INDIANA **RENEWABLE ENERGY**

Siting through Technical Engagement and Planning (R-STEP™)

Towards the Economic Effects of Renewable Energy Restrictions:

Evidence from Indiana, USA

Produced for the Indiana R-STEP Collaborative by the Center for Business and Economic Research, Ball State University

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Towards the Economic Effects of Renewable Energy Restrictions:

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Executive Summary

This study evaluates the economic and fiscal effects of county-level restrictions on renewable energy (i.e., wind and solar power). To accomplish this, we build a two-way fixed effect difference-in-difference model to test the effect of wind and solar regulations on a variety of outcomes.

We find that restrictions on renewable energy sources have not significantly impacted countywide gross domestic product (GDP), employment, population, or capital investment. Our findings are robust when considering various model specifications, regulatory data sources, and different time frames (e.g., analysis in 2016, 2019 versus 2021 to avoid the influence of the COVID pandemic and to reduce post-treatment bias).

However, we do find robust evidence of shifts in the industrial landscape within counties with restrictions. Counties with more stringent regulations on alternative energy sources have witnessed a decline in utilities sector GDP, which aligns with the intended purpose of such regulations to reduce utilities sector GDP within a county. Additionally, counties have experienced reductions in GDP within the information and durable goods manufacturing sectors. Collectively, these losses amount to approximately $240 million annually at the state level.

Our investigation also reveals a decrease in employment in the manufacturing sector, resulting in a statewide loss of approximately 2,200 jobs, as well as reductions in the transportation and warehousing sectors, which translates to nearly 5,300 fewer jobs statewide.

Moreover, we find that counties with renewable energy restrictions now rely more on tax abatements and incentives to attract new businesses. The extent of this reliance varies depending on the model specifications, ranging from an additional $12.5 million to $61 million per year in tax incentives.

Background

During 2008, Indiana's first industrial scale production of wind power was opened, and solar (photovoltaic) production began on industrial scale during 2012. Today, roughly 12 percent of total energy production in Indiana is derived from wind and solar power (EIA, 2024).

Wind facilities, and to a lesser degree, solar production facilities are visible in many parts of the state. At the time these facilities were in the planning stages, the state also experienced growth in regulations regarding the construction of renewable energy facilities. These regulations included setback provisions, drainage control, decommissioning bonds and limits on emissions of light, sound and electromagnetic transmissions. Some counties also introduced a ban on new wind facilities. We review these in more detail in the next section.

Restrictions on renewable energy have both direct and indirect economic effects. Directly, all of these restrictions limit the placement of new wind or solar facilities within the affected county. In some cases, the effect may be very modest. In other cases, the restrictions are entirely prohibitive. That is the design of certain regulations.

Indirect effects of these regulatory restrictions potentially appear because access to renewable energy sources is an increasingly important part of corporate strategy in the United States.[1] For example, an increasing share of these strategies are implemented through Power Purchase Agreements (PPA), that are increasingly linked to the availability of renewable energy sources. These PPAs are generally long-term contracts to purchase energy from a specific firm, source or type. Increasingly, these specify renewable sources.

Power Purchase Agreements are typically developer driven through the designing, permitting, financing and installation of renewable energy. The buyer benefits from energy costs that are often lower than local utility rates. The developer may benefit from associated income and tax incentives as a result of the agreement. Selected agreements by industry are displayed in *Table 1*.

Table 1. Renewable Power Purchase Agreements by Firms Operating within Indiana

Industry	Contract Kilowatt Hours (kWh) per Year
Automotive	1,251,884,385
Chemical	361,963,084
Consumer Products	154,098,590
Food & Beverage	735,282,391
Health Care	243,314,000
Hotels & Lodging	1,473,418
Industrial Goods & Services	1,647,528,415
Restaurants & Cafes	443,886,000
Retail	6,000,185,767
Technology & Telecom	13,664,038,878

Source: Deloitte, 2024

1 See Deloitte, 2024 (https://www2.deloitte.com/us/en/pages/audit/articles/esg-survey.html)

Indiana's Regulatory Framework

The land use regulatory environment in Indiana is highly decentralized. The Indiana Code gives county governments the ability to create areas of permitted uses, prohibited uses and special exceptions.[2] Regulations to permit, prohibit, or create special exceptions on wind or solar power construction are created by county or municipal governments.

Ogle and Salazar (2021) analyzed regulations for commercial renewable energy developments in Indiana. Included in the commercial renewable energy developments were commercial solar energy systems (CSESs) and commercial wind energy conversion systems (CWECs). The study analyzed the regulations put into place by different counties that impact the development of renewable energy.

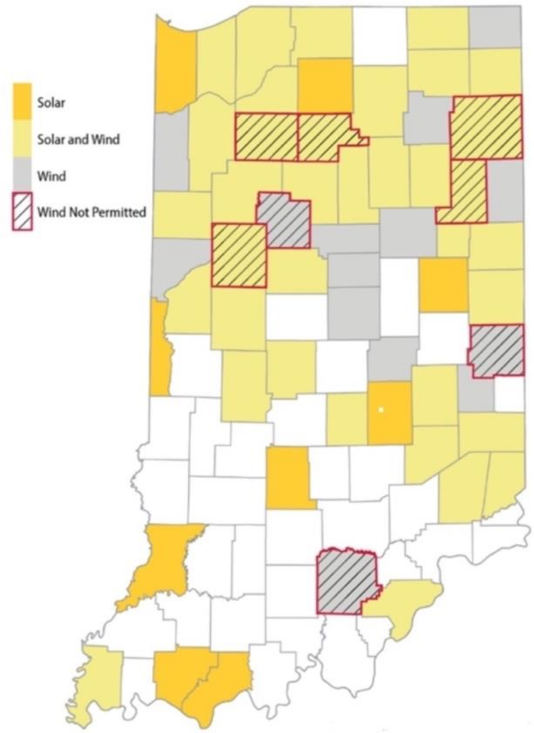
These authors report that the majority of counties regulate CSESs depending upon where the energy from the systems is used. Other counties regulate CSESs based on their size, whether that be the amount of energy produced, system size, or facility size. A few counties regulate all solar energy systems the same, whether they be commercial or small-scale energy systems. Commercial systems are generally owned by utility firms, small scale systems for wind or solar may be installed at airports, municipal buildings, schools, or some other location. These are not utility scale. However, some counties have no regulations regarding CSESs.

CWECs are often regulated in a similar manner to their counterparts, CSESs. Most counties again regulate based upon where the energy produced is used, whether it is going into the grid, transferred, or some other contract arrangement. Similar to CSESs, some counties base their CWECs regulations on the size. The definition of size of CWECs can be based on the number of wind turbines, the height of conversion systems, the land use, or the amount of energy produced. A few counties regulate all wind energy systems the same, whether they be for commercial use or small-scale systems. Similar to CSESs, a few counties do not specifically regulate CWECs at all.

Figure 1 (next page) identifies counties that have solar and wind regulations. Some counties have only one type of regulation, whether that be wind or solar, and some do not permit wind energy conversion systems at all. The definition of wind development varies by county. In particular, it depends on whether or not counties include small-scale facilities in their definition. Indiana is one of many states that have regulations concerning renewable energy developments, but each county chooses the way in which these facilities are regulated and what definition they use to determine the allotment of certain facilities in their area. Several counties do not have any regulations at all meaning that wind and solar energy developments are under no set of specific standard regulations, but they are still subject to existing land use regulations.

2 See Indiana Code Title 36. Art. 7, Ch. 4, Local Planning and Zoning.

Figure 1. Land Use Regulations on Wind and Solar Energy Production in Indiana



Source: Ogle and Salazar (2021)

This study comprehensively examines commercial renewable energy developments in Indiana counties, to gauge the current state of renewable energy developments and perhaps illuminate the future of renewable energy. As renewable energy systems are deployed across the state, so will the regulations, and studies concerning those regulations. A complete county-level list of regulations appears in *Appendix Table A26*.

It should be noted that we were unable to identify the implementation dates of renewable energy regulations.[3] Likewise, it is difficult to construct a data series of enforcement quality for regulations, or whether regulations that appear similar in design are implemented differently in practice across local government units. We do not believe it is possible to do so for each county or regulation. This is obviously problematic for the application of the most common forms of causal modeling (difference in difference estimation). That is because the absence of introduction date means we compare treated counties with non-treated (control) counties. This biases our results towards zero, changing the interpretation of our estimates as a lower (absolute value) bound of the effects of regulation on economic activity. Nevertheless, this provides more granular detail to policymakers and to the research literature.

The stated limitations are not a critique of this study, which is the best available review in Indiana, and among the better empirical analyses we have observed of other jurisdictions. However, the lack of availability of key data elements forces a careful approach to modeling the impacts of these land use regulations as well as a thorough examination of the existing

3 The data we use to create the panel datasets on renewable energy regulations are from Ogle and Salazar (2021), which surveyed county and municipal planning departments and plan commissions during the summer of 2021 and included four broad categories of regulation: districts and approval process, buffers and setbacks, other use standards, and plans and studies required. The survey included the question: *"When was the commercial solar or wind ordinance last updated?"* This question was filled in by 30 respondents. For counties that did not respond to the survey, the information was collected from their ordinance which did not include the date of adoption. Information on the year county renewable energy ordinances were first adopted or amended and if the amended regulation was more restrictive is not available.

research on renewable energy sources. As a result, we perform several robustness tests. We begin this analysis with a review of recent studies on wind and solar regulation.

Existing Research on Wind and Solar Regulation

Few empirical studies have addressed the role of restrictive state and local regulations on the deployment of wind and solar energy systems. There are a limited number of studies evaluating incentives for renewable energy sources. Sarzynksi, et al. (2012) examined the role of state subsidies and renewable portfolio standards (RPS), finding they directly affect industrial scale or grid connected solar systems. Shrimali and Jenner (2013) reported that property tax incentives and direct subsidies along with interconnection standards reduced entrance costs for photovoltaic cell systems connected to the grid. Krasko and Doris (2013) reported that interconnection standards, net metering and RPS are the major policy influences on solar deployment. None of these studies attempted to isolate causal effects in their analysis.

Ko (2023) reported rapid diffusion of setback restrictions that resulted from rural opposition to solar arrays in South Korea. Codemo, et al. (2023) surveyed Greek residents about their economic and environmental concerns regarding large scale solar fields, recommending local considerations that mitigate effects of height, pattern and density of the solar arrays. Li and Gou (2023) attempted a quasi-experimental design using six rural areas, with and without solar arrays, and surveyed residents regarding the visual appeal and other factors. They reported that residents preferred areas without solar arrays (residential and commercial).

Lerner (2022) conducted a review of local regulations and wind power placement in more than 1,000 counties in 23 states. He reported that local policymakers were more likely to adopt wind ordinances after long periods of deliberations with wind developers and if restrictions were implemented in surrounding counties. He also found that more severe restrictions on wind development occurred in counties adjacent to counties with large scale facilities. He concludes that these factors suggest growing restrictions on wind deployment.

A study of state and local policies promoting wind reported that Renewable Portfolio Standards (RPS), fuel disclosure rules, mandatory renewable power options and public benefit funds (state or local incentives) all promoted an increase in wind energy (Sarzynksi, et al., 2102). Menz and Vachon (2006) also report RPS at the state level tend to increase wind capacity in a cross-sectional model. They also report that longer duration of state RPS standards increases wind capacity.

The adoption of retail choice of energy sources reduced wind deployment. Polzin, et al. (2015) used structural econometric model to evaluate the role incentives and regulatory regimes play on OECD national deployment of energy. Like nearly every other study of energy deployment, this study focused on the role of policy in promoting (rather than restricting) wind and solar power.

We found several studies that attempted to answer questions about the role of public policy in renewable energy deployment. These include Delmas, et al. (2011), Kilinc-Ata (2016), Nicolini and Tavoni (2017), and Shrimali and Kneifel (2011). However, each of these studies are challenged by not establishing causal relationships between policy and deployment. The non-experimental setting of these regulations challenged every modeling approach. Likewise, these models focus primarily on the expansion of wind and solar through policy intervention. Opposition to renewable energy deployment is a more recent, and less extensive occurrence that has not been heavily studied.

Nonetheless, nearly all these studies reported an effect of public policy on the deployment of renewable energy. Tax incentives, regulations and standards for adoption all routinely play a role in the construction and location of wind and solar facilities. This partially mitigates the lack of causal estimates that are often unavoidable in this type of policy analysis. However, if fiscal and regulatory policies can promote the deployment of wind and solar, it seems likely that they can also prevent or reduce its deployment. Salazar et al. (2025) found that the fiscal impact on the county is one of the top five pieces of information local officials need to make decisions about county-level changes to renewable energy regulations in Indiana.[4]

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4 Information about the impact on property values, environment, public health and energy reliability were other topics in the top five.

The remainder of this study outlines our method of addressing the causal impacts of local regulatory restrictions on wind and solar deployment in Indiana.

Modeling County Effects

Indiana's regional variation in wind and solar power regulation offers the framework for an analysis of economic effects. In a typical economic study of this kind, researchers may have available treatment and control groups (counties with and without regulatory restrictions), the date of the treatment, and abundant data on outcomes prior to and after the treatment (regulation).

With certain available data, we could know the approximate start year of land use regulation periods (i.e., 2006-2021) but cannot more exactly identify each county's statute enactment. So, we implement a causal estimate of the effects of wind and/or solar restrictions on overall economic activity within a county.

Data limitations do not preclude a substantive analysis, as we will demonstrate. However, such data limitations do weaken the identification of causal effects of the regulations we are examining on economic outcomes such as employment and GDP growth.

We employ two modeling approaches to test whether land use restrictions on solar or wind power influence the size and mix of economic activity within a county. Our first model uses the framework of a causal model — a difference-in-difference panel analysis with an event study. Our difference-in-difference model provides all the elements of a causal model, except that we cannot precisely identify when the date restrictions were placed on wind or solar development.

Our second model is a traditional shift-share approach, which decomposes changes in the size and mix of an economy into national, industry and local effects. By creating distinct regions based upon the type of restriction and degree of urban-ness, we can examine the effect of regulatory restrictions on economic activity.

Before proceeding with the technical analysis, we remind readers that the goal of local restrictions on wind or solar development may be varied. Some regulations may be designed to prevent any deployment of wind or solar facilities. Other regulations may be designed to limit potential objections to deployment. Some, perhaps many of these restrictions only weakly restrict expansion, or simply provide standards, or clarify existing regulations. Thus, we expect non-positive effects of renewable energy regulations on utility growth (e.g., GDP or employment), but cannot discern the distribution of costs imposed on wind or solar expansion by each regulation, making this an empirical question in our treatment effect design. However, these regulations necessarily have other potential effects.

As previously noted, a growing share of domestic manufacturing employs Power Purchase Agreements (PPA) that specify a physical relationship to energy producers. By some estimates it is now the most common type of PPA (Zeigo, 2023). Thus, de facto restrictions on physical PPAs may limit manufacturing expansion or development within a county.

Nearly all expansions of data centers will employ PPAs, so the effects of restrictions on that industry are also of interest. Likewise, some of these restrictions might be intended to preserve agricultural production, so we are interested in examining the effect on that sector. The following sections outline our technical approach and report our findings for the panel model estimating the effects of wind and solar restrictions on economic activity.

Our Time Series Cross-Sectional Analysis

To examine renewable energy regulations, we use the comprehensive list developed by Ogle and Salazar (2021). This list includes seven types of restrictions on county-level deployment of commercial wind or solar power. Again, there is little or no available archival data to ascertain the date these restrictions were implemented. Similarly, we do not know when or how these restrictions may have influenced deployment of renewable energy before being enacted in local zoning. This may have influenced the decision of new wind or solar development. Also, some rules were implemented following the deployment of wind or solar production activities. All of these reduce the strength of our empirical design.

We test the impact of wind and solar regulations on employment and real gross domestic product (GDP) using Indiana county-level data from 2001-2019, in sectors where there are sufficient observations available. Summary statistics are shown in *Table 2*.

Table 2. Summary Statistics, Full Sample

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
Total Employment	53,955	22,658	762,669	4,020	97,245
Manufacturing Employment	7,614	4,228	75,324	353	11,121
Utilities Employment	194	95	1,917	1	296
Farm Proprietors Employment	630	568	2,113	170	291
Transportation Employment	1944.216	707.5	52076	43	5221.229
Information Employment	635.5469	164	13816	7	1716.453
Gross Domestic Product (GDP)	4,419,030	1,540,513	105,000,000	196,684	10,672,011
Utilities GDP	61,916	11,314	936,721	0	120,572
Agriculture GDP	42,186	30,497	261,681	149	41,523
Durable Goods Manufacturing GDP	690,425	319,907	7,737,114	5,516	1,051,249
Non-Durable Goods Manufacturing GDP	485,279	99,700	21,904,372	1,543	2,281,080
Information GDP	14,439	10,576	73,149	4	13,190
Agriculture GDP	42,186	30,497	261,681	149	41,523
Transportation GDP	123,447.9	41,394	3,388,287	838	333,624.7
Wind Restrictions	0.150	0	1	0	0.358
Solar Restrictions	0.111	0	1	0	0.315
Both Restrictions	0.365	0	1	0	0.482
Wind Moratorium	0.082	0	1	0	0.275
Net Assessed Value (NAV) (in $Millions)	608.86	330	10,458	10	1,049.61
Gross Assessed Value (GAV) (in $Millions)	3,464.33	1,642.85	49,103	62	5,982.30

Table 3 reports selected variables in one of our control/treatment groups (wind and solar restrictions), and *Table 4* compares these selected variables in the pre-/post-treatment periods to include a means test.

