastructure. Places that invest in infrastructure during the booms can benefit from those resources during the busts and potentially avoid the adverse potential economic outcomes associated with resource extraction.

2.2 Local Effects of Energy Booms and Busts

One potential reason for the natural resource curse is the boom and bust cycles of energy development. When energy prices fall, development falls, and this puts pressure on local economies. Black et al. (2005a) studies the impact of the 1970s coal boom and subsequent 1980s bust on coal-producing local labor markets in Kentucky, Ohio, Pennsylvania, and West Virginia (part of the Appalachian region that we further describe below). The authors find asymmetric multiplier effects showing an increased negative impact from the bust. For every 10 coal sector jobs created during the boom, 2 jobs were created in the non-tradable sector (construction, retail, etc.); however, during the bust, 3.5 non-tradable jobs were lost for every 10 coal sector jobs lost. In related research, Black et al. (2005b) show that the coal boom led to a sizable increase in the wages of low-skilled workers, which led to a decrease in high school enrollment rates.

Other research finds similar negative local labor market impacts. Examining UK mine closures in the 1980s, Aragón et al. (2018) find evidence of lower population, wages, and reallocation of employment from mining to manufacturing. Following the former UK coal miners who suffered from the industry's collapse in the 1980s, Rud et al. (2024) show that they had persistent negative earnings.

Finally, an indirect way in which energy booms and busts can affect local labor markets and the long-term economic vitality of regions is through the shocks to funding for local governments. Many energy-producing U.S. states have severance taxes that are levied on energy production, raising funds for local governments. Additionally, local schools are generally at least partially funded through property taxes, which can wax and wane during boom and bust cycles. Because of this, energy booms tend to provide windfalls for local schools through (positive) property tax base shocks (Weber et al., 2016; Newell & Raimi,

2015) and closures of mines could create a credit crunch for local governments. With fewer funds, local governments may be unable to make important investments to avoid a natural resource curse. However, funds could be raised through new taxes or from state or federal governments.

2.3 Poverty in Appalachia

The federally designated Appalachian Regional Commission (ARC) was created in 1965 to address the persistent poverty in a region of the eastern United States including the Appalachian Mountains and the surrounding area (Stephens & Partridge, 2011). This region, particularly Central Appalachia, has long relied on extractive industries, starting with timber, then coal, and more recently natural gas. Appalachia has tended to suffer from higher poverty and lower earnings than the rest of the U.S., which is in part due to an absence of high-skilled workers and lower returns to those high skills, which disincentivizes human capital investment (Bollinger et al., 2011). In other words, there has been some evidence of a natural resource curse. And, while poverty rates, overall, have declined in the region, it still lags the rest of the country in terms of educational attainment, transportation access, employment growth, and health outcomes, and the population in the region is both slow-growing and aging (ARC, 2015).

3 Empirical Approach

3.1 Data

We use data from the U.S. Energy Information Administration (EIA) from 2000 to 2019 to construct our county treatment status indicator. By law, each coal mining company that owns a mine that produces 50,000 or more short tons of coal in the reporting year must submit an EIA-7A form for each mine it operates.[2] This data contains mine-level production totals, company information, mine location and operating status, labor hours, and the number of employees. The U.S. Mine Safety and Health Administration (MSHA)

[2]See here for a copy of the form: *https://www.eia.gov/survey/form/eia_7a/form.pdf*. Anthracite mines have a lower threshold at 10,000 or more short tons. Failure to comply is a criminal offense.

assigns each coal mine in the U.S. a unique MSHA ID number, which allows us to create a panel of the near universe of coal mines that existed in the U.S. from 2005 to 2009. We limit the mines in our data to those within the southern, central, or northern Appalachian Basin, drop any mine that changes counties in the data from 2000 to 2019, and drop any mine not listed as permanently abandoned in the last year that it appears in the data.[3] This gives us 1,405 unique mines within the Appalachian Basin from 2005 to 2009.

Using this data, we identify counties with a mine closure between 2005 and 2009. A county with a permanently abandoned mine that was active in the preceding year is considered treated. Three different control groups are used. First, we use counties within the Appalachian Basin with at least one active mine and no closures in the EIA-7A data from 2000 to 2019, which we refer to as our "Mine" control group. Next, we consider any additional county that overlies the Appalachian Basin as a control, which we refer to as our "AB" control group. In this case, additional control counties are those that could have coal mines based on underlying geological features. The final control group includes any county in the original 360 ARC counties, which we refer to as our "ARC" control group. Figures 1 through 3 visualize our treatment counties against our three respective control groups. Figure 4 shows the number of mine closures in each county that appears in the EIA-7A data from 2005 to 2009.

Table 1 contains information on the number of counties that became treated from 2005 to 2009, and Table 2 shows the number of treated counties per state. Here, we can see that most counties with mine closures experienced them towards the start of our treatment period. Kentucky, Pennsylvania, and West Virginia counties are most exposed to mine closures. Table 3 presents descriptive statistics on employment and production levels in abandoned mines in the last year of operation. While the average mine employed about 22 individuals and produced over 82,000 short tons of coal, there is significant variation in employment and production among closed mines.

[3] Because the EIA-7A form is only mandated for companies with a mine that produces over 50,000 short tons of coal, we cannot tell whether mines that are not listed as permanently abandoned in the last year that it appeared became abandoned, or the operating company was no longer mandated to report.

We use county-level poverty data from 2001 to 2019 from the U.S. Census Bureau's Small Area Income and Poverty Estimates (SAIPE) for our primary outcome variables. This data contains poverty count estimates for all U.S. counties for all ages and for those under 18. These estimates, along with all-age poverty rates constructed by taking the ratio of a county's total poverty count and population from the Census Bureau's Population Estimates Program (PEP) intercensal resident population estimates, are our main dependent variables of interest. Figure 5 shows a time series of all-age poverty rates for our treatment counties and each of our sets of control counties from 2000 to 2019. Poverty rates for all groups were higher at the end of the period than at the beginning, and poverty rates spiked during the Great Recession from 2007 to 2010. Figure 6 shows poverty rates for the set of original ARC counties in 2000, which was 14.6 percent overall and two percentage points higher than the U.S. rate of 12.6 percent. Initial poverty rates were the highest throughout southern West Virginia and Eastern Kentucky, the heart of Appalachian coal country.

Covariates and data to explore the potential mechanisms come from various sources. Unemployment and labor force participation rates come from annual averages released by the Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics (LAUS). Undisclosed county-level data for employment, self-employment, wages, and establishment counts by detailed industry are available under a license from Lightcast. They are used to measure total jobs, self-employment, employment by industry, total wages, wages by industry, and establishment counts. Data from the U.S. Bureau of Economic Analysis (BEA) Regional Accounts are used for per capita personal income, GDP, and transfer payments.[4] The number of SSI recipients and total county-level SSI payments are from the U.S. Social Security Administration (SSA) SSI Recipients by State and County. Annual births, deaths, and net migration rates are from the Census Bureau's PEP Estimates of the Components of Resident Population Change for Counties. Data from the Census Bureau's Business Formation Statistics (BFS) measure annual business applications by county from 2005 to 2019. Educational attainment rates by highest degree achieved are from the Census Bureau's American

[4]Because county FIPS codes between the Census Bureau and the BEA do not match up for several independent cities and counties in Virginia in our sample, we aggregate all variables to consolidated county FIPS codes which combine Virginia's independent cities with the counties that envelop them.

Community Survey (ACS) 5-year estimates and are measured at the midpoint (e.g. 2007 comes from the 2005-2009 estimates, 2008 comes from the 2006-2010 estimates, etc.).

3.2 Methodology

We use two empirical approaches for our main results: two-way fixed effects (TWFE) difference-in-differences and the Callaway & Sant'Anna (2021) (CS) estimator. The TWFE specification is as follows:

$$y_{it} = \alpha_i + \delta_t + \beta D_{it} + \epsilon_{it}. \quad (1)$$

We first estimate the impact of a coal mine closure on poverty in treated counties using TWFE where the dependent variable y_{it} is the natural log of the poverty rate in county[5] $i = 1, \ldots, 112$ and year $t = 2000, \ldots, 2019$. Area and time fixed effects are captured by α_i and δ_t, respectively. Dummy variable D_t equals one after each respective treated county experienced its first coal mine closure. All mine closures within our sample occurred between 2005 and 2009.

