Aerospace Place-Based Policy: The Impact of Boeing on South Carolina's Aerospace Industry

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Abstract

South Carolina offered Boeing nearly $1 billion to locate a 787 Dreamliner assembly plant in North Charleston, which opened in 2011. Using difference-in-differences and synthetic difference-in-differences estimators, I find a substantial impact of the plant on South Carolina's aerospace employment (311 percent or 6,000 jobs), wages (10 percent), and establishments (44 percent) in the subsequent decade. The estimated number of aerospace jobs generated by the plant exceeds Boeing's 3,800 promised jobs. However, much of the state's aerospace establishment growth does not appear to be directly related to the Boeing plant, with most of it occurring in the Upstate region (Greenville, Spartanburg) late in the treatment period. An analysis of the Charleston metropolitan area's economy reveals a five-year local employment multiplier of 2.6 per promised job.

Keywords: Aerospace Manufacturing, Location Choice, Regional Economic Development.

JEL Codes: R11, R58, L62.

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1 Introduction

U.S. state and local governments have long utilized subsidies to attract employers within their administrative boundaries, a strategy referred to by economic development professionals as industrial recruitment. The effectiveness of this strategy in regard to firm recruitment (Bartik, 2018), efficiency (Mast, 2020), job creation (Bartik, 2018; Slattery & Zidar, 2020), and local productivity (Greenstone et al., 2010; Patrick & Partridge, 2022) has been widely studied and debated within the literature. Manufacturing plants have traditionally received large incentive packages from governments, with assembly plants being particularly valuable due to their reliance on suppliers of individual components. Policymakers tend to push for the recruitment of plants that have the ability to attract upstream suppliers, thus creating even more indirect jobs for their jurisdiction (Adams, 2016). Furthermore, economic research on the benefits of industry clusters has resulted in state and local governments justifying their recruitment efforts of firms within traded industries (e.g., aerospace, advanced manufacturing, biotechnology) that might evolve into clusters (CMU, 2002). Clusters are "geographic concentrations of firms, suppliers, support services, specialized infrastructure, producers of related products, and specialized institutions that arise in particular fields in particular locations" (Porter, 1998, p. 1).

One prominent economic development initiative to promote clustering through industrial recruitment was South Carolina's successful bid to obtain BMW's first manufacturing facility outside of Germany in 1992. With a \$150 million incentive package, South Carolina outbid 250 other locations to secure the facility for Greer, which opened in 1994. Adams (2016) found that the plant's establishment was followed by a 68 percent increase in automotive supplier employment within the Spartanburg region. As of 2018, the plant employed 11,000 workers and upstate South Carolina's automotive cluster consisted of 232 automotive-related suppliers (Korn, 2019; Donahue et al., 2018). Nearly 20 years after its BMW bid, South Carolina offered Boeing an incentive package to locate a 787 Dreamliner final assembly and delivery facility in North Charleston. Estimates of the total incentive package vary between \$800 million and \$1 billion and include subsidies, tax breaks, tax credits, and a state-funded worker training program (Seattle Times, 2010). The North Charleston facility (Boeing South Carolina) opened in 2011 (Boeing, 2022). As of January 2022, Boeing employed 5,521 people in South Carolina implying a cost to the state of between $145,000-180,000 per direct job created over the past ten years (Williams, Emily, 2022). However, the Boeing facility may have brought indirect economic benefits to the state through an increase in supplier and related firms (and their employees) within its aerospace industry.

This article analyzes the impact of Boeing South Carolina on aerospace firms, employees, and wages ten years after the assembly plant's opening. Following the empirical approaches of Greenstone et al. (2010) and Adams (2016), I use a matched runner-up differences-in-differences design that compares changes in South Carolina's aerospace industry to five states identified as finalists but each of which failed to obtain the 787 Dreamliner assembly plant: California, Kansas, North Carolina, Texas, and Washington. Since Boeing's location decision was presumably made to maximize profits, this type of control group is necessary as South Carolina is likely to differ from an average or randomly chosen state in factors that will affect the plant's productivity and profit potential (e.g., transportation infrastructure, quality of workforce, presence of input suppliers) (Greenstone et al., 2010). The identifying assumption is that the aerospace industries in the losing states form a valid counterfactual for that of South Carolina after conditioning on differences in preexisting trends, state fixed effects, and year fixed effects. I also run a synthetic difference-in-differences analysis with an expanded donor pool of control states in order to better match the pre-treatment trends of aerospace employment and establishments. My study is the first ever ex post economic impact evaluation of South Carolina's Boeing 787 plant.

