



C. William  
**Swank Program**  
in Rural-Urban Policy

# A Bigger Bang Approach to Economic Development: An Application to Rural Appalachian Ohio Energy Boomtowns

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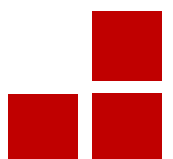
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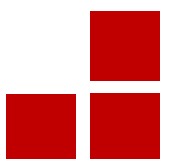
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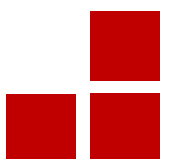
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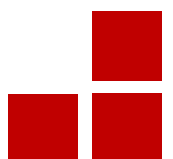
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# Executive Summary & Key Findings

Given the economic stagnation or collapse of many natural-resource dependent economies, it is time for a fresh start to consider new economic-development approaches that leverage high-impact activities-; a strategy that does not double-down on natural-resource extraction that caused the problem in the first place or create even more environmental degradation that promotes out-migration and further degrades a community's future.

Appalachian Ohio is a good example of a region in need of a new strategy. Its long history of resource-extraction through logging, coal mining, and oil and gas development has not generated sustained economic prosperity. The region continues to lag the nation economically without any apparent catch up. Coal mining has played an outsized role in the region's economy and its culture for decades, but no longer fuels its economy. Ohio coal-mining employment fell from over 40,000 in 1919, to 13,500 in 1982, falling all the way to 452 by 2021.<sup>1</sup>

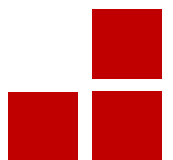
Coal's legacy includes fueling the nation's development and industrialization. However, coal's legacy also includes environmental destruction, dying coal communities, and a swath of health issues including a surprising uptick in Black Lung Disease in the last 20 years (Labao, et al., 2021). These negative externalities and coal's long-running weak economic outlook have stimulated out-migration from Appalachian coal-country and very few people in-migrate. In fact, Betz et al. (2015) find that Appalachian regions with more coal mining suffer *greater population losses* than otherwise similar places, and their finding is after considering weak economic conditions in coal country—i.e., adverse environmental effect—not just poor economic prospects—also induce people to leave coal country.

Oil and gas have replaced coal as the main natural-resource based industry in Appalachian Ohio. But as we will show, oil and gas drilling also employs relatively few workers and has not generated sustained growth in Southeast Ohio. Yet, being stuck in a natural-resource mentality means that economic-development strategies always seem to revert to more resource extraction or grand ideas about adding more value to the resource before shipping it away. In other words, the strategy boils down to [keep doing the same thing over and over, hoping for a different outcome, which Einstein \(allegedly\) defined as insanity.](#)

The oil and gas boom, for example, has heralded [calls to develop a petrochemical industry](#)

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<sup>1</sup> Labao et al. (2021) is the source for 1919 and 1982 Ohio coal employment and the U.S. Bureau of Labor Statistics, *Quarterly Census of Employment and Wages* is the source for 2021 using the sum of employment in NAICS 2121 Coal Mining and 213113 Coal Mining Support.

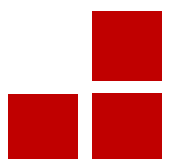


[along the Ohio River valley](#). These efforts do not make sense. The Gulf Coast already has a developed petrochemical hub (nicknamed “cancer alley”) that possesses a strong first-mover advantage. Further, petrochemical production is a large greenhouse-gas contributor, [as well as having a litany of other environmental and public-health concerns](#). Indeed, besides a [Shell Cracker plant in western Pennsylvania that will permanently employ 500 \(built with \\$1.6B public subsidies\)](#), there is little to show for such efforts. And in the case of Shell, the results has been far from what was promised to local residents. [The plant has experienced a reported 43 malfunctions since it opened in 2022 and has leaked volatile organic compounds and benzene \(a carcinogen\) in multiple flaring and odor incidents while struggling to operate](#). People generally have plenty of options of where to live and are not going to pick one with a dirty environment and a poor economic outlook. Couldn’t policymakers find a better use of \$1.6B to develop the region? Besides the human costs of another failed development strategy in a hard-hit region, approaches based solely on an abundance of wishful thinking and a lack of imagination detract from finding sustainable strategies that work.

This study appraises a new place-based strategy from Centralia, Washington and evaluates whether it can be effective in places like Appalachian Ohio’s oil and gas communities. The “**Centralia Model**” was implemented in response to the area losing hundreds of jobs at a local coal mine and the still-ongoing job losses at a nearby coal-fired powerplant, slated to fully close in 2025. Centralia faced other adverse events leading up to its new development model in 2016. These include difficulties in its timber economy and catastrophic 2007 floods, along with the normal problems faced by remote rural communities. Centralia, like Appalachian Ohio, has a long history of natural-resource dependence, and like Appalachian Ohio, has faced extended periods of economic stagnation. Another similarity is that Centralia has a long history of (generally failed) economic development strategies centered around resource extraction and its downstream industries, such as sawmills or powerplants. In sum, like Appalachian Ohio, Centralia was ripe for a new approach.

Beginning in 2016, Centralia’s new place-based development model centers on a \$55 million transition fund underwritten by [TransAlta](#), the owner of the nearby powerplant and the closed mine. Clearly, before the Centralia economic-transition model, the area verged on a downward “death spiral”, reinforced by self-fulfilling expectations. Reversing this is a difficult task for any policy maker and nearly impossible for the traditional, extraction-reliant economic development playbook.

Centralia’s approach, explained below, was to diversify and strengthen its local economy. It



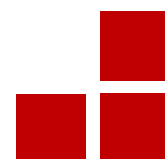
is potentially a suitable model for other local policymakers facing economic stagnation. [It is increasingly promoted as a model for other communities](#), such as Colstrip, Montana.<sup>2</sup> The Model is particularly intriguing due to its relatively low. By high-impact forms of economic development, rather than hoping outsiders save the day or providing expensive subsidies to large corporations, it taps Centralia's own assets. As this analysis will show, this lifted growth prospects and makes local economies more resilient to future adverse events (what economists label as "shocks"). Another benefit is that it appears to be inclusive of a broad array of local stakeholders, not just a small clique of local "elites" who often conflate their own individual prosperity with broad-based shared growth. Hence, Centralia's Model seems to have garnered widespread local buy-in, especially as it continues to gain credibility through its apparent success.

The core feature of the Centralia Model is that it uses the \$55 million provided by TransAlta to establish a transition grant fund which invests in highly labor-intense local economic activity. A portion of the funds, for instance, are directed to energy efficiency and weatherization work conducted by local contractors and construction companies. These investments have the added benefit of not only creating local jobs, generating additional monthly utility savings and increased property values to customers who receive free or steeply discounted home improvements such as heat pumps or new windows. Other uses of the funds include investments in quality-of-life amenities in the area, local business improvement, and attracting additional outside dollars from partners to fund novel start-ups and research into how Centralia can capitalize on technological changes in the new energy economy. The net effect is as close to a "win-win" as can be found in economic development. Centralia has kept almost the entirety of the \$55 million from TransAlta in the region, triggering local economic multipliers to create jobs and income. TransAlta was able to build a positive reputation while saving millions in the long-run, avoiding the need to make upgrades to the aging coal-fired powerplants—a process that would have involved more dollars spent on specialized equipment produced abroad and contractors from outside the region, with fewer dollars staying in southern Washington.

One should generally be skeptical of the latest fads in economic development until they have been rigorously evaluated. The Centralia Model is no different. Whether its High-Tech I (everybody's Quixotic quest to be Silicon Valley in the 1980s and 1990s), High-Tech II (today's Quixotic quest become "the next Silicon Valley"), biotechnology, "clusters," courting "the creative-class", reshoring manufacturing (the 2020s term for "smokestack chasing"), and of course, large

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<sup>2</sup>[See the Ohio River Valley Institute \(ORVI, 2021\) for more discussion.](#)





tax incentives and subsidies, the track records of the most popular economic development “strategies” are not good. Even worse, communities jump from economic-development fad to the next fad and bet their future on too-good-to-be-true unproven plans that lack convincing, data-supported evidence of success.

Green-based based economic development is often another such fad, with a mixed track record. Primarily, it often almost exclusively focused on large-scale alternative energy projects such as wind or solar farms. While such efforts are unquestionably more environmentally friendly, they require massive upfront investment, and after their initial construction, produce few jobs.<sup>3</sup> Hence, selling solar farms or wind farms as a strategy for economic rejuvenation of former fossil-fuel communities is disingenuous—policymakers must think outside the box of energy generation. For example, the Biden Administration touts that their energy initiatives will create [9-million direct jobs](#) drawing from a Blue-Green Alliance funded [study](#).<sup>4</sup> It is true the Administration’s plan is not just solar and wind farms, but such over-the-top predictions of 9-million new jobs relies on best case scenarios and ultimately damages the credibility of the entire climate agenda.

For comparison, while the Centralia Plan is touted as “green,” its design minimizes the conceptual problems associated with large-scale green initiatives and theoretically should

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<sup>3</sup>For Washington, [U.S. Bureau of Labor, Quarterly Census of Employment and Wages](#) data indicate that while wind power accounted for 11% of its 2021 summer electrical-generating capacity ([U.S. Energy Information Agency](#)), employment in wind-electricity generation totaled only 68 (NAICS 221115). In 2020, solar-electricity power generation (NAICS 221114) employed only 3. [Analogous Ohio wind and solar electricity-generating employment equaled 113 and 44 in 2021 out of a total 5.5 million nonfarm jobs.] An example of overhyping the capability of large-scale renewable energy projects to produce sustainable rural development was [TransAlta’s proposed one-thousand-acre, 180MW solar farm near Centralia in Thurston County, which was to create only 4 permanent jobs](#) after construction. [[This project was cancelled.](#)] Another case is [TransAlta’s 136.8 MW Skookumchuck Wind Project](#) near Centralia that will employ only [6 or 7](#) when operational. With the project costing over [\\$200 million](#), each permanent job requires an investment of \$30-\$50 million—which is outrageously expensive if job creation is a success metric. Though building Skookumchuck was purported to create around [270-300 temporary construction jobs](#), it’s also a cautionary tale of how small rural labor pools are often not tapped, even during construction, due to lack of skilled workers. Hence, the construction workforce will be mainly composed of temporary in-migrants or in-commuters, limiting the local stimulus. Centralia-area labor unions had little luck in acquiring jobs for their members on the project and much of the construction workforce was reportedly from out-of-state. Further limiting economic stimulus is the local supply-chain and associated jobs are almost nonexistent because components are sourced elsewhere. In sum, these large renewable-energy projects likely pass benefit/cost analysis due to environmental gains, but are poor local economic-development strategies due to: (i) minuscule long-term (local) labor needs, (ii) lack a corresponding local supply-chain, and (iii) much of the profits leak out of the region to corporate owners.

<sup>4</sup>The Biden Administration’s use of the term “direct jobs” means the claim of 9 million new jobs do **not** include any indirect new jobs from the associated supply chain or induced new jobs created from the spending of newly hired workers, which makes the prediction even more fantastical. Besides high capital-intensity of green- (and fossil-fuel) energy production that limit job creation, it is unclear who will take the 9+ million new jobs. BLS data indicates that there are only 5.657 million unemployed workers as of April 2023, and it is highly likely that most these individuals lack the necessary skills for the touted jobs. Even if they possess the skills, are they going to simply relocate to where the touted jobs are found. Finally, when discussing “job creation,” credible economists count associated job losses in the fossil-fuel industry during this transition—i.e., when economist say, “all else equal,” they are discussing *net* effects. Environmental concerns alone justify many green-energy initiative, but political claims about “millions of new good-paying jobs” undercut their whole program’s credibility and plays into the hands of critics.

produce better local-development results, especially in rural settings. Hence, the Centralia Model is something new! But is the Centralia Model *responsible* for the economic impacts seen in the raw economic data? That is what this study evaluates and it should not be summarily dismissed as typical over exaggeration. Unwarranted job claims undercut public support for climate-change policy and distract from the looming potential disaster and this study aims to accurately estimate the impact of the Centralia Model over the last eight years.<sup>5</sup>

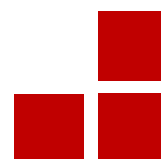
In what follows, we review whether the oil and gas drilling “boom” in much of Appalachian Ohio has brought the region sustained prosperity. Findings from a host of indicators show that it has not. We then explain why such findings are unsurprising. This explanation centers on what economists call the “natural resource curse”—the counter-intuitive phenomenon in which resource-dependent regions underperform otherwise equal places who lack natural resources. Appalachian Ohio shares many of the features typical of the curse. Southeast Ohio has produced significant amounts of natural gas that has sharply increased its GDP, but GDP is not the same as the residents’ income, which has not greatly changed alongside oil and gas operation. The oil and gas region has also not gained jobs on *net* and is losing population at a faster rate than before the boom.

We then turn to explaining local spillovers from job creation—i.e., when new jobs are created, other jobs are created as the firm seeks inputs from the local supply chain and other jobs are generated when new workers make purchases at local stores, restaurants, etc. Economists label these spillovers as “multiplier effects.” Successful economic-development strategies target activities with larger spillovers/multipliers—or “more bang for the buck.” Activities supporting *local* small businesses and new startups have proven larger multiplier effects (on a per job created basis). Understanding multipliers is essential for assessing the effectiveness of the Centralia Model—and any other economic development strategy.

Economic-development officials and firms often tout their proposals with bold claims that “X number of jobs will be created” and “local incomes will rise by Y”. These figures are typically derived from commercial software that estimates local economic impacts. Two major providers are IMPLAN and REMI. In our context, advocates often use these results to justify oil and gas development due to the large forecasted economic gains or argue that closing a coal power plant will create severe economic distress. We point out several reasons why the public and policymakers alike should be highly skeptical about such claims. For example, the model’s users

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<sup>5</sup>The fossil-fuel industry also makes “over-the-top” economic predictions. From Ohio, we will discuss how job-creation claims from the oil and gas industry overstated actual new jobs by 10-fold or more from fracking-led development.

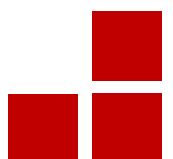


sometimes incorrectly double-count supply-chain effects, which inaccurately increases the reported economic gains or losses. Also, models such as IMPLAN do not consider prices, which is a very peculiar economic assumption. Most importantly, they do not consider “displacement effects”, such as how economic development crowds out other economic activity that otherwise would have taken place. There are only so many workers and capital in a region, and singular large projects drive input prices (especially wages, land values, and housing prices) higher, leading other businesses to forgo projects or investments. This is a relatively common observation when a new firm is recruited to region (usually with a tax incentive package) and offers higher wages, luring workers away from existing local businesses. While higher wages and more jobs are generally good, there are offsetting impacts that eat away at the net benefit typically promised by the company when it negotiates with local officials. In sum, results from these models may give us an estimate of how related industries are affected by an economic impact, but that is not the same as *net* job growth that accounts for all the positive *and* negative spillovers.

After this background in local economic-development and multipliers, we turn to the core of the report: (1) fully describing the Centralia Model; (2) assessing whether it is actually the Centralia Model that *caused* Centralia’s strong post-2016 growth(as compared to other factors); (3) comparing economic and demographic characteristics of Appalachia Ohio and Centralia to assess whether Appalachia Ohio is a good fit to apply the Model (the answer is yes); and finally draw conclusions and point out economic features that increase or decrease the Model’s effectiveness.

Our main conclusions are summarized as:

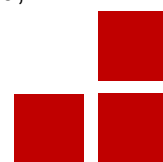
1. The Centralia Model appears to be an important cause of the Centralia region’s remarkable economic reversal after 2016: more jobs, rapid population growth, and rising income for its residents. This is shown by how economic conditions changed in Centralia relative to the nation in the first half of the 2010s vs. the second half of the decade and early 2020s. This finding is further supported by statistical analysis that shows Centralia’s economic performance greatly improved after 2016 relative to an otherwise equal county that did not implement the policy.
2. Centralia captured these economic gains at a modest cost of \$55 million, which is garnering more economic prosperity than (say) what the Shell cracker plant with its \$1.6B in public subsidies have yielded in Beaver County, PA.



3. The Model particularly targets construction, small businesses, and firm startups. Thus, we should observe Centralia's economic growth is accompanied by strong small-business income growth, more robust startup behavior, and construction leading the area's job growth. If not, one should be cautious about whether the policy was a key factor. Indeed, we find a dramatic increase in noncorporate business income after 2016 along with a small uptick in startups, but where the number of jobs directly created from each startup increased markedly (especially in construction). Moreover, construction job growth greatly accelerated after 2016 relative to the U.S. In sum, Centralia's post-2016 experience is proceeding exactly as expected if the policy is the actual driver.
4. We point out that Centralia has key assets that likely improved the odds of success including having a modest urban cluster of about 30,000 residents, spectacular natural amenities, strong transportation links, and being in a state with a reputation for good government.
5. Southeast Ohio shares many of the same features—sometimes a little better and sometimes a little worse. For example, Appalachian Ohio has favorable natural amenities (perhaps not at Centralia's level), even better transportation networks, and greater access to higher education from a multitude of nearby high-quality universities in three states and workforce-training centers. The region lacks urban areas, though this is partially offset by proximity to Cleveland, Columbus, and Pittsburgh. Appalachia Ohio also trails in large anchor institutions such as hospitals. It's also unclear if the state and local governments are as capable as those in Washington state, and the Ohio climate for small businesses and new startups (especially in Appalachian Ohio) is near the bottom of the country, and trails Centralia.

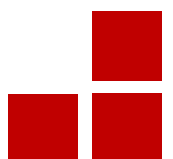
All things considered, even with the differences just described, Appalachia Ohio is exactly the type of region in which the Centralia Model has potential for success.

7. Even with clear targeting towards high-impact activities, the Centralia Model is not a miracle worker. True, it appears to be the key factor behind Centralia's rejuvenation and has promise in parts of Appalachia, but there are places whose economies face so many structural barriers that no sum of money can change their dynamics—think of the heavy agriculture regions in the western Great Plains that have greatly depopulated. One implication is that in areas facing stiff structural challenges, the Centralia Model needs to be augmented with other interventions such as infrastructure provision (not just roads but improvements like water and sewer infrastructure), better access to affordable broadband,



improved healthcare provision, and education and human-capital development.

8. Regional economies don't respect administrative boundaries. Activities such as commuting, shopping, and recreation are conducted in broad regions that extend well past the boundaries of small towns or counties. Because economic development is regional, incentivizing multi-county development efforts is necessary when individual counties lack the necessary scale to go-it-alone. Regionalization avoids pointless and wasteful competition between neighboring communities, which often only benefits companies seeking to leverage such competition into tax incentives. In Southeast Ohio, the Appalachian Regional Commission (ARC) can greatly facilitate the "regionalization" process by providing seed grants and by playing a broker role, bringing multiple jurisdictions and key organizations to the table.



# Introduction

The long struggle of Appalachia to keep pace with state and national economic growth is well documented. Traditional economic development policies are largely based on outdated economic theories and have not led to a shared prosperity for Appalachian residents in the form of higher wages and long-term job opportunities. [Data from the Appalachian Regional Commission](#) (ARC) shows that in 2019, prior to the effects of COVID-19, U.S. per-capita market (personal) income was \$46,968.<sup>6</sup> The region, which the ARC classifies as including portions of thirteen states, had 2019 per-capita *market* income of just \$33,926, which was 27.7% less than the nation. In Appalachian Ohio, 2019 per-capita market income was an even lower \$30,966, lagging the U.S. by 34%.

What stands out is that the economic prosperity of Appalachian residents has not improved relative to the rest of the country despite vast investments by the oil and natural gas industry during the shale-energy boom over the last decade-plus (Kowalski 2022). Data from 2010, predating the energy boom, shows that per-capita market income in the entire Appalachian region lagged the nation by 25% and Appalachian Ohio lagged the nation by 35%. This means that non-government transfer income for Ohio's Appalachian residents improved by only 1% relative to the nation over the "boom" decade, trailing even the nearly 3 percentage point improvement for all of Appalachia.

Before the drilling boom, industry funded studies suggested largescale job gains. The industry's Ohio Oil and Gas Energy Education Program funded a study by Kleinhenz and Associates' (2011, p.3) that predicted the energy boom would deliver Ohio, "More than 204,000 jobs will be created or supported by 2015 due to exploration, leasing, drilling and connector pipeline construction for the Utica Shale reserve." Similarly, an Ohio Shale Coalition funded study conducted by Cleveland State University estimated that nearly 66,000 jobs would be created by the oil and gas industry in Ohio by 2014 (Thomas, et al., 2011).

A later [Cleveland State University study](#) commissioned by JobsOhio (the state's prime economic development agency) concluded that the energy sector had cumulatively invested over \$97.8 billion in Ohio between 2011 and 2021. While JobsOhio [claimed in 2022](#) that "the

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<sup>6</sup> Market income is a measure of how much local income is derived by *market activities* such as from profits, rents, and wages. It is derived by subtracting government transfer payments from resident's personal income because transfer payments are not market-based earnings. Personal income measures wages and salaries, dividends, rental income, other labor income, and government transfers earned by *residents*.

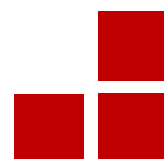
cumulative investment in shale gas development over time has brought thousands of jobs to hard-working Ohioans and affordable energy to residential and industrial consumers,” Appalachian Ohio still lags the nation in per-capita market income by 34% with no tangible job spike during this decade period.

This report explores the contrast between a growing shale and oil industry in Appalachian Ohio and the continued economic stagnation for its residents. Further, it explores whether alternative economic-development approaches can produce better, sustainable economic outcomes for Appalachia via greater positive spillovers that retain more income in the region and support more local jobs and families.

While increasing domestically sourced oil and gas has many beneficial effects for the U.S. overall, economic benefits to local communities and their residents over the long-term—including through the booms *and the subsequent energy busts*—is a question that has received insufficient attention from economists and policymakers. Sure, there are economic gains during a boom, but do these gains persist in a bust? This question is especially important to consider against the backdrop of the costs of energy extraction including environmental degradation and socioeconomic disruption.

Across the nation, counties that encourage energy development are often areas that are the most desperate for economic growth and would struggle regardless (Rajbhandari, Faggian, and Partridge, 2022). They are willing to tolerate negative externalities from drilling including pollution, traffic accidents, and increased crime in the hopes of new economic activity. These counties tend to be rural and are typified by areas in Appalachia Ohio, Pennsylvania, West Virginia, and Kentucky. These areas also experienced considerable energy development in the past (usually coal). Recently, the federal and Ohio state governments have committed large sums of money to improve the resiliency of Appalachian communities. For example, Ohio House Bill 377, enacted in June 2022, commits \$500 million to Appalachian economic development (The Governor of Ohio, 2022). An initial planning phase of \$50 million will be followed by \$450 million in grants to Appalachian communities and regional partnerships to enact “transformational plans” that incorporate infrastructure, healthcare, and workforce development.

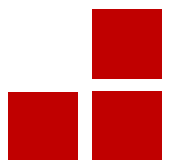
But even as governments directly invest in local communities, energy development in coal, oil and gas remain the dominant focus among Appalachian residents and policymakers. There is a long-held belief that natural-resource extraction leads to more local jobs and higher incomes. Basically, economic-development thinking has barely evolved over the last couple of centuries as energy extraction receives an oversized emphasis compared to other possibilities. JobsOhio’s



[most recent Shale Investment Report](#) notes that *shale-energy production* grew in Ohio for the 4<sup>th</sup> consecutive year after the severe bust that began in late 2014. Another JobsOhio commissioned study tracked the state’s cumulative shale investment, finding that cumulative shale *investment* was \$95.3 billion between 2011-2021 (JobsOhio, 2022). Assuming this total is accurate, it would be impressive, but *production and investment are not the same thing as widespread economic prosperity experienced by most residents*. Indeed, [a series of Ohio River Valley Institute \(ORVI\) reports](#) illustrate that this is not the case. Specifically, they show that soaring local production/output/GDP growth in the oil and gas sectors have not translated into corresponding gains in jobs, population, or residents’ income fact, it appears that energy development may have handicapped many communities and they lag otherwise similar communities **without** any tangible energy development during the oil and gas “fracking boom.”

This report draws on recent *peer-reviewed economic research* to help explain why such vast investments in extraction and mining have not generally generated the large numbers of jobs promised for permanent residents. Focusing on Appalachian oil and gas regions, the PI and wages of residents in these counties have not grown compared to the nation. Much of this body of research explores different aspects of local economies and considers the impact of the energy sector across different industries, education levels, considers migration patterns, and the interplay between metropolitan and nonmetropolitan areas. While considerable research indicates a more muted effect than claimed by many policymakers and the industry, there is growing evidence to suggest that redirecting public investment to build from *within* communities can lead to successful socioeconomic outcomes. Such developments can produce a more “just transition” with better outcomes than either continuing down the path of fossil-fuel development or by doing nothing.