Table 3. Treatment & Control Group Summary Statistics, Selected Variables

Variable	Wind and Solar Restrictions (Treatment) Mean	Wind and Solar Restrictions (Treatment) Std. Dev.	No Restrictions (Control) Mean	No Restrictions (Control) Std. Dev.
Employment	30,535	40,497	48,860	105,018
GAV ($Millions)	477	471	620	1,186
GDP ($Millions)	2,200,703	3,014,626	3,966,576	10,908,865
Personal Income ($Thousands)	2,028,532	2,540,570	3,169,517	6,202,187
Manufacturing Employment	5,409	5,787	6,517	11,997
Population	57,409	65,661	82,409	143,385

Table 4. Comparison of Pre-/Post-Treatment, Selected Variables

Variable	Pre-Treatment (2001-2006) Mean	Pre-Treatment (2001-2006) Std. Dev.	Post-Treatment (2007-2021) Mean	Post-Treatment (2007-2021) Std. Dev.	t-Statistic
Employment	39,926	82,723	41,922	86,601	-2.434
GAV ($Millions)	526	952	577	935	0.724
GDP ($Millions)	2,572,217	6,573,063	3,549,587	9,415,962	-8.485
Personal Income ($Thousands)	2,099,013	3,788,567	2,980,288	5,485,924	-6.659
Manufacturing Employment	6,566	10,833	5,821	9,507	5.705
Population	68,937	112,613	73,549	121,640	-6.881

Renewable Energy Restrictions and GDP

Our first test develops a difference-in-difference specification for the examination of regulatory effects on real GDP. Formally, the model is expressed as follows:

$$\boldsymbol{Y_{i,t} = \alpha + \alpha_i + \alpha_t + \beta S_i * T_{2006} + \gamma W_i * T_{2006} + \delta B * T_{2006} + \widehat{W}Y_{i,t} + e_{i,t}} \qquad (\textbf{\textit{Equation 1}})$$

…where $\boldsymbol{Y}$ denotes natural log of real GDP (2022 dollars), in each of the six sectors, in county $\boldsymbol{i}$, and year $\boldsymbol{t}$. $\boldsymbol{Y}$ for non-share variables was expressed in natural log form throughout the paper. There are common fixed effects, $\boldsymbol{\alpha}$, and one for each county, $\boldsymbol{i}$, and time period $\boldsymbol{t}$. This is a two-way fixed effects model that controls for idiosyncratic effects in each year and each county. Dummy variables for solar restrictions ($\boldsymbol{S}$), wind restrictions ($\boldsymbol{W}$) and both ($\boldsymbol{B}$) are interacted with an implementation dummy variable at 2006 and later. This permits a difference in difference estimator of $\boldsymbol{\beta}, \boldsymbol{\gamma}$, and $\boldsymbol{\delta}$, which provides estimates of the effect of these restrictions on GDP in the years after 2006. The term $\boldsymbol{\widehat{W}Y_{i,t}}$ is the first order spatial autocorrelation (average of contiguous county values), which is a control for spatial autocorrelation. This is the likelihood that the dependent variable is correlated across county borders. If left uncorrected, this might bias the estimated effects. The white noise error term, $\boldsymbol{e}$, is for each county and year.

Our reasoning for using three regulatory category approach (rather than two) is that dual restrictions on both wind and solar is seemingly a more restrictive regulatory model specification. Results are not sensitive to this choice, as we later discuss.

We approach this issue using several different geographic definitions of control and treatment groups. The first we define as the state's 92 counties. There is significant variation in regulatory adoption that provides, in our judgement, a reasonable control and treatment pool. On this sample, we treat both wind and solar regulation.

The second geography we examine considers windspeed potential as it likely influences the placement of industrial turbines. Here, we confine our sample counties classified as Wind Power Class 3, with wind speeds at 50-meter elevation averaging between 14.3 mph and 15.7 mph. See *Figure 2* (next page) and *Appendix Table A27*.

Of the 1,684 industrial turbines in place by 2023 in Indiana, all but 5.5 percent were located in six of the 19 counties with Class 3 wind speed. However, we know of attempts to place industrial turbines in Class 2 counties, that were ultimately rejected by county commissions (with zoning authority).[5] In this sample, we test both wind and solar restrictions.

Figure 2. Areas with Class 3 Wind Power

Source: U.S. National Renewable Energy Laboratory (NREL). Note: Class 3 wind areas have wind speeds between 14.3 and 15.7 miles per hour at 50 meters elevation.

Our third sample consists of all counties, but tests only solar restrictions, omitting restrictions on wind. We also used several different regulatory measurement approaches from Ogle and Salazar (2021). This survey collected data in seven broad categories and separated into 16 specific types of restrictions across wind or solar. Here we report dummy variables for any type of regulation and use the disaggregated specific types as count data to provide more variability in the independent variables.

There are econometric considerations that merit early discussion. As we noted earlier, the first is that the use of difference-in-difference with treatment dates that are not known with precision must be approached with caution. In our case, we are less certain of the deployment or end date of regulatory change. So, by including longer post-deployment periods, we risk biasing the findings toward zero. So, in each of the following tables, we report estimates for the longer time period, 2001-2021. We report the coefficients across two shorter time periods separately (see *Appendix Tables A23-A25*) and discuss the differences in results between the full period (2001-2021) and shorter periods (through 2016 or 2019) in the text below.

Generally, in a spatial setting we would prefer to use clustered standard errors (Abadie, et al., 2023). However, the short sample period leaves us with reduced rank coefficient matrix, which argues for use of a standard error correction

5 See https://www.courierpress.com/story/news/local/2018/12/14/wind-turbines-posey-county-e-renewables/2291486002/

recommended by Thompson, 2011. We have used this approach in most of the following estimates (we denote which in each table). Our GDP results appear in *Table 5*.

Table 5. Effects of Renewable Energy Regulation on Real GDP (Indiana Counties, 2001-2021)

-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions $\boldsymbol{\beta}$	0.02 (0.73)	0.14 (0.77)	-0.320* (-1.79)	0.169 (0.82)	-0.367* (-1.95)	-0.109 (-0.91)	-0.194 (-0.56)
Wind Restrictions $\boldsymbol{\gamma}$	0.017 (0.30)	-0.21** (-2.16)	-0.085 (-0.77)	-0.024 (-0.12)	-0.055 (-0.46)	0.047 (0.36)	0.387* (1.82)
Both Restrictions $\boldsymbol{\delta}$	0.01 (0.49)	0.12 (0.76)	-0.108* (2.05)	-0.097 (-0.59)	-0.055 (-0.49)	0.066 (0.90)	0.125 (0.51)
$\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$	0.31*** (2.77)	0.023 (0.27)	0.193 (1.46)	-0.216** (-2.14)	-0.175 (-0.72)	-0.134 (-1.22)	0.684*** (7.66)
TWFE $\boldsymbol{\alpha_i + \alpha_t}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N (i,t)	1932 (92, 21)	931 (91, 21)	875 (84, 21)	905 (83, 21)	1067 (81, 21)	554 (66, 21)	658 (86, 20)
Adj. R2	0.99	0.94	0.98	0.97	0.95	0.98	0.26

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011). The dependent variable, $\boldsymbol{Y}$, was expressed in natural log form.

The model detects several effects of wind and solar regulations on GDP (*Table 5*). We find that restrictions on wind only have a strong, negative effect on utility GDP that persists across all three post-treatment samples. Neither solar, nor both restrictions appear to affect utility GDP. Durable goods manufacturing is affected by both solar and wind restrictions, across all three sampled periods, and only in the longest period for solar restrictions. The information sector experienced a negative effect of solar restrictions, that likewise persisted across samples, growing modestly larger in the longer periods (to 2019 and 2021). There were no detected effects on county total GDP, non-durable goods manufacturing GDP, or transportation and warehousing GDP. Wind restrictions resulted in a modest increase in agricultural GDP across all three sampled post-treatment periods; however, the goodness of fit suggests this is a weak relationship.

Here it is useful to explain again the potential transmission mechanism of regulatory restrictions on economic activity. The first point is relatively straightforward. Restrictions on wind or solar installations are designed to restrict economic activity in these sectors, which appear in the utilities data.

For other sectors, we rely upon the large-scale presence of Power Purchase Agreements (PPAs), which typically include renewable portfolio standards (RPS). Since most manufacturing, warehousing and other economic activity in Indiana has relied upon energy produced by coal or natural gas, the ability of many multi-establishment firms to meet renewable energy goals requires most new installations to have PPAs, which specify renewable energy (RPS) goals. So, the use of renewable energy on the margin of newly constructed firms would be much higher than the average of all firms. This would also be especially true of new information sector activities (i.e., data centers or data warehouses) because those sectors have been explicitly criticized for large-scale energy requirements.

Thus, the expansion or relocation of utility scale activities will largely be connected to renewable energy production of wind and solar. The expansion or relocation of manufacturing, warehousing or information sector activity would be highly influenced by the ability of the firm to use proximally located renewable energy.

Conversely, we are interested in agricultural activities to capture the common complaint that utility-scale wind and solar power activities divert land use from agriculture to energy production, reducing farming.

Our findings suggest that regulatory restrictions on wind and solar energy production influence the mix of economic activity within a county. Our model results do not have an overall effect on GDP or employment.

All our models, with the exception of the agriculture sector, explained between 94% and 99% of the variation in GDP in each county. The restrictions on agricultural GDP explained only 26% of variation in GDP. The lower explanatory power of the agricultural model is not surprising given the variability of county GDP in that sector due to variation in commodity prices.

The estimates using shorter time periods (through 2016 and 2019) show a decrease in the statistical significance of solar restrictions on durable goods manufacturing GDP (below traditional levels of statistical significance with p = 0.15). The coefficient values remain unchanged. All other regulatory effects were unchanged in significance or coefficient values (using a Wald test). Intercept and spatial elements were minimally affected.

Importantly, the higher level of significance in the longer panel may reflect a longer effect due to the very long development planning cycles on manufacturing, information and utility sector investments. It may also reflect the growing role of firm level commitments to renewable portfolio standards. For example, the CDP (formerly the Carbon Disclosure Project) reports rapidly increasing numbers of firms committing to renewable energy targets, rising from 245 in 2002, to 3,000 in 2010, to 5,500 in 2015 and to 18,700 by 2022.[6] Though this is a global registry, it suggests that a very large share of the total number of firms with renewable energy commitments did so in the later years of this study.

The magnitude of the change in industrial mix are substantial (*Table 6*). Overall, restrictions on the deployment of wind power is correlated with a $28.9 million annual reduction in utility GDP, while solar regulations reduced information GDP by $22.6 million annually. However, the largest effect of these restrictions is on the growth of durable goods manufacturing. Restrictions here reduce durable goods manufacturing GDP in affected counties by a total of $194.1 million each year.

Table 6. Statewide Effects of Implementing Renewable Energy Regulation on Real GDP

-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions	0	0	-$36,846,000†	0	-$22,592,000	0	0
Wind Restrictions	0	-$28,905,000	0	0	0	0	+$40,788,000
Both Restrictions	0	0	-$157,313,000	0	0	0	0

A second econometric condition of relevance is that a difference in difference assumes a stable unit treatment value (SUTVA). In the context of our modeling problem, this assumption precludes the possibility of spatial spillovers of the regulatory framework, so regulation in county $\boldsymbol{i}$ does not affect outcome variables in county $\boldsymbol{j}$. Delgado and Florax (2015) recommend a spatial model to account for both direct and indirect treatment effects.

We expand the Delgado and Florax approach, including a follow up approach (Sun and Delgado, 2021), which accounted for criticism of the unidirectional effects by Kolak and Anselin (2019). The original Delgado and Florax specification accounted for the effects of own and neighboring county effects such that an adjustment of *Equation 1* would take the form:

$$\boldsymbol{Y_{i,t} = \alpha + \alpha_i + \alpha_t + \beta S_i * T_{2006} + \gamma W_i * T_{2006} + \delta B * T_{2006} + \beta \widehat{W} S_i * T_{2006} +} \ldots$$

$$\ldots \boldsymbol{+ \gamma \widehat{W} W_i * T_{2006} + \delta \widehat{W} B * T_{2006} + e_{i,t}} \qquad \textbf{(Equation 1a)}$$

…where $\widehat{\boldsymbol{W}}$ denotes the first order contiguity matrix for county $\boldsymbol{i}$ in our sample. However, this specification is unidirectional, accounting only for effects of bordering counties on own county outcomes ($\boldsymbol{Y}$). To address this, we conduct two more specifications to specifically address this.

Our second additional SUTVA test is introduced by Sun and Delgado (2023), which is similar to that of Delgado and Florax, but omits the 'own county' regulatory structure and introducing the spatial autoregressive term:

$$\boldsymbol{Y_{i,t} = \alpha + \alpha_i + \alpha_t + \beta \widehat{W} S_i * T_{2006} + \gamma \widehat{W} W_i * T_{2006} + \delta \widehat{W} B * T_{2006} + \widehat{W} Y_{i,t} + e_{i,t}} \qquad \textbf{(Equation 1b)}$$

This specification isolates the adjacent county effects, allowing fixed effects to absorb own county regulation, while preserving the spatial autoregressive control for the own county outcomes.

[6] See https://www.cdp.net/en, reports from various years.

The third approach assesses own county regulations on neighboring counties, so that the outcome measure is the weighted average of neighboring (contiguous) counties, $\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$.

$$\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t} = \boldsymbol{\alpha} + \boldsymbol{\alpha}_i + \boldsymbol{\alpha}_t + \boldsymbol{\beta S}_i * \boldsymbol{T}_{2006} + \boldsymbol{\gamma W}_i * \boldsymbol{T}_{2006} + \boldsymbol{\delta B} * \boldsymbol{T}_{2006} + \boldsymbol{e}_{i,t} \qquad (\textbf{\textit{Equation 1c}})$$

This is interpreted as the effect of own county solar-only, wind-only, and both solar and wind restrictions on the average adjacent county (Mean = 5.05 counties; Median = 5).

It is tempting to replicate the specification of the DG test (*Equation 1a*), replacing the dependent variable with $\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$, but the interpretation of the coefficients on the spatially treated restrictions does not have a clear interpretation, as the matrix $\widehat{\boldsymbol{W}}$ adjusts both the dependent and independent variables.

The interpretation of these three estimates is that when estimated in a spatial context, the coefficients $\boldsymbol{\beta}, \boldsymbol{\gamma}$, and $\boldsymbol{\delta}$ are the effect of own and adjacent county regulations on own county outcome variables (*1a*), the effect of adjacent county regulation on own county when controlling for spatial effects on the dependent variable cross-sectionally (*1b*), or the indirect effect of policy of own country regulation on adjacent counties (*1c*).

For ease of interpretation, we focus on *Equation 1c*, which is the indirect effect of regulatory restrictions in county $\boldsymbol{i}$, on the average of adjacent (neighboring) counties, $\boldsymbol{j}$. We report all variations in the appendix (*Appendix Tables 1-7*), but report those of *Equation 1c* here in *Table 7*.

Table 7. Indirect Effects (SUTVA) Tests on GDP (Dependent Variable = $\widehat{W}Y_{i,t}$, *Equation 1c*)

-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions $\boldsymbol{\beta}$	-0.0029 (-0.09)	-0.011 (-0.17)	0.022 (0.12)	0.093 (0.96)	-0.110** (-2.49)	0.057 (0.51)	0.087 (1.13)
Wind Restrictions $\boldsymbol{\gamma}$	-0.0264 (-0.87)	0.099 (0.88)	-0.241** (-2.79)	0.012 (0.15)	-0.075* (-1.84)	0.049 (0.65)	0.229* (1.97)
Both Restrictions $\boldsymbol{\delta}$	-0.037* (-1.76)	0.123* (1.85)	-0.215** (-0.24)	-0.025 (-0.32)	-0.137*** (-3.30)	0.172** (2.47)	0.257** (2.62)
TWFE $\boldsymbol{\alpha}_i + \boldsymbol{\alpha}_t$	Yes, Yes	Yes, Yes	Yes, Yes	Yes, Yes	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	879 (82, 21)	1045 (91, 21)	941 (86, 21)	960 (84, 21)	1150 (83, 21)	674 (70, 21)	879 (82, 21)
Adj. R2	0.70	0.96	0.98	0.99	0.99	0.99	0.70

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level; † at the 15% level. Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

The results (*Table 7*) show that the existence of both restrictions in county $\boldsymbol{i}$ increases utility GDP, transportation and warehousing GDP, and agriculture GDP in adjacent counties; and it decreases total GDP, durable goods manufacturing GDP, and information GDP in adjacent counties.