The estimated impact of Boeing South Carolina on aerospace wages is 10 percent in the ten-year period after the plant's opening. Additionally, aerospace establishments grew 44 percent. However, most aerospace establishment growth in South Carolina occurred late in the treatment period and in the Upstate region of the state (about 200 miles away from North Charleston) casting doubt on whether these firms located in state due to Boeing or other factors (e.g., low unionization rate statewide, existing automotive cluster in Upstate South Carolina). The employment impact is estimated to be 311 percent or roughly 6,000 jobs, which exceeds Boeing's 3,800 promised jobs. I also conduct an analysis of Boeing's impact on the Charleston Metro Area using U.S. Census' County Business Patterns data, where controls are identified by those having pre-treatment aerospace employment industry location quotients greater than two. The metro-level analysis estimates a 2.6 local employment multiplier per promised job.

1.1 Literature Review

Place-based policies refer to government efforts to spur economic activity in targeted areas, where the intended outcomes tend toward more job opportunities and higher wages for incumbent residents (Neumark & Simpson, 2015). Early U.S. place-based policies took the form of industrial recruitment strategies which attempted to lure large employers to selected localities with tax incentives. This likely began with Alexander Hamilton's pitch to Congress for "bounties" to encourage manufacturing innovation in the late-eighteenth century and his subsequent establishment of Paterson, New Jersey, as a national hub of industry centered on the power potential of the Great Falls (Katz & Lee, 2011; Rojas, 2018). However, the modern practice of industrial recruitment did not become widely prominent as an economic development strategy until the 1930s (Deller & Goetz, 2009). Since Mississippi's Balance Agriculture with Industry (BAWI) program passed in 1936, which allowed local government to sell bonds to develop manufacturing facilities for private enterprise, manufacturing recruitment has been a key industrial policy for state governments throughout the U.S. South (Cobb, 1993; Freedman, 2017). Beyond its tendency to provide government subsidies, the region has become a desirable location for domestic firms considering the relocation or establishment of plants (usually from the Northeast or Midwest) as well as international firms due to the region's low unionization rates, business-friendly labor laws, and ample supply of low-wage labor (Cobb, 1993).

As a result of industrial recruitment's drawbacks as well as findings from Birch (1981) suggesting that smaller firms drove most of U.S. job creation, a second wave of economic development policy emerged in the early 1980s that focused on retaining and growing smaller firms in blighted areas. Enterprise Zones are an example of such a policy in that they rely on tax incentives to local firms for hiring, capital investment, and facility expansion. Neumark & Simpson (2015) notes that these zones have been designated in at least 40 states in one form or another, as well as at the federal level, since the 1970s. Evidence of their effectiveness at job creation and poverty reduction is mixed (Neumark & Simpson, 2015; Neumark & Young, 2019).

An ongoing research question in the economic development literature is whether incentives are effective recruitment tools or firms are simply locating in the same areas they would have chosen had they not received the incentives. Bartik (2018) suggests that typical government incentives tip between 2 percent and 25 percent of targeted firms toward their ultimate location choice, implying that at least 75 percent of the firms would have made the location decision without the incentive. Mast (2020) suggests that competition between jurisdictions results in tax reductions for mobile firms but does not improve the efficiency of business location. Cobb (1993) is ambivalent about the South's history of industrial recruitment. The author argues that Southern officials perpetuated the South's deficiencies by often selling to the lowest bidder, thus gaining low paying and slow growing firms, while acknowledging that "there is no evidence that the South's economy would have grown more rapidly had industry not received concessions and tax exemptions" (p. 63). Regarding the employment effects of incentive-winning firms, Bartik (2018) suggests that the job multiplier effect, how many additional jobs result from the creation of one new job, ultimately determines whether these incentives end up being cost-effective for jurisdictions and their local taxpayers. Slattery & Zidar (2020) study firm incentives across eight states from 2002 through 2017 and do not find evidence of broader economic growth at the state or local levels: "although these incentives are often intended to attract and retain high-spillover firms, the evidence on spillovers and productivity effects of incentives appears mixed" (p. 91).

Researchers have investigated whether large manufacturing firms that ultimately receive state incentives to relocate might benefit other firms of the same industry in their jurisdiction through positive externalities, or an agglomerative effect. Positive externalities might occur through knowledge spillovers, labor market pooling, and input sharing and ultimately result in higher productivity for all local manufacturing firms (Rosenthal & Strange, 2001;

Greenstone et al., 2010). By comparing counties that ultimately won plants to those that offered incentives but lost their bids, Greenstone et al. (2010) find that large manufacturers that are attracted through recruitment competition result in large productivity spillovers for winning counties' existing firms due to agglomeration spillovers. However, Patrick & Partridge (2022) utilize a similar framework and find little evidence that the average highly incentivized large plant generates significant productivity spillovers.