In doing this, we specifically explore the case of Centralia, Washington – a community once highly reliant on a coal power plant and coal mining. The community partnered with the operator of the power plant and coal mine—TransAlta—to start their transition to a more diversified local economy that capitalizes on workforce and infrastructure assets. As a result of the grants implemented in Centralia, which are significantly less expensive than large-scale investments made in drilling, mining, and energy production, the once struggling local economy grew more the national average in many different economic measures. We will discuss in greater detail below how this occurs. Yet, the “Centralia model” has key advantages over natural resource based economic development with the feature being that a much greater share of the economic activity remains at home, allowing greater local prosperity.





# Has the shale boom produced local prosperity in Appalachia?

The answer to the question requires a thorough understanding of the economic relationship between natural-resource dependence and economic growth. Though originally examined in the context of resource-rich developing nations (Sachs, 1999), this link has also been explored for energy development for U.S. local regions. As we will discuss, many, but not all, of these regions have various unique underlying characteristics that have contributed to sluggish long-term economic growth, despite major investments in energy infrastructure.

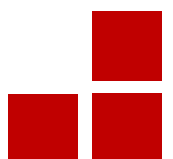
## The Subnational “Natural Resource Curse”

Economists are increasingly skeptical that natural resource led development leads to long term prosperity. There is a large body of economic literature on the relationship between economies heavily dependent on natural-resource endowments and various socioeconomic outcomes. The Natural Resource Curse was originally proposed to explain why countries such as Venezuela, Nigeria, and Libya have economically struggled despite amazing endowments of natural resources (Sachs, 1999). Many explanations have been proposed for the negative relationship between natural resource dependence and economic growth, including corrupt or outdated institutions/governments, lack of education, or a tendency for social strife. (Frankel, 2010; Papyrakis and Gerlagh, 2004). In the US, one could point to the supposed outsized political influence of the oil, gas, or coal industry in Congress or state legislatures.

In what is arguably the most telling example of natural-resource curse leading to corruption and suboptimal outcomes is the case of the Anaconda (Copper) Company (aka “The Company”) and Montana. From the period of ca 1880 to 1970, The Company dominated Montana politics and associated economic policies that favored its interests (Fisher, 1923; Shibold, 2006; Toole, 1984). The Company’s political influence extended to controlling parts of the judiciary, control of the state’s major newspapers and media, and its diversified portfolio led to dominance over a wide range of operations statewide.<sup>7</sup> Fisher (1923, p. 290) described Anaconda Company’s dominant role as:

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<sup>7</sup>Anaconda’s oversized influence extended abroad. For example, after Chile fully nationalized their extensive copper industries including Anaconda’s large holdings in 1971, President Nixon ordered accelerated efforts to destabilize Chilean President Allende’s government, leading to a 1973 coup and Allende’s death. The resulting repressive military government brutally ruled until 1990 when democracy was restored ([US. Senate Intelligence Committee \(“Church Report”, 1975\)](#)).



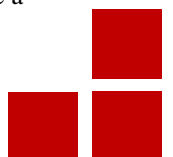
## Montana and “The Company”

*“The all-pervading and unrelenting nature of the struggle admits of no neutrals. Since the territory’s admission to statehood in 1889 the struggle has continued. On the one hand, firmly entrenched, stand the ramifying and inter-linked corporate interests centering in the copper industry, now under the leadership of the Anaconda Copper Mining Company. On the other stands the rest of the population which feels it has no stake in the Company’s prosperity, but it suffers from the Company’s exploitation of every natural resource and profitable privilege, its avoidance of taxation, and its dominance of the political and educational life of the State. The latter side has the largest potential man power, although the forces of the company, including all officers, henchmen, agents, sub-agents, employees who feel their livelihood is dependent upon their public attitude, unaffiliated business interests who sell to the Company and its subsidiaries or who must secure banking credits, and professional men to whom business can be thrown and who desire to rise in the social world—all these total a considerable number. But the opposition is only partially united by farmer and labor organizations led by intermittent crusaders for the democratic idea, frequently by men not entirely devoid of personal political ambition, although even for these the risks and sacrifices are by no means small. But the Company is led by a single united command of professional soldiers designated in Montana by the term “on the pay roll.” The local field office in Butte is popularly known as “The Fourth Floor of the Hennesey Building”—awe-inspiring title. Of the general headquarters back of the lines, ultimate source of all authority, Montanans are never reminded by the local press except when a short news item announces that the private car of Mr. John D. Ryan or Mr. Con Kelly arrived on the Missoula or Great Falls or Butte siding last night—from New York City (Fisher, 1923, p. 290).”*

Popular claims for how oil and gas extraction is imagined to help grow regional economies works through what economists call “agglomeration economies” and “multiplier effects.” Agglomeration economies arise based on the notion that firms in more populated regions are more productive, on average.<sup>8</sup> The expectation is that oil and gas boomtowns attract population and firms, allowing

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<sup>8</sup> Advantages for firms in more populated and/or densely populated regions include being closer to both their input suppliers and their customers, reducing transport costs on both ends. Likewise, having a larger pool of workers suggests they overall possess a greater range of skills and range of firms that seek workers with specialized skills. Thus, both firms and workers can achieve better employment matches that yield higher wages and productivity, as well as reduce chances for unemployment, or having *underemployed* specialized workers. Similarly, firms also have a



them to cross “agglomeration thresholds” that allow them to attract even more people/firms—i.e., oil booms set off a virtuous cycle that lead affected communities to long-term prosperity. So, the key is for sustainable growth that is sufficiently long-term, allowing communities to cross thresholds such that even more growth can take off. A short-term boom followed by a bust is not sufficient to generate such thresholds.

Multiplier effects represent the other key factor behind the economic benefits related to oil and gas booms. The economic theories behind those effects will be discussed in detail later. Yet, the basic premise is that the creation of (say) one new job, via *external* forces such as investment by an outside company, brings new jobs and income to the region. This new income is spent locally, creating even more jobs—i.e., why the term “multiplier” is used. Likewise, a new firm purchases inputs locally, which in turn sets off another set of positive local economic multiplier/spillover effects. The logic is that over time, population growth, job growth, and growing incomes in the region will, in turn, generate agglomeration economies that set off a virtuous circle of prosperity for the local economy.

The expected overall positive link between fossil-fuel energy development and employment and income, however, is not so straightforward (e.g., Tsvetkova and Partridge, 2016). While some reports (generally not peer-reviewed) estimate relatively “large” positive job multiplier effects above 2.0 when using input-output models such as IMPLAN, Munasib and Rickman (2015) note that input-output type models often overstate multiplier effects for a variety of reasons, especially for export-based economic activity such as oil and gas.<sup>9</sup> One reason is input-out style models used to make the job and income predictions do not include prices—and prices are the core economic signal that shift factors of production and produce offsetting economic effects in *actual* economies.<sup>10</sup>

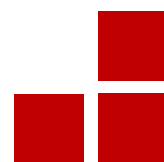
Omitting prices lead to a host of totally unrealistic assumptions for real economies. For one, omitting prices means that models like IMPLAN assume perfectly elastic supplies of goods, labor,

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wider variety of input-suppliers—e.g., patent attorneys and venture capitalists—further increasing firm productivity due to their close access. Likewise, larger regions have more resources to construct (shared) facilities such as airports and road networks, or stadiums and cultural venues, etc. Finally, there are potentially more firms possessing “advanced processes/technology” that allow other firms the opportunity to copy their behavior through knowledge spillovers, leading to increased productivity for all firms. However, the advantages of agglomeration economies are limited. Recent research finds that doubling population or density leads to productivity increases of about 3 to 5 percent (see Puga’s (2010) survey)—hardly an overwhelming advantage unless there are very large population/density increases. There are other factors that offset agglomeration economies include “congestion effects” such as greater transport costs for workforce commuters, firm inputs, or final products to customers. Economists also include related “congesting” factors such as more pollution, crime, and growing governance challenges.

<sup>9</sup> Regional economists use terms “exports” and “imports” to broadly refer to goods and services shipped to consumers *outside* the *region* or local consumers buying goods and services originating from *outside* the region, respectively. The *region* can be local, national, or international depending on use.

<sup>10</sup> For more discussion of overestimating multipliers, see Edmiston (2004), Harrigan and McGregor (1989), and Rickman (1992).



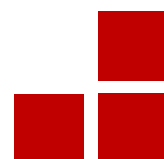
and land. For example, as oil and gas companies hire more workers, input-out models inherently assume that local wages are unaffected. In reality, the resulting upward wage pressures mean that existing firms and potential startups face higher labor costs that reduce their competitiveness and sales, causing some existing firms to close or downsize and fewer local business startups. These factors partially (or can entirely) offset the positive economic effects of a local oil and gas boom. Similarly, the failure to account for prices means that input-output models assume that as oil and gas workers move into a community, housing costs *aren't bid up* when, in actuality, housing costs rise. Higher housing costs deter some migrants who may want to move to the community and can raise costs for existing households, forcing some current residents to leave.<sup>11</sup> Economists describe these “displacement effects” and other offsetting negative economic effects from natural-resource-extraction booms in the “natural resource curse” literature.

The foundation of multipliers for variables like GDP or job creation follows from John Maynard Keynes in the 1930s Great Depression (Kinnaman (2011)). A so-called “Keynesian economy” is when the economy does not always operate at full employment—i.e., there are unemployed individuals wanting employment—and there are “sticky” prices. To spur growth, Keynes argued governments should stimulate the economy to encourage individuals to purchase more goods and services, and private businesses to make investments, both supporting new job creation. The newly employed workers’ income is then re-spent, creating a multiplier effect.

Other economists, including Milton Friedman, argue that there are limits to how much direct spending increases employment and income. If most potential workers in a region who want employment are already working, added expenditures and investment will not generate net new income. Instead, workers are just shuffled around firms. In this case, there are minimal multiplier effects and inflation becomes problematic. Indeed, in environments with low unemployment, added spending by individuals, businesses, and/or governments mean that there are minimal multiplier effects because of capacity constraints and higher prices—the US stagflation of the 1970s may be the best example. Economists label this the “crowding out effect,” in which new expenditures lead to limited net-output and -employment changes. In reality, oil and gas booms create both Keynesian and crowding-out effects. How much local jobs and income change depends on the relative size of each effect.

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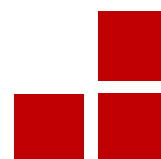
<sup>11</sup> Input-output models such as IMPLAN also assume highly unrealistic assumptions around the production process of *all* firms. One is assuming universal *constant returns to scale* (CRS) at all production levels—i.e., universal CRS implies that regardless of a firm’s scale of production, an X% increase (decrease) in all inputs such as land, labor, and capital implies an X% increase (decrease) in output. CRS means that firm productivity is always constant and equal across all firms regardless of being a big or a small firm; shrinking or expanding; with old or new technologies; across all industries; and firms never face capacity constraints that reduce productivity or increase average costs.



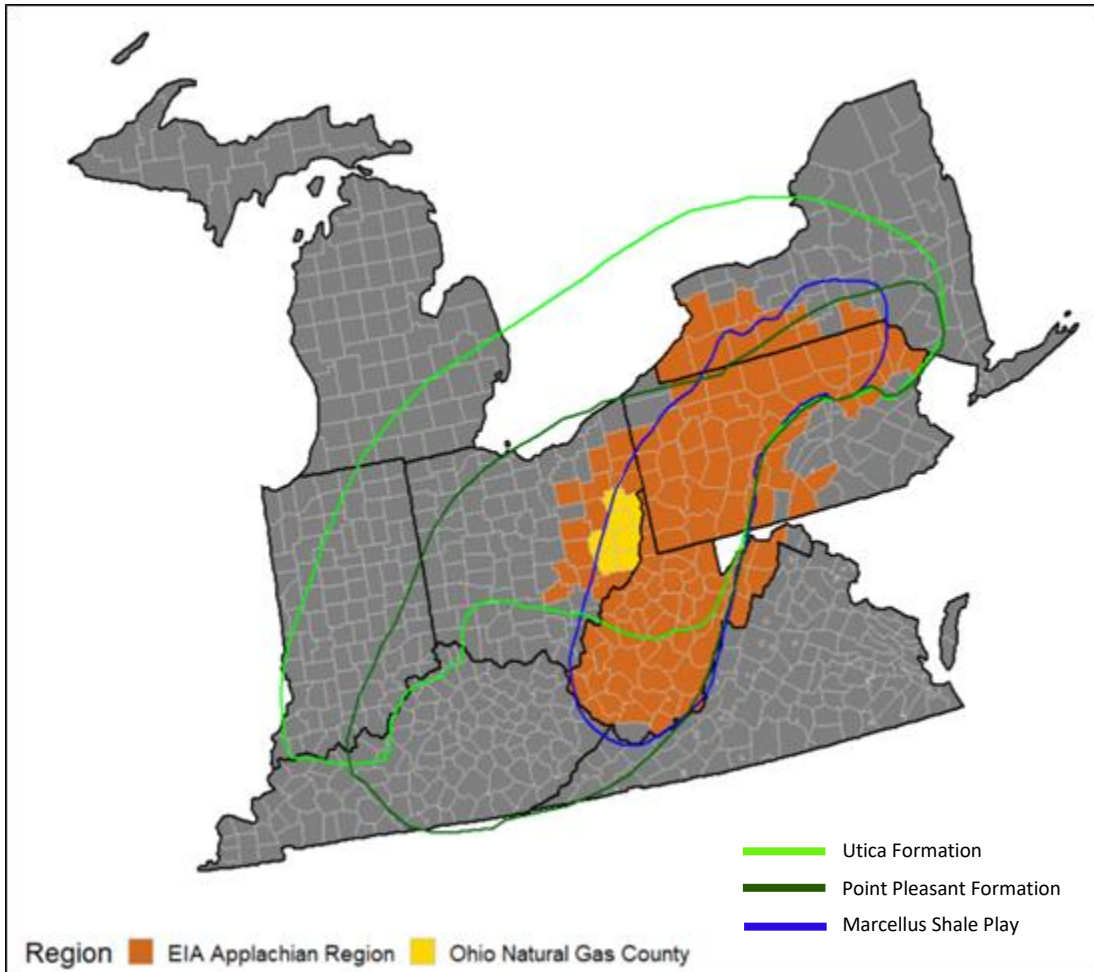
In the natural gas and petrochemical context, Kinnaman notes that firm servicing pads, drilling, constructing roads, and providing transport are then unavailable for other construction projects within a region, as well as become unavailable for any other economic activity. Direct investment by oil and gas companies may simply shift resources away from the production of other goods and services—i.e., crowding out. In such a setting, the *net* overall economic impact of the oil and gas industry investment on jobs, incomes, and tax revenue is approximately zero.

These two different economic views provide insights into the experience of many oil and gas producing regions in the last 10 to 20 years. The shale revolution largely coincided with the Great Recession and the early part of the subsequent economic recovery when unemployment was high and economic resources were underutilized. The direct private investment by oil and gas companies in shale plays is a private stimulus in a Keynesian context—in which there are positive multiplier effects, rising incomes, and employment. Yet, as economies employ more workers and as firms approach capacity constraints, positive economic effects taper off. The dissipation of any potential positive effects is further amplified when energy busts occur, usually when global energy prices sharply decline. Indeed, research by Abboud and Betz (2021) finds that oil and gas bust cycles impacted rural counties – who are already more likely reliant on resource extraction – more negatively in job losses. In [a recent study](#) of the full boom-bust cycle of the 1970s/early1980s energy boom conducted by the USDA, Economic Research Service (ERS), the University of Oregon, and the University of Wisconsin-Madison found that cumulative income for the average household in a “boom county” was \$7,600 lower than for an average household in an otherwise equal non-boom county (Jacobsen et al., 2021)—showing resource-curse effects dominated.

To explore the *net*-economic effects on affected oil and gas boom communities, we analyze summary data from both the entire United States, as well as the Appalachia’s Marcellus and Utica shale plays as defined by the Energy Information Administration (EIA). These two shale plays also overlap Ohio’s largest natural gas producing counties. See the corresponding map of these Appalachian shale plays in **Figure 1**.

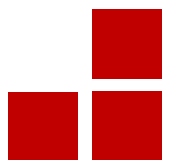


**Figure 1. Appalachian Region, Ohio Gas Counties, and Utica and Marcellus Shale Plays**



**Data Source:** Energy Information Administration

In the following sections, the economic impact of the shale energy boom on Appalachia, and specifically Ohio’s key natural gas producing counties, is examined. First, we appraise job creation and show that many jobs created are transient and are mainly associated with the initial infrastructure investments and rig construction. Even as gas production takes off, the number of jobs in the extraction sector declines as infrastructure and rig construction taper off. Additionally, there is little evidence that the growth of the oil and gas sector has generated any significant economic multipliers in the region. This is evidenced by the relative consistency (and in some cases decline) of total part and fulltime nonfarm jobs in Ohio’s largest gas producing counties from the beginning of the boom to today. Second, we examine the disconnect between high productivity and GDP growth in Appalachia attributable to the oil and gas industry and the simultaneous relative



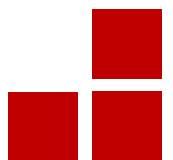
stagnation of the region's PI—i.e., regional GDP is a measure of the value of *output* and PI is the *income received* by the region's residents.

## Most Shale Jobs are Temporary and/or Filled by Outside Commuters

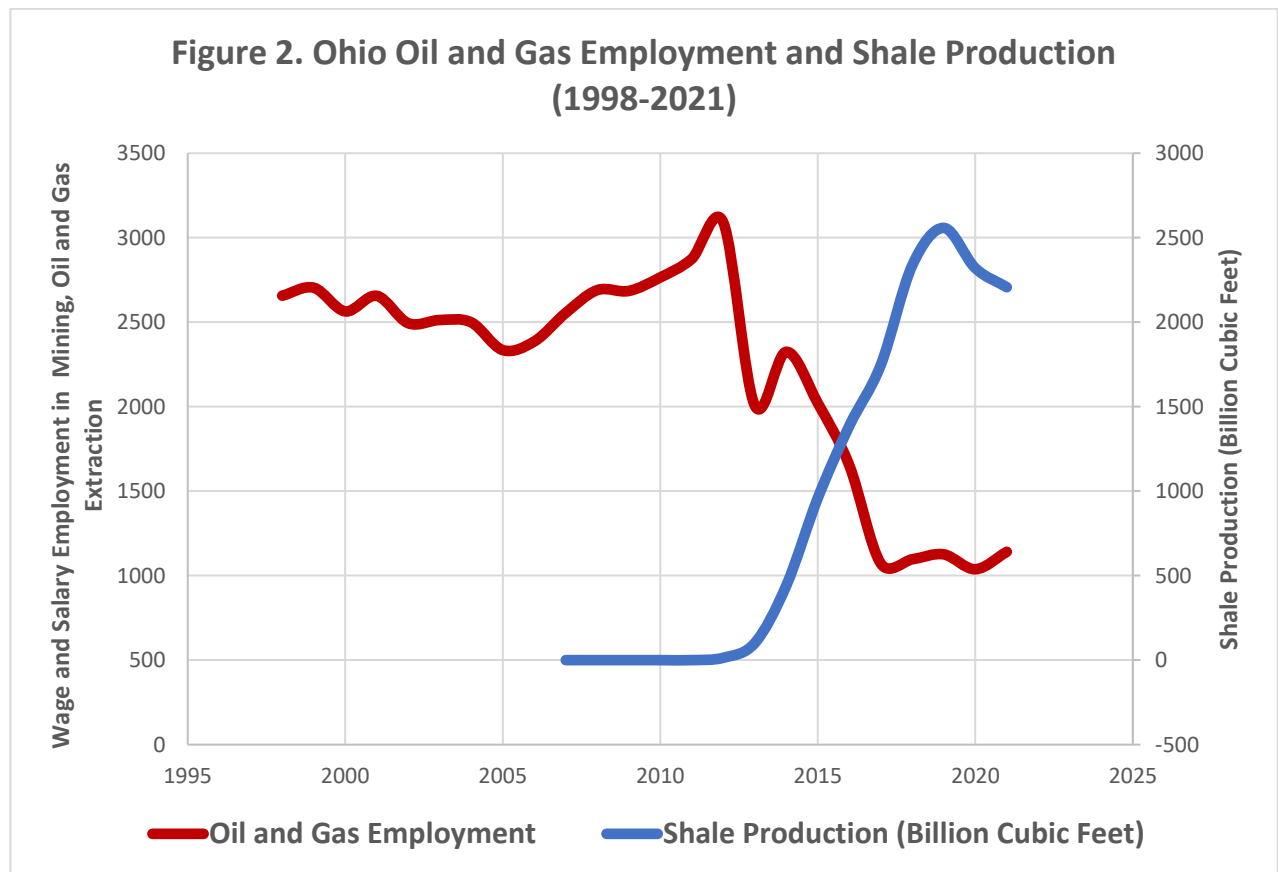
The past two decades have seen radical innovation and rapid technological change in hydraulic-fracturing methods and micro-seismic technology. These innovations, alongside higher energy prices that generally persisted to late 2014, drove oil and natural gas booms in many U.S. communities. Today, U.S. energy production remains near peak levels of the boom. According to the EIA, Ohio's first tangible shale production occurred in 2012, [with 14 billion cubic feet of gas](#). The following year, production soared to 101 billion cubic feet, peaking at 2,558 billion cubic feet in 2019. Through 2021, production remained above 2,200 billion cubic feet each year. This remarkable production growth along with correspondingly high natural gas prices in the early/mid 2010s was accompanied by dramatic gains in gross domestic product (GDP) in heavy gas-production counties. According to [Baker Hughes Rig Count](#) data, Ohio had just 7 operating oil and gas rigs in the first week of January 2010, but this grew to a peak of 48 on the week of January 16, 2015 before beginning to decline. There were 10 rigs during the week of May 19, 2023. Despite skeptics, it was widely believed that a massive growth in both production and infrastructure investment would usher in an era of prosperity for affected Appalachian Ohio communities. But it is now apparent that gas production and local economic prosperity are more disconnected than optimists assumed.

Driving this disconnect is that most of jobs generated by shale extraction occur in the early phases of development and are not permanent jobs for the region's residents. These more transitory jobs involve initial pad preparation, rig work, and fracturing processes, and collectively can take just several months. Once a well is drilled and completed, it can produce natural gas for decades, if it is a conventional well, and at least several years for unconventional wells. Monitoring producing wells does not require many fulltime employees and even "re-fracking" an unconventional well whose production is no longer profitable takes considerably fewer workers than the initial drill.

These relationships can be seen in Figures 2 and 3 below. Figure 2 plots Ohio shale production between 2007 and 2021 as well as the total number of Ohio jobs in oil and gas extraction. As the data indicates, the oil and gas extraction sector likely contributed to a temporary increase in employment after 2011 and peaking in 2014 or 2015. Since 2016, the number of mining, quarrying and oil and gas extraction jobs in the state has rapidly declined.



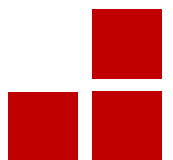
Quarterly Census of Employment and Wages (QCEW) data suggests that this decline is not solely attributable to mining and quarrying and that the total number of Ohioans employed in the oil and gas sector is now below 2007 levels— four years before Ohio began producing shale gas. While the claim that shale development brought “thousands of jobs to hard-working Ohioans” may technically have been true between 2011 and 2014 (but certainly not the hundreds of thousands the industry promised), unfortunately it appears most jobs were not permanent. Further, in no way did the oil and gas boom deliver the numbers of jobs promised by the industry.