As we did for *Table 6* previously, we calculate the statewide indirect effect of current regulatory restrictions on wind and solar energy production on neighboring counties (*Table 8*). These results provide a compelling narrative of the role of regulation on shifting economic activity between sectors.

Table 8. Statewide Indirect (Spillover) Effects of Wind & Solar Restrictions

-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions	$0	$0	$0	$0	-$25,037,000	$0	$0
Wind Restrictions	$0	$0	-$106,220,000	$0	-$28,546,000	$0	$79,944,000
Both Restrictions	-$45,567,000	$110,147,262	-$232,999,000	$0	-$128,064,000	$168,380,000	$221,159,000

Table 8 depicts the regulatory effects of wind and solar regulation on adjacent county GDP by sector. The overall effect is modest, with statewide impact of only a $45 million loss. Adjacent counties' utility GDP benefits from neighboring counties' restrictions. This is consistent with the existence of some regional preferences by utilities for wind and solar installations. In other words, restrictions in county ***i***, lead to higher utility GDP (presumably wind and solar production) in adjacent counties.

Consistent with the renewable energy commitment mechanism described earlier, both durable manufacturing and information sectors saw significant declines in GDP due to adjacent county regulation. We think this captures the lower likelihood of these sectors expanding or retaining production in locations where access to renewable energy sources is less available or unlikely to expand. Statewide the indirect effects of renewable energy restrictions reduced manufacturing and information GDP (*Table 8*) by or about 0.2% and 1.6% per annum, respectively.

Both transportation and agricultural GDP experience higher adjacency effects from wind and solar restrictions. This emphasizes our point that the dominant economic effect of these restrictions appears to be in the reallocation of economic activity across locations within Indiana.

Finally, *Table 9* reports the sum of *Tables 6 and 8*, to provide the estimated direct and indirect (spillover) effects of wind and solar restrictions.

Table 9. Total Statewide Effects of Implementing Renewable Energy Regulation on Real GDP (Direct & Indirect Effects)

-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions	$0	$0	-$36,846,000	$0	-$47,629,378	$0	$0
Wind Restrictions	$0	-$28,905,000	-$106,220,148	$0	-$28,546,414	$0	$120,732,224
Both Restrictions	-$45,567,011	$110,147,262	-$390,312,680	$0	-$128,064,118	$168,380,288	$221,159,711

Again, *Table 9* illustrates significant reallocation of economic activity, by type attributable to wind and solar restrictions across the state. These restrictions reduce own county utilities, manufacturing and information GDP, while increasing agricultural GDP. The indirect estimates (SUTVA tests) point to large spillover effects on neighboring counties. In this case, we observe neighboring county reductions on overall GDP, durable manufacturing and information GDP. Interestingly, the sign of the effect on utilities, the sector representing wind and solar production, has a negative own-county effect of regulation, but a positive spillover. This suggests firms will locate wind or solar facilities in counties adjacent to those that are regulated. It is possible that the effects extend beyond adjacent county, but we do not possess the sample size to conduct that level of test. Similarly, agriculture and transportation and warehousing are positively affected by restrictions in adjacent counties.

This reallocation of economic activity is large at the county and aggregate level, accounting for the movement of roughly $1.15 billion within Indiana. But the net effects of restriction on one's own county and surrounding counties are modest, estimated at a loss of $45 million per year.

Renewable Energy Restrictions and Employment

The GDP effects are only one set of potential outcomes of energy restrictions. Our second set of tests examined the relationship between wind and solar energy restrictions and employment. Data suppression in these data series is more extensive, and the Bureau of Economic Analysis combines aggregated manufacturing employment to limit this problem. *Table 10* reports our findings.

Table 10. Effects of Renewable Energy Regulation on Employment (Indiana Counties, 2001-2021)

-	Total	Utilities	Manufacturing	Information	Transportation & Warehousing	Farm Proprietor
Solar Restrictions $\boldsymbol{\beta}$	-0.003 (-0.13)	0.005 (0.70)	-0.113* (-1.81)	0.024 (0.32)	-0.234*** (-4.29)	0.013 (0.46)
Wind Restrictions $\boldsymbol{\gamma}$	0.019 (0.43)	-0.001 (-0.09)	-0.051 (-0.55)	0.048 (0.61)	0.0960 (0.62)	-0.0019 (-0.07)
Both Restrictions $\boldsymbol{\delta}$	-0.014 (-0.73)	-0.002 (-0.51)	-0.092** (-2.11)	0.027 (0.40)	0.047 (0.92)	0.043** (2.17)
$\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$	0.271*** (2.38)	0.929*** (33.26)	0.182 (1.38)	-0.034 (-0.66)	0.202 (1.51)	0.457** (2.52)
TWFE $\boldsymbol{\alpha_i + \alpha_t}$	Yes	Yes	Yes	Yes	Yes	Yes
N (i, t)	1932 (92, 21)	1127 (77, 21)	1659 (89, 21)	1077 (75, 21)	554 (66, 21)	1932 (92, 21)
Adjusted R2	0.99	0.99	0.98	0.98	0.98	0.98

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Our standard errors (in parentheses) are clustered using the two way cluster technique proposed by Thompson (2011).

Across the board, these results identify no effects of wind or solar restrictions on total employment. There are no effects of wind only restrictions on employment in any of these sectors. However, we do find that manufacturing, transportation and warehousing, and farm proprietor employment are affected. Solar only restrictions reduce manufacturing employment by about 47 jobs in the median county, or roughly 4,311 statewide. For manufacturing, wind and solar restrictions result in about 35 fewer jobs per county, or roughly 3,150 statewide.

For transportation and warehousing, this translates into 16 jobs per affected county or roughly 1,490 statewide. Agricultural (farm) job gains due to the presence of both wind and solar account for just over 2 jobs in the median county, or 113 statewide.

These results are similar to the results for GDP within manufacturing, which provides us greater confidence in our results. As a further check of our results, we calculate GDP per worker from these two estimates and find they are very close to the statewide average in both manufacturing and transportation and warehousing.

In the shorter duration models, the statistical significance of manufacturing employment falls slightly out of statistical significance (p = 0.13), as was the case in the GDP estimate. The magnitude of the coefficient was unchanged. The employment effect on transportation and warehousing saw a statistically significant decline in the size of the coefficient (in absolute value) from a -0.23 to -0.14. Thus, the size of the effect is roughly 40 percent lower in the shorter estimate.[7]

We report the statewide estimates from the full sample in *Table 11*.

7 The employment estimates for alternative time periods are available upon request from the authors.

Table 11. Effects of Renewable Energy Regulation on Employment (Indiana Counties, 2001-2021)

-	Total	Utilities	Manufacturing	Information	Transportation & Warehousing	Farm Proprietor
Solar Restrictions $\boldsymbol{\beta}$	0	0	-4,311	0	-1,491	0
Wind Restrictions $\boldsymbol{\gamma}$	0	0	0	0	0	0
Both Restrictions $\boldsymbol{\delta}$	0	0	-3,152	0	0	113

Employing the same methods for stable unit value assumption estimates we used for GDP, we estimated *Equations 1a, 1b, and 1c* for employment in *Table 12*.

Table 12. Indirect Effects (SUTVA) Tests on Employment (Dependent Variable = $\widehat{WY}_{i,t}$, *Equation 1c*)

-	Total	Utilities	Manufacturing	Information	Transportation & Warehousing	Farm Proprietor
Solar Restrictions $\boldsymbol{\beta}$	0.007 (0.23)	0.026 (1.08)	0.009 (0.19)	-0.116* (-2.14)	-0.072 (-1.45)	0.006 (0.32)
Wind Restrictions $\boldsymbol{\gamma}$	-0.005 (-0.20)	0.226** (2.61)	-0.086** (-2.56)	-0.037 (-1.04)	0.128 (1.47)	0.016 (0.88)
Both Restrictions $\boldsymbol{\delta}$	-0.033* (-1.86)	0.059* (1.75)	-0.026 (0.87)	-0.116*** (-3.67)	0.111† (1.66)	0.013 (0.98)
TWFE $\boldsymbol{\alpha_i} + \boldsymbol{\alpha_t}$	Yes, Yes	Yes, Yes	Yes, Yes	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1932 (92, 21)	179 (33, 21)	1701 (91, 21)	1150 (83, 21)	674 (70, 21)	1932 (92, 21)
Adj. R2	0.99	0.98	0.99	0.99	0.99	0.98

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level; and † at the 15% level.
Our standard errors are clustered using the two-way cluster technique proposed by Thompson (2011).

These model estimates reveal a similar pattern of industrial adjustment as the GDP estimates. One notable difference is the detection of lost employment overall of roughly 1,500 statewide due to spillovers. Another notable estimate is that we observe spillover effects in utilities sectors that are positive (137 additional jobs) as in our GDP model. The information sector sees modest job losses (82 for wind only and 67 for counties with both wind and solar restrictions).

We report the statewide indirect (or spillover) effects in *Table 13*, and the total losses (both direct and indirect) in *Table 14*.

Table 13. Statewide Employment Indirect (Spillover) Effects of Wind & Solar Regulations

-	Total	Utilities	Durable Goods Manufacturing	Information	Transportation & Warehousing	Agriculture
Solar Restrictions $\boldsymbol{\beta}$	0	0	0	-82	0	0
Wind Restrictions $\boldsymbol{\gamma}$	0	127	-1,972	0	0	0
Both Restrictions $\boldsymbol{\delta}$	-1,501	10	0	-67	0	0

Table 14. Statewide Total Employment Effect (Direct & Indirect/Spillover) of Wind & Solar Restrictions

-	Total	Utilities	Durable Goods Manufacturing	Information	Transportation & Warehousing	Agriculture
Solar Restrictions $\boldsymbol{\beta}$	0	-4,311	0	-82	-1,491	0
Wind Restrictions $\boldsymbol{\gamma}$	0	127	-1,972	0	0	0
Both Restrictions $\boldsymbol{\delta}$	-1,501	-3,142	0	-67	0	113

Again, these estimates depict reallocation of economic activity within the state, with net effects that are more modest than the reallocation of GDP, because wind and solar restrictions appear to destroy some jobs, create some jobs and shift jobs among counties. The net effect is a loss of roughly $190 million in GDP annually, distributed across those counties with restrictions, and in neighboring counties. The direct and indirect (spillover) effects of wind and solar restrictions result in a statewide net loss of more than 12,250 jobs (*Table 14*).

Analysis of Class 3 Wind Areas

Our estimates of GDP and employment changes were performed on a statewide model, with both solar and wind regulation, making no distinction into the placement restrictions that might be due to wind speeds. So, in our second set of models, we alter the sample to include only the 19 counties with Wind Class 3 areas (see *Figure 2*).

Table 15. Effects of Renewable Energy Regulation on Real GDP (Wind Class 3 Counties, 2001-2021)

-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions $\boldsymbol{\beta}$	-0.340** (-2.54)	0.043 (0.11)	-0.856*** (-14.32)	-0.091 (-0.60)	-0.303 (-0.66)	-0.764** (-2.83)	-0.218 (-0.59)
Wind Restrictions $\boldsymbol{\gamma}$	-0.124 (-0.85)	1.254 (1.39)	-0.013 (-0.10)	-0.363*** (-2.92)	-0.534 (-0.02)	-0.098 (-0.34)	0.194 (0.49)
Both Restrictions $\boldsymbol{\delta}$	-0.163 (-1.17)	1.548 (1.53)	-0.331** (-2.79)	-0.147 (-0.99)	-0.320 (-0.63)	-0.269 (-1.04)	0.256 (0.76)
$\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$	0.0001 (0.00)	0.043 (1.40)	0.142 (0.17)	-0.850* (-1.81)	-0.106 (-0.23)	0.061 (0.14)	-0.809 (-0.04)
TWFE $\boldsymbol{\alpha_i} + \boldsymbol{\alpha_t}$	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
N (i,t)	399 (19/21)	322 (19/21)	339 (16/21)	348 (19/21)	197 (16/21)	304 (18/21)	328 (19/21)
Adj. R2	0.99	0.60	0.95	0.96	0.96	0.95	0.49

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

This test provides similar estimates as those in *Table 5*, with a few important differences. In the shorter period (2001-2016) the effect of wind restrictions on GDP becomes statistically significant, though the magnitude of the coefficient was statistically unchanged across the two time periods.[8]

The effect sizes of solar restrictions on overall GDP were -$58 million, solar and combined restrictions on durable goods manufacturing was -$386 million. The effect on transportation and warehousing GDP was large (-$97 million statewide), while the effect on information and agriculture GDP dropped from any reasonable level of statistical significance. Those statewide GDP effects are reported in *Table 16*.

[8] Supplementary employment estimates are not reported in the appendix but are available from the authors upon request.

Table 16. Statewide Effects of Implementing Renewable Energy Regulation on Real GDP (from Wind Class 3 County Estimates)

-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions	-$58,855,000	0	-$98,447,000	0	0	-$97,985,000	0
Wind Restrictions	0	0	0	-$32,660,000	0	0	0
Both Restrictions	0	0	-$288,407,000	0	0	0	0

Note: ‡Not statistically significant in the 2001-2021 period, only in the 2001-2016 and 2001-2019 periods.

Performing an employment test yields similar findings. Within this sample solar restrictions reduced employment overall, and in manufacturing (combined durable and non-durable in the Bureau of Economic Analysis data) and transportation. Utilities could not be tested due to suppression of data in the employment (but not the GDP) data. So, some caution should be observed in interpreting these estimates, viewing these as a robustness test on our full sample reported elsewhere.

We observe a positive effect on farm proprietor employment, accounting for about 1,500 jobs throughout the sample period. This effect has a stronger statistical significance in the shorter (2001-2016) sample period, the coefficient is statistically identical, again using the Wald test.

Table 17. Effects of Renewable Energy Regulation on Employment (Wind Class 3 Counties, 2001-2021)

-	Total	All Manufacturing	Information	Transportation & Warehousing	Farm Proprietor
Solar Restrictions $\boldsymbol{\beta}$	-0.301*** (-2.15)	-0.579*** (-10.90)	-0.385 (-1.00)	-0.722* (-2.10)	0.014 (0.35)
Wind Restrictions $\boldsymbol{\gamma}$	-0.118 (-0.81)	-0.061 (-0.44)	-0.315 (-0.82)	-0.013 (-0.04)	0.056 (1.07)
Both Restrictions $\boldsymbol{\delta}$	-0.230 (-1.7)	-0.243*** (-2.72)	-0.419 (-1.12)	-0.289 (-0.91)	0.089* (1.94)
$\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$	0.147 (0.15)	0.203 (0.72)	0.362 (0.70)	-0.084 (-0.10)	0.105 (0.84)
TWFE $\boldsymbol{\alpha_i + \alpha_t}$	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
N (i, t)	399 (19, 21)	363 (19, 21)	340 (18, 21)	304 (18, 21)	399 (19, 21)
Adjusted R2	0.99	0.96	0.98	0.94	0.96

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011). Utilities could not be tested due to suppression of data in the employment.

Additional Analysis of Solar Restrictions

In our third sample, we test only solar restrictions on the full set of Indiana counties as a robustness test. In this model, we remove not only the wind restrictions, and wind and solar restrictions from our specification, but also relax our assumption of spatial dependence, removing the spatial autoregression component $\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$ of our model. We discuss this change as we discuss results.

Table 18. Effects of Solar Energy Regulation on Real GDP (Indiana Counties, 2001-2021)

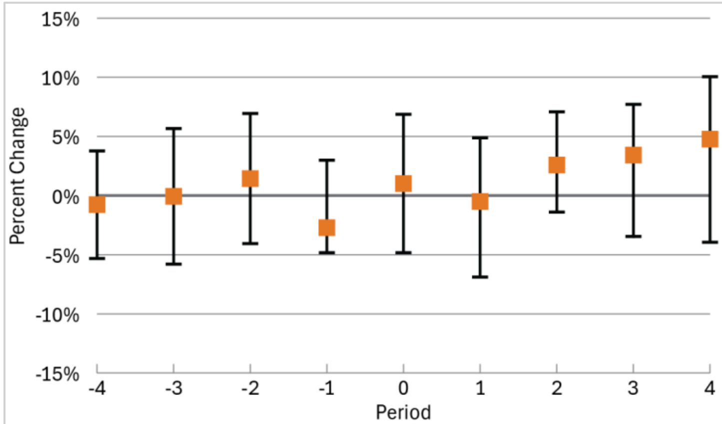
-	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
Solar Restrictions $\boldsymbol{\beta}$	0.025* (1.69)	-0.075 (-0.97)	-0.112** (-2.18)	0.211*** (3.08)	-0.131*** (-3.07)	0.008 (0.21)	-0.292** (-2.41)
TWFE $\boldsymbol{\alpha_i + \alpha_t}$	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
N (i,t)	1932 (92, 21)	931 (91, 21)	875 (84, 21)	905 (83, 21)	1067 (81, 21)	554 (66, 21)	757 (92, 21)
Adj. R2	0.99	0.94	0.98	0.96	0.98	0.98	0.76

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

In the GDP estimate, we report a positive effect on GDP overall, and on non-durable goods manufacturing. We report negative effects of regulation of solar facilities on durable goods manufacturing, information and agricultural GDP. These results persist across all three periods of analysis (2001-2016, 2001-2019, and 2001-2021). They are also insensitive to the inclusion of spatial autoregressive value in the estimate. The size of the effects is, however, small. The GDP effect of solar restrictions is roughly a positive $2.6 million statewide. Examining this effect in an event study offers only minimal confidence in the interpretation of these results.[9] See *Figure 2*.