A related field of research has examined the benefits of clusters. The relationships between these organizations include those between suppliers of raw materials and producers, producers and customers, and universities that supply skilled labor to local firms. Doeringer & Terkla (1995) argue three reasons why firms of different industries cluster together: collaboration economies through production channels, transfers of knowledge through labor market relationships, and partnerships with governments and unions. Delgado et al. (2016) finds that successful clusters can result in higher regional growth of employment, wages, establishments, and patents. However, Duranton (2011) suggests that despite the very large economic benefits that accrue to certain clusters (e.g. Silicon Valley's Tech Cluster), viable strategies for achieving successful clusters through policy remain ambiguous since "this intermediate outcome [clustering] is only weakly related to the final prosperity outcomes that local policymakers should be interested in [local earnings and productivity]".

The literature on the location choice decisions of automotive parts suppliers suggests that supplier firms are more likely to locate near assembly plants and other parts suppliers (Smith & Florida, 1994; Klier & McMillen, 2008). However, Adams (2016) finds only small changes in supplier employment (500 jobs on average) near new assembly plant sites within five years of opening. Historically, aerospace assembly plants and their suppliers tended to cluster within the same region such that supply chains were very short (e.g., Toulouse, Seattle, Southern California), but over the past several decades the industry has begun to utilize more complex and globalized supply chains (Hickie & Hickie, 2021; Kaglic, 2014). Kaglic (2014) suggests that since South Carolina is competing globally to bring suppliers to the state the 787 assembly plant's potential impact on supplier firms and employment will likely be diluted, and finds a weak early impact on statewide aerospace establishments.

1.2 Background on Boeing South Carolina

Global civil aircraft manufacturing is a duopoly between U.S.-based Boeing and its European counterpart Airbus, although the former has typically held the majority market share since the 1990s (Kuker, 2011). Both companies have historically benefited from substantial subsidies from their respective governments, which have allowed each of them to expand research and development as well as production.[1] These subsidies led to a seventeen year dispute between the companies at the World Trade Organization with each arguing that the other's subsidies enabled them to lower their costs, win sales, and unfairly improve market share (Brunsden et al., 2021; Kuker, 2011).

In the midst of the "Airbus-Boeing Dispute," South Carolina offered Boeing an incentive package to locate a 787 Dreamliner final assembly and delivery facility in North Charleston. Estimates (*Seattle Times*, 2010) of the total incentive package vary between $800 million and $1 billion and include:

- $270 million in upfront money from the state
- $356 million in property-tax breaks
- $47.5 million in state corporate tax credits
- $33 million for a state-funded worker-training program
- $100 million in further property-tax breaks related to the Dreamliner aircraft that fly 787 airplane sections in and out of North Charleston.

The incentive package was officially codified into South Carolina state law in 2009 with the passage of House Bill 3130 which granted certain tax exemptions and economic development bonds to taxpayers who create 3,800 full-time jobs and invest a minimum of $750 million in the state (Kuker, 2011). In October 2009, Boeing announced that it would place its second 787 assembly line in North Charleston [2], which came over a year after the company

[1] Boeing has received subsidies from NASA, the Department of Defense, and the state governments of Washington, Kansas, Illinois, and South Carolina. Airbus has received subsidies from France, Germany, Spain, and the United Kingdom (Kuker, 2011).

[2] Boeing's first 787 assembly line was located at its factory in Everett, Washington.

had started buying and consolidating existing 787 parts suppliers in the region (Boeing, 2009b; AP, 2008; Boeing, 2009a; Kaglic, 2014). The 2009 announcement to locate the plant in North Charleston came roughly a year after a 57-day work stoppage at its Everett-WA manufacturing plant cost the company over $1 billion in lost profits (Kaglic, 2014). The machinists union through the National Labor Relations Board unsuccessfully pursued legal action against Boeing as they contended that the location of the plant to South Carolina (and away from Washington), which has a low unionization rate due to its right-to-work law, was retaliation for the 2008 strike (Greenhouse, 2011).