Data Sources: U.S. Energy Information Agency and U.S. Bureau of Labor Statistics: Quarterly Census of Employment and Wages

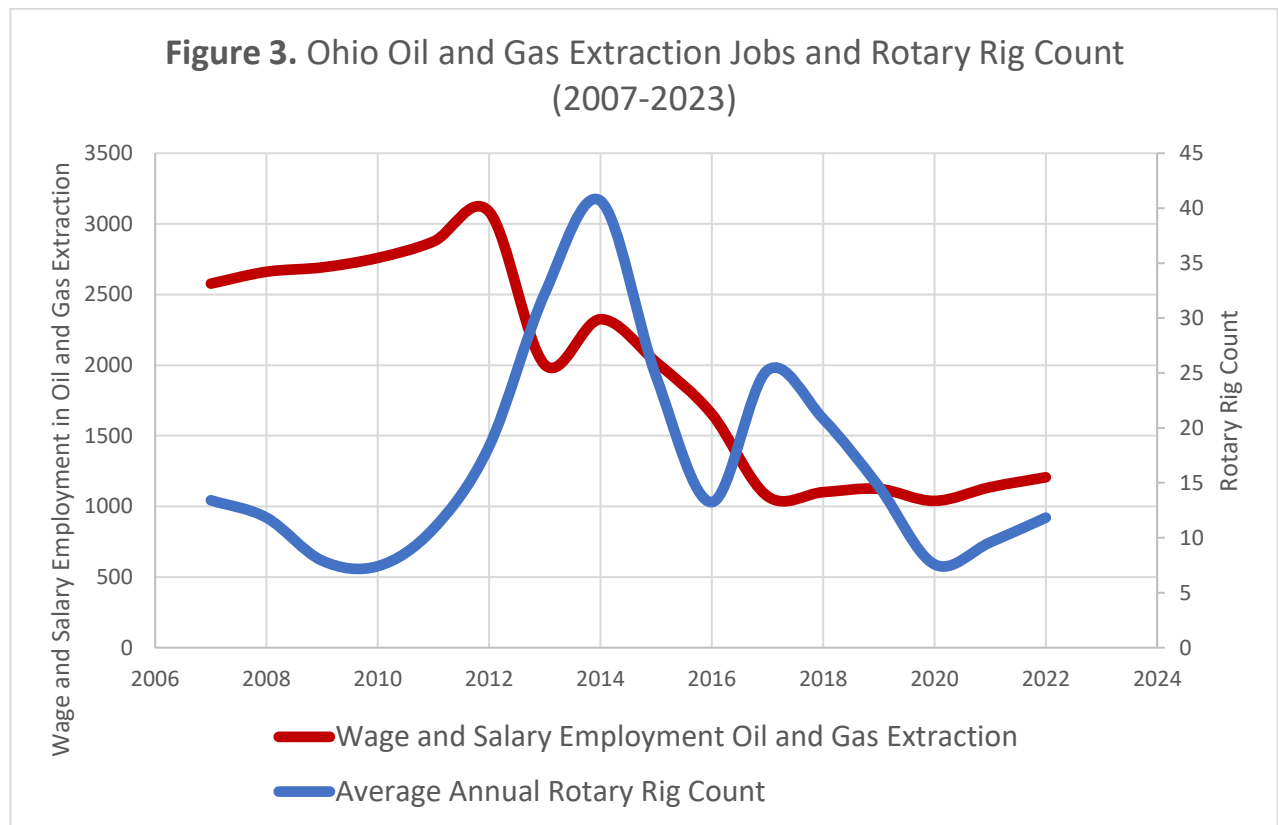
Figure 3 plots the same oil and gas extraction jobs data for Ohio but now includes the Baker Hughes rotary rig count as a proxy to measure oil and gas infrastructure investment. The rig count is available weekly or monthly and averaged over each year.

Two facts stand out in Figure 3. First, in 2021, Ohio’s total rig count has declined to a level near its 2011 starting point, at the beginning of the shale energy boom in Ohio. This decline has occurred while gas production has generally been increasing. This highlights the fact that ongoing operation and increasing production efficiency means less-intensive future infrastructure





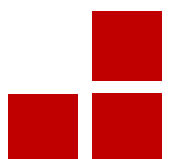
investment is needed in the region. Second, and most important, the peak number of jobs in the sector coincides almost exactly with the state’s peak rig count. This is consistent with the findings by Partridge and Weinstein (2011), Weinstein (2014) and Weinstein et al. (2018) that the local economic impacts of energy booms can change and dissipate over time with different phases of energy extraction. Most oil jobs were generated in the early phases of shale boom, when infrastructure investments were highest, and have since waned despite the ongoing high production.



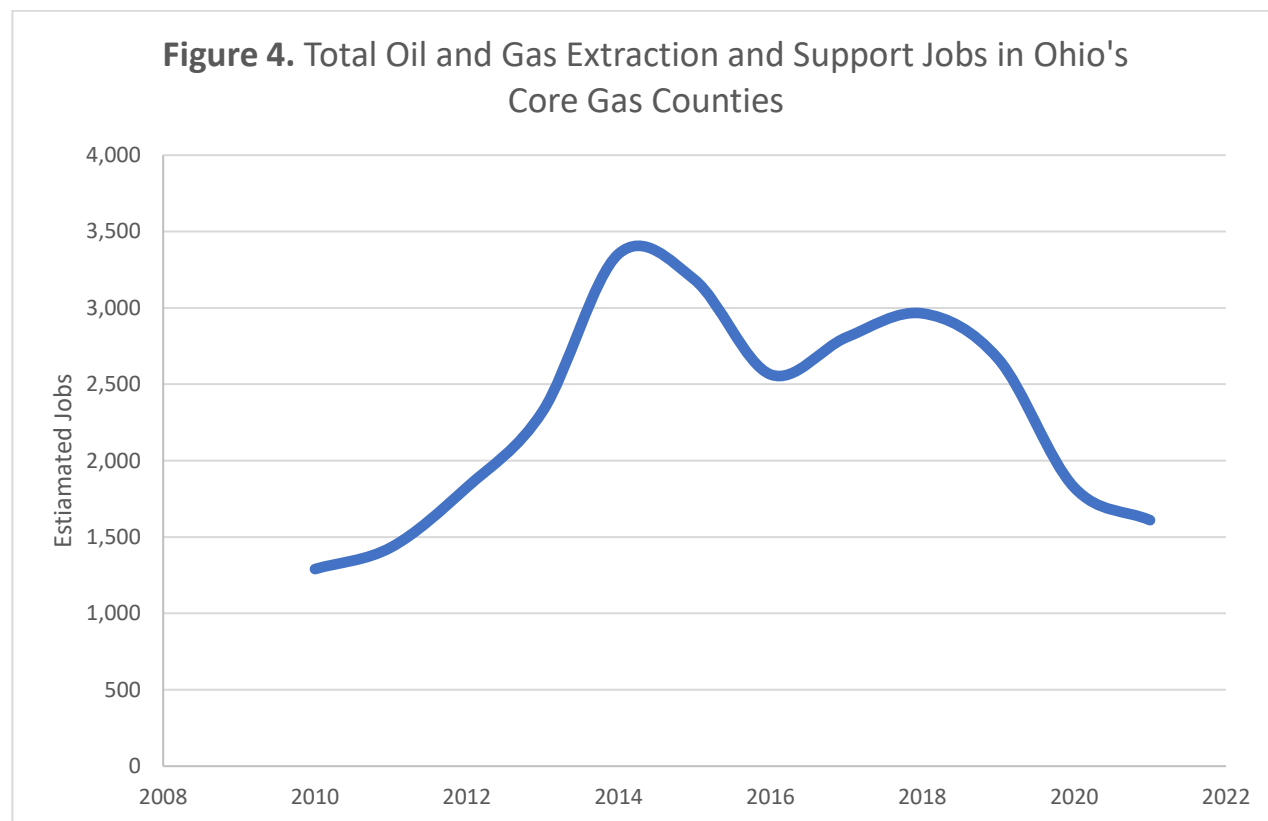
Data Sources: Baker Hughes Rig Count and U.S. Bureau of Labor Statistics: Quarterly Census of Employment and Wages. Data for 2022 are averaged from January through September due to availability.

But could the employment decline in mining have been a product of increases in oil and gas jobs being offset by losses in quarrying, coal mining, and other related industries? The evidence suggests no. Figure 4 shows mining, quarrying, and oil and gas related jobs in the 6 largest Ohio shale producing counties from the map in Figure 2: Belmont, Carroll, Guernsey, Jefferson, Harrison, Monroe, and Noble Counties.

Ohio’s shale counties generally followed the same trend as the state. After hydraulic fracturing began expanding in earnest in Ohio between 2011 and 2012, the sector’s employment



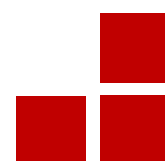
grew rapidly between 2011 and 2014. As more wells came online, fewer employees were needed to maintain active production and the sector's employment declined, returning to the same general level as 2010 before the state's shale boom. **Figure 4** shows that in the oil and gas sector, employment in Ohio's seven most productive counties is barely above 2010 levels and well below the 2014 peak.



*Notes: Ohio's core gas counties includes Belmont, Carroll, Guernsey, Harrison, Jefferson, Monroe, and Noble Counties. The data presented are scaled estimates using total mining, quarrying, oil and gas extraction jobs for each county and adjusting by Ohio's statewide proportion of mining jobs (NAICS 21) that come from oil and gas extraction (211), oil and gas drilling (213111), and oil and gas support activity (213112).*

**Data Sources:** U.S. Bureau of Economic Analysis and American Community Survey (ACS) 5-year estimates.

If hypotheses about the positive economic impact of the oil and gas industry are correct, income and job growth between 2011- 2014 should have created multiplier effects that generated additional jobs outside of the direct oil & gas extraction sector (including direct sector support) that reinforce employment growth. Figure 5 shows such widespread multiplier effects did not occur. Total full and part-time employment in shale counties has generally been stable or declining, even prior to the COVID-19 pandemic. For example, in Belmont County (Ohio's largest shale producer), total wage and salary employment in 2019 (prior to the COVID-19 pandemic) was *below* its 2007 level. The same is true of the wage and salary employment in other large



Appalachian Ohio counties. In Harrison, Jefferson, Monroe, and Noble Counties, employment also declined over the 2007 to 2019 period. For example, when summing wage and salary employment across all seven counties, total employment equaled 86,371 in 2007, 79,578 in 2012 (when the boom began in earnest) and 74,586 in 2021.<sup>12</sup> It is clear from the data that, although the oil and gas industry briefly created jobs and income in the region coinciding with the boom's initial phases, natural gas industry investments have not generated long-term permanent jobs, nor have they induced sustainable long-term job growth in those county's other economic sectors.

Another important factor is that oil and gas extraction and their associated support activities generally have relatively low-labor intensity, with the result that relatively little industry output is allocated to employee compensation. Using U.S. BEA data on employee compensation in oil and gas extraction and mining-support activities, labor's share of output for oil and gas extraction is approximately 9.8% of value added.<sup>13</sup> This labor share compares to the 2022 US average share of 53.4% across all industries, making oil and gas extraction one of the most capital-intensive industries.<sup>14</sup> On average between 2014 and 2021, the fixed-capital assets per fulltime equivalent worker in the oil and gas extraction sector (NAICS 211) is 33.9 times greater than the average for the overall private sector.<sup>15</sup> Even combining the part of the oil and gas industry that is extraction support (NAICS 213112), the corresponding ratio of fixed assets per fulltime equivalent worker is still 13.95 times greater than the overall private-business sector.

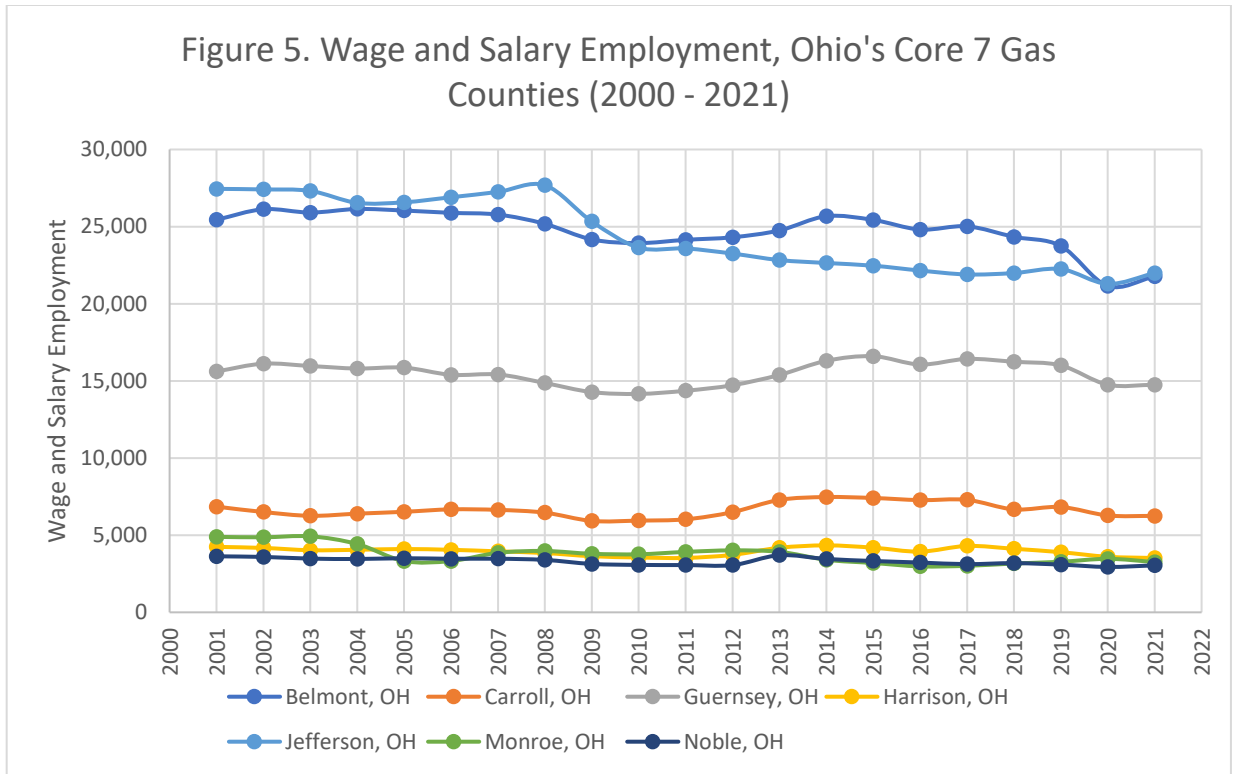
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<sup>12</sup> Source: U.S. Bureau of Economic Analysis

<sup>13</sup> Using BLS data, we assume that approximately 76% of mining support activities are oil and gas support activities. Our calculations weight the BEA's measure of mining support activities by its employment share.

<sup>14</sup> The data is from the BEA, Table 7, found at: <https://www.bea.gov/data/gdp/gross-domestic-product>.

<sup>15</sup> This figure is first derived by collecting BEA data for total fulltime-equivalent workers and fixed-capital assets in the: (1) overall private-business sector, (2) oil & gas extraction sector, and (3) *mining-support* sector. For both the total private sector and the oil & gas extraction sector (NAICS 211), we simply divide fixed assets by fulltime equivalent employment to obtain capital per fulltime-equivalent-worker in each case, which is how the 33.9 ratio is derived. Because BEA data does not split mining-support employment and fixed assets into the part due to the oil & gas sector, we use the BLS oil & gas support-employment share of total mining-*support* employment to create an estimate of BEA mining-*support* employment and total-fixed assets in the oil and gas sector—i.e., we multiple both BEA mining-sector-support employment and fixed assets by the BLS employment share for mining support that is in the oil & gas industry. We then add the BEA oil & gas extraction sector figures to the estimated oil and gas support sector figures to obtain the ratio of dollars of fixed capital per fulltime-equivalent-worker in the combined sector, which is how the 13.95 estimate is obtained.



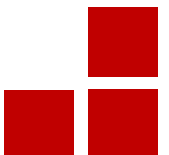
Data Source: US Bureau of Economic Analysis

Next, we consider whether the oil and gas boom brought impoverished Appalachia Ohio communities increased incomes. It is possible that even though the boom appears to have very little positive net effects on jobs, low-paying jobs were replaced by higher-paying jobs that when combined with other factors, such as lease and royalty payments, induced higher incomes for residents? We again find this is not the case.

### The Boom Raised Appalachian Ohio GDP but not Local Incomes of its Residents: Local Output is not the Equivalent of Local Resident Income

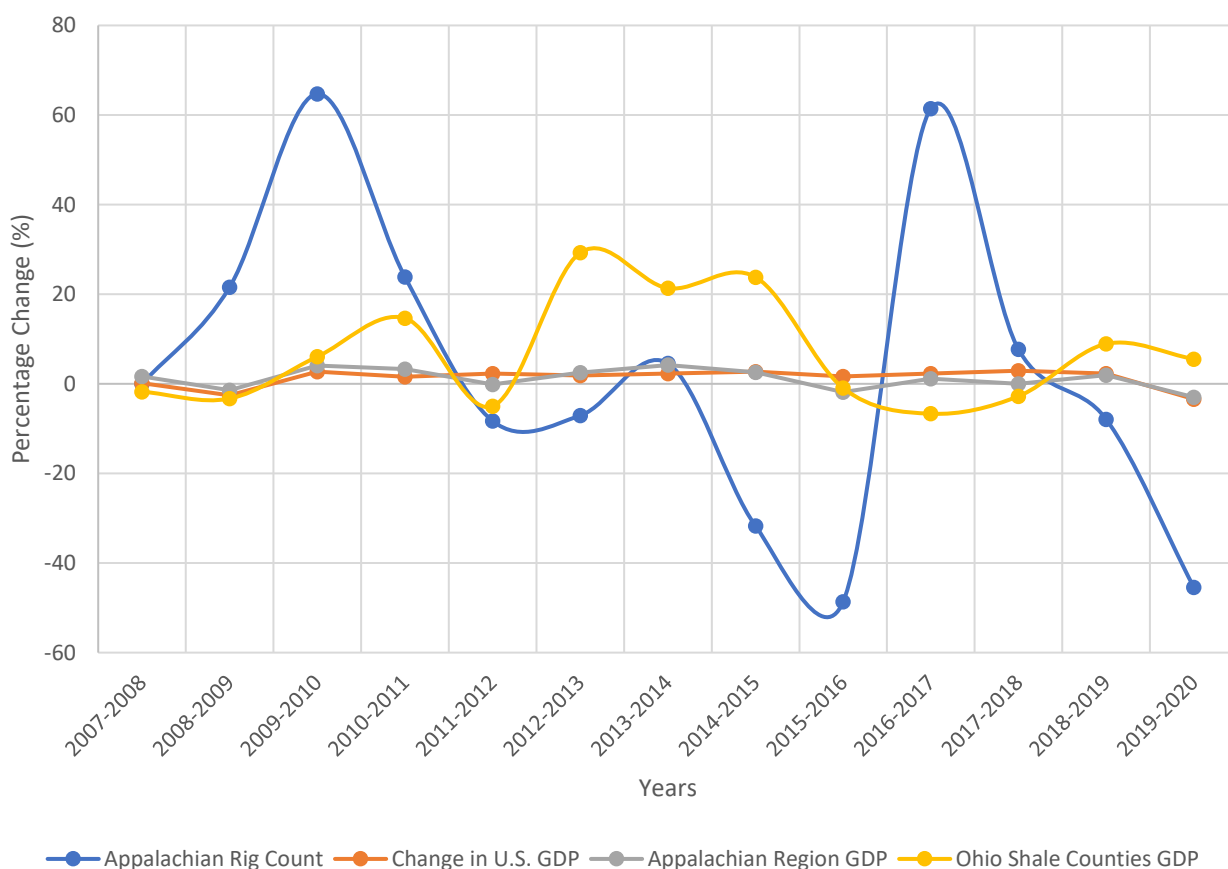
To assess whether the 2011-2021 Appalachian Oil shale boom increased local incomes in the affected Appalachia Region, we focus on two common economic measures of well-being: (residential) PI and gross domestic product (GDP).

GDP is a widely used measure of economic well-being. It measures the value of economic production over a given period and for a particular region such as a nation, state, metropolitan area, or county, regardless of who earns the income from the production. PI, on the other hand, measures the income of residents including wages, employee benefits, rents, dividends, interest, profits earned by proprietors, and other investment returns earned by region's residents. At the national



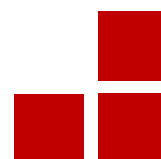
level, GDP and PI move closely over time, but at the subnational level (especially for smaller geographies like counties), PI and GDP movements can diverge rather widely, meaning local production of goods and services can greatly vary from the income earned by the region's residents. Percentage changes in GDP between 2007 and 2020 are shown in **Figure 6**, and the corresponding PI changes are shown in **Figure 7**. In both cases, the percentage change in the Baker Hughes rig count in Appalachia is plotted as a proxy for direct investment by oil and gas companies. Note that this differs from the *Ohio* rig count shown in previous figures and captures all U.S. Appalachian counties as classified by the ARC.

**Figure 6. Change in Rotary Rigs and Change in Chained GDP, 2007-2020**



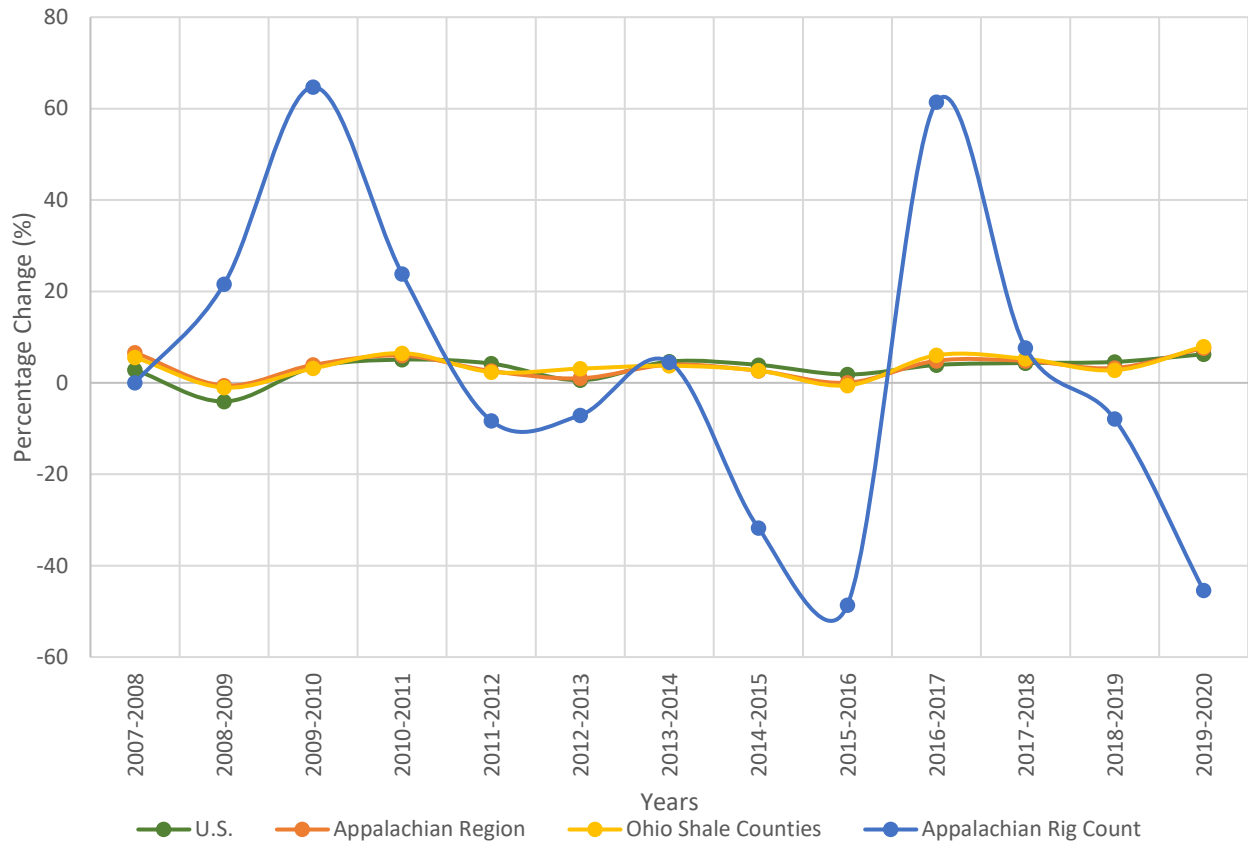
Data Sources: U.S. BEA and U.S. EIAnergy Information Administration

From **Figure 6**, it is apparent that Ohio shale counties experienced a period of rapid GDP growth shortly after hydraulic fracturing began. But, as with job data, this rapid growth was not long-lived. Although total GDP in the counties grew, the pace of growth declined. At the end of the decade, as the Ohio shale boom neared 10 years old, natural gas production stabilized and county GDP growth became negative, or at best, moderately positive. This further supports the idea that



Appalachian oil and gas extraction is an example of the natural resource curse, which indicates that oil and gas development is not an ideal long-term economic development strategy.

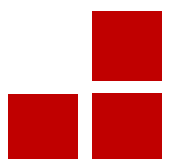
**Figure 7. Change in Rotary Rigs & Real Personal Income Per Capita, 2007-2020**



Data Sources: U.S. BEA and U.S. EIA

**Figure 7** further underscores the oil and gas boom’s failure to produce long-term economic growth despite the initial rapid GDP growth between 2011 and 2016. Local residential PI in Ohio shale counties mirrored the more modest Appalachian and national growth trends. Despite dramatic increases in GDP generated by oil and gas, the relatively flat PI growth shown in **Figure 7** over the period illustrates that rather little of this natural wealth remained with residents. Coupled with the fact that per-capita market income in Appalachian Ohio still trails the national average by nearly 34%, it can be reasonably concluded that oil and gas investments have not generated sustained prosperity for Appalachian.