Secondly, we estimate the average treatment effect of coal mine closures on poverty in treated counties using the staggered difference-in-differences design developed by Callaway & Sant'Anna (2021). As Cunningham & Goodman-Bacon (2025) note, the CS estimator overcomes biases that staggered treatment may present in a TWFE setting by using only untreated control units. The CS estimator creates cohort- (based on year of initial mine closure) and time-specific average treatment effects on the treated (ATT) counties with two-period/two-group difference-in-difference estimators as in Equation 1. Then, the CS estimator aggregates those individual ATTs using weights based on the size of each treatment cohort, generating the overall ATTs that we report in our results. Thus, in our case CS will produce 5 cohort ATTs for each year between 2005 and 2009. Since most of our treated counties experienced their first mine closures in 2005 and 2006 (see Table 1), those two cohorts receive the largest weights in the reported overall ATT.

[5]This equation denotes our primary model specification, which uses the 47 "Mine" control counties plus the 65 treated counties for a total of 112 counties. Our "AB" control group contains 178 counties and our "ARC" control group contains 286 counties.

4 Results

Figure 7 plots point estimates and 95% confidence intervals for the two-way fixed effects difference-in-differences and Callaway & Sant'Anna (2021) estimators on poverty rate. These results suggest that poverty rate growth was significantly lower in counties experiencing coal mine closures in the late-2000s and 2010s compared to other counties in Appalachia. The respective treatment effects between the TWFE and CS estimators are qualitatively similar to one another across the three control group estimates (Mines, AB, and ARC), indicating little bias introduced into the standard TWFE estimator by staggered treatment. Additionally, we find consistently negative treatment effect estimates across our three control groups. Specifically, our most restrictive "Mines" control group indicates a 4 percent decrease in the poverty rate over the treatment period, the "AB" estimate is slightly stronger at 5 percent, and the "ARC" estimate is strongest at 6 percent. The size of the mine closure treatment effect on the local poverty rate is positively correlated with the sample size of the control group, as "ARC" contains roughly 6 times as many counties as the "Mine" control group. As the median treated county had a poverty rate of 21.6 percent in 2005, these results suggest that coal mine closures led to a decrease of around 0.9 and 1.3 percentage points in the median treated county between 2005 and 2019.

Figure 8 indicates little difference in pre-treatment poverty rate trends between the treated and "Mines" control counties.[6] The chart indicates that the negative effect of a coal mine closure on the poverty rate becomes significant one year after treatment, which reaches a peak effect between 5 to 8 years later before tapering off. In the next section, we explore several potential mechanisms that may have facilitated poverty reduction over that period.

5 Potential Mechanisms

In this section, we explore some of the potential mechanisms that could explain the causal link between coal mine closures and local poverty rates in treated counties.

[6] We also find little evidence of pre-trends in the event study plots using the "AB" and "ARC" control counties, respectively.

5.1 Population Change

ARC (2015) and Bowen et al. (2021) suggest that population has been declining in Appalachian coal mine counties in recent decades. This could be partially due to a reduction in local job opportunities as coal mining has become more capital intensive and less labor intensive (Kolstad, 2017). Consequently, diminishing local job opportunities could induce both increasing outmigration and decreasing inmigration of working age individuals. Therefore, it seems plausible that coal mine closures could induce population decline relative to counties with active mines through the same channels. As outlined in Section 3.2, we use the Callaway & Sant'Anna (2021) estimator to determine whether coal mine closures impacted the population of treated counties compared to "Mine" control counties and find that coal mine closures reduced local population by 0.8 percent over 5 years and 1.4 percent over 10 years. Our event study plot in Figure 9 shows that there is a monotonically decreasing effect of coal mine closures over time. If we look at net migration rates between median control and treated counties in Figure 10, we can see that net migration rates were very similar between the groups between 2004 and 2010. However, after 2010, both groups saw consistently negative net migration rates with the median treated county experiencing net outmigration roughly 3 times higher than the median "Mine" control county by 2017. Therefore, it seems possible that outmigration of impoverished individuals and households may have contributed to the decrease in poverty rates that we find in our main results.

5.2 Labor Market and Local Economy

In this section, we examine whether coal mine closures resulted in changes in local employment and wages between treated and "Mine" control counties using the same CS methodology as outlined in Section 3.2. Figure 11 shows the treatment effects of coal mine closures on log employment by 2-digit North American Industry Classification System (NAICS) industries over a ten-year treatment period. While there is very little impact on total employment, there are large impacts on employment growth across several industries despite none of them being statistically significant at the p-value=.05 level. Unsurprisingly, there is a 21 percent decrease in employment within NAICS 21 - Mining, Quarrying, and Oil and Gas Extraction, which is marginally significant. There are similarly large negative effects on manufacturing employment (NAICS 31 & 33). However, treated counties experience a 17 percent increase in Educational Services employment (NAICS 61), which is strongest and most significant 2-4 years after closure as seen in Figure 12.

Despite seeing little effect on overall employment, we estimate large effects on overall wage growth and within several industries as seen in Figure 13. We find a 3 percent statistically significant increase in wages across all industries in the five years after a mine closure. The largest statistically significant effects on wages appear to be in NAICS 56 - Administrative, Support, Waste Management and Remediation Services (+7 percent), NAICS 61 - Educational Services (+6 percent), NAICS 48 - Transportation and Warehousing (+5 percent), NAICS 81 - Other Services except Public Administration (+4 percent), and NAICS 62 - Healthcare and Social Assistance (+2 percent). Therefore, it appears that coal mine closures coincided with large increases in wages across treated counties in the first five years after treatment. These wage increases appear to have raised relative personal income across households at a proportional rate (see Figure 16), which may have helped bring many out of poverty in the ensuring decade. These wages could have been due to an increase in demand for workers, a decrease in supply, or an increase in productivity.

We also estimate treatment effects on several additional local economic variables in Figure 16. We find little to no effect on gross domestic product (GDP) per capita, unemployment rate, establishments, or business applications. However, we find a 1 percent increase in the labor force participation rate in treated counties.

5.3 Educational Attainment

We see large impacts of coal mine closures on educational services employment and wages in section 5.2, so it is possible that closures are causing individuals to invest more in their own education. We seek to understand this mechanism better by studying educational attainment measures. We use 5-year estimates from the ACS from 2005 to 2022 to determine whether there was a difference in educational attainment for individuals aged 25 years or more during our treatment period. We are not able to estimate a CS model, since the ACS did not begin producing these statistics until our treatment period began in 2005. Thus, we have no pre-treatment statistics to estimate a causal treatment effect.

Figure 14 plots the median share per educational status across both treated counties and "Mine" control counties from 2007-2019. The year plotted represents the middle year of the 5-year estimate period (e.g., 2007 is the estimate for 2005-2009). We see very little difference between the educational attainment trajectories between treated and control groups except for the "some college" status on the middle right side of the panel. The median treated county experiences an increase in "some college" educational attainment of roughly 5-6x the rate of the median control county from 2007 to 2019 (14.7 to 17.6 percent compared to 16.3 to 16.8 percent). This could indicate that individuals increased their educational attainment through vocational or certificate programs at community colleges, rather than through formal degree programs, as a result of the diminishing labor opportunities following the coal mine closures. This increased education may have resulted in productivity gains, which may have contributed to the higher wages in treated counties estimated in section 5.2.

5.4 Public Benefits

It is possible that the decreased job opportunities from the coal mine closures resulted in more economic distress, and thus, people became eligible for public benefits programs. These public benefits could push people above the poverty line and reduce the poverty rate. In this section, we examine whether coal mine closures resulted in changes in public benefits per capita between treated and "Mine" control counties using the same CS methodology as outlined in Section 3.2. Figure 15 shows the 5-year treatment effects of coal mine closures on log total public benefits per capita, log Supplemental Security Income (SSI) Enrolled per capita, and log Supplemental Security Income (SSI) Funds per capita. Consistent with our main estimates that show a reduction in poverty, we find that total public benefits per capita decreased by 1 percent on average. Additionally, we find little change in SSI enrollment or SSI funds per capita.

6 Conclusion

Given the long history of resource extraction in the Appalachian region, and prior literature that has shown some evidence of a resource curse in the region, we examine whether the closure of coal mines could help reverse the curse. We find evidence that Appalachian counties which experienced coal mine closures between 2005 and 2009 saw improvements in poverty over the 2000s and 2010s. These results are robust to several different specifications and when comparing the counties which experienced these closures to several different control groups. Using the Callaway & Sant'Anna (2021) estimator, we find significant negative impacts on the poverty rate of between 1 and 2 percentage points over a ten-year treatment period.