9 This is a traditional event study with cross-sectional fixed effects, and four leads and lags, in the 2001-2021 sample period.

Figure 2. Event Study Effect of Solar-Only Regulation on Real GDP (Indiana Counties, 2001-2021)



Year	Point Estimate	Lower Bound	Upper Bound
-4	-0.00767	-0.05316	0.03782
-3	-0.00060	-0.05792	0.05671
-2	0.01443	-0.04059	0.06944
-1	-0.02718	-0.04827	0.02996
0	0.01020	-0.04827	0.06868
1	-0.00496	-0.06893	0.04881
2	0.02591	-0.01400	0.07077
3	0.03431	-0.03450	0.07721
4	0.04765	-0.03952	0.10051

The estimate on employment was likewise small, with weak statistical certainty. The solar only estimates of both GDP and employment point to weakly observed effects of regulation. The effects on total GDP and employment are small, with modest (or nonexistent) statistical certainty.

Table 19. Effects of Solar Energy Regulation on Employment (Indiana Counties, 2001-2021)

-	Total	Utilities	Manufacturing	Information	Transportation & Warehousing	Farm Proprietor
Solar Restrictions $\boldsymbol{\beta}$	0.006 (0.62)	-0.025 (-0.59)	-0.046* (-1.77)	-0.116*** (-3.32)	-0.107** (-2.48)	-0.007 (-0.23)
TWFE $\boldsymbol{\alpha_i + \alpha_t}$	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
N (i, t)	1932 (92, 21)	1127 (77, 21)	1659 (89, 21)	1739 (90, 21)	554 (66, 21)	1932 (92, 21)
Adjusted R2	0.99	0.98	0.98	0.98	0.98	0.98

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

We can offer a few conclusions from the estimates generated from these three samples. First, the role of spatial autocorrelation seems to play a minimal role in the coefficient estimates but does point to some spatial effects.[10] This is not surprising, given the land requirements of these selected industries.

10 With consideration toward treating these effects conservatively, we did not include spatial estimates in the effects outlined in *Tables 4 and 7* (the magnitude estimates) as suggested by LeSage and Dominguez (2012).

The findings detailed above do point towards a set of effects that appear consistently across our sample choice and specification. First, there is no consistent effect of regulation of wind or solar on GDP or employment that is robust to different treatment and control groups or timing. This strongly implies that there is not an aggregate effect of wind or solar regulation on employment or GDP.

However, it is clear that regulation does influence the composition of economic activity within a county. Generally, wind and/or solar restrictions appear to reduce GDP and employment in manufacturing, transportation, information and utilities. The most persistent effects occur across durable goods manufacturing, followed by transportation, then information. The utilities effect is less common, because it occurs in fewer counties.

This is consistent with the possibility that certain industries with large shares of firms that have RPS standards may view access to wind or solar energy in adjacent counties as a key determinant of location choices. We feel a larger sample size would be necessary for a conclusive determination of that dynamic, though our results certainly suggest that the demand for renewable energy plays a role in location choice. We will examine this issue again later.

Overall, the nature of the data and the tests we perform argue for several alternative robustness tests of our findings. The goal is to either refute or support the results we present above by altering our measures of regulation definition, timing or model specification.

Alternative Tests of Model Robustness

We undertook a number of tests to evaluate the quality of our model specification, the data we use (sample areas) and the approach we follow in determining the start of the treatment effect.

First, we tested for pre-trends in GDP and employment, manufacturing and agricultural GDP and employment (farm proprietorship) and in utility and information employment. In all cases, we are satisfied that there are no differences in pre-trends between counties who chose to regulate and counties that did not regulate wind or solar energy production. The pre-trends tests were performed prior to our difference-in-difference models. We feel the comparison of our pre-trends analysis (event study) and the more comprehensive difference-in-difference models present reasonably similar results, thus confirming the robustness of these approaches. Our discussion of pre-trend testing, and the issues involved in sample length appear in the appendices (*Tables A14-A20*).

Our next concern was whether the use of three regulatory frameworks (i.e., solar, wind and both) was appropriate. We collapsed our three measures of restrictions into two categories (i.e., solar and wind). Using replicated estimates, the collapsed categories show no meaningful differences (i.e. both magnitudes and statistical significance changed modestly, but not enough to meaningfully alter these findings). We are confident that either approach provides similar results. Therefore, we report the results of our three regulatory frameworks.

We are also uncertain whether our measure of regulation is too blunt of an instrument, so we also devised another measure of regulation, a count variable of the number of restrictions placed in each county. This ranged from zero to nine from the Ogle and Salazar (2021) study. Again, we tested this on GDP and employment, finding no effect. We report these in the following section on fiscal effects only.

We also used the single most restrictive rule, a complete wind power moratorium. This is in place in nine counties. There was no statistically meaningful effect ($p = 0.87$ on GDP, which was representative of all models). We also tested this model on all counties, then omitted fast-growing Tippecanoe County, which hosts Purdue University in the Class 3 wind area and has a wind moratorium (it is a plausible outlier). Again, across both samples there was no effect on GDP or employment. We conducted a similar test on population, which yielded no effects.

As noted above, we cannot know the implementation date of each regulation. Thus, we use an implementation after 2006.[11] However, that selection will precede regulation for many counties. To test whether that affects our results, we relaxed the start date of the introduction of regulation by year, from 2006 to 2011, and tested year change on overall GDP and employment. None of these results changed with the start date of regulations.

Our difference-in-difference model (*Equation 1*) uses the standard two-way fixed effects difference-in-difference specification (see Hicks and Faulk, 2023). However, an alternative specification eliminates the county fixed effects, using time fixed effects only, and the next step was to change the difference-in-difference specification to the following traditional model that cannot be estimated with time fixed effects:

$$\boldsymbol{Y_{i,t} = \emptyset_1 Z_i + \emptyset_2 T_{2006} + \emptyset_3 Z_i * T_{2006} + e_{i,t}} \qquad (\textbf{\textit{Equation 2}})$$

…where $\boldsymbol{\emptyset_3}$ is the difference-in-difference estimator, $\boldsymbol{Z}$ is the matrix of regulations (solar, wind and both) and $\boldsymbol{T}$ is the treatment period (2006 or later). We again tested this on GDP and employment with no meaningful difference. ($\boldsymbol{Y}$ for non-share variables was expressed in natural log form). We also altered the treatment date incrementally, from 2006 to 2011, again finding no differences. We prefer the estimator reported above (*Equation 1*) because this better controls for county and year effects. However, given the small sample size and the subjectivity of creating control and treatment geographies (due to wind availability), reporting more, rather than fewer results are warranted.

We also estimated a specification using 2019 as the end year for our analysis for the GDP and employment estimates. We did this to avoid the potential existing disequilibrium in labor markets resulting from the COVID-19 pandemic. Again, this did not affect our results meaningfully. This approach is similar to the abbreviated the post-treatment sample but is done for the purpose of avoiding the COVID disequilibrium not preventing bias due to excessive post-treatment periods.

Another robustness test is straightforward. We perform a two-period difference-in-difference model of the nine different regulatory restrictions described earlier. This has the advantage of working around both the implementation date concern (we used 2001 start date) and COVID (we used 2019 end date). It also has the advantage of examining specific economic impacts directly. Some of these restrictions are very common, so we focused on the three rare examples: setbacks and height, sound level limits, and decommissioning restrictions.

The difference-in-difference in the decommissioning and sound level limits were effectively zero in magnitude. The effect on setbacks was large, but not statistically significant ($p = 0.88$). We tested this in both the two period and 20-year models, with similar results.

This set of robustness tests provides a very exhaustive analysis of the issues affecting the estimation of the effect of renewable energy regulatory restrictions on economic outcomes at the county level in Indiana. But we are also interested in fiscal effects, which aid in isolating and explaining the effects we described above for two important reasons. First, the fiscal structure of Indiana is sensitive to the capital intensity of industries. The industries we find affected by wind and solar regulation are among the higher capital-intensive sectors in the state. So, effects of a compositional change to economic activity due to wind or solar restrictions should manifest itself in fiscal conditions (primarily assessed value). Second, most Indiana counties employ tax abatements to lure capital intensive businesses. Thus, if wind and solar restrictions affect the geography of wind and solar facilities, it is plausible that the policy response in counties with restrictions would be to offer larger incentives.

11 The earliest wind ordinances were adopted during 2006-2008 according to Tamara Ogle in email correspondence with the author on September 1, 2023.

Fiscal Effects of Alternative Energy Restrictions

Next, we turn to a fiscal analysis of local level renewable energy regulations, using data on assessed value in Indiana's counties in 2001-2019, from the *Indiana Handbook of Taxes, Revenues, and Appropriations*, published annually. Our interest here is twofold.

First: Do we detect an effect of regulation on capital growth in a county (i.e., gross assessed value)?

Second: Do counties with regulatory restrictions change their abatement practices, which we derive from county-level net assessed value (NAV) and gross assessed value (GAV) estimates?

Indiana imposed significant changes to the property tax system during this period, capping tax rates and expanding the type and level of local income taxes that are available to local governments (see Thaiprasert, Faulk and Hicks, 2010, 2013; Hicks and Faulk, 2016). We can control for the unobserved effects of these changes through our two-way fixed effects model, but we cannot directly assess the change in regulation on the level or mix of actual taxes during this period.

Table 20 shows the results across four specifications. First, we test *Equation 1* (our preferred specification) on gross assessed value (GAV) of personal property (machinery and equipment), and the abatement share of personal property, which is simply one minus the NAV/GAV for personal property. Assessed value is the closest proxy to physical capital available. Here we used assessed value of personal property, which is almost exclusively business personal property (machinery and equipment). We then test the difference-in-difference estimator without the two-way fixed effects. Finally, we test the model where regulation counts serve as our measure of regulation.

Table 20. Fiscal Effects of Renewable Energy Restrictions on Personal Property & Abatements

-	GAV Personal Property (*Equation 1*) (log)	GAV per Capita Property (*Equation 1*)	Personal Property Abatement Share (*Equation 1*)	Personal Property Abatement Share (*Equation 2*)	Personal Property Abatement Share (Wind & Solar Only)	Personal Property Abatement Share (Regulation Count Model)
Solar Restrictions $\boldsymbol{\beta}$	0.081 (1.04)	0.082 (1.06)	0.047 (1.14)	0.041 (0.95)	0.009 (0.42)	. . .
Wind Restrictions $\boldsymbol{\gamma}$	0.034 (0.50)	0.013 (0.22)	0.075† (1.72)	0.063*** (2.13)	0.043* (2.02)	. . .
Both Restrictions $\boldsymbol{\delta}$	0.090 (1.58)	0.097 (1.64)	0.062 (1.46)	0.051† (1.66)	. . .	. . .
Post 2006	. . .	. . .	. . .	-0.009 (-0.34)	. . .	. . .
Dummy Solar ***Z***	. . .	. . .	. . .	0.059** (2.37)	. . .	. . .
Dummy Wind ***Z***	. . .	. . .	. . .	0.022 (0.88)	. . .	. . .
Dummy Both ***Z***	. . .	. . .	. . .	0.016 (0.89)	. . .	. . .
Count of Regulations	. . .	. . .	. . .	. . .	. . .	0.003 (0.47)
$\widehat{\boldsymbol{W}}\boldsymbol{Y}_{i,t}$	0.519*** (2.36)	0.57** (2.83)	0.092 (0.98)	0.046 (0.62)	0.087 (0.87)	0.097 (0.96)
TWFE $\boldsymbol{\alpha_i} + \boldsymbol{\alpha_t}$	Yes	Yes	Yes	No	Yes	Yes
N (i, t)	1732 (92, 19)	1732 (92, 19)	1724 (92, 19)	1724 (92, 19)	1724 (92, 19)	1724 (92, 19)
Adjusted R2	0.96	0.88	0.13	0.02	0.08	0.16

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level; † at the 15% level. Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

We find no effect of solar or wind restrictions on gross assessed value of personal property, either in log or per capita form. This is consistent with our broad findings above regarding regulatory restrictions on GDP and employment. There are essentially no effects across this broad measure of primarily commercial economic activity.

However, we find reasonably strong effects on abatement practices among counties with wind power restrictions, and those with wind and solar restrictions. These findings are consistent across the specifications of this model, though in the shorter (2001-2019 period) the statistical significance of the abatement share (*Table 20, Column 4*) falls just outside the level of traditional statistical significance (p = 0.105).

The model results suggest that counties that restrict wind and solar offer more abatements to attract new businesses or expansions of existing businesses. This suggests that a tradeoff may exist between the introduction of renewable energy restrictions and the desirability of a county for new business formation in industries that are transitioning to higher share of renewable energy use.

Note that each of the four tests on personal property abatement reflect the same robustness tests discussed previously with regard to employment and GDP. We did not report our models with different regulatory start dates, but they did not affect the results. That issue is discussed in the appendix, which evaluates the potential for pre-trends with different implementation dates of wind or solar restrictions.

These findings point to fairly large fiscal effects of these restrictions. Wind restrictions in particular increased the abatement share of countywide business personal property taxes between 4.0 percent and 6.2 percent. That translates into tax abatements and exemptions statewide between $39 million and $61 million each year associated with restrictions on wind and solar power.

We also test this effect in a simpler specification, examining solar and wind restrictions and the sum of those restrictions (presence dummy and count of restrictions). In this estimate (reported in *Table 21*), we find similar results. Restrictions on the placement of wind or solar and wind development (as measured by a presence dummy) increase the share of personal property abated withing the county by 3.6 percent to 2.7 percent, respectively. The combined wind and solar effect (in the count model) is small, 0.09 percent, but the mean count of regulations across all counties is 14.9, which yields a roughly 0.13 percent effect (compared to the 2.7 percent effect noted in the wind and solar dummy model).

Table 21. Fiscal Effects of Renewable Energy Restrictions on Personal Property and Abatements

-	Personal Property Abatement Share (Solar Only)	Personal Property Abatement Share (Wind & Solar Only)	Personal Property Abatement Share (Combined)	Personal Property Abatement Share (Regulation Count Model)	Personal Property Abatement Share (Regulation Count Model)	Personal Property Abatement Share (Combined Regulation Count Model)
Solar Restrictions $\boldsymbol{\beta}$	0.005 (0.27)	0.012 (0.57)	. . .	0.0017** (2.53)	0.0013 (1.50)	. . .
Wind Restrictions $\boldsymbol{\gamma}$	. . .	0.036** (2.44)	. . .	. . .	0.001 (1.01)	. . .
Both Restrictions $\boldsymbol{\delta}$	. . .	. . .	0.027* (1.85)	. . .	. . .	0.0009*** (3.30)
TWFE $\boldsymbol{\alpha_i} + \boldsymbol{\alpha_t}$	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
N (i, t)	1742 (92, 21)	1742 (92, 21)	1742 (92, 21)	1742 (92, 21)	1742 (92, 21)	1742 (92, 21)
Adjusted R2	0.07	0.07	0.07	0.07	0.07	0.07

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level; † at the 15% level (when the coefficient value of relevant magnitude). Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Overall, in our more heavily parameterized models (*Table 20*) we find that restrictions on wind lead to higher abatement spending of 4.2 percent and 6.2 percent, or statewide of between $39 million and $61 million each year associated with restrictions on wind and solar power. In our spare model, the effects are smaller, with effects ranging from 2.7 percent to 3.6 percent in the presence models ($27 million to $35 million per year, statewide).

In a further balancing test, we conduct event studies on selected potential covariates of wind or solar regulations discussed in this work. These tests conducted on wind and solar regulations as the treatment group found no treatment effects that rose to statistical significance. See *Appendix Figure 2*.