The primary reason for this outcome as found by the peer-reviewed economic literature is that energy shocks such as oil and gas booms do not generally generate large (net) economic

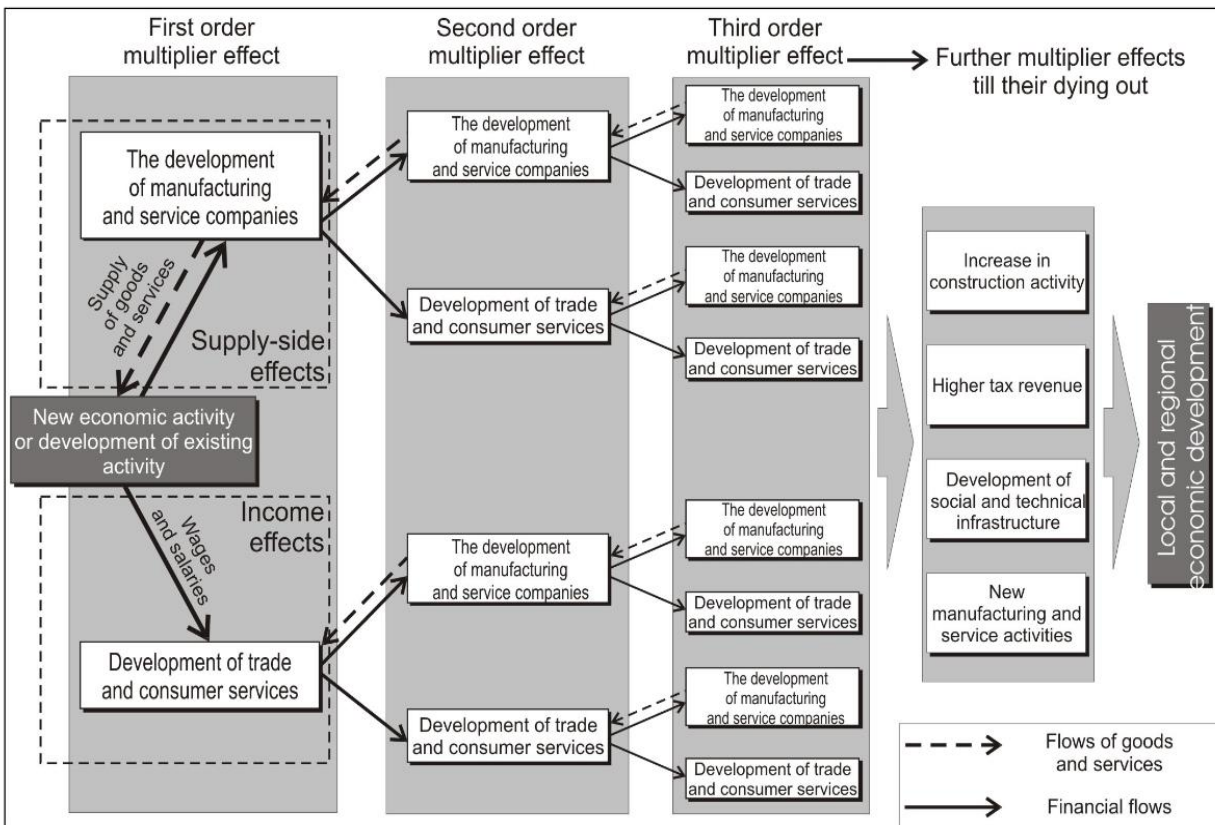


multipliers. These multipliers are discussed in detail in the following section. Then, we turn our attention to the case study of Centralia, Washington’s alternative economic development pathway.

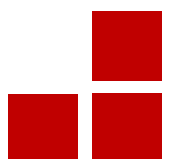
## Local Economic Multipliers, Spillover Effects, and Economic Growth

Multiplier effects can be triggered by responses from either firms or households. On the supply side, new business startups (or growing existing ones) generate added demand for their suppliers. For example, the opening of a new hotel with a conference center generates increased demand for local caterers, which in turn creates additional demand for food suppliers. The growth of a hotel business allows linked suppliers and other businesses to grow as well. Meanwhile, a firm that adds employees or raises wages spurs added household spending by its newly hired employees, which in turn drives growth in other businesses that provide goods and services to those employees, and so-on. The multiplier process is illustrated in **Figure 8** following Domanski and Gwosdz (2010).

**Figure 8. Basic Mechanism of the Multiplier**



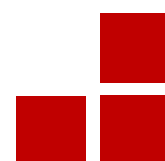
Source: Domanski and Gwosdz, 2010, Figure 1.



Decisions by policymakers aimed to promote growth are generally about maximizing overall medium- to long-term economic output over time. Larger economic multipliers from new private or public investment accelerate this process. Multipliers arise because dollars spent by an individual in one place become income for another individual within the economy. A share of each new dollar of local income is removed for private savings or taxes, while some income is removed as spending is directed on good and services from outside the area. However, the remainder of the dollar is re-spent and once again becomes income for another individual. This process, in which dollars are spent and re-spent through the economy, diminishing in each round, is the multiplier effect. The magnitude, or size, of the multiplier determines the extent of spillovers that the new economic activity has on the rest of the economy. Multiplier effects larger than 1 indicate that each dollar spent is magnified, meaning 1 dollar in new economic activity spurs additional activity beyond the initial spending.

Multipliers have been examined by economists since at least the 1930s (e.g., see Walter, 1951). For example, if a government-stimulus program multiplier is 1.4, then each dollar of stimulus spending has the net effect of \$1.40 after it flows through the economy, undergoing multiple rounds of income and spending. The \$1.40 is decomposed into \$1 from the initial stimulus and \$0.40 in spillovers elsewhere in the economy. Likewise, if a multiplier is less than one, it indicates that each dollar spent leads to a less than \$1 increase in GDP—i.e., the net spillovers are negative. Multipliers under one indicate large crowding out effects or displacement, whereby workers hired as a direct result of government or new private spending include those who would have otherwise been hired elsewhere by the private sector (Dupor and Guerrero, 2017). Conversely, as Bartik and Sotheland (2019) note, multipliers are generally overestimated by industry and policymakers, often to grossly exaggerate the positive economic impacts of economic decisions to build public political support.

Multipliers help quantify the effect of policies on measures such as job creation, PI, GDP, and wages. There are corresponding multiplier effects when discussing wages, PI, or GDP. To meet higher demand, employers need to compete to attract more workers by raising wages. Estimating the size of multipliers is the goal of many economic studies. Several features of multipliers, detailed in Box 1, are important to consider in local economic development.

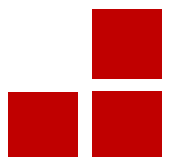




## Box 1. Features of Economic Multipliers

- 1. Positive multipliers reflect growth and negative multipliers represent economic contraction.** Just as the opening of a new factory or business generates positive ripple effects in the local economy, the closure of an employer can generate negative cascading effects as the above mechanisms reduce economic activity in reverse. It is also true that equal-sized growth and contraction (booms and busts) can trigger different sized multipliers. For example, a seminal paper by Black et al. (2005) found that the positive economic effects of the 1970s coal boom on central Appalachian coal regions were less than the negative effects of the subsequent economic bust in the 1980s. That is, the net effect of the boom/bust cycle was overall negative on those coal communities; they were worse off in the long run from the coal boom compared to non-coal mining regions.
- 2. There is not just “one” multiplier.** The size and distribution of multiplier effects can vary greatly across industries and not all industries have the same sized spillover effects on other industries or on local spending. Supply-chain proximity or availability differs across regions. For instance, the higher-ordered elements of the oil and gas supply chains are centered in the southwestern oil patch, meaning that specialized engineers or manufactured products are typically of non-Appalachian origin. The same is true of local workforce availability, which is discussed further below. Finally diverse industries (and their suppliers) pay different wages, that in turn differentially affect local expenditures.
- 3. Multipliers can be defined for a range of different-sized geographies and their values can vary across geographies.** Many studies aim to examine the geographic extent of the economic impact of policies and events such as firm openings, closures, expansions, or downsizings. Multipliers are generally positively affected by the amount of exports originating from the new entity and inversely related if the new entity imports a larger share of its inputs. The definition of an export or import depends on the geography in question. Obviously at the national level, trade outside the country defines an import or export, whereas trade outside the region in question defines an import or export—e.g., to be an import (export) at the county level, all that matters is the origin (destination) is outside the county, not necessarily across international boundaries.

As described below in point #6, exports (and imports) can create offsetting movements of capital to the region that can offset the effects of exporting (or importing) more out (in) to the region.
- 4. The size of multipliers usually (but not always) increases as geography grows.** National multipliers are typically larger than state multipliers, which are typically larger than (multicounty) metropolitan-area multipliers, which are typically larger than county multipliers—but this is not always true. The main reason is that, the larger the area in



question, the more likely it is that inputs for a new economic activity will be sourced within the larger region—e.g., inputs for a factory are more likely sourced within the same *country* or *state* than within the same *county*.<sup>16</sup> Yet, outsourcing/offshoring of business services via technology or of other production stages can play a significant role in reducing the size of multipliers over time. For instance, as manufacturing supply-chains globalized and outsourcing expanded over the last 40 years, manufacturing multipliers became smaller—i.e., modern manufacturing has smaller “bang for buck” than yesteryear.

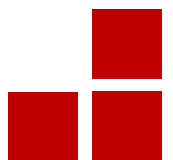
As with the geographical-scope of a labor-market area, commuting also affects multipliers. At the county level, for example, some of the workforce typically commutes from adjacent areas, leading to leakages of workforce earnings. At the metropolitan-area level, such “commuting leakages” are considerably smaller as they are mostly internalized in the metro area, and they are smaller yet at the state level because cross-state commuting is a much smaller share of a state’s economic activity. At the national level, unless you count relatively minuscule net-international immigration at the national level, labor-market leakages are nearly zero. However, to the extent that the new economic activity in each locale displaces activity in nearby places, then the multiplier could approach zero. For example, if County A provides incentives to attract a Walmart that is currently located in adjacent County B, then while the multiplier for County A is likely between 1 to 1.5, but when considering Counties A and B as a unified region, the multiplier equals zero. All that happened was economic activity was moved from one part of the region to another, with no *net* increase in activity.

Multipliers can even be negative if new activity crowds-out sufficiently large amounts of existing activity. Crowding-out was discussed earlier, but here, there are likely other factors such as the industry creating such negative externalities that residents may out-migrate in large numbers—e.g., pollution, crime, social instability, higher housing prices, etc. Perhaps one example is the Appalachian oil and gas industry, as ongoing population decline accelerated *after oil development began*—consistent with people not wishing to be near externalities such as pollution, crime, traffic accidents, etc.

5. **Multipliers are larger when the profits, dividends, and rents resulting from the new activity remain local.** For example, activity initiated by large international corporations have larger leakages because very little of the profits stay local.
6. **Multipliers for traded-good industries are not necessarily larger than for other activities.** One of the longest running misconceptions in economic policy at the national and local level is

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<sup>16</sup> It is possible that national multipliers can be smaller than subnational multipliers if there is significant crowding-out in the financial markets. Here for example, a large stimulus funded by deficit financing (as typically the case) can bid up interest rates to the degree that the stimulus effects are offset by reduced business investment and lower household investment in durable goods such as new homes, cars, and other large items. Crowding-out accelerates as the economy approaches full-employment. Specifically, expanding projects due to (say) federal stimulus means the newly hired workers are unavailable in private activities that otherwise would have taken place.



that new or existing firms that export their products (or more exports in general) have larger positive effects on growth than other economic activities. Basically, such mercantilism dominated economic thinking pre-Adam Smith. In earlier times, exporting was thought to be the main path to accumulate wealth—picture an European King’s desire to acquire gold for the treasury. Mercantilist thinking was widely discredited by Adam Smith and other economists such as David Ricardo in the 18<sup>th</sup> and 19<sup>th</sup> century and remains discredited today. Somehow this bad idea continues to survive including among much of the public and many policymakers, including our two most recent Presidents and early Presidents through Herbert Hoover. [To be sure, places with trade surpluses can flourish, but that’s not always the case. Yet, places purchasing imports can acquire necessary items such as advanced capital goods at a lower price than if they produced themselves, assuming they can produce it themselves.] Other forms of development can generate equal or greater local economic growth than export-led strategies:<sup>17</sup>

- a. A surplus (deficit) on the *current account* (defined as exports minus imports) is by definition equal to the deficit (surplus) on the *capital account*.<sup>18</sup> This means that if a country/region has a current account surplus (often called a trade surplus), it must lend money to the rest of the world (ROW) to finance their purchases. Places with large trade surpluses have large capital outflows through direct investment or loans (or funding by equity) to support investments in other areas or countries. So, for locations with large trade surpluses, their businesses and residents are funding investment and infrastructure projects elsewhere. This means, *all else equal*, there is more investment capital for places with trade deficits and less in places with trade surpluses. In sum, trade deficits *can* be part of the development process related to import purchases of needed goods and technology for investment (especially if the importing region lacks

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<sup>17</sup> See Kilkenny and Partridge (2009) for a formal theoretical discussion. An informal discussion is Paul Krugman’s [2018 New York Times column](#) explaining the link between a region’s growth and their trade/capital-account balance. For example, in discussing Los Angeles and Atlanta, Krugman said:

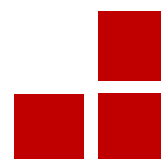
“Los Angeles is a very big metropolitan area, but also one whose growth has slowed a lot: it has run out of land, and zoning restrictions have kept it from building up. So its population rose only 3.7 percent from 2000 to 2010. As a result, it has probably become a big exporter of excess savings, hence a city with big trade surpluses, around 9 percent of GDP (probably even bigger if we had data on services).....

...Atlanta, which has been one of our fastest-growing metropolitan areas: a 24 percent increase in population between 2000 and 2010. And we’re talking about a big [goods deficit] – about 13 percent of metro GDP. What’s that about?

The answer, surely, is that the deficit is a reflection of Atlanta’s growth: we’re talking about building lots of housing, office parks, and so on, and much of that is financed by capital inflows from the rest of the country.”

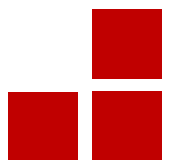
Like here, Krugman is not arguing for or against trade surpluses/deficits, rather their link to economic growth is tenuous and depends on the particular circumstances.

<sup>18</sup> The University of Minnesota has an overview of the current and capital account at <https://open.lib.umn.edu/macroeconomics/chapter/15-2-international-finance/>.



necessary technology), as well as generate necessary capital financing from outside sources—e.g., U.S. story of late 19<sup>th</sup>-century and pre-World War I, 20<sup>th</sup>-century.

- b. Of course, deficit countries need strong institutions to curtail excessive borrowing. Indeed, the US has experienced trade deficits for much of its existence and the resulting capital surplus funded much of the country's growth—especially during the critical late-19<sup>th</sup> century to early-20<sup>th</sup> century.
  - c. Examples of how “regional” trade surpluses do not produce growth include the farm belt and rustbelt. First, agriculturally-intensive places in the first-half of the 20<sup>th</sup> century faced significant restructuring. In the rural Great Plains, a result has been wholesale population losses in many farm-dependent counties. Population losses of 60% to 80% since 1920 are not uncommon. These locations typically have rather large trade surpluses and virtually all of their output (farm products) is exported. Yet, the resulting surpluses were usually not reinvested locally, or to start local businesses; instead they were often invested in banks that lent the money elsewhere, or invested in global financial markets. Given the downward trajectory of their communities, such behavior is sensible, but large trade surpluses did not lead to local prosperity.
  - d. The manufacturing belt of the US is another key example. The American heartland's massive manufacturing capacity led to trade surpluses with the rest of the country and rest-of-the-world (ROW). Yet, since the late-1960s, the region has experienced significant out-migration. The Midwest's capital surplus (by definition equal to negative of its current account/trade account) has instead funded investments elsewhere and constrained the region's ability to diversify its economy.
  - e. Similarly, energy-boom communities typically experience similar features resulting from their large trade surpluses. They often have less local capital resulting from capital outflows due to “local trade surpluses—” e.g., (1) absentee landowners investing their energy-development lease and royalty payments elsewhere, (2) local landowners investing their analogous payments in national banks and financial markets, (3) in-commuters and in-migrants investing earnings in their *origin* locations, (4) as well as some of extra profits and wages of local wage earners and businesses invested in national banks and financial markets. The outcome of such capital outflows is critically needed investment funds to diversify the local economy flee energy-development regions.
7. **Manufacturing and other traded goods including agriculture and mining have large productivity growth, which all else equal, means less employment in local industries over time.** Thus, productivity growth implies smaller long-run multipliers, *ceteris paribus*. For example, picture steel mills of the mid-20<sup>th</sup> century, there were thousands of employees versus the hundreds of today. Similarly, Appalachia coal communities ravaged by downsizing



due to mechanization. Global competition spurs productivity growth in goods and services that are traded—if firms do not compete, they will not survive, which accelerates this trend. Productivity growth is something to generally celebrate, but like everything in economics, there are winners and losers.

Today, traded-goods production typically relies on dispersed global supply chains. Inputs originate from around the world vs. more local or regional in the past. This means much of the potential economic benefits of local economic investment leaks out to other localities supplying their inputs. By contrast, goods and services produced for local consumption typically rely more on local supply chains, reducing leakages. Similarly, those locally-oriented firms usually have local ownership, allowing profits to remain local as well. [see Tsevtkova et al., 2019 for a discussion of the significantly larger local multipliers from small businesses and new startups.] So even though traded-goods firms often pay higher wages that support local expenditures, a host of other reasons limit their multiplier effects compared to other firms.

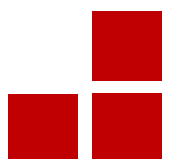
## Small Business Development has Larger Local Multipliers

Domanski and Gwosdz (2010) note that local businesses tend to have comparatively large multipliers due to their extensive links to other local businesses. Extensive research supports the critical role of small businesses and start-ups in creating economic growth. Self-employment also has a substantial effect on economic growth (Tsvetkova and Partridge. 2019; Haltiwanger et al. 2013; Neumark et al. 2011). This has special relevance for Appalachian communities, as recent empirical research has found casual evidence that new firm formation initially decreases in energy-boom regions, although it can recover with time (Partridge, Rohlin, and Weinstein, 2020). This suggests that although shale development may create some short-lived jobs with modest multipliers, the intense use of labor and capital in the region energy crowds out entrepreneurship and business formation activity that offer higher long-term economic activity.

## How are local multipliers estimated by economists?

There are various ways to estimate multipliers, some better than others. Attempts to estimate economic multipliers date back to economic-base theory in the early/mid-20<sup>th</sup> century. Economists used these theories to forecast regional population changes as economic conditions changed (Domanski and Gwosdz, 2010; Hoyt, 1954).

As discussed earlier, it is common for industry advocates and policymakers to cite forecasts derived from input-output (I-O) models. Yet, I-O models reflect mid-20<sup>th</sup> century economic thinking. I-O modes were originally developed by Nobel Laureate Wassily Leontief for



national studies in the 1930s, followed by Walter Isard's extensions to the subnational-regional level in the 1940s and early 1950s. At both the national and regional levels, I-O models show the interdependence (mainly through supply-chain linkages) between industries in national or regional economies.<sup>19</sup> Input-output coefficients that define the model equal how much of good  $j$  is used in the production of good  $i$ . These, along with regional demand, determine how growth (or decline) of one sector sets off changes in other sectors, especially going up the supply chain for industry  $i$  (Miller and Blair, 1985). The sum of these changes underlies many of the (positive) multiplier effects described earlier. I-O models rely on various assumptions that limit their practical use and also reduce their accuracy. I-O-style models are optimally designed to facilitate central planning such as practiced in the Soviet Union between the late 1920s and the early 1990s, as well as other 20<sup>th</sup>-century centrally-planned Communist countries.

To be sure, just because commercially produced software is widely used does **not** mean it is highly accurate. IMPLAN is a popular I-O model. Like other I-O models, IMPLAN does not include prices of goods or services, nor does it account for the effects of changing wages, housing costs, etc. A main tenet of economics is prices are signals that direct resources to their highest-valued (*most efficient*) use. Hence, I-O models do not incorporate "self-correcting" price signals, meaning the whole notion of crowding-out is absent. This flaw is just one reason why I-O-type models generally overestimate economic impacts. Without prices, accurately modelling a regional or local economy is quite challenging and likely inaccurate. **Box 2** provides more details.

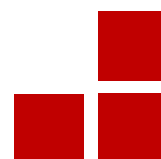
## Box 2: Limitations of Multipliers Derived from Input-Output Models

IMPLAN and RIMS from the BEA are two of the most widely used U.S. input-output (I-O) models. However, like all I-O models, multipliers tend to be overestimated. Furthermore, users of I-O-derived multipliers are typically unaware of the imprecision of their estimated multipliers. One reason is that these models do not use history of similar economic impacts to derive their outputs. For instance, they only indirectly use historical data after similar changes such as a new plant opening, or new policy. This contrasts with econometric methods, which use data on the actual changes in jobs, income, or production that occur before and after an economic shock. The assumptions used in I-O models omit a wide variety of changes and crowding-out effects that skew the estimated multipliers. Some of these issues are highlighted below.

### *Issue 1: I-O Models Don't Include Prices or Wage Effects*

When large economic changes take place, such as the opening of a new firm or plant, new laws that deregulate industries, or large investments by government or industry, they can lead to a host of interdependent changes within a market. New construction of billion-dollar facilities means that local

<sup>19</sup> See Leontief, W. (1986) *Input-Output Economics*, New York, Oxford Univ. Press.



supplies of construction material, equipment, and skilled workers will experience an increase in demand, which in a free market bids up prices—for materials and equipment and the wages for workers.

In markets, price signals direct resources to their highest-valued uses of money and investments. In response to an economic shock, which causes a change in prices for goods and labor, such as large facility opening or government stimulus, other businesses in the region alter their planned projects and may delay or shut down some operations. In Central Ohio, for example, [contractors and trade unions have fiercely battled to hire construction workers](#) to meet the rising demands after Intel announced in 2022 that it would construct a heavily subsidized \$20 billion semiconductor manufacturing facility. Thus, with a significant share of the region's construction workforce occupied with the Intel facility, other projects that otherwise would have occurred will not take place due the short-term shortage of construction workers and the higher costs due to higher wages, all of which lowers the multipliers associated with building the Intel plant. If new economic activity promises “higher paying jobs” for the region, this puts pressure on existing establishments and firms to raise their own wages or risk more employee turnover. These negative economic responses to rising prices and heavily strained local supply chains offset positive impacts of new investments in a way that input-output models do not capture because they lack prices or supply constraints that, if present, would lower the multiplier effect.

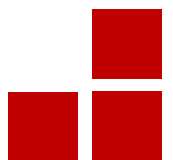
#### *Issue 2: I-O Models assume Constant>Returns-to-Scale in all Cases*

Multipliers from input-output models assume constant-returns to scale (CRS). This means that if all a firm's inputs (labor, capital, land, etc.) increase (decrease) X%, output increases (decreases) exactly X%—meaning average productivity remains exactly constant as output increases. However, this ignores common production processes in which productivity rises with output (e.g., increasing returns to scale) or falls with output (e.g., decreasing returns to scale). More importantly, it ignores the fact that the capital stock is usually fixed in the short-run, meaning, for example, that if a local supplier receives a significant increase in orders from a new local firm, they won't be able to immediately expand their buildings, order new equipment, and hire a sufficiently trained labor force. These effects mean either the local supplier won't fulfill new orders or their costs will increase. In any event, the local supplier will likely raise their prices.

#### *Issue 3: I-O Models Use National, Not the Region's Production Parameters*

IMPLAN and other commercial I-O models often use average *national production parameters* from the BEA I-O table (and these parameters are CRS or constant across all levels of production). Specifically, I-O models are parameterized by input-output linkages—e.g., it takes (say) 500 pounds of steel to make an automobile. If steel prices soared due to global factors, automakers would try to find alternatives for steel to reduce costs. I-O models don't allow real-world substitution adjustments that should be made in response to changes in relative input prices. Furthermore, production processes can diverge regionally due to differing availabilities of inputs, varying government regulations and tax regimes, and differing vintages of technology.

Standard “off the shelf” commercial I-O models like IMPLAN do not allow for different technology usages like this. If a specific region employs either advanced or outdated production technology and infrastructure, national constants from the IMPLAN model may under or overrepresent the productivity of businesses in



the region, generating misleading multiplier estimates (Bartik and Sotherland, 2019). This is particularly true in many rural and Appalachian areas with well-documented struggles in delivering high-speed internet, for example. National production constants would incorrectly assume these firms have access to the national average technology when that is not the case.

#### *Issue 4: I-O Models Assume Perfectly Elastic Factor Supplies including Labor*

Input-output modeling generally assumes a perfectly elastic labor supply. This means that any change in wages will result in an *infinite* amount of change in labor. The reality is that, if a region is suffering economic decline, wages do not fall, slowing the region's readjustment and return to competitiveness. Or if a region is undergoing a boom, no wage increase is necessary to attract needed migrants, regardless of changes in local cost of living. These are unrealistic propositions. A region's labor supply is constrained by rising housing prices, congestion as infrastructure keeps up with population growth, and moving costs that slow household migrations. Similarly, price increases (decreases) from any spike (plunge) in demand for any input, whether nationally or locally driven, would cause firms to change their use of that input and its potential substitutes, but such effects are not allowed in I-O models.