Further analysis suggests that the primary mechanism causing poverty rates to decline in treated counties is rising income (via proportionate wage growth). These wage increases may have resulted from a relative decrease in labor supply, an increase in labor demand, or an increase in labor productivity. While a decrease in labor supply is possible due to decreasing population via net outmigration, we also find a proportionate increase in the labor force participation rate among treated counties over the same period. Additionally, we see no major change in employment levels over the period compared to the control group. Regarding labor demand, we find no change in the number of establishments or business applications among treated areas and little change in GDP per capita. Labor productivity appears to be the best explanation for the relative wage increases in treated counties, given our documented increase in educational services employment, wages, and "some college" educational attainment for residents 25 and older. These results suggest that any investment in education is unlikely to be driven by degree-granting programs but could be due to vocational or certificate programs through community colleges. Furthermore, increasing educational attainment and reduced competition with the coal industry for labor may have resulted in better matching of firms to employees after mine closures.

Although we find that these coal mine closures resulted in population loss via net migration compared to control counties, our results suggest that coal mine closures did not result in increased economic distress within their surrounding counties' economies. We find little effect on overall employment, GDP per capita, unemployment, or local business activity via establishments or business applications. Additionally, we find overall increases in the labor force participation rate (1 percent). Surprisingly, in contrast to the recent literature (Michieka et al., 2022; Hanson, 2023; Krause, 2024), we find that total government benefits transfers per capita decreased by 1 percent. Overall, our results suggest that, in general, the closure of coal mines in Appalachia and the local economies transitioning away from coal may be helping to reverse the natural resource curse.

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Year	Number of Treated Counties	New Treated Counties
2005	36	36
2006	47	11
2007	56	9
2008	59	3
2009	65	6

Table 1: Number of Treated Counties per Year

State	Number of Treated Counties
Alabama	3
Kentucky	20
Ohio	5
Pennsylvania	11
Tennessee	4
Virginia	6
West Virginia	16

Table 2: Number of Treated Counties per State

Statistic	Mean	St. Dev.	Min	Max
Average Employees	22.057	19.792	1	196
Production (Short Tons)	82,517.160	160,727.500	0	2,472,308