The fiscal effects we find are consistent with regulatory restrictions that by design and effect alter the mix of economic activity within the county. We detect no overall effect on capital (gross assessed value of personal property), but we do observe large increases in the use of abatements and exemptions. Because these are primarily associated with manufacturing, information, logistics and utility development, officials in these locations may feel the need to offer more substantive incentives. This is the most likely transmission of higher abatements in counties with more restrictive renewable energy restrictions.

Overall, our results here provide fairly clear results. Generally, restrictions on renewable energy have not had an effect on countywide GDP or employment. This finding is robust to alternative specifications of our model, alternative data of regulation and alternative dates of both regulation and end date (2019 versus 2021 to avoid the COVID pandemic). Neither does our analysis find evidence of population effects, or changes in gross assessed value of personal property. This latter finding is interesting because we might expect the wind turbines or solar panels to contribute to gross assessed value in the counties that have them. However, the phase in of the property appears, on average, to be slow enough that it does not affect overall gross assessed value.

However, we do find strong evidence of changes in industrial structure within a county. Counties with more restrictive regulations on alternative energy have seen a negative effect on utility GDP. This is unsurprising because the higher regulation on renewable energy is designed to reduce utility GDP directly within a county. However, they have also experienced declines in GDP in information and durable goods manufacturing. Altogether, this loss is roughly $240 million per year statewide (direct effect).

We also observe reductions in employment in manufacturing that statewide account for roughly 2,925 jobs and in transportation and warehousing, which statewide account for just under 5,300 fewer jobs.

We also report evidence that the counties that have regulated renewable energy are now more reliant on tax abatements and incentives to attract new firms. The size of this is dependent upon the model specification, but it ranges from $39 million to $61 million per year in additional tax incentives.

The following section outlines the adjustments within counties, by regulatory type, using a ten-year shift share analysis. This method examines the intra-county changes to industry mix.

Economic Transition During Peak Solar/Wind Expansion

This section illustrates the intra-county change in industry structure associated with regulations on renewable energy. To accomplish this, we use a shift-share analysis. A shift-share analysis is a commonly used technique in regional economics to decompose changes in regional employment or economic activity into various components. It helps to understand the factors contributing to regional economic growth or decline (Blair, 1995).

Shift-share analysis typically involves breaking down changes in a particular region's economic indicators, such as employment or GDP, into three main components:

> **National Growth Effect (NG):** This component reflects the portion of the observed change that can be attributed to overall national or global economic trends. It assumes that if the region had the same industry structure as the entire country, it would experience this growth. NG is calculated by applying the national growth rate to the regional base period employment or economic indicators.
>
> **Industry Mix Effect (IM):** This component represents the change in the region's indicators due to the differences in the regional industry mix compared to the national industry mix. In other words, it measures how the region's industrial composition affects its performance relative to the national economy. IM is calculated by applying the difference between the regional and national industry shares to the national growth rate.
>
> **Local Competitive Effect (LC):** The LC captures the portion of the change that results from the region's relative competitiveness in specific industries. It compares the regional industry's growth rate with the corresponding national industry's growth rate. If the regional industry is growing faster than the national average, it contributes positively to the LC.

The formula for calculating the total change in regional employment (or economic activity) is:

Total Change = NG + IM + LC.

To illustrate with an example, let's say you are analyzing the change in employment in a specific region over a given period:

> **NG:** This accounts for the region's employment change that would occur if it experienced the same growth rate as the national economy.
>
> **IM:** This reflects how the region's industrial mix (i.e., the distribution of industries in the region) differs from the national average and how that impacts employment change.
>
> **LC:** This considers the competitive advantage or disadvantage of specific industries in the region relative to their performance at the national level.

The interpretation of the results is as follows: If the ***Total Change*** is greater than the ***NG***, it indicates that the region is outperforming the national average. If the ***IM*** is significant, it may suggest that the region's industry mix is a key driver of change. A positive ***LC*** means that the region is competitive in certain industries.

We focus our analysis on the counties with no wind or solar restrictions (*Table 22*) compared to counties with restrictions on both solar and wind deployment (*Table 23*). We also examine rural and urban counties to identify potential changes in both of these geographies (for brevity's sake, we only report the rural counties in total; see *Tables 24 & 25*). We use a ten-year period (2012-2022) because it corresponds with the first large known restriction on solar or wind (in 2013) and provides a more contemporary estimate of effects. We focus on manufacturing employment because it is the most sensitive to restrictions (as we report above) and limit our discussion to that sector.

Table 22. Shift Share, Counties with Neither Wind nor Solar Restrictions

Industry	Actual Growth	National Growth	Industry Mix Share	Local Competitiveness
Agriculture, Forestry, Fishing, and Hunting	19	1,347	-1,040	-288
Mining, Quarrying, and Oil and Gas Extraction	-1,459	485	-1,870	-74
Utilities	-1,075	833	-1,047	-861
Construction	11,962	7,662	9,115	-4,815
Manufacturing	34,990	23,786	6,821	4,382
Wholesale Trade	5,357	5,787	-1,099	669
Retail Trade	-3,711	14,764	-7,127	-11,348
Transportation and Warehousing	20,189	7,945	24,060	-11,816
Information	-4,637	2,337	-3,339	-3,636
Finance and Insurance	-419	5,148	27	-5,595
Real Estate and Rental and Leasing	-464	2,313	467	-3,245
Professional, Scientific, and Technical Services	17,176	6,653	8,359	2,165
Management of Companies and Enterprises	2,637	1,848	1,783	-993
Administrative and Support and Waste Management and Remediation Services	3,895	10,311	4,392	-10,808
Educational Services	-1,301	10,652	-7,505	-4,448
Health Care and Social Assistance	22,163	20,837	46	1,280
Arts, Entertainment, and Recreation	-872	2,386	-1,117	-2,141
Accommodation and Food Services	1,108	11,934	420	-11,246
Other Services (except Public Admin.)	859	7,130	-6,465	193
Public Administration	-383	7,195	-3,467	-4,110
Unclassified	14	0	0	14
Total	106,049	151,354	21,415	-66,720

Table 23. Shift Share, Counties with Both Wind & Solar Restrictions

Industry	Actual Growth	National Growth	Industry Mix Share	Local Competitiveness
Agriculture, Forestry, Fishing, and Hunting	789	2,240	-1,784	333
Mining, Quarrying, and Oil and Gas Extraction	70	134	-87	23
Utilities	20	463	-460	17
Construction	14,835	6,201	8,596	38
Manufacturing	12,654	25,848	-7,626	-5,569
Wholesale Trade	2,414	4,642	-1,706	-522
Retail Trade	2,990	14,828	-7,217	-4,621
Transportation and Warehousing	16,137	5,914	12,877	-2,654
Information	-3,739	1,791	-3,629	-1,900
Finance and Insurance	181	3,800	-309	-3,310
Real Estate and Rental and Leasing	1,710	1,476	226	8
Professional, Scientific, and Technical Services	5,410	3,703	4,152	-2,445
Management of Companies and Enterprises	787	1,006	936	-1,155
Administrative and Support and Waste Management and Remediation Services	2,162	6,721	2,955	-7,514
Educational Services	-7,145	12,400	-8,860	-10,685
Health Care and Social Assistance	14,142	16,874	88	-2,820
Arts, Entertainment, and Recreation	492	1,876	-1,237	-146
Accommodation and Food Services	7,025	11,120	1,047	-5,141
Other Services (except Public Admin.)	2,909	6,499	-5,697	2,107
Public Administration	-559	5,480	-1,909	-4,130
Unclassified	11	0	1	10
Total	73,293	133,015	-9,644	-50,078

Table 24. Shift Share, Rural Counties with Neither Wind nor Solar Restrictions

Industry	Actual Growth	National Growth	Industry Mix Share	Local Competitiveness
Agriculture, Forestry, Fishing, and Hunting	13	1,070	-978	-79
Mining, Quarrying, and Oil and Gas Extraction	-1,375	424	-1,729	-71
Utilities	-171	343	-596	82
Construction	3,852	2,134	3,183	-1,465
Manufacturing	12,468	7,440	116	4,912
Wholesale Trade	1,525	1,012	-359	872
Retail Trade	-303	4,354	-638	-4,020
Transportation and Warehousing	12,199	1,564	5,315	5,320
Information	-595	376	-834	-138
Finance and Insurance	-369	775	-389	-755
Real Estate and Rental and Leasing	339	331	-22	30
Professional, Scientific, and Technical Services	3,417	1,122	1,298	997
Management of Companies and Enterprises	-2	173	165	-339
Administrative and Support and Waste Management and Remediation Services	-2,270	1,769	904	-4,943
Educational Services	144	2,862	-1,903	-815
Health Care and Social Assistance	1,814	4,459	-1,205	-1,439
Arts, Entertainment, and Recreation	-1,992	710	-1,364	-1,338
Accommodation and Food Services	2,596	3,031	296	-731
Other Services (except Public Admin.)	213	1,691	-1,586	108
Public Administration	908	2,315	-1,148	-260
Unclassified	7	0	0	7
Total	32,416	37,955	-1,474	-4,065

Table 25. Shift Share, Rural Counties with Both Wind & Solar Restrictions

Industry	Actual Growth	National Growth	Industry Mix Share	Local Competitiveness
Agriculture, Forestry, Fishing, and Hunting	912	1,750	-1,631	793
Mining, Quarrying, and Oil and Gas Extraction	29	92	-72	9
Utilities	-127	233	-291	-69
Construction	4,281	2,218	3,122	-1,058
Manufacturing	4,469	14,121	-4,084	-5,567
Wholesale Trade	507	1,555	-578	-471
Retail Trade	917	4,727	-952	-2,859
Transportation and Warehousing	2,210	2,092	6,274	-6,156
Information	-1,184	590	-1,547	-227
Finance and Insurance	-530	1,080	-214	-1,396
Real Estate and Rental and Leasing	603	363	-47	288
Professional, Scientific, and Technical Services	809	1,008	1,165	-1,364
Management of Companies and Enterprises	-862	500	474	-1,836
Administrative and Support and Waste Management and Remediation Services	-1,403	2,107	1,335	-4,846
Educational Services	-1,797	3,825	-2,740	-2,882
Health Care and Social Assistance	-2,241	5,037	-1,391	-5,887
Arts, Entertainment, and Recreation	-573	643	-603	-613
Accommodation and Food Services	1,169	3,344	513	-2,688
Other Services (except Public Admin.)	516	2,062	-1,909	364
Public Administration	-486	2,086	-639	-1,932
Unclassified	5	0	0	5
Total	7,227	49,432	-3,814	-38,391

Focusing solely on manufacturing, we report that there were substantial local competitiveness effects in this sector for places without restrictions over the 2012 to 2022 period. Counties with wind and solar restrictions experienced a decrease in manufacturing employment (-5,569 jobs), while counties without restrictions experienced an increase of 4,382 manufacturing jobs (*Tables 22, 23, and 26*). Further analysis of rural counties (*Tables 24 and 25*) shows that manufacturing employment in rural counties was most affected.

It is useful to focus on the columns without restrictions and those with restrictions on both solar and wind, because the fuller set of restrictions should be interpreted as far more restrictive. Rural places that did not adopt restrictions performed very differently than those with restrictions. Rural counties with restrictions experienced manufacturing jobs losses of more than 5,500 while rural areas with no restrictions experienced jobs gains of over 4,900.

Table 26. Local Competitiveness Effects on Manufacturing Employment (Shift-Share Analysis)

-	No Restrictions	Solar Restrictions Only	Wind Restrictions Only	Solar and Wind Restrictions
Full Sample	4,382	314	3,186	-5,569
Rural Only	4,912	740	1,221	-5,567
Urban Only	-530	-426	1,966	-1

We interpret the urban effects as suggesting little or no effect of wind and solar restrictions on urban manufacturing. Again, this is not formally a causal analysis, but the shift-share approach is useful in identifying local effects. What those effects are not certain. That local effects differ between these two extreme regulatory regimes is certain. Job creation figures across these regimes differed by 9,951 total jobs in manufacturing due to local effects. These results mimic the findings from our econometric modeling.

Summary and Policy Discussion

This study offers an attempt to identify the causal relationship between the adoption of regulations restricting the deployment of wind and solar power generation on economic activity at the local level. Nearly all of our analysis and robustness tests attempt to mitigate a key data limitation that the timing of adopting or implementing local regulations is unknown and appears not to be knowable despite costly efforts to assess these regulations (Ogle and Salazar, 2021). This limitation risks biasing our estimated coefficients towards zero because the differential timing of regulation compares treated counties in later years against non-treated as well as previously treated counties. Without this data limitation, our challenge would have been a reasonably straightforward staggered difference-in-difference estimation.

In response to this bias risk, we undertake a number of mitigation strategies, from altering the control and treated groups, to shortening the post-treatment period as outlined above. The result remains small, albeit non-trivial, effects that correspond to both economic theory and common sense. Under many specifications, counties with more restrictions experience lower levels of GDP and employment in manufacturing, information services, and utilities, while enjoying very modestly higher levels of agricultural GDP and farm employment. This is entirely consistent with the expectations that firms with renewable portfolio commitments would, at the margin, select locations more proximal to renewable energy sources. From a purely commonsense approach, counties with these restrictions would experience higher levels of agricultural activity, all things equal, than those without these restrictions. We also find that counties with these regulatory restrictions avail themselves of higher levels of fiscal incentives to attract businesses.

All these findings should be viewed against the risk of bias in the coefficient estimates. We know the direction of this bias (towards zero, or statistical insignificance), but not the magnitude of that bias. In that regard, the findings summarized below should appropriately be interpreted as reflecting the lower threshold of the potential effect of regulatory restrictions on wind and solar production.

The estimates themselves are performed through the use of a two-way fixed effects panel difference-in-difference model, on Indiana's 92 counties in 2001-2021, and shorter periods (to 2016 and to 2019). We test the effect of wind, solar, and combined regulatory restrictions at the county level on GDP growth, employment, sectoral GDP and employment, and tax incentives.

We report that restrictions on the deployment of wind and solar power reduce GDP in utility production by $28.9 million annually and reduce GDP in information by $22.6 million annually over this period (direct effects). However, the largest effect of these restrictions is on the growth of durable goods manufacturing. Restrictions here reduce manufacturing GDP in those counties by a total of more than $190 million each year.

We find employment effects as well. For manufacturing, the strictest regulatory controls on the deployment of wind and solar translates into a decrease of roughly 7,400 manufacturing jobs statewide (direct effects). For transportation and warehousing, this translates into a decrease of 16 jobs per affected county or just under 1,500 statewide. Importantly, these results are very similar to the results on GDP within manufacturing, which provides us greater confidence in our results.

We also find strong evidence of changes in industrial structure within a county as a result of renewable energy restrictions. Counties with more restrictive regulations on alternative energy have seen a negative effect on utility GDP. This is unsurprising because the higher regulation on renewable energy is designed to reduce utility GDP directly within a county. However, they have also experienced declines in GDP in information and durable goods manufacturing.

We also report evidence that the counties that have regulated renewable energy are now more reliant on tax abatements and incentives to attract new firms. The size of this is dependent upon the model specification, but ranges from $39 million and $61 million per year in additional tax incentives. This might be interpreted as the fiscal cost of implementing restrictions on wind or solar. These findings were submitted to a large battery of model specifications and robustness tests.

We also performed a decade-long shift-share analysis of job changes across rural and urban places and across our four different regulatory environments (no restrictions, wind only, solar only, and restrictions on both). The shift-share is not formally a causal analysis, but the shift-share approach is useful in identifying local effects. We found significant restricting effects that accompanied both wind and solar effects. Local job creation figures across these regimes differed by 9,951 jobs in manufacturing. These results support the findings from our econometric modeling.

Implications

Our study contributes to the regulatory literature on solar and wind placement in several ways. First, many of our specifications are as close to a causal analysis of regulatory restrictions as is now available within the literature. The shortcoming is that we do not know the exact start date of the restrictions. We conduct several tests to examine the robustness of these results.

Second, to the best of our knowledge, this is the first empirical test of regulatory restrictions on solar and wind deployment. The academic and policy literature has focused heavily on incentives and regulation to promote new construction of wind and solar. There is some work suggesting a difficult local environment for this type of development, but our work is the first to assess this empirically. We conclude that there is some symmetry in public policy effects on wind and solar.

Third, we examine overall and sectoral GDP and employment change along with fiscal effects of restrictions. Our findings are compatible with the canonical interpretation of regulation having a clear trade-off in terms of employment, GDP, and fiscal effects. The absence of overall GDP effects suggests that the additional fiscal expenditure on incentives is partially mitigating the negative effects of regulation on GDP and job growth. Alternatively, these restrictions work to alter the mix of economic activity.

Finally, we think the combination of the two-way fixed effects DiD panel model, with its focus on identifying casual effects, combined with the testing of multiple sectors, a battery of robustness tests on model specification, timing, and data definitions makes this a strong contribution in a literature that will be of growing importance.

There are policy dimensions to this work as well, primarily in the informational content of regulatory deliberations. The restrictions placed on wind and solar power deployment are intended to alter the economic landscape within a county. Our analysis confirms that they do so. From a policy perspective, our findings are useful in quantifying the direction and magnitude of these effects.