#### *Issue 5: I-O Models Assume No Land Constraints, Land Price Changes, or Housing Price Effects*

Land availability and affordability are important for firms and households. Land use is usually constrained by zoning or access to existing infrastructure such as roadways, sewer, water, and other utilities. When a large new operation, such as a factory, opens, it drives nearby land and home prices up. This can make it difficult to attract new businesses, especially if they do not receive the same subsidization that the first mover received. Indeed, Partridge et al., (2020) find that tax incentives that are typically used to fund new large facilities crowd out local start-ups, which as pointed out earlier, new start-ups create a disproportionate share of innovation and new jobs. Further, if the economic development strategy hinges on also attracting new workers to the region, rising home prices dampen their migration response, meaning economic activity that otherwise would have taken place no longer occurs because of a smaller labor force and less induced local expenditures. Together, this further reduces actual multipliers below I-O standard multipliers. In exurban and proximate rural areas, farmers may be especially impacted as large industrial investment may drive up farmland prices, making it difficult to expand operations or for a new operation to start-up. [This was also the case in Central Ohio](#) after Intel's new plant announcement.

#### *Issue 6: I-O Models Don't Account for Other Social, Environmental, and Economic Spillovers*

Economists define externalities as "impacts of a market decision whose cost is not accounted for within the price used in the market transaction" (Blais, 2010). Alternatively, the buyer and the seller of a good or service does not bear the full costs or benefits of producing or consuming that item. Unregulated or under-regulated markets will overproduce products associated with negative externalities and underproduce products associated with positive externalities.

Major economic shifts in a region almost always include externalities, or similarly, a redistribution between economic actors in a region when policies create winners and losers. In development contexts, this could be caused by rezoning land for commercial or industrial enterprises, constructing a new factory, or changes in local taxes and regulations. These types of events impact the entire community in ways that are both seen (i.e. the physical presence of a new factory) and unseen (the factory's emissions and waste products).



As Correia and Roseland (2022) note, externalities include air pollution, traffic congestion, accidents, and deaths from increased use of certain roadways, over-burdened public services such as schools and healthcare systems, inadequate water, sewage, and storm facilities, and undesirable visual impacts from new development.

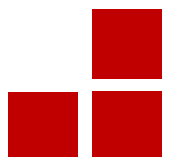
Some other examples include how oil and gas boomtowns are associated with higher incidence of crime and volatile population changes during booms and busts that can cause significant alterations and burdens to policing, infrastructure, and provision of other public services (Ruddell et al., 2022, Archbold et al., 2014). In many cases, alleviating these types of congestion effects requires building new roads, schools, and healthcare facilities, as well as expanding or upgrading public and private utility infrastructure. These are not costless activities, and the burden often falls on existing residents via increased taxes. This is particularly true if a company making the initial investment is receiving a tax incentive package, in which case it may not share at all, or only partially share, in paying for added social and economic development costs. And if there is a bust, as inevitable in natural-resource commodity cycles, the impacted area is left with an over-abundance of infrastructure that is expensive for the now diminished population to service. I-O models such as IMPLAN or RIMS do not capture these negative externalities, spillovers, and pecuniary effects that further reduce positive multipliers.

*Issue 7: I-O Model Results from Standard Commercial Packages Provide Inexperienced (or even experienced) Users a False Sense of Accuracy and Precision and Users Often Misinterpret the results.*

Users of commercial I-O software regularly misinterpret the results as *new job and income creation*. For example, it is almost a certainty that at least some of these jobs would have arisen even without the new development's creation—e.g., recall the displacement and crowding-out discussion above. Similarly, many of the jobs associated with supplying the new development and its employees would have existed anyhow as these suppliers would have instead identified alternative markets, or they would not have been adversely affected by the new development bidding up input prices in general (etc.).

For an opening of a new manufacturing facility, for example, the I-O software output will report detailed sectoral data such as (say) 47 additional fulltime-equivalent jobs will be required at restaurants, 57 new fulltime-equivalent jobs will be needed at wholesalers, and 27 more jobs will be necessary in real estate to fulfill the demands generated from the new facility. Yet, as noted above, users of these programs do not understand that these do NOT represent the number of jobs *created* by the new manufacturer. Rather, they are the expected number of jobs associated with supporting that manufacturing activity in a given sector, which does not account for *any* of the crowding-out described above.

In another big drawback, commercial I-O software used to make projections of jobs, output, and other measures of economic value can appear to be very accurate to users. Yet, the software provides virtually no guidance as to the actual precision of its estimates. The actual results can be little more than guesses backed by poor assumptions and imprecise data. Unfortunately, users often do not understand that commercial IO software output is actually imprecisely estimated and, in some cases, can be highly inaccurate. For example, we already explained how the assumed production process can be greatly inaccurate for some regions and production exactness can further vary across sectors. These issues



reduce the software result's accuracy when production processes deviate from the national average and/or CRS is an inaccurate measure of a sector's productivity in a local area. To be sure, the *national I-O* production coefficients are BEA estimates, meaning that local I-O production models begin with imperfect national data. Similarly, packages such as IMPLAN and RIMS make assumptions about the shares of inputs that are purchased locally and from outside the study region. This is consequential because assuming larger shares of inputs from outside of the region decrease multipliers, while assuming smaller shares increase multipliers. These estimates are often facilitated by transportation surveys using imperfect assumptions, or do not apply to the specific economic shock being considered.

Another key estimate in I-O models is the regional purchase coefficient (RPC). The RPC estimates the share of local expenditures that are for goods and services produced locally—a higher RPC increases local multipliers. The RPC is estimated statistically with standard errors that further reduce the accuracy of estimated I-O model multipliers. Indeed, to accurately estimate local RPC and I-O production coefficients requires a keen understanding how individual households, governments, and firms in an area substitute between locally produced and non-locally produced consumer goods and firm inputs. Further, accuracy requires an understanding of how households substitute across different products and firms substitute across different inputs and factors of production. And this detailed knowledge applies separately for each local area being considered. There are scores of other I-O parameters that have to be statistically estimated (with potential for error) and/or assumed to derive the I-O software's estimates of economic impacts, which further increases the potential for faulty estimates. Users of these models should better understand the limitations of I-O models before making such driving.

In sum, inexperienced (and many experienced) users of I-O software typically have no idea that the I-O-model software produces results that are potentially highly inaccurate. Worse is when the media or policymakers simply confidently repeat the results, further increasing the scope of the fallacy. If they were aware of these inaccuracies, local users would be much more cautious in their use of I-O forecasts and in developing policy based on their results.<sup>20</sup>

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<sup>20</sup>There are simple solutions for economic-development software such as REMI or IMPLAN to give users more guidance regarding the precision of the model estimates, vs. the current approach that typically misleads users into falsely believing their results are highly precise. The easiest improvement is with Monte Carlo analysis using the standard-errors of the model's parameter estimates from their statistical derivation (e.g., for RPC) to create a distribution of outcomes of an estimated local impact. For readers who have seen ESPN's or 538.com's sport predictions, computer indexes of team quality, and/or probability a team wins a particular game or league may know that they provide readers the precision of their estimates—e.g., (say) the Browns have a 57% probability of defeating the Bengals in next Sunday's game with the expected margin being 2 points, while IMPLAN's or REMI's corresponding output would say the Browns **will win the game by 2 points—full stop**. Basically, ESPN or 538.com re-estimates their model 100,000 (or so) times in which each simulation changes the underlying parameters based on random draws using the parameter standard errors—i.e., a Monte Carlo analysis. From this, to derive a range of outcomes to assess the confidence in the software's prediction, we propose economic-development software providers develop a similar "bootstrapping" and Monte Carlo simulation approach to more honestly provide users an accurate measure of how much confidence they should have in the results. Thus, providers like IMPLAN or REMI would rise to the level of basic-textbook statistics, as well as to the likes of ESPN and 538.com. Moreover, unlike a Browns-Bengals game, the results from economic-development software programs are used to make decisions that can greatly affect the lives and well-being of their community's residents. Perhaps they should take the same care that frivolous predictors of sports games do.

**Issue 8: As with typical impact-studies of oil and gas drilling, Powerplant-Closing Impact Analysis with Standard-Commercial Models can vastly overpredict economic losses.**

**Case Study:** Regardless of the setting, economic-impact studies should always be viewed with a skeptical eye. For example, a [2018 University of Montana economic-impact study](#) of the effects of the (then expected 2025-27) closure of the Colstrip, MT Units 3 & 4 powerplant estimated that Montana would lose just under 3,300 jobs and over 6,000 residents, along with a host of other negative outcomes.<sup>21</sup> These large-scale losses were forecasted even though (a) most of the plant's generated electricity was used out-of-state, (b) the plant only employed 348 workers including 20 parttime (which includes any employees who were later laid-off from closing Units 1 & 2 at the end of 2020, which is not included in their analysis). The study's estimate also included losing 289 coal mining jobs at the adjacent Rosebud Mine.

First, one wonders if the Rosebud Mine would have closed anyhow given the scores of U.S. coal-mine closures and the precarious situation of its owner [Westmoreland Coal, which recently emerged from bankruptcy](#)?<sup>22</sup> Among the study's other questionable assumptions were Montana's electricity prices would rise 10%<sup>23</sup> and the study, remarkably, did not consider the *offsetting* economic impacts of building 220MWs of replacement electricity capacity that would be necessary to provide the lost Montana electricity from closing the Colstrip units (p. 24 of the report). The study's authors assumed the replacement would be

<sup>21</sup>Northwestern Energy, a "key" owner of the Colstrip plant (along with Talen Energy), announced in early 2023 that they will keep the Colstrip plant open for [the rest of the decade](#) after they and Talen Energy purchased ownership rights from other co-owners. Yet, our focus is on the inaccuracy of the study's impact analysis.

<sup>22</sup>Coal production at the nearby Rosebud Mine that supplies the Colstrip powerplant has steadily declined from [13.4m short tons in 2007 to 6.5m short tons in 2021](#) (latest data available). 2021 is the first year after the closing of Colstrip Units 1 & 2 (it was 8.5m tons in 2019 before closing 1 & 2). It appears Rosebud Mine's market collapsed after 2007, with 2021 production under one-half of its 2007 level. Lost production means Rosebud Mine is squandering its economies of scale for productivity and is likely one reason their owner [Westmoreland Coal is unsuccessfully trying to expand its size](#). Yet, with excess U.S. coal-mine capacity, it is unclear why Rosebud Mine, with its remoteness (and expense to transport bulky coal), has a market for more production given it had lost market share so rapidly after 2007. In 2021, U.S. Energy Information Agency data (EIA, Table 12) indicates that surface U.S. coal-mine utilization was at [61.7% capacity in 2021, whereas in Wyoming—Montana coal's main competitor for low Sulphur coal—mine capacity utilization was 58.0%](#). Coal-mining productivity growth has been key behind declining coal-mining employment—i.e., Rosebud mine employment would decline even if the plant remained open. Between 1919 and 2017, U.S. coal-mine production increased 21-fold while U.S. coal-mining employment fell 94% (from 1923 to 2019) (Lobao et al., 2021). Similar issues are that within the Powder River Basin (PBR), home to the Rosebud Mine, [average 2021 productivity is 28.3 thousand short-tons per labor hour](#) vs. [21.7 thousand short-tons at the Rosebud mine](#). Given Rosebud Mine's higher transport costs relative to the PBR average and given its 23.4% productivity disadvantage within the PBR, it is hard to see how the mine's future is secure. Hence, the study's assumptions of the Rosebud Mine's job losses if Colstrip Units 3 and 4 closed are suspect.

<sup>23</sup>The study's assumption assuming Montana's electricity prices would increase 10% as result of a Colstrip powerplant closure strains credibility. Yet, this assumption leads to the loss of Montana jobs due to the higher costs faced by employers. [In 2000, EIA data \(Table 7b\) shows that coal was the source of 53.4% of U.S. electricity generation, which steadily declined to 20.1% in 2022. The corresponding change in the electricity share generated from natural gas increased from 14.2% in 2000 to 38.8% in 2022, whereas the wind and solar share of U.S. electrical generation increased from 0.2% to 14.2%, suggesting that coal has long been an uncompetitive fuel for electricity generation, even before considering future climate-change regulations.](#) Hundreds of coal powerplants closed by 2018 and [EIA](#) does not forecast any future coal powerplants coming online. The collapse of the coal share of electricity production towards gas, wind, and solar will continue. [EIA data predicts a 52% decrease in coal-generating capacity between 2022 and 2050.](#) In sum, the market for coal has greatly dwindled since 2000 and is likely to continue to at least 2050. Key reasons for declining coal usage include [falling costs in natural gas, wind, and solar, as well as the old age of coal powerplants increase their costs](#) from added maintenance and updates for pollution regulations. Hence, the evidence suggests that market-forces encouraged switching electricity production from ancient coal powerplants to new natural gas, wind, and solar facilities. Thus, Montana employment may increase after retiring Colstrip Units 3 & 4 due to lower electricity costs.

natural-gas powerplants, though later it became apparent the [actual replacement will be wind power](#).<sup>24</sup>

Regardless of how the lost 220MW capacity for Montana users is replaced, there will be offsetting numbers of jobs created whether it is from natural gas, solar, or wind.

*Issue 9: I-O Models have important uses but are NOT Designed for Forecasting Economic Impacts.*

I-O models were originally designed for central planning in the first half of the 20<sup>th</sup> century to derive estimates of the inputs needed to produce a given set of outputs, information needed to ensure an adequate supply-chain. For a mid-20<sup>th</sup> century Soviet planner desiring the economy to produce X tons of steel, an I-O model's results would inform the planner how much of each input and how many workers are necessary to fulfill this goal. Their underlying assumptions mean that I-O models are not designed to estimate economic impacts because they do not account for the range of crowding-out effects and lack essential economic features like prices. Instead I-O models are a simulation based on economic assumptions. They are not based on *observed* links between economic shocks and associated *net*-economic outcomes.

A good analogy is using the popular NFL football video game *Madden 23* to predict next year's Super Bowl winner. *Madden 23* uses assumptions about the ability of each player and how they interact to derive team strength. I-O models are akin to using *Madden 23* to predict football games. Conversely, the econometric approaches we describe for estimating multipliers use *actual* outcomes to predict behavior, or in the case of football, using the outcomes of actual games played during the season to make a Super Bowl prediction—i.e., *Madden 23* and I-O models make predictions based on assumptions, econometrically-estimated multipliers from economists use actual behavior for their predictions. Similarly, using I-O models for economic-impact predictions is the same as sports-casinos using *Madden 23* to set sports lines, instead of using the prior results of actual games.

What this means is that I-O models are optimally used for understanding how a local economy's industries are interlinked. For example, local planners may want to understand how constructing (say) a local fertilizer plant will affect local firms through the supply chain. Models like IMPLAN and RIMS are well versed for such exercises. Moreover, while inaccuracies of how assumptions used in models like IMPLAN produce inaccurate results, we do not believe their errors are systemic nor do we believe that (say) IMPLAN built their models using faulty methods. We very well may have used similar approaches as these software vendors. *Yet, commercial software providers should give vastly more guidance as to the accuracy of their output.* Moreover, commercial I-O models and similar forecasting software should be used for what they are designed for and more recent economic econometric and natural-experiment developments should be used

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<sup>24</sup> Though touted as a long-term “green” economic-development strategy, Houston-based [Talen Energy's partnership with Pattern Energy on the joint 600MW “Siverthorn” wind-turbine project in Rosebud and Treasure Counties, Montana](#) will create few jobs. [This \\$1 billion investment is central to Talen and Pattern's transition plan to eventually replace Colstrip coal power plants in Rosebud County](#) with green-energy. [Silverthorn claims](#) that the 18-month construction period will require (temporary) 450-600 construction jobs but will only (permanently) employ 12-16 workers to operate the facility once operational—hardly a realistic economic turnaround strategy, even for sparsely populated locations (e.g., landowner lease revenues will be concentrated among a relatively few owners). Rosebud and Treasure Counties together are about 6,000 square miles and have about 8,700 residents. Their small labor pool means that locals can only fill a tiny part of the temporary construction workforce, which instead will be in the form of temporary migrants or commuters from larger cities such as Billings, roughly 100 miles away, further limiting local impacts. The point is economic-development approaches that do not account for the high-capital intensity of affected industries will likely fail, despite large upfront investments.

to predict economic-impacts—e.g., econometrically-estimated multipliers. Not only are they more accurate, but users would have a much better assessment of the potential forecast accuracy as standard errors are an outcome of the estimation.

## Empirical Evidence Suggests Modest Oil & Gas Multipliers

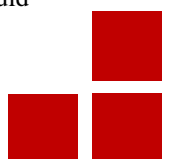
As described, Appalachian counties situated on large shale plays have not experienced significant long-lasting jobs and income growth and still greatly lag national averages. These counties are also generally characterized by the ARC as having lower overall employment as compared to their non-Appalachian Ohio peers. Thus, with a century-plus history of Appalachia Ohio, and Central Appalachia in general, greatly trailing their counterparts, it appears that resource extraction including mining, oil and gas investment has **not** generated sustainable prosperity. One reason is *de facto* place-based incentives aimed at coal, oil & gas companies, as well as other extractive industries, often end up generating few long-term jobs and usually at a high cost per job (Bartik, 2020). Another is that economic-development efforts have not been sufficiently innovative nor effective at targeting the parts of local economies that generate most economic growth.

The modest local economic impact of most energy booms, followed by the stinging effects of the inevitable resource-sector bust, has been a focus of academic research over the past few decades. The oil and gas industry remained a relatively small share of the total U.S. economy even during the peak of the shale boom. As Weinstein, Partridge, and Tsvetkova (2018) note, the share of total U.S. nonfarm employment in the oil and gas industry grew from 0.23% in 2001 to 0.44% in 2014. Since the late 2014 peak, as of early 2023, employment has declined across nearly every industry classification of the oil, gas, and coal sectors, as well as for associated pipeline and support sectors. This is shown in **Figure 9**.

Additionally, oil & gas extraction is capital-intensive (capital/labor ratios are over 30 times greater than the overall economy as described above) and ongoing innovations and automation have dramatically increased productivity while simultaneously reducing the needs for local labor in affected drilling communities. For example, BEA data shows that just between 2012 and 2022, overall productivity in the oil & gas extraction sector (NAICS 211) increased 186.7% versus only a 13.2% productivity increase in the overall nonfarm-business sector. Unfortunately, unlike basic economic predictions that compensation growth should track labor productivity growth, (nominal) compensation in the oil & gas extraction sector increased only 32.9% vs. 63.2% in the overall nonfarm-business sector.<sup>25</sup>

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<sup>25</sup>Even assuming that oil & gas extraction support employment (NAICS 213112) should be included oil and gas extraction (NAICS 211) in stating labor-productivity and wage growth, 2012 to 2022 labor-productivity growth would



Further reducing local employment gains is that once new wells are drilled and infrastructure is in place, substantially less labor is required to maintain production. This is noted in both **Figures 2 and 3**, as well as the over 50% national decline in jobs classified as **support for drilling oil and gas wells** (NAICS code 211). As shown in **Figure 9** as output has generally increased.)

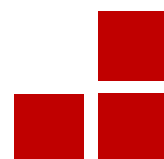
Rajbhandari et al. (2022) examines the *types* of jobs created in these oil and gas boomtowns.<sup>26</sup> They find that job-creation multiplier effects are generally positive for occupations which require post-high school vocational and technical training and for jobs which require at least a bachelor's degree and prior work experience such as petroleum engineers. Overall, they estimate a 1.18 jobs multiplier, which is in the ballpark of the 1.3 industry multiplier estimated by Weinstein (2014). Creating 1 job in the oil and gas sector is associated with the creation of 1.18 jobs in the total economy. However, different industries contribute to this overall average-job-multiplier effect, with some industries seeing no significant jobs increase.

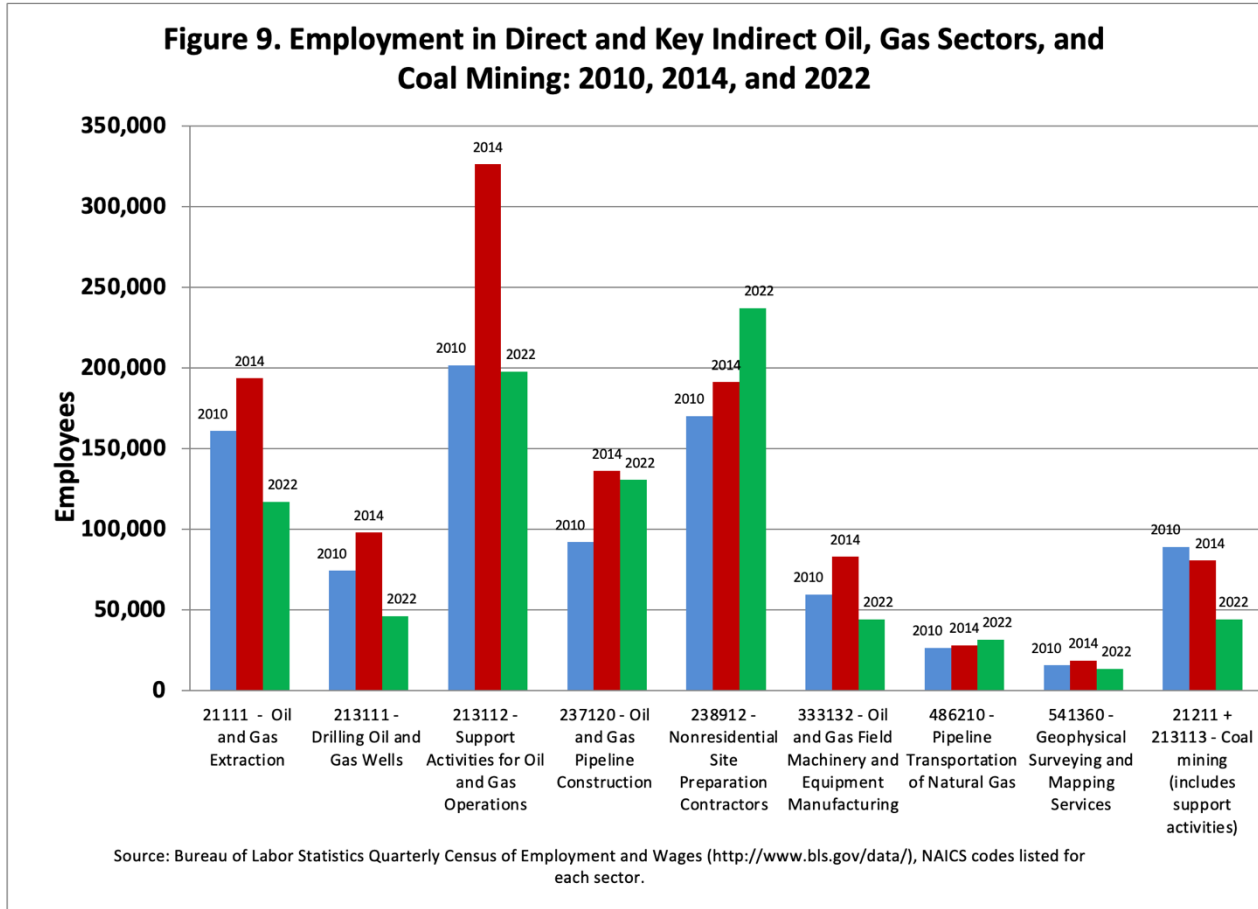
In terms of oil and gas specifically, there is strong evidence that they generate less “bang for their buck.” Tsvetokova and Partridge (2016) also find that oil and gas employment is associated with a multiplier of about 1.3 while the economy-wide average multiplier is approximately 1.5, excluding oil and gas. Another empirical study focusing specifically on self-employment in non-metro areas finds that self-employment (i.e. small business) is associated with a much higher multiplier of 5.4. This is interpreted to mean that the creation of 1 job in the self-employment sector results in 4.4 additional jobs being created from the induced effects of that job. Paired with the general trends of declining employment in oil and gas related industries, these results suggest that investing in local entrepreneurship and small businesses is a better path to prosperity for rural regions than reliance on large multinational corporations conducting resource extraction.

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be 79.3% and (nominal) hourly-compensation growth would be 20.3%, which are respectively well-above and well-below the overall nonfarm business-sector's performance. These figures are derived using the BLS employment shares in oil and gas in extraction (NAICS 211) and oil and gas support (NAICS 213122), in which the BLS reports more disaggregated data for NAICS 213.

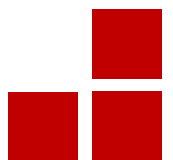
<sup>26</sup>Rajbhandari et al. (2022) employ a first-difference methodology as well as instrumental variable methods based on geological measures of shale gas and oil fields to ensure they obtain causal estimates. They econometrically estimate county-level job multipliers from energy booms to estimate employment changes by detailed BLS Standard Occupation Classification (SOC) codes.