Table 3: Statistics for Abandoned Mines in Last Year of Operation

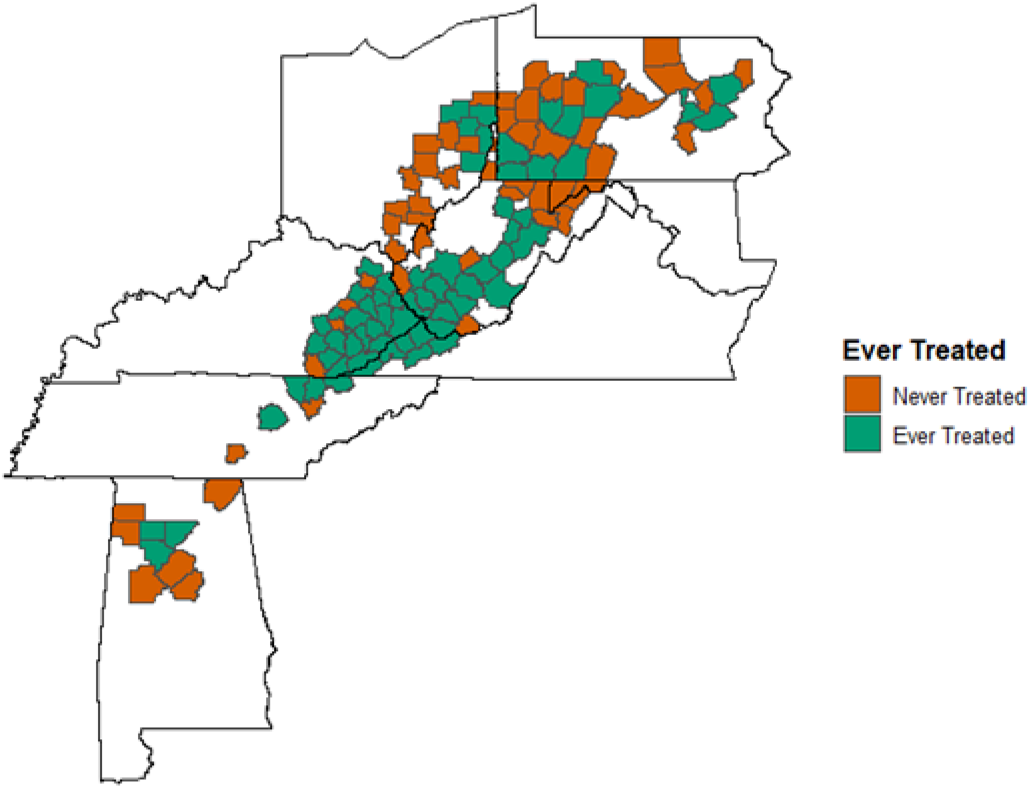

Figure 1: Treatment and Control Counties, Contain Mines During Period

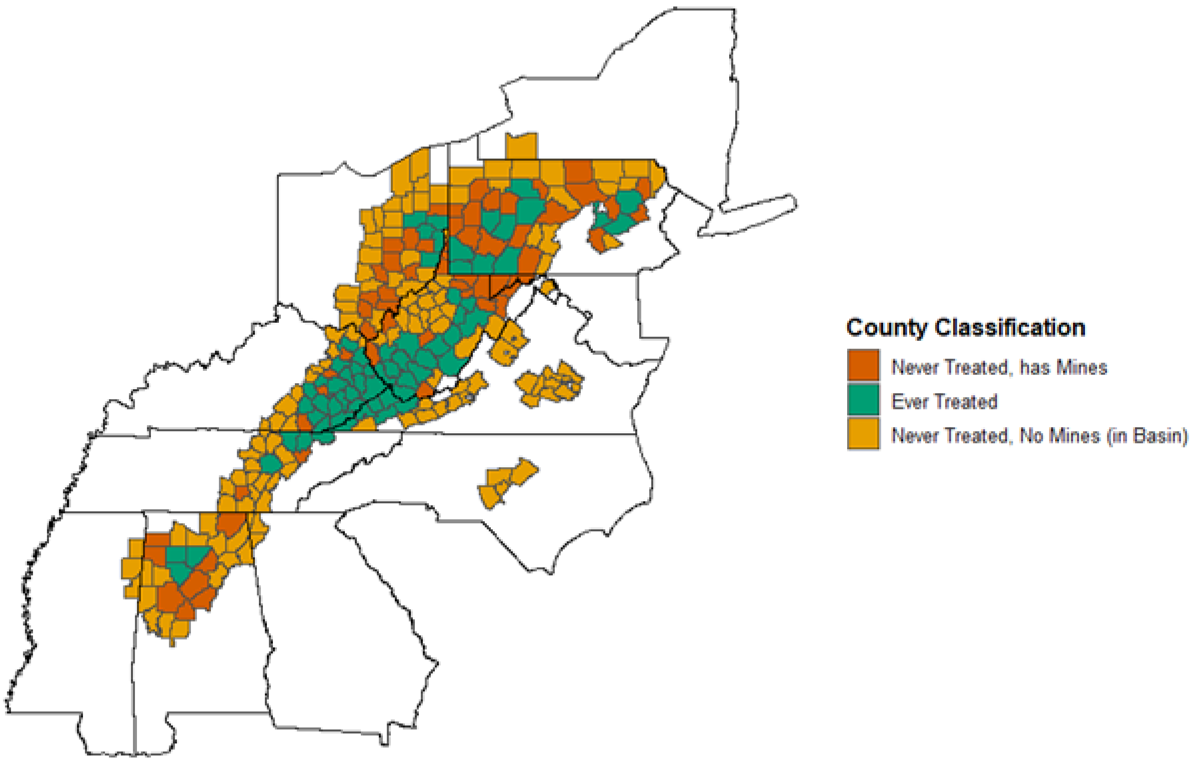

Figure 2: Treatment and Control Counties, Overlying the Appalachian Basin

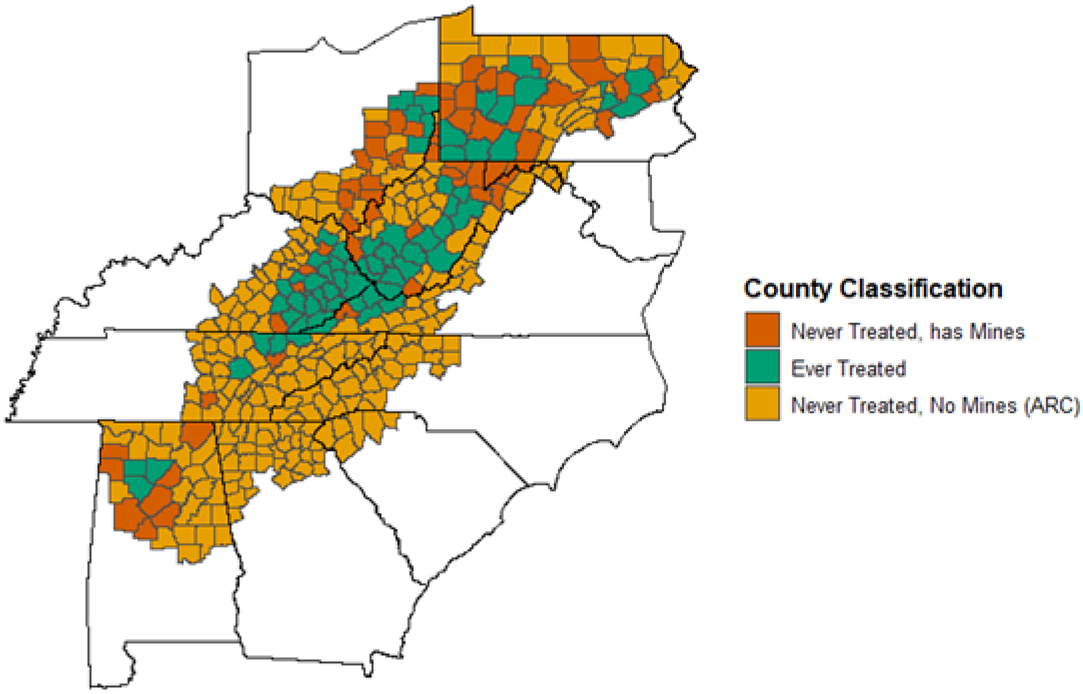

Figure 3: Treatment and Control Counties, Original ARC Counties

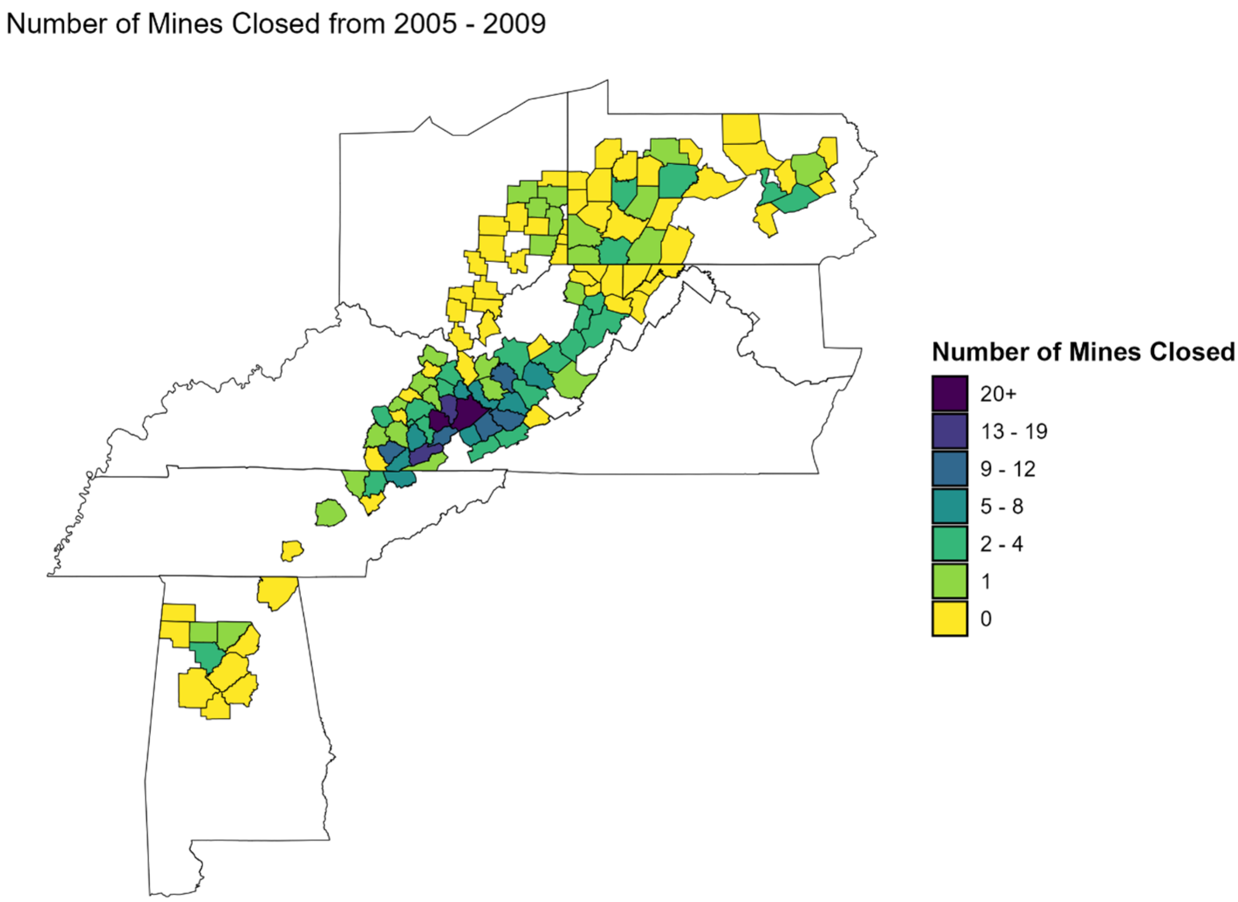