Clearly, rules that limit the deployment of wind and solar will result in less economic activity (jobs and GDP) associated with the production of renewable energy. They will also reduce GDP and employment in the sectors that increasingly rely upon renewable energy — primarily manufacturing, transportation/warehousing, and information services.

We find no negative effects of these restrictions on agricultural GDP or farm employment, which is often the stated cause for seeking these regulations. We also find a fiscal effect where counties with these restrictions offer much more extensive tax abatements, presumably to offset the effects of regulation.

These effects should be considered by taxpayers and policymakers as they consider whether and how to restrict the placement of wind and solar facilities within their jurisdictions. Regulatory changes have trade-offs; there is no 'free lunch' available in the restriction of economic activity. That does not mean these trade-offs are not appropriate, but failure to recognize that they exist, where they exist, and the magnitude of the effects will impede good policy design.

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Appendix

Contents

SUTVA Tests for GDP (Tables A1-A7)

We use the Stable Unit Treatment Value Assumption test to calculate effect on gross domestic product by industry.

Table A1. SUTVA Tests on Gross Domestic Product

All GDP	$Y_{i,t}$ (1a)	$Y_{i,t}$ (1b)	$\widehat{W}Y_{i,t}$ (1c)
Solar Restrictions (β)	0.155180 (1.22)	. . .	-0.002975 (-0.09)
Wind Restrictions (γ)	-0.024751 (-0.30)	. . .	-0.026434 (-0.87)
Both Restrictions (δ)	-0.043526 (-0.87)	. . .	-0.036628* (-1.73)
Solar Restrictions ($\widehat{W}\beta$)	0.041294 (0.96)	0.105931 (0.88)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	0.017920 (0.27)	-0.023073 (-0.27)	. . .
Both Restrictions ($\widehat{W}\delta$)	0.012249 (0.35)	-0.010480 (-0.25)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.302558*** (2.82)	
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1932 (92, 21)	1932 (92, 21)	1932 (92, 21)
Adj. R2	0.99	0.99	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level. Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A2. SUTVA Tests on Utilities Gross Domestic Product

Utilities GDP	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions (β)	-0.113724 (-0.61)	. . .	-0.010934 (-0.17)
Wind Restrictions (γ)	0.272778 (0.64)	. . .	0.099655 (0.88)
Both Restrictions (δ)	0.049154 (0.22)	. . .	0.122720* (1.85)
Solar Restrictions ($\widehat{W}\beta$)	-1.262833† (-1.61)	-0.136429 (0.52)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	1.508715† (1.52)	1.024155 (0.87)	. . .
Both Restrictions ($\widehat{W}\delta$)	-0.116891 (-0.42)	-0.037156 (0.25)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.027527 (0.10)	
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1712 (92, 21)	931 (91, 21)	1045 (91, 21)
Adj. R2	0.86	0.94	0.96

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A3. SUTVA Tests on Durable Goods Manufacturing Gross Domestic Product

Durable Goods Mfg GDP	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions (β)	-0.075744 (-0.06)	. . .	0.021665 (0.12)
Wind Restrictions (γ)	0.138658 (1.01)	. . .	-0.241366** (-2.79)
Both Restrictions (δ)	0.005775 (0.05)	. . .	-0.214641** (-0.24)
Solar Restrictions ($\widehat{W}\beta$)	0.141542 (0.50)	-0.564337 (-1.32)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	-0.653539** (-2.73)	-0.441937*** (-3.27)	. . .
Both Restrictions ($\widehat{W}\delta$)	-0.114112 (-0.75)	-0.122591 (-0.95)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.171488 (1.29)	
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1712 (92, 21)	875 (91, 21)	941 (86, 21)
Adj. R2	0.86	0.94	0.98

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A4. SUTVA Tests on Non-Durable Goods Manufacturing Gross Domestic Product

Non-Durable Goods Mfg GDP	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions (β)	0.157317 (1.05)	. . .	0.092735 (0.96)
Wind Restrictions (γ)	0.055975 (0.41)	. . .	0.012486 (0.15)
Both Restrictions (δ)	-0.035082 (-0.40)	. . .	-0.024952 (-0.32)
Solar Restrictions ($\widehat{W}\beta$)	-0.203971 (-0.46)	-0.479151 (-1.10)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	0.315737† (1.72)	0.445646* (2.02)	. . .
Both Restrictions ($\widehat{W}\delta$)	-0.069400 (-0.39)	-0.552760*** (-2.86)	. . .
$\widehat{W}Y_{i,t}$	. . .	-0.196682* (-2.03)	
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1608 (90, 21)	905 (83, 21)	960 (84, 21)
Adj. R2	0.96	0.98	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A5. SUTVA Tests on Information Gross Domestic Product

Information GDP	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions (β)	-0.184958 (-1.41)	. . .	-0.110162** (-2.49)
Wind Restrictions (γ)	-0.005660 (-0.05)	. . .	-0.075361* (-1.84)
Both Restrictions (δ)	0.039492 (0.41)	. . .	-0.137060*** (-3.30)
Solar Restrictions ($\widehat{W}\beta$)	-0.242440 (-0.69)	-0.187921 (-0.43)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	0.096156 (0.52)	0.134331 (0.56)	. . .
Both Restrictions ($\widehat{W}\delta$)	-0.059702 (-0.35)	-0.106465 (-0.48)	. . .
$\widehat{W}Y_{i,t}$	. . .	-0.158159 (-0.63)	
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1739 (90, 21)	1067 (81, 21)	1150 (83, 21)
Adj. R2	0.96	0.95	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A6. SUTVA Tests on Transportation and Warehousing Gross Domestic Product

Transportation & Warehousing GDP	$Y_{i,t}$ (1a)	$Y_{i,t}$ (1b)	$\widehat{W}Y_{i,t}$ (1c)
Solar Restrictions ($\boldsymbol{\beta}$)	0.012460 (0.16)	. . .	0.056975 (0.51)
Wind Restrictions ($\boldsymbol{\gamma}$)	0.108737 (0.84)	. . .	0.049512 (0.65)
Both Restrictions ($\boldsymbol{\delta}$)	0.045244 (0.57)	. . .	0.171793** (2.47)
Solar Restrictions ($\widehat{W}\boldsymbol{\beta}$)	0.448503† (1.70)	-0.168238 (-0.58)	. . .
Wind Restrictions ($\widehat{W}\boldsymbol{\gamma}$)	-0.25422 † (-1.64)	0.030533 (0.20)	. . .
Both Restrictions ($\widehat{W}\boldsymbol{\delta}$)	-0.054606 (-0.49)	0.309373** (2.22)	. . .
$\widehat{W}Y_{i,t}$	. . .	-0.109312 (-0.95)	
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1739 (90, 21)	554 (66, 21)	674 (70, 21)
Adj. R2	0.96	0.98	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A7. SUTVA Tests on Agriculture Gross Domestic Product

Agriculture GDP	$Y_{i,t}$ (1a)	$Y_{i,t}$ (1b)	$\widehat{W}Y_{i,t}$ (1c)
Solar Restrictions ($\boldsymbol{\beta}$)	-0.191057 (-0.84)	. . .	0.087239 (1.13)
Wind Restrictions ($\boldsymbol{\gamma}$)	0.281928 (1.36)	. . .	0.229394* (1.97)
Both Restrictions ($\boldsymbol{\delta}$)	0.195627 (1.35)	. . .	0.257270** (2.62)
Solar Restrictions ($\widehat{W}\boldsymbol{\beta}$)	0.535966 (0.81)	1.167371* (1.75)	. . .
Wind Restrictions ($\widehat{W}\boldsymbol{\gamma}$)	0.180274 (0.53)	-0.253962 (-0.54)	. . .
Both Restrictions ($\widehat{W}\boldsymbol{\delta}$)	0.607056** (2.46)	0.370438** (2.72)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.693925*** (7.67)	
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1739 (90, 21)	554 (66, 21)	879 (82, 21)
Adj. R2	0.96	0.98	0.70

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

SUTVA Tests for Employment (Tables A8-A13)

We use the Stable Unit Treatment Value Assumption test to calculate effect on employment by industry.

Table A8. SUTVA Tests on Employment

Employment	$Y_{i,t}$ (1a)	$Y_{i,t}$ (1b)	$\widehat{W}Y_{i,t}$ (1c)
Solar Restrictions (β)	0.023438 (0.23)	. . .	0.006974 (0.23)
Wind Restrictions (γ)	-0.066343 (-1.33)	. . .	-0.005430 (-0.20)
Both Restrictions (δ)	-0.075090* (-1.74)	. . .	-0.032873* (-1.86)
Solar Restrictions ($\widehat{W}\beta$)	0.009375 (0.35)	0.012892 (0.13)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	0.040790 (0.78)	-0.091333* (-1.47)	. . .
Both Restrictions ($\widehat{W}\delta$)	-0.008690 (-0.38)	-0.050103 (-1.47)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.303556*** (2.98)	. . .
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1932 (92, 21)	1932 (92, 21)	1932 (92, 21)
Adj. R2	0.99	0.99	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A9. SUTVA Tests on Utilities Employment

Utilities Jobs	$Y_{i,t}$ (1a)	$Y_{i,t}$ (1b)	$\widehat{W}Y_{i,t}$ (1c)
Solar Restrictions (β)	-0.014283 (-0.18)	. . .	0.026091 (1.08)
Wind Restrictions (γ)	0.120912 (1.30)	. . .	0.225644** (2.61)
Both Restrictions (δ)	0.079500 (1.10)	. . .	0.059216* (1.75)
Solar Restrictions ($\widehat{W}\beta$)	-0.965152*** (-3.35)	-0.762841** (-2.40)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	0.048810 (0.36)	0.006364 (0.04)	. . .
Both Restrictions ($\widehat{W}\delta$)	-0.146011 (-1.20)	-0.015505 (-0.11)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.028700 (1.21)	. . .
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1127 (77, 21)	558 (72, 21)	179 (33, 21)
Adj. R2	0.98	0.98	

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A10. SUTVA Tests on Manufacturing Employment

Manufacturing Jobs	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions ($\boldsymbol{\beta}$)	0.055677 (0.27)	. . .	0.009920 (0.19)
Wind Restrictions ($\boldsymbol{\gamma}$)	-0.217750* (-1.91)	. . .	-0.086227** (-2.56)
Both Restrictions ($\boldsymbol{\delta}$)	-0.027746 (-0.31)	. . .	-0.026128 (0.87)
Solar Restrictions ($\widehat{W}\boldsymbol{\beta}$)	-0.083398 (-1.29)	0.216531 (0.01)	. . .
Wind Restrictions ($\widehat{W}\boldsymbol{\gamma}$)	-0.045120 (-0.45)	0.122673** (-2.34)	. . .
Both Restrictions ($\widehat{W}\boldsymbol{\delta}$)	-0.074556† (-1.65)	0.085905 (-1.28)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.133759 (0.74)	. . .
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1870 (92, 21)	1870 (92, 21)	1701 (91, 21)
Adj. R2	0.99	0.99	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A11. SUTVA Tests on Information Employment

Information Jobs	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions ($\boldsymbol{\beta}$)	-0.184958 (-1.47)	. . .	-0.115953* (-2.14)
Wind Restrictions ($\boldsymbol{\gamma}$)	-0.005660 (0.96)	. . .	-0.037184 (-1.04)
Both Restrictions ($\boldsymbol{\delta}$)	0.039492 (0.68)	. . .	-0.115806*** (-3.67)
Solar Restrictions ($\widehat{W}\boldsymbol{\beta}$)	-0.242440 (0.50)	-0.187921 (-0.43)	. . .
Wind Restrictions ($\widehat{W}\boldsymbol{\gamma}$)	0.096156 (0.61)	0.134331 (0.59)	. . .
Both Restrictions ($\widehat{W}\boldsymbol{\delta}$)	-0.059702 (0.73)	-0.106465 (-0.48)	. . .
$\widehat{W}Y_{i,t}$	. . .	-0.158159 (-0.63)	. . .
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1739 (90, 21)	1067 (81, 21)	1150 (83, 21)
Adj. R2	0.96	0.95	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A12. SUTVA Tests on Transportation and Warehousing Employment

Transportation & Warehousing Jobs	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions (β)	-0.015350 (-0.19)	. . .	-0.071682 (-1.45)
Wind Restrictions (γ)	0.239018† (1.63)	. . .	0.127656 (1.47)
Both Restrictions (δ)	0.076232 (1.09)	. . .	0.110584† (1.66)
Solar Restrictions ($\widehat{W}\beta$)	0.473581* (1.79)	0.236111 (0.63)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	-0.171576 (-1/11)	-0.180283† (-1.62)	. . .
Both Restrictions ($\widehat{W}\delta$)	0.027252 (0.25)	0.245821** (2.18)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.315280** (2.47)	. . .
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1496 (90, 21)	554 (66, 21)	674 (70, 21)
Adj. R2	0.96	0.98	0.99

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Table A13. SUTVA Tests on Agricultural (Farm Proprietor) Employment

Farm Proprietor Jobs	$Y_{i,t}$ **(1a)**	$Y_{i,t}$ **(1b)**	$\widehat{W}Y_{i,t}$ **(1c)**
Solar Restrictions (β)	8.10E-05 (0.003)	. . .	0.006436 (0.32)
Wind Restrictions (γ)	0.009612 (0.62)	. . .	0.016272 (0.88)
Both Restrictions (δ)	0.006579 (0.49)	. . .	0.012949 (0.98)
Solar Restrictions ($\widehat{W}\beta$)	-0.066278 (-1.39)	0.009986 (0.14)	. . .
Wind Restrictions ($\widehat{W}\gamma$)	-0.007661 (-0.28)	0.020385 (0.57)	. . .
Both Restrictions ($\widehat{W}\delta$)	0.038772 (1.45)	-0.003963 (-0.13)	. . .
$\widehat{W}Y_{i,t}$	. . .	0.465980*** (2.65)	. . .
TWFE ($\alpha_i + \alpha_t$)	Yes, Yes	Yes, Yes	Yes, Yes
N (i,t)	1739 (90, 21)	1067 (81, 21)	1932 (92, 21)
Adj. R2	0.96	0.95	0.98

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level, and † at 15% level.
Our standard errors (in parentheses) are clustered using the spatially dependent technique of Thompson (2011).

Pre-Trend Tests (Tables A14-A22)

Our pre-trend analysis strategy was complicated by two factors. The first is the unknown date of regulation implementation (after 2006). The second was data availability limitations due to either absence of data (Indiana fiscal data, prior to 2001), the absence of county level GDP prior to 2001, or the NAICS changeover that affected industry employment data at 2001. This was an issue for most sectors, but was especially challenging for utilities and transportation, which were combined in the SIC, and separated in NAICS. We treat these concerns in two ways.

First, for any variable with clear data connection to the pre-2001 series, we conduct a longer pre-trend analysis, 1990-2021. These tests include a two-way fixed effect. For our shorter time period, we preserve degrees of freedom by eliminating the two-way fixed effects estimator in the earliest years, due to start date restrictions and reducing the number of lags and leads.

Second, for the longer series we vary the implementation date we test, ranging 2006-2010, reporting selected dates. For the shorter series, we use 2008 and 2010 (because of restrictions on pre-observation effects).

We test the wind and solar restrictions together, and then the solar-only and wind-only restrictions for 2006. Results follow in *Tables A14-A22*.