Rajbhandari et al. (2022) find the largest positive occupation multiplier was for construction. The construction-occupation multiplier was estimated to be 0.50, which suggests that the creation of 10 oil and gas sector jobs is associated with 5 new construction jobs. However, the multiplier for construction, as well as for other energy-related occupations such as transportation and material moving, are *negative* when accounting for counties with higher initial shares in the oil and gas sector. This is because counties with large, pre-existing energy infrastructure, such as pipelines and roads, need fewer construction and support workers because much of the infrastructure is already in place (Tsvetkova and Partridge 2016; Weber 2012, 2014).

The greater demand in oil- and gas-boom areas for high- and intermediate-skilled workers attracts in-migrants with those abilities. Yet, there is evidence to suggest that when it comes to job creation, many jobs demanded by the oil and gas industry are often mismatched with the skills of local workers. Previous work found that medium- to high-human capital workers tend to in-migrate to rural areas experiencing oil or natural gas booms, although these migration effects can differ greatly across regions (Rajbhandari et al., 2022). Such migration is, in fact, the primary supply



response in energy producing states (Partridge and Rickman, 2006). Given the likelihood that many of the new long-term oil and gas jobs are currently filled by in-migrants (or commuters), workforce-development policies aimed at providing technical training, education, and experience—all of which increase *local* human capital—are likely to have a greater impact on a region’s economic resilience in response to energy shocks (Diodato and Weterings, 2015).

Resident’s PI in oil and gas boomtowns can be very volatile over the energy boom-bust cycle, meaning that the expected high earnings are generally short-lived. Paredes et al. (2015) used well counts to study job-creation and per-capita PI in the Marcellus-shale play. They find that while employment grows with the number of wells being drilled, incomes are practically unaffected. This is consistent with our earlier findings, where both the Appalachian Region and the 7-natural gas-intensive Ohio counties have tracked national trends in per-capita PI, seemingly unchanged by the energy boom.

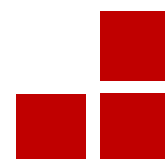
Using Census Bureau data, Ohio’s 7-largest gas-producing counties collectively lost 6.6% in population between April 1, 2010 and July 1, 2022, with none having positive growth.<sup>27</sup> In fact, the 7 counties collectively performed better in the 2000-2010 “pre-boom” decade with a total -1.8% population loss and, remarkably, all 7 performed better in the pre-boom decade than during the 2010-2022 boom period. By comparison, respectively for the 2000-2010 and 2010-2022 periods, Ohio population *net of the 7 oil-and-gas counties* changed 1.7% and then increased to 2.1%—i.e., the 7 counties trailed the state by -3.5 percentage points between 2000-2010 and by -8.9 percentage points between 2010 and 2022. That is, relative to Ohio’s relatively weak population growth, the 7 Appalachia Ohio counties fell another 5.2 percentage points compared to the rest of the state during the “boom” 2010-2022 period vs. the pre-boom decade.<sup>28</sup> In other words, residents of the state’s top-7 oil and gas counties conveyed their views of the fracking-boom by “voting with their feet,” accelerating the population decline.

Because of the population loss, there was an actual (relative) *net* loss in the region’ *total* residential income compared to elsewhere. Similarly, Komarek (2016) finds a modest positive impact on earnings and jobs from the shale boom, but these impacts disappear within 3 years after the drilling abates, again suggesting that once capital and infrastructure are built, these communities gained little from largescale natural-gas production. In sum, regarding the

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<sup>27</sup>Regarding more recent data, from April 1, 2020 to July 1, 2022, these 7 counties collectively lost 1.1% population. Only Noble County gained population equaling 1.6%, which is insufficient to offset its 2010-2020 loss of 3.7%.

<sup>28</sup>Between April 1, 2020 to July 1, 2022, Ohio net of the 7 Appalachia counties lost 0.4% population. For another comparison, U.S. population growth was 9.7% between 2000-2010 and 7.9% for 2010-2022, or deceleration of 1.8 percentage points (9.7 – 7.9) for the latter period vs. the 5.2 percentage points deceleration for the 7 Ohio Appalachia counties. Thus, comparing to the U.S. leads to the same conclusion about the 2010-2022 period.





Appalachian shale boom, the “*benefits of the oil & gas boom did not stick locally*” and the region did not greatly benefit in the long run from the vast wealth being exported from the region.

Weinstein et al. (2018) examine the earnings effect of the oil and gas industry during the energy boom. They differentiate between metro and nonmetro counties. Significantly, they find that outside commuting plays a key role in reducing oil and gas boom multipliers for earnings. Their point estimates for total employment are in fact higher than total earnings in nonmetro counties, suggesting that earnings from the oil and gas activity are even more prone to leak out of the counties where wells are located, often toward the nearest metro areas.

Weinstein et al. (2018) also find that employment and income effects vary significantly by region and shale play. North Dakota boom counties experienced remarkable growth during the energy boom *and* a remarkable bust during the post-2014 oil crash.<sup>29</sup> Other boom regions such as Appalachia did not experience such explosive growth or significantly suffer during the bust. There are many possible explanations. North Dakota boom counties had small initial populations and lacked significant historical oil and gas supply chains and infrastructure. This led to a need to rapidly accommodate a booming energy industry. Since very little of the required workforce resided in those sparsely populated rural counties, workers had to be “imported” through in-migration, yielding a much larger multiplier. However, in the Utica- and Marcellus-play regions of Ohio, Pennsylvania, and West Virginia, there are large underemployed populations, as well as a legacy of historic mining infrastructure that limits the need to build infrastructure to support development. Underutilized resources and smaller infrastructure needs restrained the multipliers’ size.

Now we turn to examine an alternative economic-development strategy to transition from long-term economic stagnation and/or transitioning away from the boom/bust natural resource sector. There is growing literature for developing new development strategies to transition away from declining industries or away from industries with significant negative externalities such as energy development (e.g., see Bartik, 2017 for related discussion). For this, we turn to the Centralia, WA case study. Centralia has also faced a series of energy-sector busts including a coal-mine closure in 2006 and the 2011 announcement of a pending closure of a coal-fired power plant.

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<sup>29</sup>For example, in the North Dakota Bakken shale play, Williams County is center. For a point of reference, their job growth began to accelerate after 2004, so we select the month with the highest employment in 2003 (July) as the boom’s beginning. Thus, job growth from July 2003, the beginning of the boom, to November 2014, the boom’s employment peak, *QCEW* data shows that private employment increased 449.2%. The employment trough occurred in January 2017, in which jobs fell 46.8% from peak to trough, before rising 18% by February 2020, just before the Covid Pandemic and the beginning of the next bust. BEA data indicate that Williams County PI rose 279.3% from 2003, the beginning of the boom, to 2014, the boom’s peak, before falling 40.6% by 2016, the annual PI trough.

# The Centralia Model of Economic Transition

## Background: Centralia vs. Appalachian Ohio Energy Region

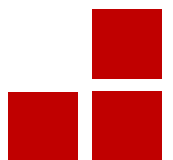
The town of Centralia is located in Lewis County in a bucolic part of southwestern Washington state. It is located on the major I-5 interstate corridor and is approximately equidistant from both Seattle to the north and Portland, OR to the south, being about an hour-and-a-half drive from both. Lewis County is 2,445 square miles in size. [Ohio counties are approximately 500 square miles on average.] The Centralia micropolitan statistical area coincides with Lewis County and shown in **Figure 10**.

Geographically, the Southern Cascade Mountain range is to the east of Centralia and the smaller Coastal Range is to the city's west, providing Lewis County residents a stunning landscape. The county has [135 named mountains with Big Horn Mountain at 7,986ft elevation the tallest](#). During clear weather, spectacular views of Mt. Rainier (elevation 14,417ft and part of Mt. Rainier National Park extends into Lewis County), Mt. Adams (elevation 12,281ft), and Mt. St. Helens (elevation 8,363ft, 1,300+ feet less than before its 1980 volcanic eruption) are possible. Large parts of Lewis County are in the Gifford Pinochet National Forest, and there are other state and federal recreation areas. Besides great vista, it is also home to many lakes, waterfalls, biking and hiking trails, making Lewis County a literal outdoor recreational paradise. Hence, sustainable environmental development is essential to its economy by attracting tourists, part-year residents, and new residents who seek rural lifestyles, fantastic outdoor recreation, and bucolic landscapes. But natural-resource extraction typically runs counter to this development path.

While Lewis County recorded over 500 residents in the 1850 Census, population did not take off until the 1870s and 1880s with the arrival of the Northern Pacific Railroad (now part of the BNSF). Centralia was further solidified as a rail transport hub shortly thereafter with the arrival of the other [Class I](#) (major) railroads including the Milwaukee Road, Great Northern, and Union Pacific. Lewis County became home to a budding logging industry and an associated wood manufacturers. These industries remain paramount in the region today.<sup>30</sup> Moreover, being home to logging, sawmills, and railroads facilitated Centralia's rise as a hotspot of union organizing in the early 20<sup>th</sup> century. Further increasing the area's dependence on natural-resource extraction, [the Centralia Coal Mine—which was Washington's largest coal mine](#)—opened 1971. [In 2006, the](#)

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<sup>30</sup>Lewis County remains a prime logging area. [Washington Department of Revenue data](#) indicates that about one-seventh of the state's 2021 timber harvest (measured as million board feet, mbf) was in Lewis County, accounting for 17.6% of Washington's harvested timber value.



[mine employed about 600 workers with an average salary of \\$65,000](#) (\$101,381 in April 2023 dollars). The accompanying Centralia [coal powerplant also opened in 1971](#).

BEA data illustrates Centralia's ongoing dependence on extractive industries and their key downstream industries. Centralia's share of total earnings in logging and mining, as well as in top downstream industries in wood-product manufacturing, furniture manufacturing, paper manufacturing, and utilities (to reflect its coal powerplant) averaged about 33.9% between 1975 and 1981 (or 25.7% of Lewis County PI) compared to 5.2% for the US (or 4.0% of U.S. PI)—i.e., the *earnings location quotient* shows that Centralia's natural-resource sector was about 6.5 times more intense than the U.S. ( $33.9/5.2 = 6.5$ ). The natural-resource sector share of Centralia earnings steadily declined to 18.1% in the pre-Great Recession 2001 to 2007 period, falling to 13.0% between 2017 and 2021 (or 6.8% of Lewis County PI). The corresponding U.S. shares for 2001-2007 and 2017-2021 are 2.9% and 2.7% (or 1.9% of 2017-2021 U.S. PI)—meaning that by the 2017-2021 period, natural-resource earnings remained about 4.8 times more intense than the overall U.S. ( $13/2.7$ ).<sup>31</sup> In sum, Lewis County's remains heavily dependent on natural-resource extraction, though falling over time.

AS noted in a [2021 Ohio River Valley Institute](#) (ORVI) report, while timber remains a key part of Centralia's (relatively) shrinking natural-resource based economy, coal mining and the associated powerplant were key features of the economy. These entities are operated by the Canadian company TransAlta and collectively employed up to 1,000 workers out of a total Lewis County nonfarm wage-and-salary employment of 27,600 in 2006. Yet, those industries make up a larger share of county earnings than their employment numbers may suggest. In 2001, BEA data shows that, collectively, earnings in mining and utilities accounted for 7.8% of Lewis County's total earnings versus 10.2% for timber, wood-product manufacturing, and furniture manufacturing. By 2021, the timber and the two associated manufacturing-sectors' earnings share remained at 10.2% but the mining/utilities earnings share declined to 2.6%.<sup>32</sup> After some struggles, this

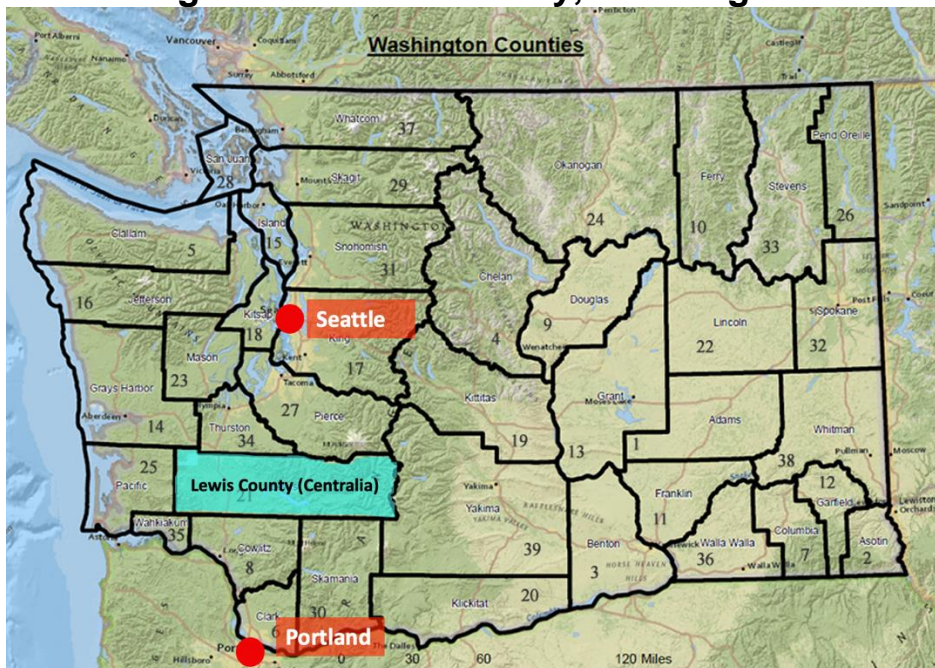
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<sup>31</sup>Another way to illustrate the unhealthy historic aspects of Lewis County's natural-resource dependence is to note the difference in the natural-resource sector's share of county GDP produced and the natural-resource sector's share of total earnings. BEA Data for county-level GDP begins in 2001. For comparability and data availability across the BEA's GDP and personal income datasets, the "natural-resource share" includes farming, forestry, and fishing; mining; and utilities to reflect Centralia's powerplant. In this case, Lewis County's share of GDP in these natural-resource industries accounted for 25.6% of GDP during the 2001 to 2007 period versus 15.6% in the 2017-2021 period. However, the corresponding natural-resource *earnings* share of Lewis County personal income during the 2001-2007 period equaled 4.4% and was 2.7% between 2017-2021. In both periods, the ratio of GDP to earnings was 5.8, suggesting that about 5.8 times more of natural-resource value left Lewis County than remained as worker and proprietor earnings. The good news is natural resources are a smaller part of Lewis County's economy going forward.

<sup>32</sup> [Employment at the coal mine when it closed in 2006 was about 600, while the coal powerplant employed about 225. In 2011, employment at the coal powerplant was 238, falling to 179 in 2020. With the closing of one of the two powerplant boilers in December 2020, only 114 employees remain.](#)

transition from coal and its downstream powerplant is no longer hindering Lewis County’s economy. Its per-capita PI relative to the U.S. average rose from 75.6% in 2001 to 81.9% in 2021, and other indicators show a similar story.<sup>33</sup> One lesson is that despite losing high-wage jobs, the overall economic effect can still be positive.

**Figure 10. Lewis County, Washington**



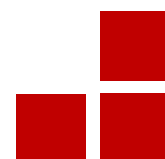
Source: Washington State County Road Administration Board

Although separated by over 2,500 miles from southeast Ohio, Centralia and Lewis County bear some striking similarities to Appalachian Ohio. **Figure 11** shows Appalachian Ohio, the 7 oil & gas boom counties, and their economic status as determined by the ARC. **Figure 12** reports descriptive statistics from between 2010 and 2021 for both Lewis County and the southeast Ohio gas-boom counties.<sup>34</sup> Besides their rural character, through the 19<sup>th</sup>, 20<sup>th</sup>, and early 21<sup>st</sup> centuries, both regions were largely reliant on development by outside international corporations in timber, oil & gas, coal, and other resources.

Greater Centralia and Appalachia Ohio oil and gas towns share a pleasant hilly/mountainous landscape that can enhance future amenity-led economic development if left unharmed. The U.S. Department of Agriculture (USDA) created a scale to measure the natural amenities of an area

<sup>33</sup>Similarly, between 2001–2021, population increased 22.4% in Lewis County vs. 16.4% for the U.S. Even more impressive, its labor earnings increased 35.9% faster than the U.S.

<sup>34</sup> The descriptive statistics are for the following 7 Ohio counties: Belmont, Carroll, Columbiana, Guernsey, Jefferson, Monroe, and Noble counties.



based on characteristics that people generally prefer including climate, pleasant landscape, lakes, and nearby oceans. **Table 12** shows that Lewis County’s amenity measure equals 3.40, whereas the 7 Ohio gas-boom counties score is 0.33. This measure tells us that Lewis County is 3.40 standard deviations above the U.S. average and the Ohio gas-boom counties are 0.33 standard deviations above the average. Comparing them to their respective state neighbors, Table 12 shows that the average Ohio-county score is -1.73 vs. 2.80 for an average Washington county. Compared to their immediate in-state neighbors, both regions—especially the Ohio gas-boom counties—have considerably better natural amenities. Of course, once the natural environment is injured, the “option value” of amenity-led development is lost.

Centralia itself is approximately 200ft in elevation with relatively flat land or rolling hills dominating to the south. Its climate is pleasant. [Using U.S. National Oceanic and Atmosphere Administration \(NOAA\) data](#), the lowest average high in Centralia is 44.4°F in late December (coldest average low is 33.6°F, also in late December), whereas the highest average high in late July/early August is 79.3°F (with a corresponding average low of 54.0°F). Centralia receives an annual average of 41.6 inches of precipitation, with an average of 6.6 inches of snow. The moderate weather is an attraction.<sup>35</sup> Though a little colder in the winter and possessing a more humid summertime, the Ohio gas-boom region’s climate is similar.

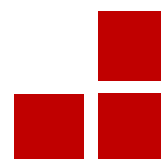
As in Appalachia Ohio, Lewis County’s natural landscape is generally forested, though traditional farming is predominant in some parts. Namely, [southern parts are home to most of its traditional farming, generally in elevations below 1,000ft. Local farming is further enhanced by moderate weather, as well as fertile “productive alluvial flood plain areas.”](#) The county possesses about 123,000ac (192 square miles) of farmland (10,000ac irrigated), composing approximately 7.8% of its total land area. About 42% of the farmland is cropland, 30% pastureland, and 21% woodland including for Christmas trees (the remaining 7% is “other” farmland). Overall, the farm share of Lewis County’s GDP was about 0.8% between 2001-2005 and 1.0% between 2017-2021. Of course, logging is the mainstay of Lewis County’s agriculture sector vs. customary crops and livestock.<sup>36,37</sup>

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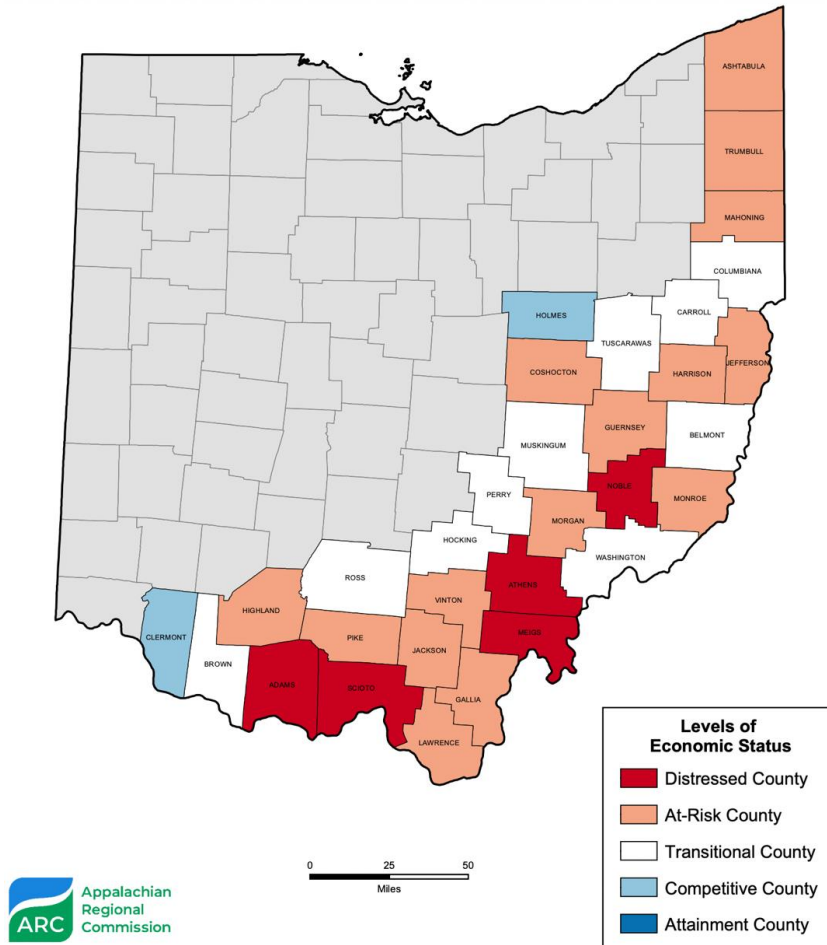
<sup>35</sup> Comparatively, NOAA data for Wheeling, WV which is located just across the Ohio River from Ohio’s major gas counties, shows that it experiences its lowest average high of 37 °F in January and its highest average high of 83 °F in late July. Wheeling is comparably mild, with an annual average of 30.8 inches of precipitation and 9 inches of snow.

<sup>36</sup>Wood-product manufacturing, an industry generally driven by proximity to the timber input, accounted for about 9% of Lewis County’s wage bill using 2019 U.S. Census Bureau *County Business Patterns* (CBP) data. By contrast, food-processing manufacturing, which is somewhat less driven by transportation costs and necessity for proximity to raw inputs, accounted for about 2.4% of the county’s wage bill.

<sup>37</sup>For comparison, logging (without downstream manufacturers) accounted for 5.4% of Lewis County’s GDP between 2001-2005 and 2.9% between 2017-2021.

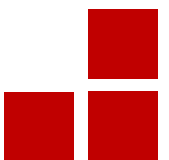


**Figure 11. Ohio's Application Counties and Their ARC Economic Status**



**Map Source:** <https://www.arc.gov/wp-content/uploads/2021/06/CountyEconomicStatusandDistressAreasFY2022Ohio.pdf>

**Figure 12: Descriptive Statistics of Ohio's Core Natural-Gas Counties & Lewis County, WA**



	1980-2010 Population Change	2010-2020 Population Change	2020 % of Population Under 18	2020 % of Population Over 65	2020 % of Population with a Bachelor's Degree	2021 Population*	US ERSA Amenity Scale**	2001 Mining, Oil, and Gas Extraction Share of Private Nonfarm Jobs	2001 Manufacturing Share of Private Nonfarm Jobs	2021 Mining, Oil, and Gas Extraction Share of Private Nonfarm Jobs	2021 Manufactur ing Share of Private Nonfarm Jobs	2020 Estimated Nonfarm Self Employment Share of Total Employment
<i>Core Ohio Gas Counties</i>	-11.78%	-6.19%	20.20%	22.80%	14.50%	33,943	0.33	2.09%	14.70%	3.36%	7.97%	7.00%
<i>Lewis County, WA (Centralia)</i>	34.40%	9.22%	21.80%	21.10%	19.00%	84,398	3.40	2.52%	12.26%	0.97%	11.40%	10.30%
<i>Washington</i>	62.74%	14.58%	21.70%	16.20%	37.30%	11.7 million	2.78	0.20%	11.56%	0.16%	7.24%	5.81%
<i>Ohio</i>	6.84%	2.28%	22.10%	17.80%	29.70%	7.7 million	-1.73	0.37%	16.78%	0.30%	11.30%	5.24%
<i>US Nonmetro Average</i>	12.90%	-0.78%	-	-	-	-	-	1.65%	18.40%	1.75%	13.40%	6.9%**

\*Presented as an average measure for Core Ohio Gas Counties

\*\* Calculated for 2019 by US Economic Research Service (ERS)

The natural amenities scale is published by the USDA and is a measure of physical characteristics of a county that enhance it as a location to live. It is constructed by combining measurements on climate, topography, water areas consistent with what people prefer, such as warmer winters, lower humidity summers, etc. It is presented as an average for Ohio's core gas counties.