Figure 4: Number of Mine Closures by County, 2005 – 2009

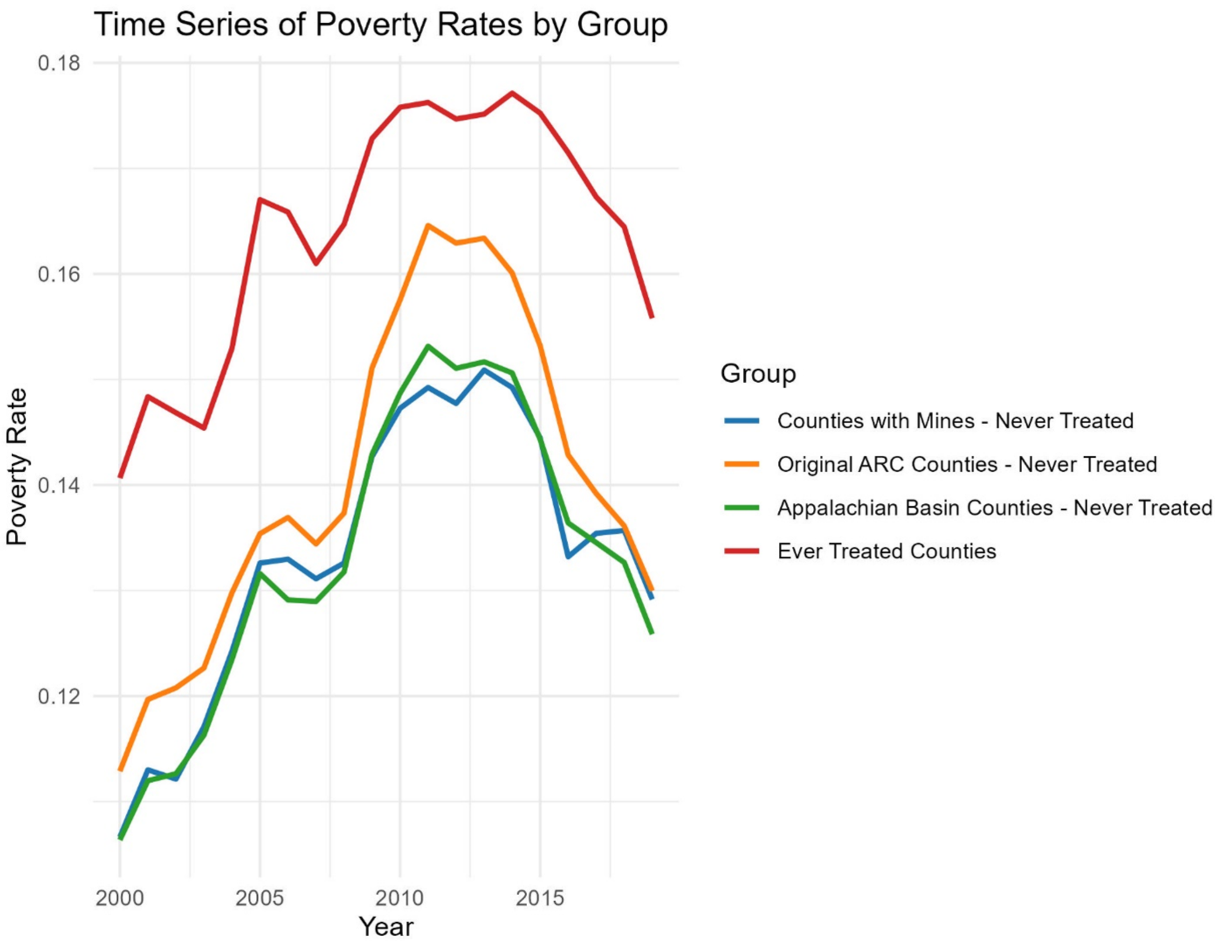

Figure 5: Poverty Rates by County Group, 2000 - 2019

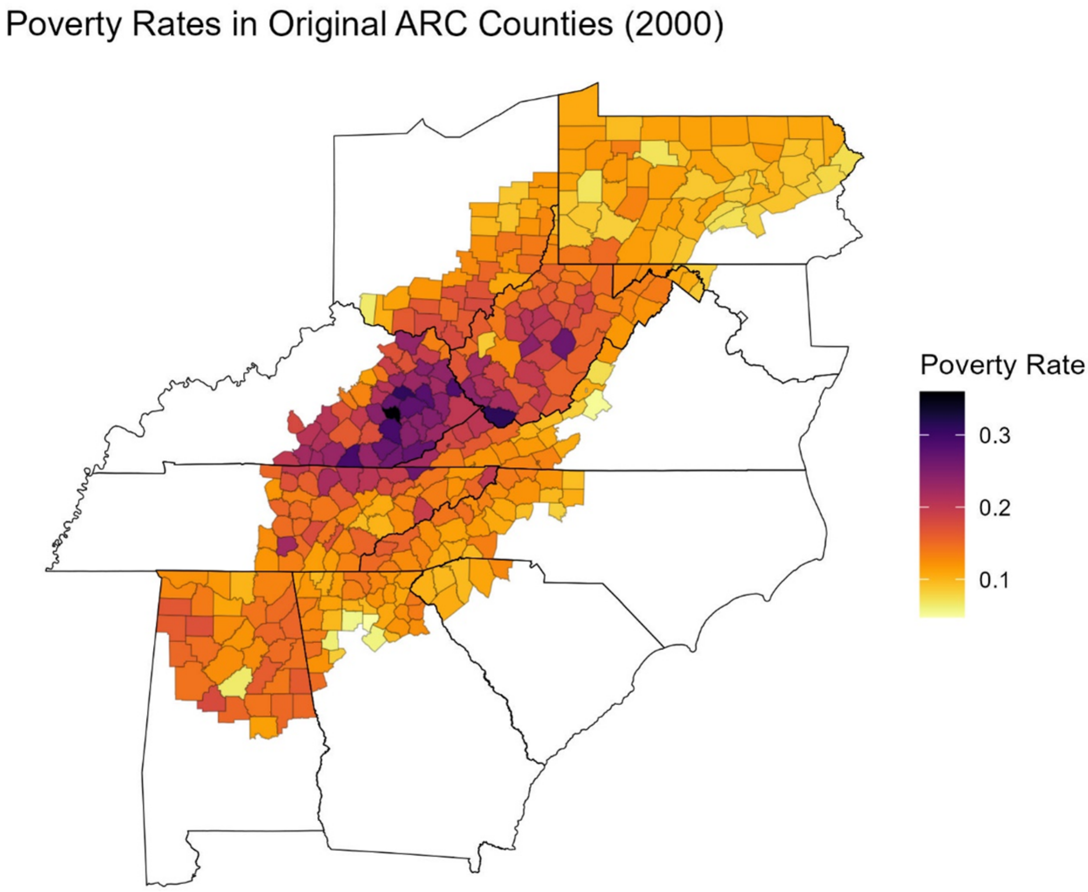

Figure 6: Poverty Rates in Original ARC Counties, 2000

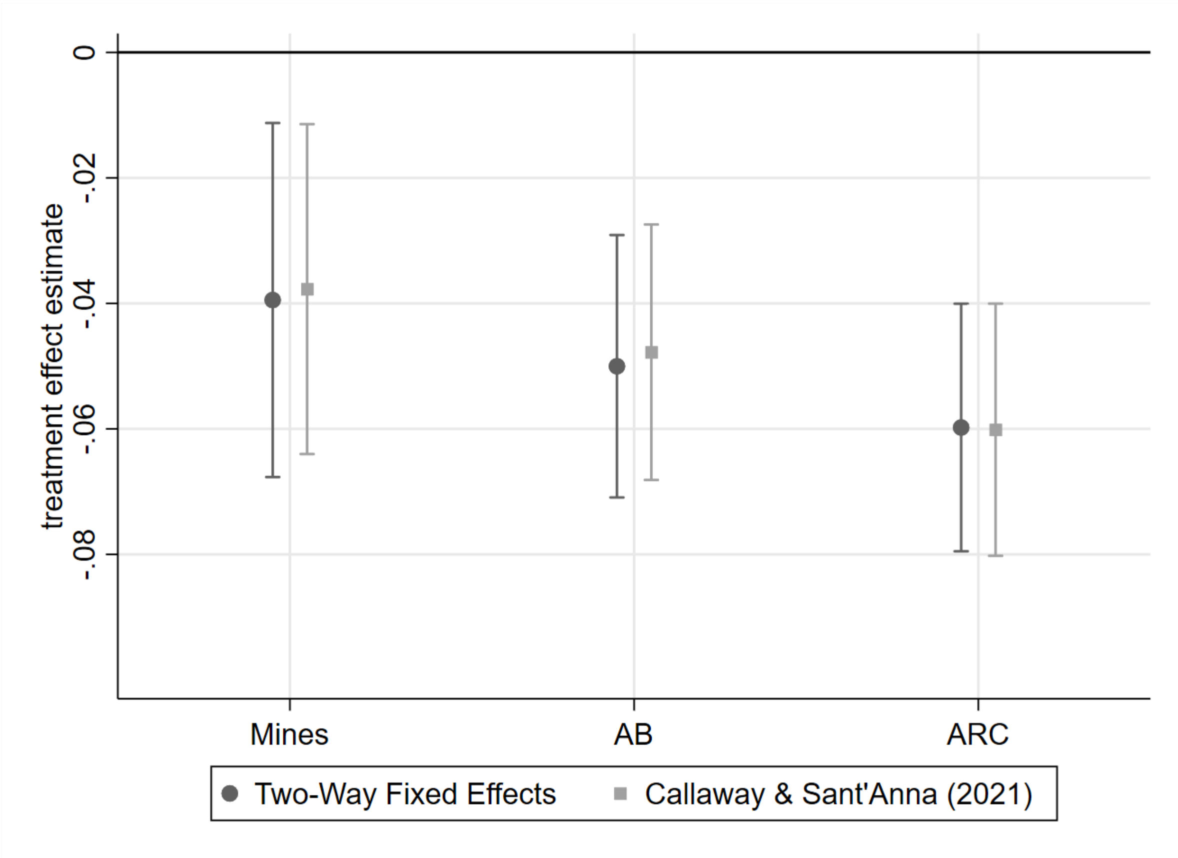

Figure 7: Point estimates and 95% confidence intervals for the two-way fixed effects and Callaway & Sant'Anna (2021) estimators on log poverty rate (by control group).