Table A14. Pre-Trends Test, Longer Time Series (1990-2021), With Treatment Year Set At 2006, Wind & Solar Restrictions, (t-Statistics in Parenthesis), Dependent Variable in Log Form

T +/- Years	Population	Employment	Manufacturing Employment	Farm Employment
-5	-0.00062 (-0.49)	-0.002705 (-0.01)	-0.011983 (-0.03)	0.002171 (0.02)
-4	-0.002573 (-0.11)	-0.001291 (-0.004)	-0.021697 (-0.06)	0.001207 (0.01)
-3	-0.00249 (-0.14)	-0.000541 (-0.002)	-0.004491 (-0.02)	0.001685 (0.01)
2	-0.00157 (-0.09)	-0.001250 (-0.004)	0.030427 (0.08)	0.001215 (0.010
-1	-0.0011 (-0.07)	-0.000291 (-0.001)	-0.063935 (-0.21)	0.001040 (0.01)
Treatment	-	-	-	-
1	-0.0024 (-0.16)	0.000514 (0.001)	-0.045058 (-0.15)	0.000588 (0.01)
2	-0.00296 (-0.16)	-0.011089 (-0.03)	0.010312 (0,03)	3.94E-05 (0.002)
3	-0.00316 (-0.18)	0.000413 (0.001)	0.015840 (0.05)	0.001654 (0.01)
4	-0.00313 (-0.18)	-0.004990 (-0.02)	-0.016164 (-0.05)	0.011565 (0.09)
5	-0.00652 (-0.49)	0.023260 (0.10)	0.260022 (1.05)	0.272648 (0.09)
TWFE	Y	Y	Y	Y
Observations	2,484	2,484	2,435	2,484
Adjusted R2	0.97	0.96	0.95	0.96

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Table A15. Pre-Trends Test, Longer Time Series (1990-2021), With Treatment Year Set At 2006, Solar Restrictions Only, (t-Statistics in Parenthesis), Dependent Variable in Log Form

T +/- Years	Population	Employment	Manufacturing Employment	Farm Employment
-5	-0.003001 (-0.13)	0.004183 (0.01)	0.005065 (0.01)	-0.001861 (-0.01)
-4	-0.001933 (-0.07)	0.002518 (0.01)	-0.013329 (-0.02)	0.000240 (0.001)
-3	0.003710 (0.13)	0.005006 (0.01)	0.000844 (0.001)	-0.001471 (-0.01)
-2	-0.000441 (-0.02)	-0.005263 (-0.01)	0.016172 (0.03)	-0.000220 (-0.000)
-1	0.001714 (0.03)	0.011924 (0.01)	-0.042287 (-0.08)	-0.007638 (-0.04)
Treatment	-	-	-	-
1	0.000533 (0.02)	-0.009203 (0.02)	-0.080875 (-0.16)	-0.008114 (-0.04)
2	0.000643 (0.02)	-4.99E-05 (0.000)	0.018900 (0.030	-0.005300 (-0.02)
3	0.000348 (0.01)	0.007929 (0.02)	0.012474 (0.02)	-0.004336 (-0.02)
4	-0.002915 (-0.10)	-0.001947 (-0.003)	0.014204 (0.02)	0.002900 (-0.01)
5	-0.018918 (-0.86)	0.513490 (1.34)	0.337342 (0.83)	-0.213210 (-1.31)
TWFE	Y	Y	Y	Y
Observations	2484	2484	2435	2484
Adjusted R2	0.99	0.99	0.97	0.96

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Table A16. Pre-Trends Test, Longer Time Series (1990-2021), With Treatment Year Set At 2006 Wind Restrictions Only, (t-Statistics in Parenthesis), Dependent Variable in Log Form

T +/- Years	Population	Employment	Manufacturing Employment	Farm Employment
-5	0.005162 (0.29)	0.008958 (0.02)	0.002238 (0.005)	-0.003304 (-0.02)
-4	0.002616 (0.11)	0.009072 (0.02)	0.029584 (0.06)	-0.001224 (-0.02)
-3	0.000986 (0.04)	0.009796 (0.02)	0.009870 (0.02)	-0.002522 (-0.01)
-2	0.002024 (0.09)	0.001793 (0.004)	0.025745 (0.050)	-0.001086 (-0.01)
-1	0.003439 (0.17)	0.008735 (0.02)	-0.011529 (-0.03)	-0.021767 (-0.14)
Treatment	-	-	-	-
1	0.005016 (0.25)	0.005855 (0.02)	0.044565 (0.11)	-0.019941 (-0.12)
2	0.002066 (0.09)	-0.008052 (-0.02)	-0.058887 (-0.13)	-0.012424 (-0.07)
3	0.005636 (0.24)	-0.011623 (-0.03)	-0.056331 (-0.12)	-0.012785 (-0.07)
4	0.005343 (0.23)	0.005395 (0.01)	-0.002304 (0.01)	0.008005 (0.04)
5	0.024994 (1.43)	-0.026862 (0.09)	-0.026099 (-0.08)	0.036335 (0.28)
TWFE	Y	Y	Y	Y
Observations	2,484	2,484	2,435	2,484
Adjusted R2	0.99	0.99	0.97	0.96

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Table A17. Pre-Trends Test, Longer Time Series (1990-2021), With Treatment Year Set At 2008, Wind & Solar Restrictions, (t-Statistics in Parenthesis)

T +/- Years	Population	Employment	Manufacturing Employment	Farm Employment
-5	-0.00157 -(0.12)	-0.00275 (-0.12)	-0.0371 (-0.70)	-0.00165 (-0.09)
-4	-0.00038 (-0.02)	-0.00213 (-0.07)	0.012723 (0.19)	0.008843 (0.36)
-3	0.000751 (0.04)	0.002989 (0.16)	0.013621 (0.20)	-0.00348 (-0.14)
-2	-0.00203 (-0.11)	-0.00119 (-0.04)	-0.0278 (-0.41)	0.006974 (-0.28)
-1	-0.00249 (-0.14)	-0.01101 (-0.39)	0.007705 (0.11)	0.003381 (0.14)
Treatment	-	-	-	-
1	-0.00067 (0.03)	-0.00496 (-0.18)	-0.01705 (-0.25)	0.005033 (0.21)
2	-0.00082 (-0.05)	-0.00395 (-0.14)	0.029803 (0.45)	0.011108 (0.45)
3	-0.00201 (-0.11)	0.004516 (0.16)	-0.00026 (-0.004)	0.009509 (0.39)
4	-0.00294 (-0.16)	-0.00557 (-0.20)	-0.03552 (-0.53)	0.007101 (0.29)
5	-0.01157 (-0.88)	-0.03123 (-1.52)	-0.01727 (-0.35)	0.016679 (0.93)
TWFE	Y	Y	Y	Y
Observations	2,484	2,484	2,435	2,484
Adjusted R2	0.99	0.99	0.97	0.96

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Table A18. Pre-Trends Test, Longer Time Series (1990-2021), With Treatment Year Set At 2010, Wind & Solar Restrictions, (t-Statistics in Parenthesis)

T +/- Years	Population	Employment	Manufacturing Employment	Farm Employment
-5	-0.00022 (-0.13)	-0.00249 (-0.10)	-0.02625 (-0.45)	0.000738 (0.34)
-4	0.000251 (0.01)	-0.00049 (-0.01)	-0.00442 (-0.07)	-0.00051 (-0.02)
-3	-0.00165 (-0.09)	-0.00114 (-0.04)	-0.02064 (-0.31)	-0.00164 (-0.07)
-2	-0.00038 (-0.02)	-0.00213 (-0.08)	0.012721 (0.19)	0.008843 (0.36)
-1	0.000751 (0.04)	0.002989 (0.11)	0.013602 (0.20)	-0.00348 (-0.14)
Treatment	-	-	-	-
1	-0.00249 (-0.14)	-0.01101 (-0.39)	0.007705 (0.12)	0.003381 (0.13)
2	-0.00157 (-0.09)	0.000407 (0.01)	0.017059 (0.26)	0.000884 (0.04)
3	-0.00067 (-0.04)	-0.00496 (-0.18)	-0.01705 (-0.26)	0.005033 (0.21)
4	-0.00082 (-0.05)	-0.00395 (-0.14)	0.029784 (0.45)	0.011108 (0.45)
5	-0.01478 (-1.13)	-0.02775 (-1.35)	-0.04838 (-1.00)	0.030591* (1.70)
TWFE	Y	Y	Y	Y
Observations	2484	2484	2435	2484
Adjusted R2	0.99	0.99	0.97	0.96

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Table A19. Pre-Trends Test, Shorter Time Series (2001-2021), Fiscal and GDP Data, With Treatment Year Set At 2008, Wind & Solar Restrictions, (t-Statistics in Parenthesis)

T +/- Years	Net Levy (Property Tax)	GDP	Gross Assessed Value	Abatement Share
-4	0.043007 (0.23)	0.052804 (0.25)	0.059365 (0.31)	-0.01441 (-0.27)
-3	-0.04342 (0.17)	0.008074 (0.03)	0.014476 (0.06)	-0.025 (-0.36)
-2	-0.13015 (-0.53)	0.00925 (0.03)	0.051775 (0.20)	-0.00109 (-0.02)
-1	0.032073 (0.13)	0.080426 (0.29)	0.061518 (0.24)	0.017667 (0.25)
Treatment	. . .	. . .	. . .	. . .
1	-0.08705 (-0.35)	-0.02927 (-0.11)	-0.05628 (-0.22)	0.001092 (0.02)
2	0.022212 (0.09)	0.01613 (0.06)	-0.06809 (-0.27)	0.054205 (0.79)
3	-0.00118 (0.004)	-0.00051 (-0.002)	-0.04883 (-0.20)	0.002276 (0.03)
4	0.11316 (0.63)	0.031422 (0.16)	0.185874 (1.03)	-0.01865 (-0.38)
TWFE	N	N	N	N
Observations	1194	1196	1192	1192
Adjusted R2	-0.07	-0.0067	0.00106	-0.003

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Table A20. Pre-Trends Test, Shorter Time Series (2001-2021), Selected Employment, With Treatment Year Set At 2008, Wind & Solar Restrictions, (t-Statistics in Parenthesis)

T +/- Years	Transportation Employment	Information Employment	Utility Employment
-4	-0.06138 (-0.25)	0.075001 (0.30)	0.115712 (0.34)
-3	0.001651 (0.01)	-0.07583 (-0.24)	-0.26741 (-0.60)
-2	0.076855 (0.23)	-0.00808 (0.03)	-0.00696 (-0.02)
-1	-0.00786 (-0.02)	-0.04714 (-0.15)	-0.03569 (-0.07)
Treatment	-	-	-
1	-0.04874 (-0.16)	0.004389 (0.014)	0.06103 (0.14)
2	-0.00193 (-0.01)	-0.06707 (-0.21)	-0.1045 (-0.23)
3	-0.08327 (-0.25)	0.091544 (0.29)	0.374895 (0.85)
4	0.24915 (1.02)	0.073156 (0.32)	-0.8517*** (-2.78)
TWFE	N	N	N
Observations	914	1084	686
Adjusted R2	-0.0004	-0.007	0.038794

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Table A21. Pre-Trends Test, Shorter Time Series (2001-2021), Fiscal and GDP Data, With Treatment Year Set At 2010, Wind & Solar Restrictions, (t-Statistics in Parenthesis)

T +/- Years	Net Levy (Property Tax)	GDP	Gross Assessed Value	Abatement Share
-4	0.008366 (0.34)	0.000321 (0.01)	-0.0108 (-0.21)	-0.1637 (-2.33)
-3	9.04E-05 (0.003)	-0.00619 (-0.21)	0.021179 (0.33)	0.150075 (1.74)
-2	-0.00582 (-0.19)	-0.0135 (-0.48)	-0.03793 (-0.60)	-0.0182 (-0.21)
-1	0.009461 (0.31)	0.015424 (0.54)	0.00414 (0.065)	-0.01595 (-0.18)
Treatment	-	-	-	-
1	0.008026 (0.27)	0.006738 (0.24)	0.083548 (1.32)	0.040406 (0.45)
2	-0.02428 (-0.81)	-0.02513 (-0.88)	0.02007 (0.32)	0.024227 (0.28)
3	0.013614 (0.45)	0.009171 (0.33)	-0.04189 (-0.66)	-0.02379 (-0.28)
4	-0.00717 (-0.27)	0.002555 (0.10)	0.10262 (1.88)	0.020238 (0.27)
TWFE	Y	Y	Y	Y
Observations	1194	1196	1192	1192
Adjusted R2	0.99	0.99	0.99	0.05

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

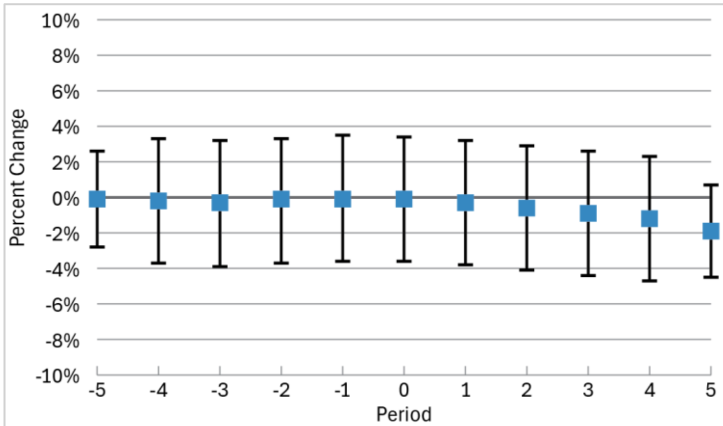
Table A22. Pre-Trends Test, Shorter Time Series (2001-2021), Selected Employment, With Treatment Year Set At 2010, Wind & Solar Restrictions, (t-Statistics in Parenthesis)

T +/- Years	Transportation Employment	Information Employment	Utility Employment
-4	-0.00731 (-0.17)	0.031724 (0.88)	0.107293* (1.99)
-3	0.013821 (0.27)	-0.0079 (-0.18)	-0.00046 (-0.007)
-2	-0.01821 (-0.35)	-0.01883 (-0.42)	-0.07806 (-1.19)
-1	0.003891 (0.08)	-0.00684 (-0.16)	0.022867 (0.35)
Treatment	-	-	-
1	0.009108 (0.17)	0.008119 (0.19)	-0.0146 (-0.21)
2	-0.01206 (-0.23)	-0.01995 (-0.45)	-0.03578 (-0.53)
3	0.012219 (0.24)	-0.00777 (-0.18)	0.052826 (0.85)
4	0.008656 (0.20)	0.011169 (0.30)	-0.00275 (-0.05)
TWFE	Y	Y	Y
Observations	914	1084	686
Adjusted R2	-0.00187	0.988887	0.98

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level.
Our standard errors (in parentheses) are clustered using the two-way cluster technique proposed by Thompson (2011).

Event Study of Wind & Solar Restrictions with Cumulative Effects (Figures A1-A4, with Corresponding Data)

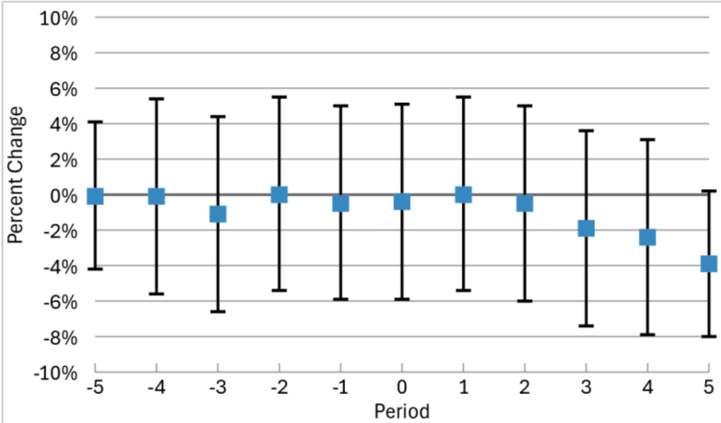
Figure A1. Cumulative Effects on Population (Post-Treatment in 2006)



Year	Point Estimate	Lower Bound (10% C.I.)	Upper Bound (10% C.I.)
-5	-0.001	-0.028	0.026
-4	-0.002	-0.037	0.033
-3	-0.003	-0.039	0.032
-2	-0.001	-0.037	0.033
-1	-0.001	-0.036	0.035
0	-0.001	-0.036	0.034
1	-0.003	-0.038	0.032
2	-0.006	-0.041	0.029
3	-0.009	-0.044	0.026
4	-0.012	-0.047	0.023
5	-0.019	-0.045	0.007

Note: Point estimates with 10% confidence intervals.

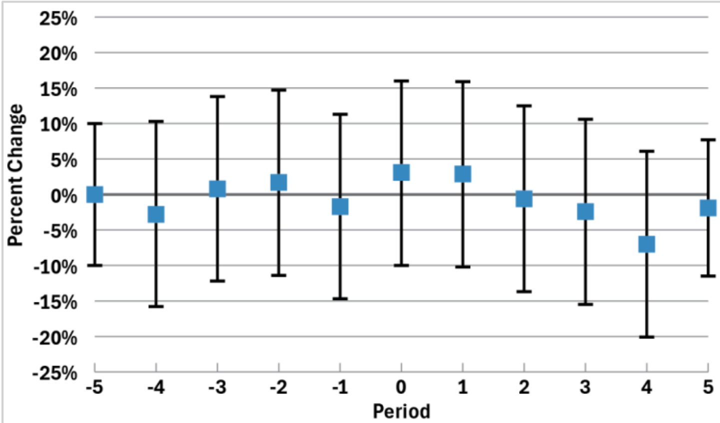
Figure A2. Cumulative Effects on Employment (Post-Treatment in 2006)



Year	Point Estimate	Lower Bound (10% C.I.)	Upper Bound (10% C.I.)
-5	-0.001	-0.042	0.041
-4	-0.001	-0.056	0.054
-3	-0.011	-0.066	0.044
-2	0	-0.054	0.055
-1	-0.005	-0.059	0.05
0	-0.004	-0.059	0.051
1	0	-0.054	0.055
2	-0.005	-0.06	0.05
3	-0.019	-0.074	0.036
4	-0.024	-0.079	0.031
5	-0.039	-0.08	0.002

Note: Point estimates with 10% confidence intervals.