Data Sources: US Bureau of Economic Analysis, US Census Bureau, US BLS Quarterly Census of Employment and Wages (QCEW)

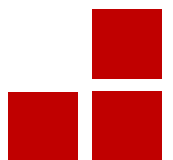
#### Box 4. A Note on Measuring Amenities

The United States Department of Agriculture (USDA) calculates a natural amenities score, used in the table above, for the counties of the 48 continental United States. This measure is reflective of seven measurements related to the geography and climate of a county: warm winter, winter sun, temperate summer temperatures, low summer humidity, topographic variation, and surface water area. The numbers above refer to the number of deviations from the national mean. More information can be found here: <https://www.ers.usda.gov/data-products/natural-amenities-scale/>

**Figure 12** shows other economic similarities between Ohio's gas counties and Lewis County, WA (Centralia). Historically, both regions rely on extractive industries. Neither region is very urbanized. The 2022 average county population was 33,792 in the Ohio region, summing to a collective population of 236,543 (the average Ohio county is about one-fifth the geographical size of Lewis County). Lewis County had 85,370 residents, growing a robust 3.9% between April 2020 and July 2022.<sup>38</sup> Centralia had just under 18,800 people, augmented by close neighbors Chehalis with just over 7,600 residents and unincorporated Ford Prairie with a population over 2,200.

The largest community in the Ohio's core natural-gas region is Cambridge (in Guernsey County) with a 2022 population of 9,985. Cambridge has faced out-migration like much of Appalachia Ohio. For example, in 1930, Cambridge's population was 16,100, losing population every decade thereafter. Not only are the two regions rural, but neither is in the direct sphere of

<sup>38</sup>Population data is drawn from the U.S. Census Bureau.



large urban areas. The Ohio region is a little closer to Akron, Columbus, Cleveland, Pittsburgh, and Youngstown urban areas than Centralia is to Seattle or Portland. Centralia's remoteness especially limits high-paying commuting opportunities that could stabilize its economy.<sup>39</sup>

Lewis County and the 7 Ohio natural gas counties respectively have 10.3% and 7% of civilian employment that is nonfarm self-employed. Both are above the US nonmetropolitan average of 6.9%, as well as their respective state averages. As noted earlier, this is important because: (1) small-business development and new startups are critical for job growth and (2), small-business development and new startups are one of the few avenues that remote rural communities have some control to enhance their economies—i.e., rather than hope some large outside company comes to the rescue, they can use their own assets to regain economic prosperity and shake control from large international corporations. The Centralia Model discussed below especially aims to increase small-business viability.

Both regions have similar dependent-population shares below age 18 and over 65, as well as less than one-fifth of their adult populations hold a bachelor's degree or higher. This trails both of their respective states in terms of educational attainment and is above both states' average in terms of an older dependent population share. In sum, both regions face demographic limitations.

Centralia and Ohio's natural-gas boom counties have experienced strikingly different economic development trajectories between 2010-2020. While job growth in Lewis County increased by 9.2% and its mining, oil and gas extraction sector shrank, the 7 southeast Ohio counties declined in population, while their mining, oil and gas extraction jobs as a share of private nonfarm employment mushroomed as a result of the "fracking boom." We now turn to the Centralia economic-development model to assess whether it can guide the future development strategy in Ohio's gas-boom region, as well as in other struggling rural regions.

## Case Study of the Centralia Development Model

In 2006, TransAlta closed its Lewis County coal mine—[Washington](#)'s largest, and later announced plans to fully retire its massive nearby coal-fired powerplant by 2025.<sup>40</sup> In the interim, powerplant employment halved. Centralia is a good example of a natural-resource boomtown whose economy

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<sup>39</sup>BEA data shows that for 7 Ohio oil and gas boom counties, commuting earnings from outside their county of residence accounts for about one-half of net-resident earnings and represents about one-fourth of PI. In Lewis County, the analogous shares are 35% and 19%, illustrating Lewis County's smaller economic links to nearby counties. Net-resident earnings is defined as resident earnings minus payroll taxes for government social insurance.

<sup>40</sup>[At the powerplant site, a smaller gas-fired power plant opened in 2002. The gas plant's capacity was 248MW, but closed in 2013. The coal power plant's capacity was 1,340MWs.](#) The coal-fired power plant is over 200ft tall (or a 20 story building) and was [Washington's largest electric plant](#) until one of its two boilers closed in 2020.



would generally had been expected to suffer as a result, which was aggravated by the region's other shortcomings such as low education and sparse population. [It would be reasonable to have predicted sluggish job growth and lower incomes in the face of the large layoffs, exacerbated by the high-paying nature of those jobs.](#) Powerplant [jobs reportedly had an average salary of \\$88,520 in 2011 \(or \\$121,340 in March 2023 dollars\).](#) As reports from ORVI show, compounding their problems was the region already had an unemployment rate nearly 3% higher than the U.S. in 2005, prior to the mine closure. This type of economic bust has been and will be replicated in many communities across the U.S. [The U.S. is currently on track to close half of its coal-fired power generating capacity by 2026.](#)

[TransAlta negotiated a 2010 deal with the Washington state government and local groups to provide \\$55 million over 14 years to establish an “energy transition grant” fund](#) to assist the region in transforming and adapting its local economy. [Moreover, TransAlta agreed to accelerate the closing of one of the powerplant’s two coal boilers to 2020, with the other coal-boiler closing in 2025.](#) Nonetheless, TransAlta also benefited from this deal because if Washington state had ordered them to keep the powerplant open after 2025 to prevent economic damage to Centralia, the costs of renovating the powerplant to fully meet current pollution standards and/or to switch to natural gas in order to meet state carbon standards would have cost upwards of \$100 million.

## Centralia Model in Detail

The \$55m in funds Transalta committed to Centralia were divided between several grant programs, including a Weatherization Fund, Economic and Community Development Fund, and an Energy Technology Fund. Grants began being dispersed in 2016 after an initial period to grow the fund's principal.

[The \\$10 million Weatherization fund](#) provides grants to the county's low-income residents as well as in two neighboring counties for energy-efficiency upgrades. The largest recipient of Weatherization grants to date is the Lewis County Department of Public Utilities Energy Efficiency Program, totaling over \$3.1m. The Economic and Community Development Fund of \$20m provides training and workforce development, particularly for workers directly impacted by the closure of the mine and powerplant. Centralia College has to-date received \$2.5 million in grants to help provide physical space to house workforce development programs, as well as education programs to provide post-secondary and vocational preparation to local high school students.<sup>41</sup>

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<sup>41</sup>Centralia College is a community college that plays a key economic-development role. It actively engages in workforce training and providing technology, trade, manufacturing, and vocational training. The college has numerous

The [Energy Technology fund](#) has been utilized so far to install solar panels on buildings owned by over ten local governments and school districts, as well as fund a renewable hydrogen pilot program and electrify the freight terminals at the Northwest Seaport Alliance, impacting ports in Seattle and Tacoma. In December 2022, Twin Transit received a \$1.8 million grant from the fund to support the installation of the region's first containerized green-hydrogen electrolyzer to collect data and provide insight into future green-hydrogen initiatives.

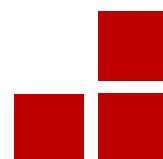
To receive these grants, [local organizations apply](#) to a board comprised of TransAlta officials, local government representatives, and various members of local economic and environmental organizations. A key feature is the grants aim to develop local infrastructure and human-capital, as well as utilize other latent local capital. Notice that a chief policy goal is to use local small businesses and entice new startups to do much of this work. Moreover, these kinds of small businesses disproportionately utilize local labor rather than new migrants or commuters, disproportionately hiring low-skilled workers who were more likely to have lost work during the mine and powerplant layoffs. And while most of these jobs don't pay as well as the lost mining and powerplant jobs, [they typically pay well-above the minimum wage](#). The low-income workers who receive these wages tend to spend more income locally, which increases local-multiplier effects. Conversely, a greater share of high-wage workers' incomes leaks out as they purchase more items assembled outside the region such as large consumer electronics, expensive vehicles, and vacations.

A key finding is that this place-base focus has allowed a relatively small investment of \$55 million to have larger local multiplier effects than major capital investments by mining, oil, and gas companies, who often promise thousands of jobs and economic prosperity. Major investments like these rely on large numbers of outside workers, inputs and equipment that originate elsewhere, which reduce multiplier effects, as well as create a host of negative externalities. Also, faster productivity growth in traded industries such as natural resources and manufacturing mean that over time, fewer employees are needed to produce a given level of output. Small businesses and locally-owned businesses tend to have larger multipliers, their profits remain local, and are at much smaller risk of relocating to (say) China.

The next section empirically examines Centralia's record and evaluates whether the Energy Transition Grant Program is at least partly responsible for Centralia's relatively strong economic

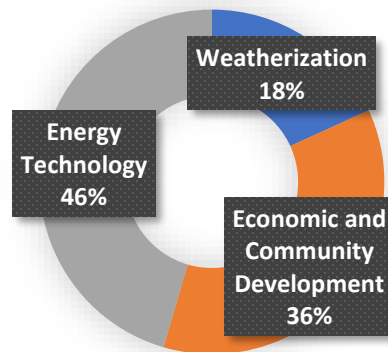
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vocational certificates and AA degree programs, as well as an RN nursing AA degree and five applied Bachelors degree programs in areas such as diesel mechanics, applied management, and K-8 teaching education. [Its 2022-2023 catalog reports a headcount of almost 6,000 with almost 2,000 fulltime equivalent students.](#)



resilience compared to otherwise similar regions.

**Figure 14. Breakdown of the \$55 Million Energy Transition Fund**

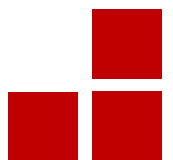


Source: <https://cctgrants.com/category/grant-recipients/>

## Rigorously Examining the Centralia Model

To more closely examine the performance of the Centralia Model’s Energy Transition Grant Fund, we use a statistical approach known as the synthetic control method (SCM). SCM was popularized in economics by Abadie et al. (2010) to conduct comparative analysis and assess the impact of policy changes. They originally tested the methodology to explore the effects of California’s tobacco control program.

SCM is often used when a satisfactory [counterfactual](#) is unavailable. For example, in testing a new medication, researchers seek to have a treatment group and control group of individuals. The control group represents the counterfactual who are otherwise the same in characteristics such as gender, age, and prior health histories. This allows researchers to be sure that an observed difference in outcomes between the two groups is because the treatment group received the trial medication. In other words, the control group of patients represents the counterfactual of what *would have* happened to the treated patients had they *not* received the treatment. In social science, it is often extremely difficult to assemble a control group of what would have happened had a policy not been enacted or changed. For example, in Centralia’s case, the transition grants are a “treatment” in response to the closure of the powerplant and mine. A randomly selected location that is identical to Centralia in every way including the recent mine and powerplant closures, but did not have the treatment of a transition board, would be a counterfactual, and nearly impossible to find.



How can we be sure that the Energy Transition Board is at least partially responsible for the relatively impressive performance of Lewis County (“Centralia”) since 2016? SCM allows us to create a control case for comparison by taking a weighted average of the other Washington counties that are similar to Lewis County to produce a counterfactual. We identify similar counties based on relative closeness in key economic factors such as past population, industry composition, educational attainment, etc. The final counties used in developing Lewis County’s counterfactual county are individually not identical to Lewis County, but the SCM method creates a weighted average of their performance that very closely matches Lewis County *up to the treatment date*, when grants began. Presumably, any subsequent variation between Lewis County and the weighted-average SCM control county reflects the transition grants’ effects.<sup>42</sup>

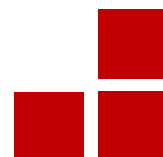
Our model accounts for several different economic and demographic variables when creating the synthetic control for Centralia. We generate our synthetic control county, accounting for population, racial composition, percentage of the population over age 65, percentage of the county’s adult population with a bachelor’s degree or higher, employment and PI shares of the county’s mining, oil and gas, manufacturing, and agriculture sectors, and whether the county is a metro county. Data to generate the synthetic control is from the BEA, Census Bureau ACS, and BLS. We also account for historic economic performance, following Abadie et al. (2010), by including 2012 and 2014 changes in PI. The model considers all Washington counties (except Lewis) and provides statistical weights to create a counterfactual “synthetic-control county.”<sup>43</sup>

After constructing the SCM-control county, we compare what occurred in Centralia (Lewis County) against the synthetic county. Specifically, our main outcomes are post-2016 percentage change in the number of jobs and PI and post 2016 growth in nonfarm proprietor (self-employment) income. These results are shown in **Figures 14, 15, and 16**. Data for the synthetic control models comes from the U.S. Bureau of Economic Analysis, the U.S. Census Bureau’s American Community Survey (ACS), and the U.S. Bureau of Labor Statistics.

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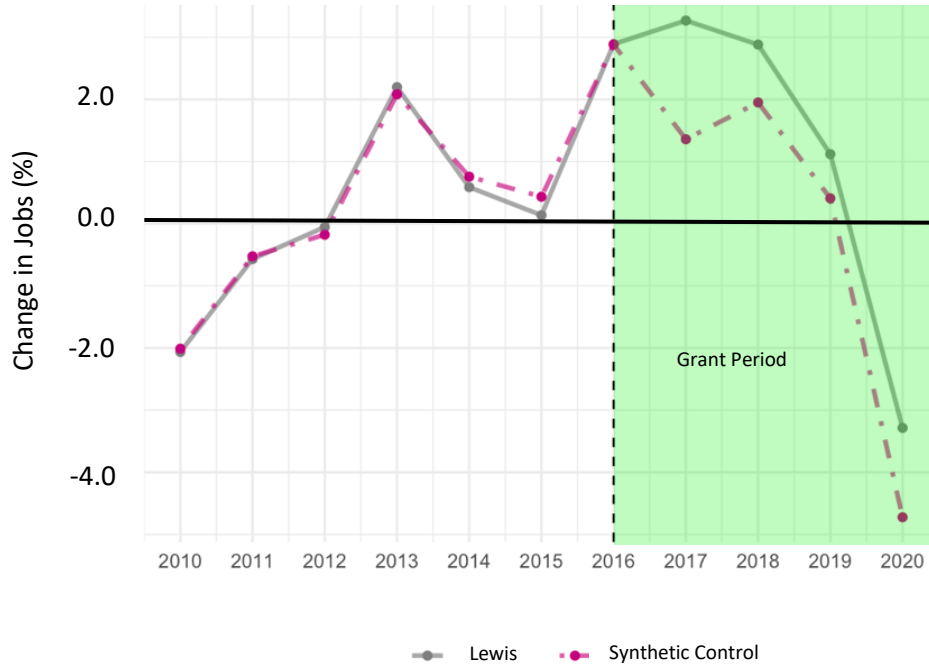
<sup>42</sup>Individual counties used as “donors” for the SCM-control county may differ from Lewis County, but the goal is that when weighting and combining the donor counties into one control county, they perform the same as Lewis County up until Lewis County is “treated” in 2016 with the Transition Board. Then differing performance between Lewis County and the SCM-control county is assumed to arise from the direct and indirect effects of the board.

<sup>43</sup>For an overview of the counties selected by the synthetic control model and their weights, see Appendix A.



**Figure 14. Synthetic Control Analysis Results Part 1**

Change in Wage & Salary Jobs for Lewis County (Centralia) and Synthetic Control County (2010-2020)

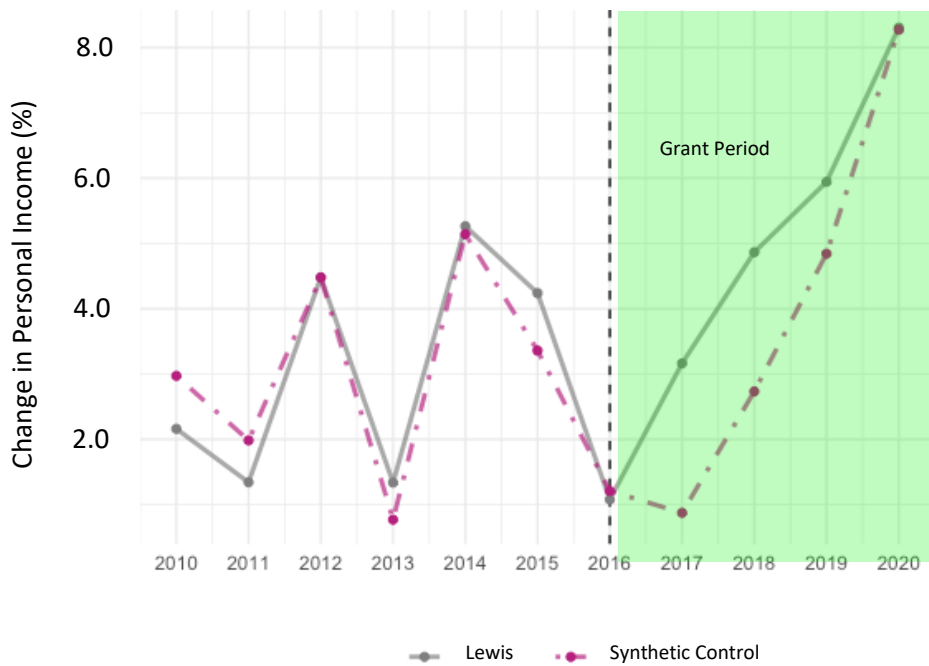


Mean Squared Prediction Error (MSPE) Ratio: 82.6

Dashed line denotes the time of the intervention.

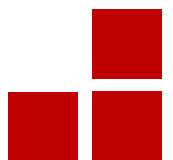
**Figure 15. Synthetic Control Analysis Results Part 2**

Change in PI for Lewis County (Centralia) and Synthetic Control County (2010 -2020)



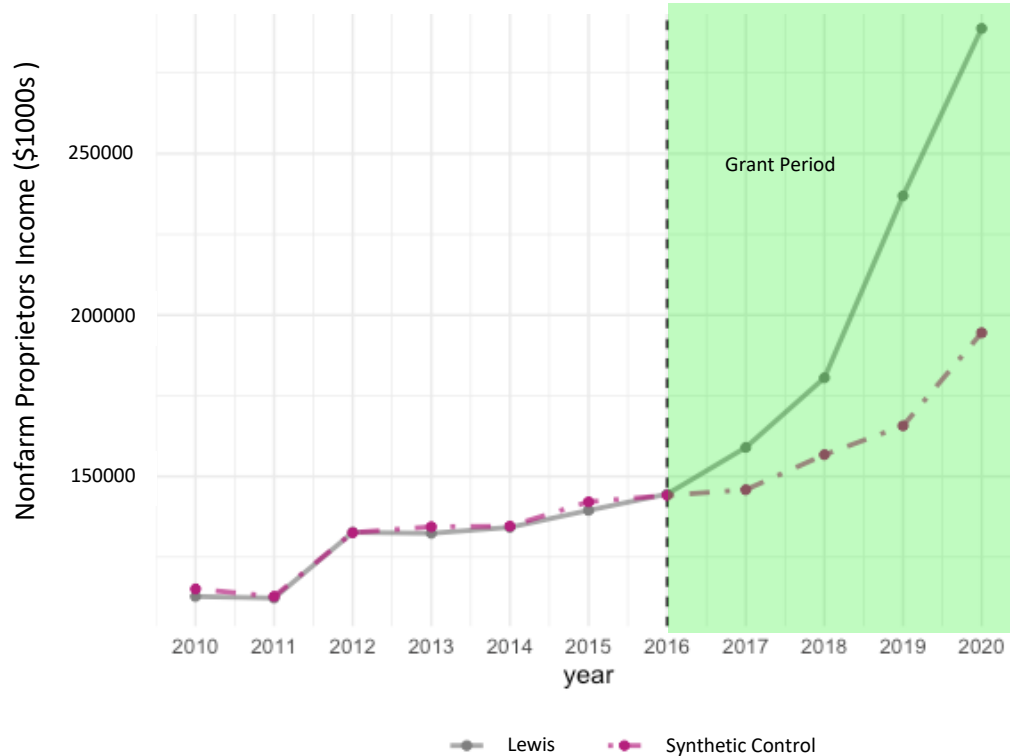
Mean Squared Prediction Error (MSPE) Ratio: 11.3

Dashed line denotes the time of the intervention.



**Figure 16. Synthetic Control Analysis Results Part 3**

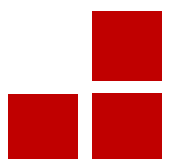
Annual Nonfarm Proprietor's (Self Employment) Income for Lewis County and Synthetic Control County (2010-2020)



Mean Squared Prediction Error (MSPE) Ratio: 1501 Dashed line denotes the time of the intervention.

The SCM results are compelling. First, it is statistically a very positive sign that Lewis County so closely tracks the synthetic county prior to 2016 in all three iterations of the model. That suggests the SCM produced a good SCM county to accurately track Lewis County prior to the start of grantmaking<sup>44</sup>. Beginning in 2016, a clear gap appears, with Lewis County outperforming

<sup>44</sup> The quality of fit for a synthetic control model is measured by the ratio of the pre- and post-treatment (grant rollout) mean squared prediction error (MSPE). In essence, the model is a good fit if it accurately predicts the pre-treatment period (small MSPE) when Lewis County and the synthetic control should be otherwise statistically the same. If the grants had any kind of effect, we would expect the post-treatment MSPE to increase as the grant's began to impact Lewis County but not the statistically modeled control county. As such, a large MSPE ratio (from dividing a larger number by a smaller number) is indicative of a strong fit for the SCM. For more, see Abadie, Alberto. "Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects." *Journal of Economic Literature* 59, no. 2 (2021): 391–425. <https://doi.org/10.1257/jel.20191450>.



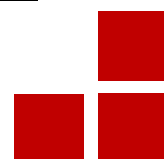
the control, coinciding with when the energy transition board grants began to matriculate into the local economy. Peaking in the years immediately following grant distribution, Lewis County job growth and PI grew nearly 2 percentage points faster than the synthetic control, a rather significant gap. Additionally, Lewis County experienced roughly \$80M more in nonfarm proprietor income than the counterfactual synthetic control. For context, \$80M represents about 2% of Lewis County's 2020 GDP.

### Box 3: The Centralia Model of Economic Development

The key to the Centralia program is investing in economic activity with higher local economic multipliers. Further, the kinds of activity supported by the grants are usually local. As a result, the full amount of money disbursed by the transition board have circulated locally, aiming to increase the multiplier. This stands in contrast to what might have happened if TransAlta had invested a sum larger than \$55 million to update and continue the powerplant's operation. In this scenario, the total dollars spent would have been larger than the transition board's grant pool but very few of the dollars would remain in the Centralia region. First, the expenditures would have supported temporary construction jobs. Then, the company likely would have, by necessity, hire highly specialized contractors from outside the region and purchase equipment and materials manufactured outside of the region and, very likely, outside the country.

Many of the grant activities are instead labor-intensive such as transitioning boiler systems to clean-energy sources or install weatherization at homes and local businesses. These actions intensively use local labor and entrepreneurship. Local contractors and businesses are more likely to source inputs and supplies locally, which result in greater indirect and induced income effects within the region. Indeed, there is strong empirical evidence that rural areas, such as Centralia, have the potential for greater marginal returns on investments supporting self-employment (Tsvetkova, Partridge, and Betz, 2016). Small businesses, such as those who conduct the weatherization work and those who own properties being weatherized, have been shown to generate jobs for owners and other employees and help change the local business culture in traditionally lagging regions (Stephens and Partridge, 2011). Grants dispersed from the Economic and Community Development and Energy Technology funds were also invested in activities to foster a more creative, entrepreneur friendly environment.

Another component that helped magnify the grants impact is the ability of the region to leverage inside and outside funds that it would otherwise be unable to access. First, grants to (say) a local homeowner typically require them to put up a moderate match to leverage an even larger impact. Grants have been awarded to in-state companies to develop and demonstrate technologies of intense national interest, such as the potential for large-scale hydrogen electrolysis or installing electric vehicle (EV) charging stations along scenic byways. [In February 2023, the state provided a \\$250,000 grant to Lewis County to support First-Mode Proving Grounds for hybrid fuel cell and battery-powered](#)



[mining trucks](#). The company plans to renovate and expand the former TransAlta coal mine site. [A state press release](#) notes that, “Lewis County could well become a symbol of Washington state’s robust and growing clean energy economy...” Grant funds have also leveraged funds from other organizations outside Washington such as from Toyota North America. Using funds this way further leverages greater local multipliers, generating more income and economic activity than would have otherwise occurred.

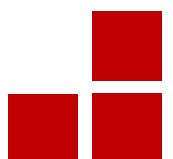
Funds from transition grants provide opportunities to invest in quality-of-life (QOL) improvements for current and future residents. Grants have been awarded to support updates including improved lighting, infrastructure and accessibility at local parks, repair local community establishments such as theaters and restaurants, and partner and support STEM activities in local schools. There is growing evidence that supports QOL’s increasing importance in both mitigating population loss, attracting new residents, and growing local economies (Weinstein, Hicks, and Wornell, 2022).

Finally, the Centralia Model features *double-dividend* effects. First, weatherization projects conducted in partnership with the local utility offer residents low- or no-cost energy-saving opportunities such as heat pumps, window updates, and improved insulation. These are effectively an annuity creating improvements, saving residents on heating and cooling bills over the long-term. The energy savings can then, in turn, be spent locally, further increasing its multiplier aspects. Additionally, such energy efficiency improvements have a well-documented capitalization into home prices. This means that for relatively low (or zero) cost to the current owner, they can make improvements that allow them to sell their home for a higher price whenever they choose to relocate. Empirical studies have estimated this effect is as high as 2% (Walls, et al., 2017). Greater community wealth from higher property values (including for local businesses) further increase local spending through what economists call a “[wealth effect](#),” further increasing multiplier effects. Moreover, there are added *triple-dividend* effects from pollution and carbon reductions from decreased energy use.