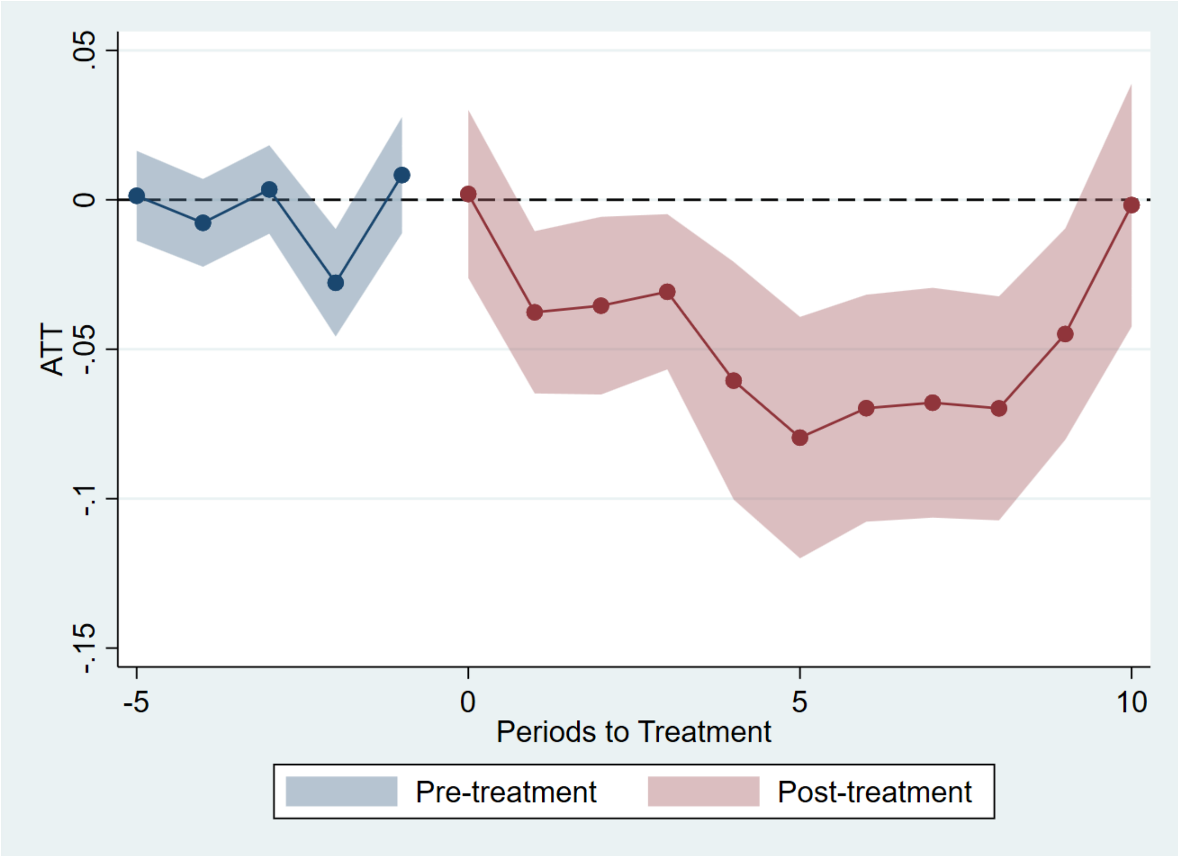

Figure 8: Event study plot from Callaway & Sant'Anna (2021) estimator on log poverty rate (using "Mines" control group).

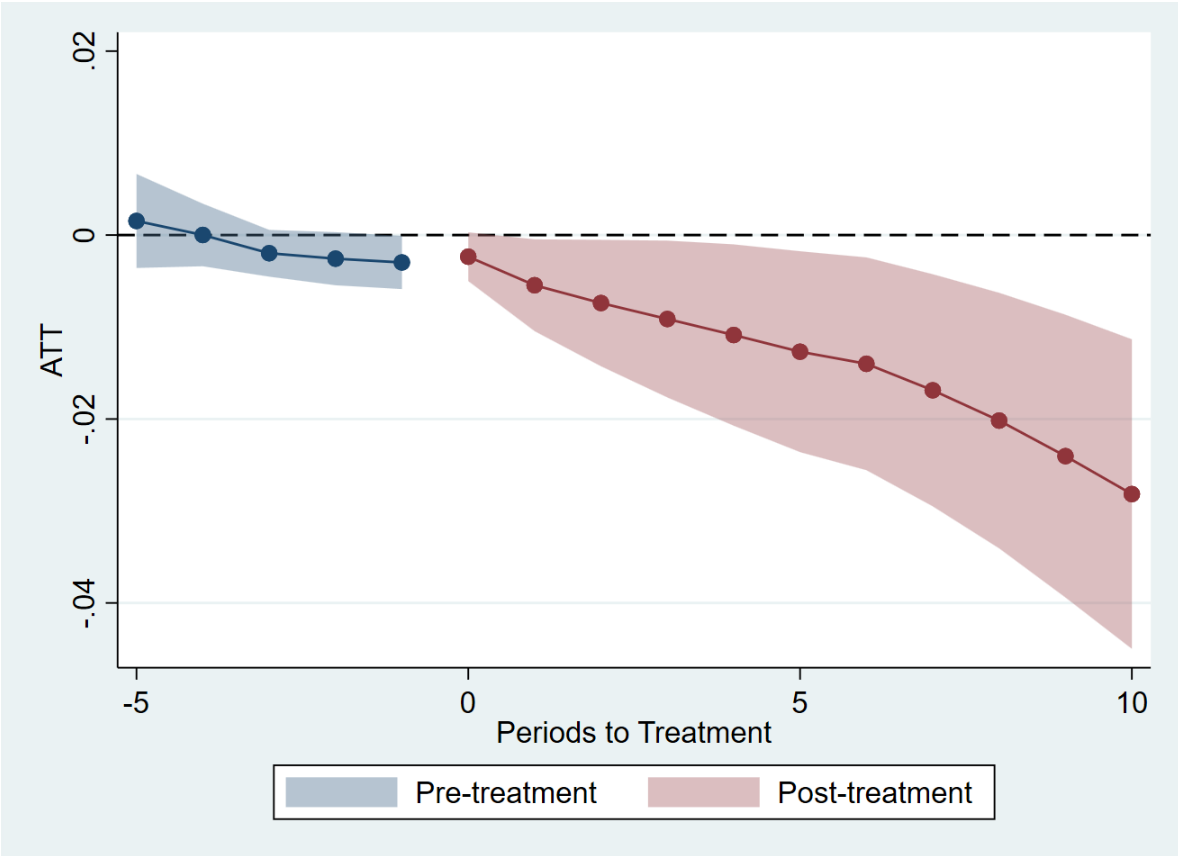

Figure 9: Event study plot from Callaway & Sant'Anna (2021) estimator on log population (using "Mines" control group).

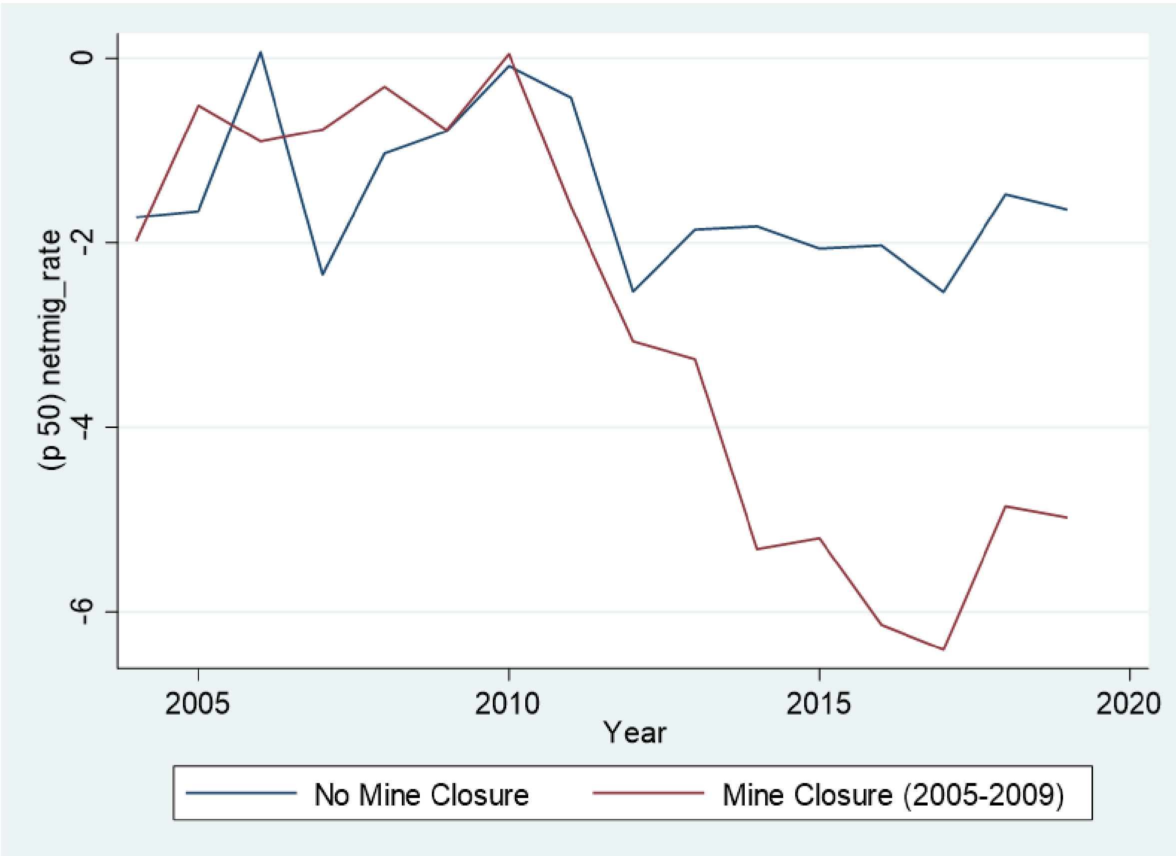

Figure 10: Net Migration Rates for Median Treated County vs. Median Control County (2004-2019)