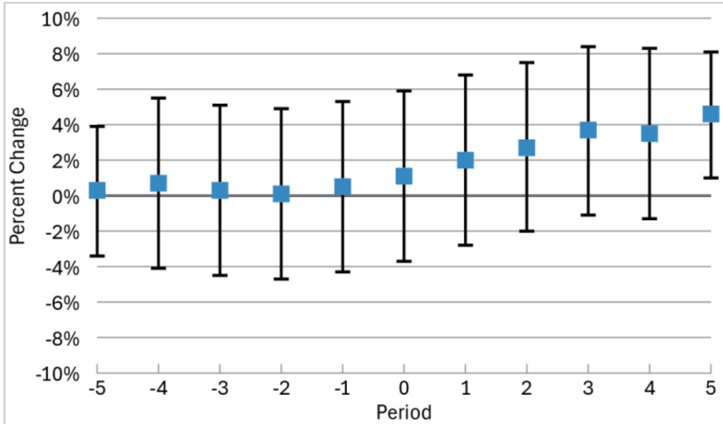
Figure A3. Cumulative Effects on Manufacturing Employment (Post-Treatment in 2006)



Year	Point Estimate	Lower Bound (10% C.I.)	Upper Bound (10% C.I.)
-5	0	-0.1	0.1
-4	-0.028	-0.158	0.103
-3	0.008	-0.122	0.138
-2	0.017	-0.114	0.147
-1	-0.017	-0.147	0.113
0	0.031	-0.1	0.16
1	0.029	-0.102	0.159
2	-0.006	-0.137	0.125
3	-0.024	-0.155	0.106
4	-0.07	-0.201	0.061
5	-0.019	-0.115	0.077

Note: Point estimates with 10% confidence intervals.

Figure A4. Cumulative Effects on Agricultural Employment (Post-Treatment in 2006)

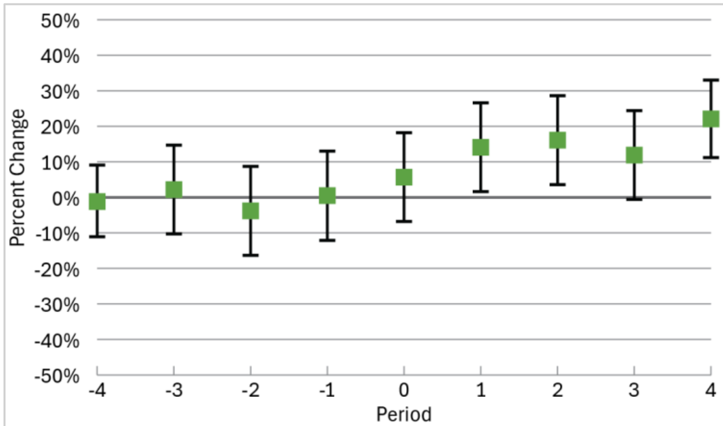


Year	Point Estimate	Lower Bound (10% C.I.)	Upper Bound (10% C.I.)
-5	0.003	-0.034	0.039
-4	0.007	-0.041	0.055
-3	0.003	-0.045	0.051
-2	0.001	-0.047	0.049
-1	0.005	-0.043	0.053
0	0.011	-0.037	0.059
1	0.02	-0.028	0.068
2	0.027	-0.02	0.075
3	0.037	-0.011	0.084
4	0.035	-0.013	0.083
5	0.046	0.01	0.081

Note: Point estimates with 10% confidence intervals.

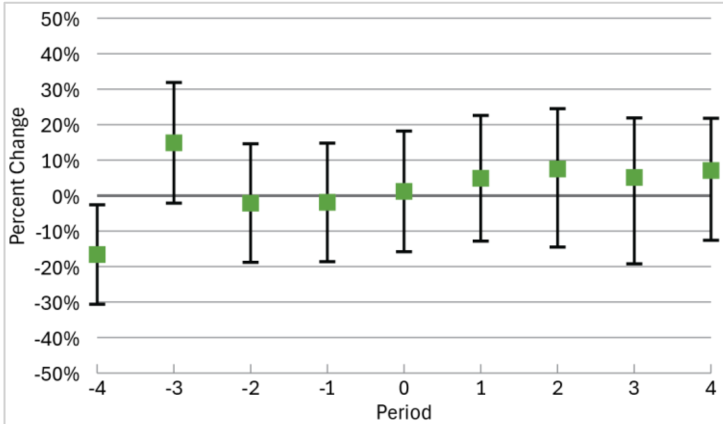
Event Study Effect of Wind & Solar Regulation on Selected Variables in Indiana Counties, 2001-2021 (Figures A5-A8 with Corresponding Data)

Figure A5. Effect on Gross Assessed Value of Business Personal Property



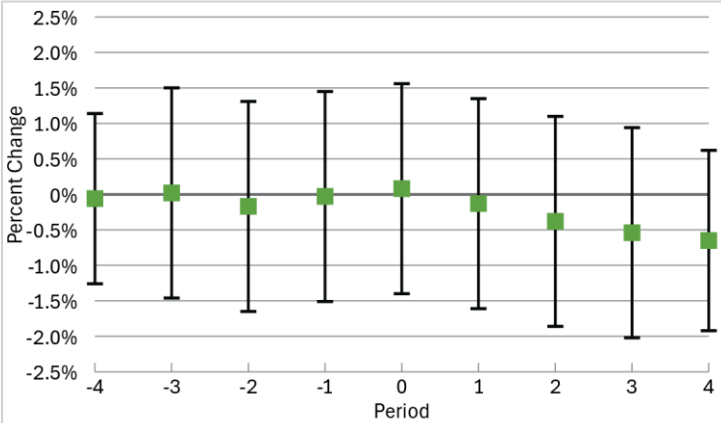
Year	Point Estimate	Lower Bound	Upper Bound
-4	-0.012	-0.111	0.091
-3	0.022	-0.103	0.147
-2	-0.038	-0.163	0.087
-1	0.005	-0.121	0.13
0	0.057	-0.068	0.182
1	0.141	0.016	0.266
2	0.161	0.036	0.286
3	0.119	-0.006	0.244
4	0.221	0.112	0.33

Figure A6. Effect on Abatement Share



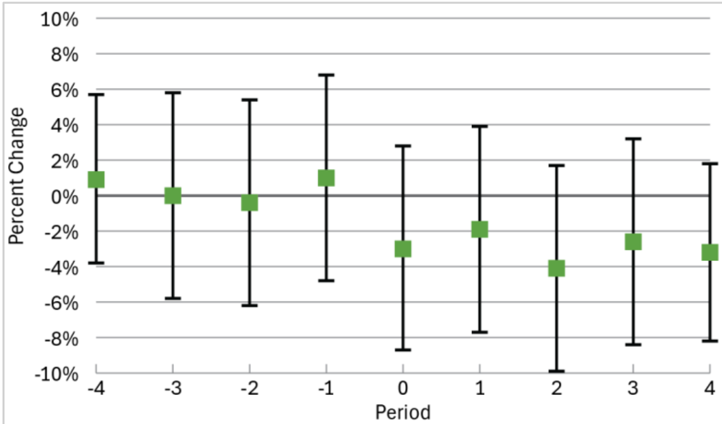
Year	Point Estimate	Lower Bound	Upper Bound
-4	-0.166	-0.306	-0.026
-3	0.149	-0.021	0.319
-2	-0.021	-0.188	0.146
-1	-0.019	-0.186	0.148
0	0.012	-0.158	0.182
1	0.049	-0.128	0.226
2	0.075	-0.145	0.245
3	0.051	-0.192	0.219
4	0.071	-0.126	0.218

Figure A7. Effect on Population



Year	Point Estimate	Lower Bound	Upper Bound
-4	-0.0006	-0.0126	0.0114
-3	0.0002	-0.0146	0.015
-2	-0.0017	-0.0165	0.0131
-1	-0.0003	-0.0151	0.0145
0	0.0008	-0.014	0.0156
1	-0.0013	-0.0161	0.0135
2	-0.0038	-0.0186	0.011
3	-0.0054	-0.0202	0.0094
4	-0.0065	-0.0192	0.0062

Figure A8. Effect on Real Net Levy per Capita



Year	Point Estimate	Lower Bound	Upper Bound
-4	0.009	-0.038	0.057
-3	0	-0.058	0.058
-2	-0.004	-0.062	0.054
-1	0.01	-0.048	0.068
0	-0.03	-0.087	0.028
1	-0.019	-0.077	0.039
2	-0.041	-0.099	0.017
3	-0.026	-0.084	0.032
4	-0.032	-0.082	0.018

Post-Treatment Comparison (Tables A23-A25)

Table A23. Comparison of Differing Post-Treatment Durations for Solar Restrictions, GDP

Solar Restrictions β	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
2001-2021	0.02 (0.73)	0.15 (0.77)	-0.320* (-1.79)	0.17 (0.82)	-0.367* (-1.95)	-0.109 (-0.91)	-0.194 (-0.56)
2001-2019	0.03 (0.78)	0.08 (0.67)	-0.31 (-1.50)	0.17 (0.85)	-0.327*** (-3.92)	-0.067 (-0.78)	-0.177 (-0.47)
2001-2016	0.03 (0.76)	0.05 (0.466)	-0.33471 (-1.109)	0.17 (0.80)	-0.255*** (-3.43)	0.011 (0.28)	-0.13 (-0.39)

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Standard errors denoted in parentheses.

Table A24. Comparison of Differing Post-Treatment Durations for Wind Restrictions, GDP

Wind Restrictions γ	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
2001-2021	0.017 (0.30)	-0.21** (-2.16)	-0.086 (-0.77)	-0.024 (-0.12)	-0.055 (-0.46)	0.047 (0.36)	0.387* (1.82)
2001-2019	0.009 (0.18)	-0.19** (-2.17)	-0.09 (00.86)	-0.05 (-0.38)	-0.049 (-0.82)	0.04 (0.40)	0.437* (1.86)
2001-2016	0.004 (0.08)	-0.17** (-2029)	-0.1219 (-1.27)	-0.10 (-0.46)	-0.018 (-0.330	0.068 (0.65)	0.43* (1.84)

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Standard errors denoted in parentheses.

Table A25. Comparison of Differing Post-Treatment Durations for Both Restrictions, GDP

Both Restrictions δ	Total	Utilities	Durable Goods Manufacturing	Non-Durable Goods Mfg	Information	Transportation & Warehousing	Agriculture
2001-2021	0.01 (0.49)	0.12 (0.76)	-0.108* (2.05)	-0.097 (-0.59)	-0.055 (-0.49)	0.066 (0.90)	0.125 (0.51)
2001-2019	0.014 (0.43)	0.13 (0.79)	-0.109* (-2.06)	-0.09 (-0.75)	-0.031* (-1.08)	0.07 (1.06)	0.11 (0.58)
2001-2016	0.009 (0.29)	0.179 (1.26)	-0.139** (-2.62)	-0.076 (-0.97)	0.008 (0.15)	0.08 (0.06)	0.082 (0.39)

Note: Statistical significance denoted as * at 10% level, ** at 5% level, *** at 1% level. Standard errors denoted in parentheses.

Regulations and Classifications by County (Tables A26-A27)

Table A26. Wind and Solar Energy Land Use Regulations by Indiana County

Source: Tabulations from Ogle and Salazar (2021)

County	Setbacks and Height	Shadow Flicker	Signal Interference	Sound Level Limit	Light Mitigation Technology	Drainage Repair	Decommissioning	No Additional Standards	Category Total
Adams		X	X	X	X	X	X		6
Allen	X							X	2
Bartholomew								X	1
Benton	X		X	X		X	X		5
Blackford	X			X	X	X	X	X	6
Boone								X	1
Brown								X	1
Carroll	X		X	X	X	X	X		6
Cass	X	X	X	X	X	X	X		7
Clark								X	1
Clay								X	1
Clinton	X	X			X	X	X	X	6
Crawford								X	1
Daviess								X	1
Dearborn	X				X	X	X		4
Decatur	X		X	X		X	X		5
DeKalb	X	X	X	X	X	X	X		7
Delaware	X			X		X	X		4
Dubois								X	1
Elkhart								X	1
Fayette	X		X		X	X	X	X	6
Floyd								X	1
Fountain	X	X	X	X	X	X	X		7
Franklin	X	X		X		X	X		5
Fulton	X	X	X	X		X	X		6
Gibson								X	1
Grant	X			X	X		X	X	5
Greene								X	1
Hamilton	X			X	X	X	X		5
Hancock	X		X	X	X	X	X		6
Harrison								X	1
Hendricks	X	X	X	X			X	X	6
Henry								X	1
Howard		X	X	X			X		4
Huntington	X	X		X		X	X		5
Jackson								X	1
Jasper	X	X	X	X	X	X	X		7
Jay	X		X	X		X	X		5
Jefferson								X	1
Jennings								X	1
Johnson	X			X			X		3
Knox	X			X		X	X		4
Kosciusko	X	X	X	X	X	X	X		7
Lagrange	X			X		X	X		4
Lake	X			X			X	X	4

County	Setbacks and Height	Shadow Flicker	Signal Interference	Sound Level Limit	Light Mitigation Technology	Drainage Repair	Decommissioning	No Additional Standards	Category Total
LaPorte	X	X		X	X	X	X		6
Lawrence								X	1
Madison	X			X	X	X	X	X	6
Marion								X	1
Marshall	X						X		2
Martin								X	1
Miami		X		X		X	X		4
Monroe	X					X	X		3
Montgomery	X	X	X	X	X	X	X		7
Morgan								X	1
Newton	X			X		X	X		4
Noble	X	X	X	X	X	X	X		7
Ohio								X	1
Orange								X	1
Owen								X	1
Parke								X	1
Perry								X	1
Pike								X	1
Porter	X	X	X	X	X	X	X		7
Posey	X	X	X	X	X	X	X		7
Pulaski	X			X		X	X		4
Putnam								X	1
Randolph	X		X	X		X	X		5
Ripley									0
Rush	X	X	X	X		X	X		6
Scott								X	1
Shelby	X		X				X		3
Spencer	X			X		X	X		4
St. Joseph	X		X			X	X		4
Starke	X			X		X	X		4
Steuben	X	X	X		X				4
Sullivan								X	1
Switzerland								X	1
Tippecanoe	X					X	X		3
Tipton	X	X	X	X		X	X		6
Union								X	1
Vanderburgh								X	1
Vermillion	X			X			X	X	4
Vigo								X	1
Wabash	X	X	X	X	X	X	X		7
Warren								X	1
Warrick	X					X	X	X	4
Washington								X	1
Wayne								X	1
Wells	X						X		2
White	X		X	X		X	X		5
Whitley	X		X	X	X	X	X		6

Source: Tabulations from Ogle and Salazar (2021)

Table A27. Class 3 Wind Speeds at 50 Meters Elevation by Indiana County

Source: U.S. National Renewable Energy Laboratory (NREL).
Note: Class 3 wind power areas have wind speeds between 14.3 and 15.7 miles per hour at 50 meters elevation.

County	Rated Wind Class 3 @ 50 Meters
Adams	No
Allen	No
Bartholomew	No
Benton	Yes
Blackford	No
Boone	Yes
Brown	No
Carroll	Yes
Cass	No
Clark	No
Clay	No
Clinton	Yes
Crawford	No
Daviess	No
Dearborn	No
Decatur	No
DeKalb	No
Delaware	Yes
Dubois	No
Elkhart	No
Fayette	No
Floyd	No
Fountain	No
Franklin	No
Fulton	No
Gibson	No
Grant	Yes
Greene	No
Hamilton	Yes
Hancock	No
Harrison	No
Hendricks	Yes
Henry	No
Howard	Yes
Huntington	No
Jackson	No
Jasper	Yes
Jay	No
Jefferson	No
Jennings	No
Johnson	No
Knox	No
Kosciusko	No
Lagrange	No
Lake	No
LaPorte	No
Lawrence	No
Madison	Yes

County	Rated Wind Class 3 @ 50 Meters
Marion	No
Marshall	No
Martin	No
Miami	No
Monroe	No
Montgomery	Yes
Morgan	Yes
Newton	Yes
Noble	No
Ohio	No
Orange	No
Owen	No
Parke	No
Perry	No
Pike	No
Porter	No
Posey	No
Pulaski	No
Putnam	No
Randolph	Yes
Ripley	No
Rush	No
Scott	No
Shelby	No
Spencer	No
St. Joseph	No
Starke	No
Steuben	No
Sullivan	No
Switzerland	No
Tippecanoe	Yes
Tipton	Yes
Union	No
Vanderburgh	No
Vermillion	No
Vigo	No
Wabash	No
Warren	Yes
Warrick	No
Washington	No
Wayne	No
Wells	No
White	Yes
Whitley	No

Source: U.S. National Renewable Energy Laboratory (NREL).

Note: Class 3 wind power areas have wind speeds between 14.3 and 15.7 miles per hour at 50 meters elevation.