It also appears that Lewis County is more economically resilient to shocks. As Figure 13 shows, the negative effect of Covid on jobs between 2019 and 2020 was significant for both Lewis County and the synthetic control. But Lewis County ended 2020 with a smaller job loss (just over -3%) compared to a nearly 5% job loss for the synthetic control county. Likewise, the effects of the Covid 19 pandemic and related federal and state government stimulus policies are likely responsible for higher PI in both Lewis County and the control county.

## Centralia’s Small Businesses, Startups, and Self-Employment

The SCM’s results illustrate that Centralia and Lewis County benefited from the transition board in economically meaningful ways. However, key to the Centralia Model is that the targeted investments are aimed at small businesses because of likely increases in local-multiplier effects.





Thus, we examine this in two ways. The first is to appraise the performance of nonfarm proprietor income. Proprietor income includes unincorporated businesses—basically if the firm’s owner(s) report IRS Schedule C income or partnership income.<sup>45</sup> Proprietor income thus measures income for almost exclusively small businesses, ones who are not treated as corporations by the IRS, meaning that income growth indicates a healthy small-business climate.

Over the 2016-2021 period, nonfarm-proprietor income rose a remarkable 107.9% in Lewis County vs. only 25.4% for the U.S. Likewise, the corresponding nonfarm-proprietor income growth rates for Lewis County and the U.S. for the 2010-2015 period were respectively 23.6% and 27.8%. Lewis County’s growth in nonfarm-proprietor income lagged the nation in the 2010-15 period by 4.2 percentage points, but after the Transition Board began in 2016, their nonfarm-proprietor income growth exceeded the nation by 82.5 percentage points—a remarkable shift indicating the county’s small businesses thrived. Over the 2016-2021 period, Lewis County PI rose 50.3% vs. 32.3% for the U.S., showing the county’s overall PI (residential) income growth was quite healthy. Soaring nonfarm-proprietor income appears to be the key impetus.

The second way to assess the Transition Board’s role on entrepreneurship and small businesses is to assess startups. [Using 2020 U.S. Census Bureau Business Dynamics Statistics Data \(BDS\) \(the latest available\)](#), the 2011-2015 overall establishment entry rate in Lewis County was 9.5% vs. 9.9% in the U.S., or the U.S. exceeded Lewis County’s new-establishment rate by 0.4 percentage points. During the 2017-2020, the gap rose to 0.6 percentage points, suggesting that startups in Lewis County basically followed the national trend.<sup>46</sup> However, when examining the number of jobs new establishments created in Lewis County, during 2011-15, an annual average of 2,297 jobs were created by establishment openings. In the 2017-20 period, an annual average of 2,525 jobs were created, or a 10% increase over the pre-policy period. The moderate increase supports the notion that startups were hiring more workers even if there was not an

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<sup>45</sup>The [BEA defines proprietor or self-employed income as:](#)

- “Includes all U.S. nonfarm sole-proprietorships that are required to file Internal Revenue Service (IRS) Schedule C (Profits or Loss from Business) of IRS Form 1040 (Individual Income Tax Return) or that would be required if they met the filing requirements.
- Includes all U.S. nonfarm partnerships that are or would be required to file IRS Form 1065 (U.S. Partnership Return of Income).
- Includes all other U.S. unincorporated private businesses—tax-exempt cooperatives providing utility services and farm marketing and purchasing services.
- Receipts include taxable income from entities otherwise classified as nonprofits.” ([BEA Handbook of Methods, Chapter 11, Table 11-1](#)).
- [Limited Liability Corporations \(LLCs\) are treated as proprietors when they ask the IRS to not treat them as a corporation for tax purposes, which typically means the business profits are reported on the owner\(s’\) Schedule C.](#)

<sup>46</sup>The establishment entry rate is basically the percentage of establishments that were less than one-year old at the time of the Census survey (see the [BDS website](#) for details). We omit 2016 because startup data is measured quarterly and that means in the first three quarters of 2016, there could be significant numbers of startups from 2015, which would confound our results. During 2017-20, the overall new-establishment rate was 8.8 in Lewis County and 9.4 in the U.S.

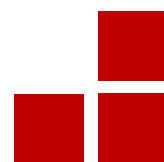
overall uptick in new-establishment formation rates.

In another confirmation test, the Centralia Model particularly targets new opportunities in local construction. Thus, any startup surge should be concentrated there. In terms of construction new-establishment rates, between 2011-15, the rate equaled 16.7 in Lewis County vs. 13.2 for the U.S., i.e., a 3.5-point gap. Between 2017-20, the corresponding Lewis County and U.S. construction new-establishment rates were 16.6 and 12.6, or a 4-point gap. Thus, the gap increased by 0.5 percentage point between the two periods, and an even bigger relative improvement when considering the slight decrease in the County's overall new-establishment rates discussed above. The relative bump in new-construction establishment rates suggests a modest increase in startups as the Centralia Model took hold. Looking more closely by assessing the actual numbers of jobs created, there is more evidence of the Model's success. Specifically, between 2011-15, an annual average of 123 jobs were created by new-construction establishments in Lewis County vs. 185 in the 2017-20 period—i.e., a 50% increase.

We find that after 2016, overall startup Lewis County rates were relatively unchanged and modestly higher in construction. Yet, the new entities were more robust in terms of overall job creation, and even more so in the key construction sector. Centralia small-business expansion lays a foundation for further expansion of new startups and entrepreneurial base. That is, a good predictor of future growth in startups and small businesses is having a large initial share of self-employment—i.e., a strong entrepreneurial climate today pays off in having a stronger future climate, creating a virtuous cycle (Stephens and Partridge, 2011).

In terms of self-employment, we again use a synthetic control model to test the impact of the transition grants. Specifically, we test nonfarm proprietor's income, generating the synthetic control on the same economic and demographic variables as before. The results in Figure 16 show that Lewis County experienced a substantial positive deviation from a well-fit control after 2016. This is consistent with many of the types of installation and contractor jobs created by the weatherization and economic development grant funds. It is also consistent with the higher overall economic multipliers generated by entrepreneurship, where more dollars remain in the local economy.

**Construction's Performance:** Given its central role in the Model, we assess how Lewis County's construction sector performed after the program began. Specifically, we examine construction job growth in the five-years before and after the program's initiation. For Lewis County, BEA data shows total construction employment rose 9% between 2010-2015 and 28.2% between 2016-2021—reflecting an acceleration of 19.2 percentage points in the latter period. For



the U.S., construction employment rose 12.2% over the 2010-2015 timespan and 13.1% between 2016-2021, or U.S. construction employment only accelerated 0.9 percentage points. Clearly, Lewis County's construction sector is much more robust after the transition grants began.

## Did the Centralia Model Create Cruddy Jobs?

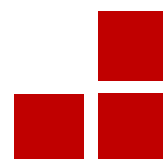
Economic-development strategies aiming to diversify resource-dependent communities often face pushback because of the perception that natural-resource-sector jobs provide “good, high-paying jobs,” whereas the proposed replacement jobs are feared to be primarily low-skilled, minimum-wage jobs. Before the Centralia Model, there is some supporting evidence for those fears. Between 2001-2006, prior to the coal-mine's closure, *QCEW* data shows that the average Lewis County wage-and-salary job paid about 97% of the U.S. nonmetropolitan average and 76.0% of the overall U.S. average. But in the 2007-2015 period, Lewis County's average wage fell to 88.9% of the U.S. nonmetro average and 72.4% of the overall U.S. average. This turned around after 2016. Between 2010 and 2015, average U.S. annual wages and Lewis County annual wages respectively grew 13.2% and 14%, giving Lewis County 0.8 percentage-point advantage. Over the 2016-21 period, corresponding wage growth was 26.1% and 30.5%, or Lewis County's lead grew to 4.4 percentage points. To be sure, Lewis County's average 2021 wage was only 75.3% of the U.S. average, but Centralia began closing the gap.

The transition board stabilized Centralia's economy at a crucial time when expectations were low. Negative expectations about the economic future reduce business startups and investment. The result is business closures, reduced in-migration, greater out-migration, and a downward spiral in local housing prices. In other words, Centralia could have faced a vicious cycle seen in other natural-resource dependent locations during bust periods. Indeed, people voting with their feet agree. Lewis County's 2010-2015 population grew 0.2%, versus 9.7% between 2016-2021 as residents' and business expectations recovered.<sup>47</sup> The influx of grants stabilized or maybe even raised future expectations, which produced the opposite outcome. In particular, improved expectations induce local businesses to make investments and for local residents to remain in the region despite recent job losses because they can see a future for the community.

To be sure, a transition board of the relatively small scale used in Centralia is not a long-term solution for many declining rural counties—at least at this small scale—but it could be one tool to restart an economy and change its medium-term trajectory. *But this requires a region to possess*

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<sup>47</sup>Corresponding U.S. population growth rates are 4.0% and 2.3%, or as Lewis County's population growth accelerated 9.5 percentage points (9.7-0.2), U.S. population growth slowed 1.7 percentage points.



sufficient assets for this to work.<sup>48</sup> Yet, it gives declining communities time to implement a more permanent, cleaner path to prosperity and reduce their reliance on volatile natural-resources.

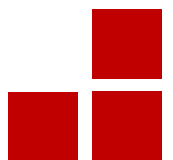
## Conclusion

Given the long history of economic stagnation or even collapse for economies reliant on natural-resource extraction, it is time for a fresh start to consider approaches that capitalize on higher-multiplier activities that do not rely on natural resources or cause pollution that further degrades their future prosperity. Centralia’s approach to diversifying and strengthening its local economy is potentially a good model and an important tool for other local policymakers facing booms and busts or steady economic decline. Most importantly, based on our *causal* analysis, the cost to generate clear positive impact on the region pales in comparison to the purported billions in investment by Appalachia energy developers that we find has produced no discernable result for long-term jobs nor positive income growth for residents. Appalachian Ohio counties still economically lag their in-state and national peers and have apparently fallen further behind their peers in the last decade, despite the “shale energy boom.”

The Centralia \$55m Energy Transition Grant program provides a pathway that can be adapted for Appalachia Ohio and elsewhere. [Individual grants have been less than \\$10 million](#)—often far less. The reason that this modest sum (by economic-development terms) has generated outsized impacts are because it has generally targeted higher-multiplier local business activity. It capitalizes on the region’s latent workforce and infrastructure. The point is that unlike resource-extraction activities, more money stays local. Examples include weatherization grants to The Juice Box, a local restaurant occupying a 100-year-old building in downtown Centralia, a generator conversion project by a local water district, and a Washington-based company’s exploration of using the old Centralia TransAlta gas plant as a location for a future fusion-energy pilot plant. The projects not only contribute to making Centralia and Washington a *first mover* in the clean-energy transition but also support local and state-based companies, governments, and nonprofits—not multinational corporations headquartered elsewhere.

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<sup>48</sup>BEA data indicates that Lewis County’s GDP (value of production) was just under \$4 billion in 2021 and local residential income (PI) was \$4.4B (or slightly over \$2.8B in private-market residential income derived by subtracting from total PI the earnings of government employees and net-transfer payments to individuals—i.e., personal transfer payments minus appropriate individual and business payroll taxes. This is relatively small compared to the \$55 million in transition funds, though to be sure, well designed economic-development programs can deliver an outsized punch. For example, Morin and Partridge (2021) find that the relatively small (Mississippi) Delta River Commission’s (DRC) multiplier effects are quite large.

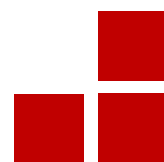


Labor for weatherization is generally done by local contractors and residents. Added benefits arise from electric-bill savings. This “double-dividend” of lower energy costs then creates additional income to support local growth. The diversification of jobs and grantees, as well as the investments in future energy technology, help contribute to making the local economy more resilient against future negative shocks, such as when a large employer decides to close or greatly downsize.

There are opportunities for Appalachian counties to pursue similar policies and diversify their economic-development strategy away from outdated approaches and to take advantage of larger economic multipliers that support local businesses and generate small-business startups. One barrier is funding. Yet, two recent Ohio developments may provide good opportunities for local communities to try initiatives like Centralia’s Energy Transition Board:

- In October 2022, Ohio Governor Mike DeWine announced [a \\$500 million grant program](#) that provides planning and development money for communities located in Ohio’s 32 Appalachian counties. These grants can be utilized by the region’s local governments, educational institutions, and nonprofits to serve as lead applicants. Projects can support infrastructure development, workforce development, and physical, mental health and substance-use disorders. This funding source is much needed and serves as a great resource for communities looking to deploy funds in a high-impact fashion, like Centralia.
- The Inflation Reduction Act signed by President Joe Biden in August 2022 amended the Clean Air Act to create a grant program called [the Greenhouse Gas Reduction Fund](#). This fund allocates \$27 billion to the U.S. Environmental Protection Agency to distribute as grants through September 30, 2024. Local communities may apply for grants aimed toward helping low-income and disadvantaged communities deploy zero-emission technology, providing financial and technical assistance in projects that reduce greenhouse-gas emissions such as weatherization, and specifically providing this assistance in low-income and disadvantaged communities such as in Appalachia.

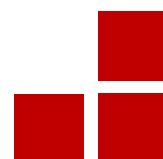
By utilizing funding from these and other sources, and creating partnerships to leverage funding, Appalachian Ohio communities have unique opportunities to build stronger, more diverse, and resilient economies that use local residents’ skills and improve their well-being. The evidence from Centralia indicates a serious potential for these communities to gain lost ground and increase job and PI growth rates. This is achieved by investing in projects that utilize local companies—especially small businesses—and use labor more intensely to generate higher



multipliers. As this report shows, energy booms can provide temporary job growth when times are good—but good times are not permanent in the highly-volatile commodity world and typically the early gains in the boom are returned in the inevitable bust.

There are a few caveats that should be noted regarding the broad applicability of the Centralia Model.

1. Centralia benefited from several assets that improve the odds of the Model's success:
  - (i) While not a metropolitan area, Centralia itself, and surrounding adjacent communities such as Chehalis, give it an urban cluster of nearly 30,000 population, providing an urban threshold to attain some agglomeration economies to induce even more growth. Unfortunately, Appalachian Ohio gas-boom counties lack a regional anchor of that size to internally leverage agglomeration economies, though closer proximity to large urban areas partially offsets this disadvantage and provides outside commuting income that provides more stability to residents' incomes.
  - (ii) Centralia possesses spectacular natural amenities that draws people and businesses to its scenic vistas and outdoor lifestyle. Fortunately, Ohio boom counties also have high natural amenities when compared to their Ohio neighbors outside of Appalachia Ohio. To implement a strategy like Centralia's, low natural-amenity areas need offsetting assets to overcome this drawback.
  - (iii) [Centralia is along U.S. Interstate 5, one of the major national highway corridors. It is also home to a major hub of large and small railroads including the BNSF.](#) The Ohio region also has good access to highways. [East/west I-70, another major U.S. highway corridor](#), cuts through the heart of the region and north/south I-77 traverses its western fringe. The region is also blessed with other divided highways and limited-access routes such as Ohio Highway 7. Moreover, [the Ohio region is at the origin of the major Ohio River water route](#), providing barge-freight access to the lower Midwest, Mid-South and Gulf of Mexico ports. [It also has good rail access, primarily through the Norfolk and Southern Railroads.](#) In terms of connectivity, the Ohio region arguably exceeds well-connected Centralia and is close to major U.S. Midwest and East-Coast markets.
  - (iv) Centralia possesses a proactive community college ([Centralia College](#)), supporting the region's cultural milieu, workforce development, and human-capital augmentation. Centralia College is an amenity itself. Centralia is also home to



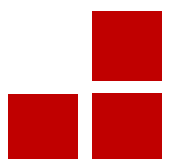
[Providence Centralia Hospital](#) with 128 beds and provides a wide-range of medical services for routine and acute medical care. The hospital has a 24-hour [Level IV trauma-center emergency room](#); birthing center; advanced medical imaging including CAT scan and MRI; and cancer care. Hence, Centralia has strong anchors to support growth including “Meds and Eds,” [which are a currently popular concept in economic development](#).

The Ohio region has several colleges including Ohio University-Eastern Campus in St. Clairsville and other community and technical colleges, giving it an apparent edge over Centralia in this dimension. However, the Ohio gas-boom region lacks the quality of hospital services as Centralia (in terms of services, bed-size of hospital, and access to a trauma center), though there are multiple hospitals in the area.

- (v) Centralia has a robust small-business community giving it a homegrown entrepreneurial culture to support future business expansion. This is a weakness of the Ohio region. For decades, Ohio has greatly lagged the U.S. in new startups, which likely is one factor behind Ohio’s nearly six-decade relative stagnation.<sup>49</sup> It’s unclear whether this is an advantage or a hindrance in terms of the effectiveness of the Centralia Model. It’s an advantage in the sense that the Centralia Model directly attacks an economic weakness of the region by targeting small businesses and promoting startups. Yet, a weak entrepreneurial culture may hinder the model’s effectiveness if local small businesses do not step up.
2. The Centralia Model is mainly for places with sufficient existing assets to induce growth. It is springboard that provides a lift to economically challenged places, but it is insufficient in itself to serve as a rocket to lift places that have been in steep long-term decline and lack sufficient existing assets. For example, the Centralia Model would have to be used in addition to other interventions lift places such as the rural Great Plains agriculture region. In many cases, the benefit/cost analysis would not justify the large investments necessary to support such interventions given scarce resources—i.e., not all places can be “saved.”
  3. If added support is necessary besides the Centralia Model, then options include funding

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<sup>49</sup>Using the BDS data, the 2016-2020 average Ohio new-establishment rate trailed the U.S. by 21.9% and over the longer 2000-2020 period, Ohio trailed by 20.2%. Similarly, the 2016-2020 average Ohio new-establishment job-creation rate (jobs created per new establishment) trailed the U.S. by 17.5%. The problem is generally more acute in the oil and gas region. For example, take Belmont and Guernsey Counties, their 2016-2020 new-establishment rate respectively trailed the U.S. by 40.6% and 37.5% and their corresponding new-establishment job-creation rates trailed the U.S. by 7.5% and 32.5%.

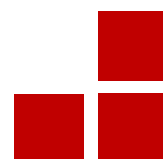


for basic infrastructure, direct support of local education, and the provision of Public Service Employment (PSE) akin to programs used from the New Deal until the early 1980s. Other possible interventions include upgrading broadband connectivity and even identify ways to provide broadband at zero or a nominal cost to jumpstart the area's technological capacity. The added jobs created would stabilize population because employment is available and improve the area's long-term productivity by improving public infrastructure.

4. Good governance is a necessary component for successful economic development. By this, not just efficient governance, but inclusive governance that includes all the key stakeholders so that the hoped for economic benefits are widespread. A prominent example of bad governance is when an "elite" group controls the main local institutions. In larger cities, a good example is how real-estate developers control the political process to garner regulatory benefits and favorable tax incentives that are of questionable social value. Another example is when a major local employer dominates the local political process for their own benefit, not the broader community. This feature is another advantage of the Centralia Model. Rather than focusing on attracting a big employer, by inducing small-business formation, no one firm dominates the local political process, allowing local institutions to focus on the well-being of all stakeholders, not just the big firm.

In rural settings, good governance also includes working regionally. Spillovers from economic development cross arbitrary administrative boundaries due to commuting and other market activities including retail shopping, healthcare, education, and recreation activities. Internalizing these spillovers and gaining efficiencies in public-service delivery by regional collaboration has potential to greatly improve economic outcomes.

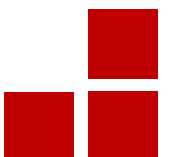
In sum, successful economic development requires more than money. It also needs strong institutions to ensure success and widespread benefits across the populous. Washington state has a reputation for good governance and lacks corruption on the scale seen elsewhere. It has a robust (relatively) well-funded higher-education system that helped turn the state into a tech powerhouse and wealth creator, rather than a tool in counterproductive political culture wars. Effective governance is necessary to ensure the Model works—don't expect poorly run state and local governments and institutions to be successful. It requires effectively allocating grants to their highest-valued social uses (not just satisfying the desires of the local elites or political contributors). It needs broad-based support and trust such that local residents and businesses





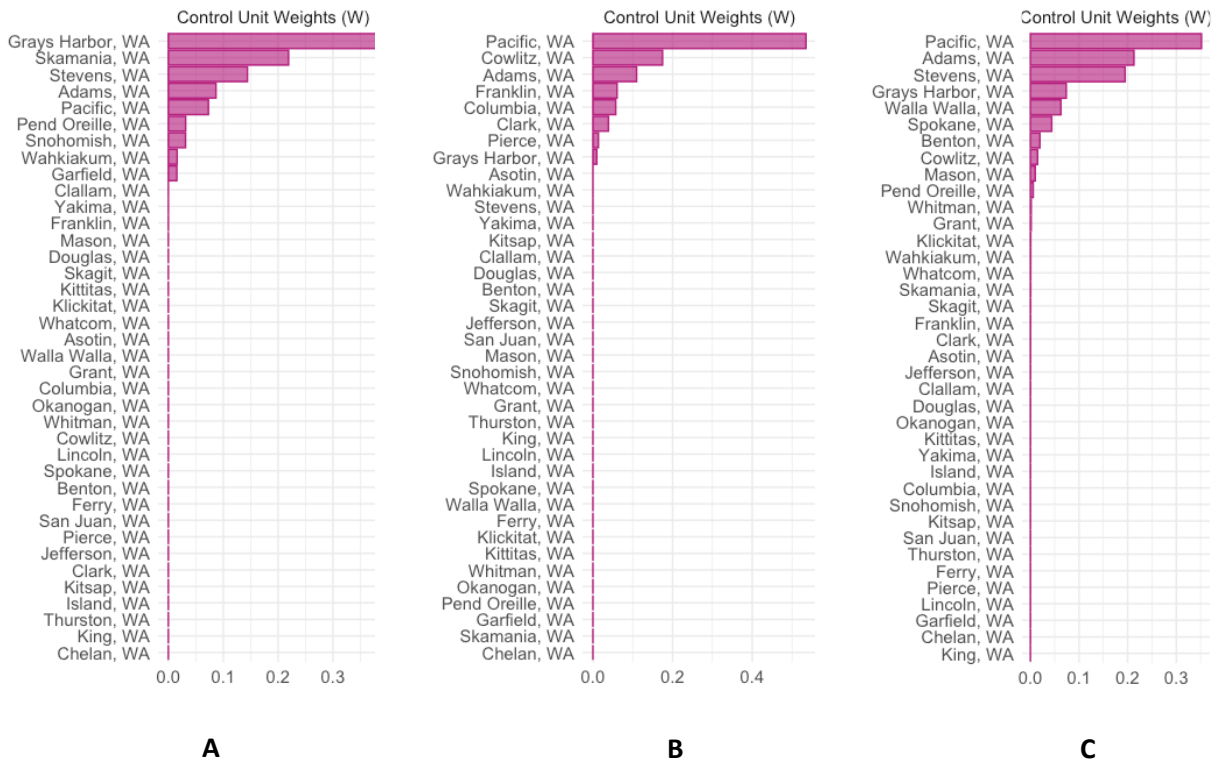
believe in their community's future success and are willing to remain in the area and invest in its future. Indeed, the lessons of Ohio's shale-boom are valuable. Despite the fervent drumbeat of the industry, state and local politicians, media, and business elite, local residents did not buy-in and left *en masse* rather than face the consequences of energy development.

The Centralia Model also requires flexibility to target resources based on evidence and not on strongly held ideological opinions or the whims of powerful special interests. In sum, its successful implementation was not based on conjecture. Its basis was evidence-based peer-reviewed science and leaders who prioritize the needs of their constituents.

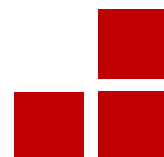


## Appendix A: Synthetic Control Weights

SCM Control County Weights for Change in Jobs Model (Figure 14)

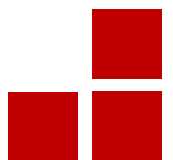


Panel (A) describes the weights assigned to each of Washington’s other counties in constructing a synthetic counterfactual version of Lewis County to compare the change in jobs over time. County weights were generated by the synthetic control model algorithm along a spectrum of variables including industry composition, population demographics, and economic variables. Panel (B) shows the weighting for the personal income synthetic control model and Panel (C) shows the weighting for the nonfarm proprietor income synthetic control model.

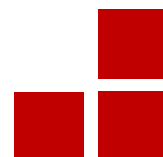


## References:

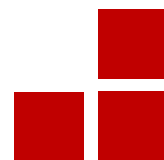
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