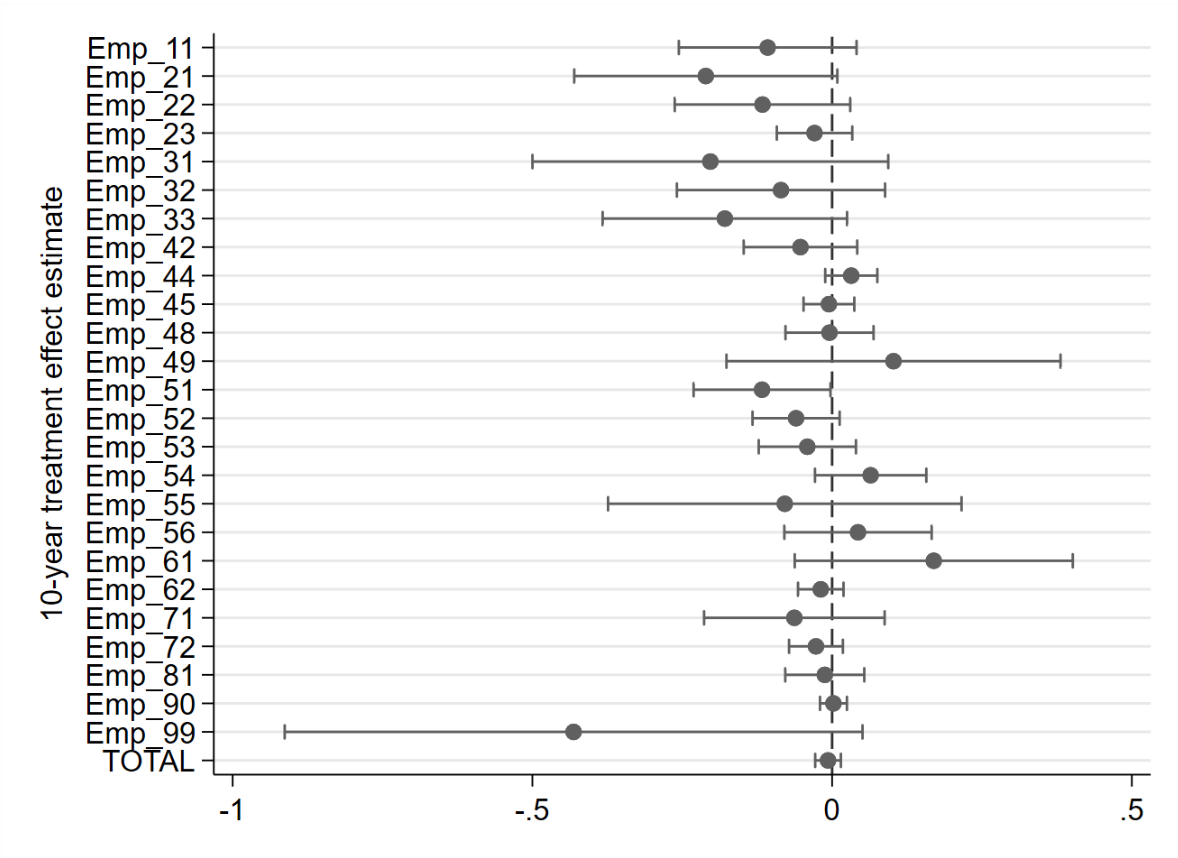

Figure 11: Point estimates and 95% confidence intervals for Callaway & Sant'Anna (2021) estimators on log employment (by industry).

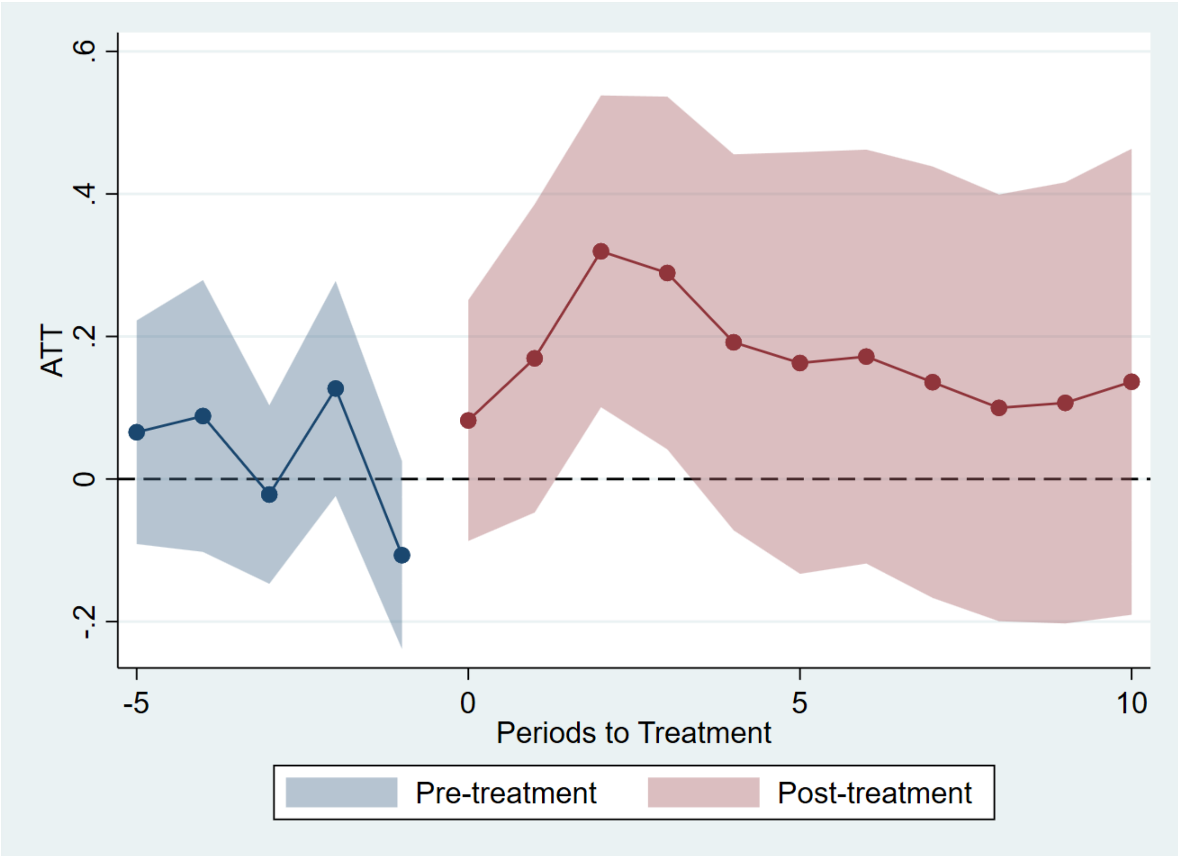

Figure 12: Event study plot from Callaway & Sant'Anna (2021) estimator on log employment in NAICS 61 - Education Services (using "Mines" control group).

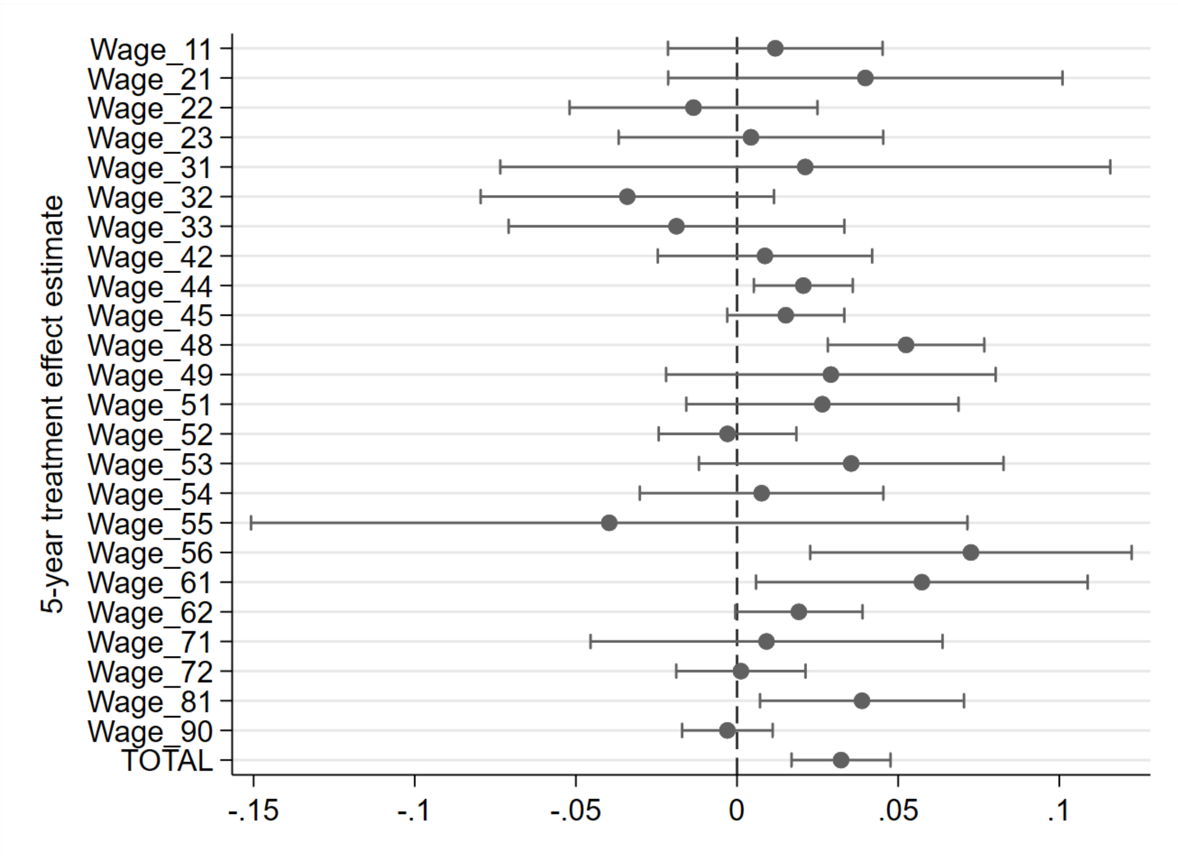

Figure 13: Point estimates and 95% confidence intervals for Callaway & Sant'Anna (2021) estimators on log wages (by industry).

Figure 14: Median Shares of Educational Attainment Status for 25+ Population 2007-2019: No HS Degree (top-left), HS Degree (top-right), Associate's (middle-left), Some College (middle-right), Bachelor's+ (bottom)

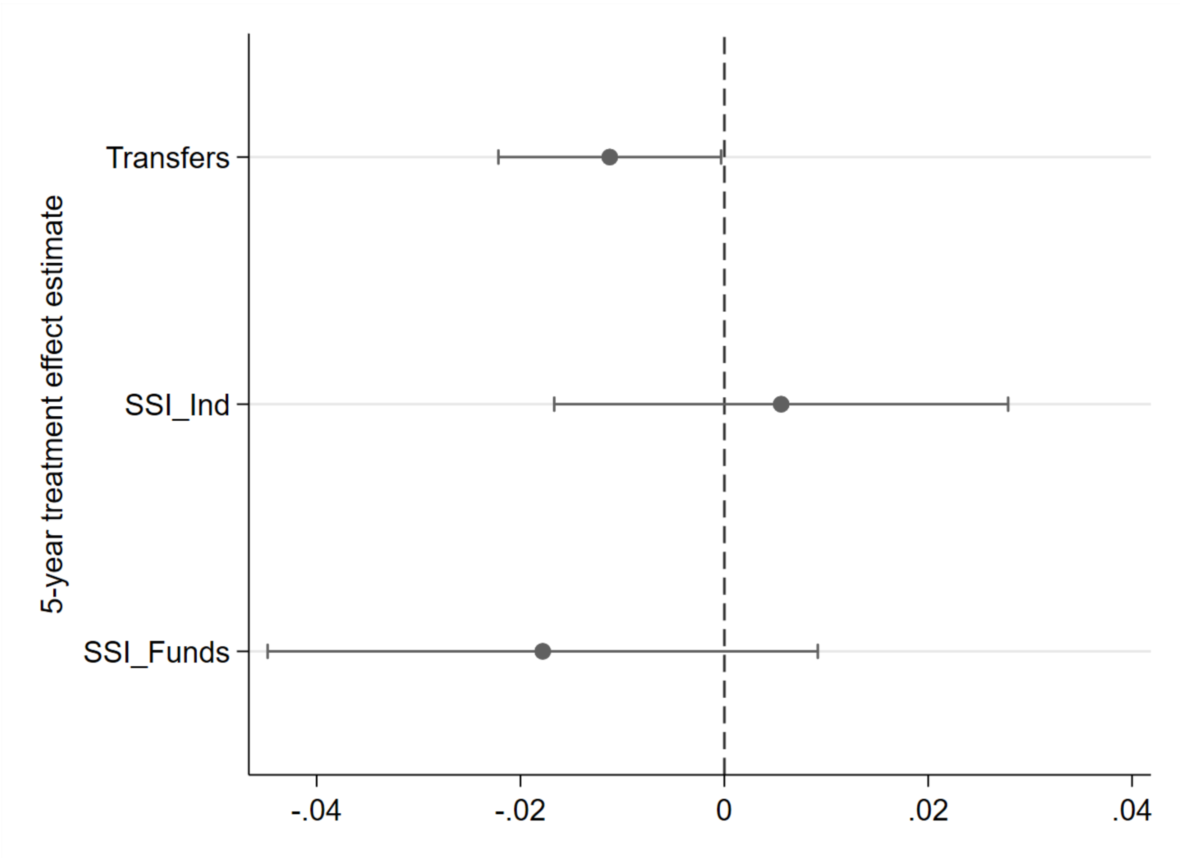

Figure 15: Point estimates and 95% confidence intervals for Callaway & Sant'Anna (2021) estimators on public benefits per capita.

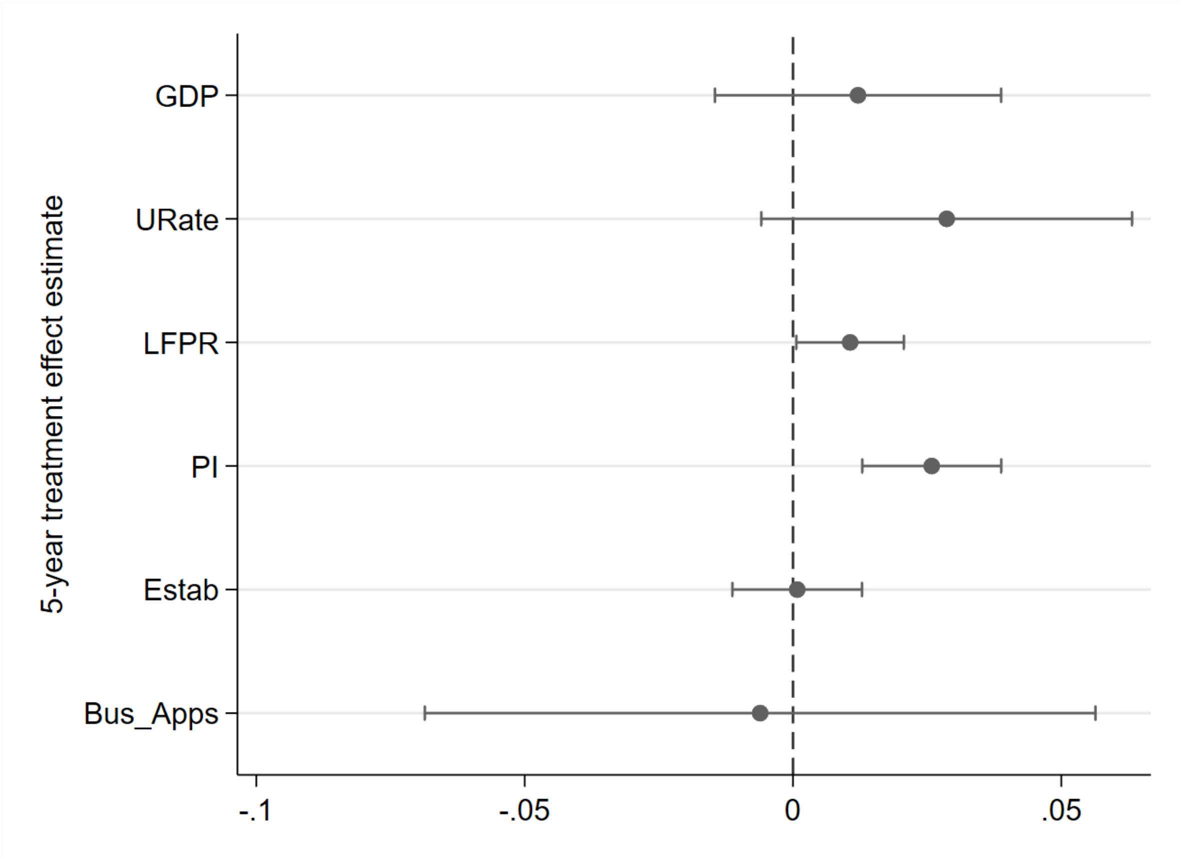

Figure 16: Point estimates and 95% confidence intervals for Callaway & Sant'Anna (2021) estimators on local economic variables.