2 Data

My source for aerospace employment, wages, and establishments is the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW). I use the North American Industry Classification System (NAICS) code of 3364, Aerospace Product and Parts Manufacturing, as my definition for the aerospace industry. This industry grouping includes the Boeing 787 assembly plant itself, which falls under 336411 — Aircraft Manufacturing, as well as its primary parts suppliers and related aerospace firms: 336412 — Aircraft Engine and Engine Parts Manufacturing, 336413 — Other Aircraft Parts and Auxiliary Equipment Manufacturing, 336414 — Guided Missile and Space Vehicle Manufacturing, 336415 — Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing, and 336419 — Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing. For every county and state, QCEW quarterly reports the number of establishments, the monthly number of employees, and the average weekly wage. I take the average across quarters for each calendar year for each of the three variables at the state level. I conduct my analysis at the state level since QCEW censors variables at the county level for confidentiality reasons when there are few establishments present. Additionally, the losing candidate sites used as the control group are identified by Boeing and the media at the state level. The panel for establishments, employment, and wages runs from 2005 to 2021, and I use it to analyze the impact of Boeing's North Charleston 787 assembly plant announced in 2009.

Table 1: Aeropsace Employment at and after Boeing Location Decision

State	Employment at announcement (2009)	Employment growth (%) after 5 years (2014)	Employment growth (%) after 10 years (2019)
South Carolina	1,917	265	285
California	70,783	0.3	10
Kansas	37,463	-18.6	-11.4
North Carolina	3,701	49.6	82.3
Texas	48,141	-7.2	2.6
Washington	82,920	13.2	6.7

Source: QCEW. Figures reflect annual average employees in NAICS 3364 establishments.

Table 2: Aerospace Wages (Nominal) at and after Boeing Location Decision

State	Wage ($) at announcement (2009)	Wage growth (%) after 5 years (2014)	Wage growth (%) after 10 years (2019)
South Carolina	1,316	34.6	46.2
California	1,737	11	23
Kansas	1,296	11.7	16.7
North Carolina	1,635	10.9	4
Texas	1,614	13.2	33.3
Washington	1,691	25.1	35.6

Source: QCEW. Figures reflect average weekly wages in NAICS 3364 establishments.

Table 3: Aerospace Establishments at and after Boeing Location Decision

State	Establishments at announcement (2009)	Establishment growth (%) after 5 years (2014)	Establishment growth (%) after 10 years (2019)
South Carolina	24	17	106
California	633	-7.7	-0.7
Kansas	147	5.6	6.5
North Carolina	49	1.5	-13.8
Texas	235	-8.2	-0.3
Washington	196	-5.8	1

Source: QCEW. Figures reflect annual averages of quarterly NAICS 3364 establishments.

My analysis will use the losing candidate states in Boeing's site selection process as the control group for South Carolina as in Greenstone et al. (2010) and Adams (2016). These losing candidate states are identified in media accounts as California, Kansas, North Carolina, Texas, and Washington (AP, 2009).[3] In the year that South Carolina was selected for the 787 assembly plant site, the state's aerospace industry was outranked by its control states with regard to employment levels, average weekly wages, and the number of establishments. Table 1 provides aerospace employment counts for South Carolina and the five control states in the year of the site announcement as well as their respective five year and ten year growth rates afterwards. In both the five- and ten-year periods after the site announcement, South Carolina's growth rate far exceeded its five controls'. Table 2 shows that wages in South Carolina's aerospace industry grew far above the control states on both horizons. Lastly, Table 3 shows that aerospace establishments grew faster than in control states after the site announcement. While most growth with respect to employment and wages occurred in the five years after the site announcement, the growth in aerospace establishments came between 5 and 10 years after. This contrasts with control states that experienced negative to flat establishment growth over the same period.

3 Methods

My main results use two specifications: a difference-in-differences model and a dynamic difference-in-differences (event study) model. The difference-in-differences model allows me to identify an average treatment effect of the Boeing 787 assembly plant opening on South Carolina's aerospace industry:

$$y_{it} = \alpha_i + \delta_t + \beta D_{it} + \epsilon_{it}. \tag{1}$$

The dependent variable is the natural log of employment, average weekly wages, and establishments in the aerospace industry for state i, $i = 1, ..., 6$, and year t, in which $t = 2005, ..., 2021$.The state and time fixed effects are denoted by α_i and δ_t, respectively, and

[3]However, Boeing narrowed their candidate states to South Carolina and Washington in the final round of the selection process (AP, 2009).

the dummy variable D_{it} equals one from 2010 onward for South Carolina (the first full year after the location decision was announced), and zero otherwise. Therefore, the treated area is South Carolina and the control group is California, Kansas, North Carolina, Texas, and Washington. The state effects control for unobserved state-specific economic characteristics that are time-invariant, while the time effects capture common trends that are experienced by all states (e.g., the U.S. business cycle). I cluster standard errors at the state level in each model.

I also utilize a generalized difference-in-differences approach which allows the inclusion of lead and lagged effects so that I may explore how the impact of the assembly plant changed over my treatment horizon.

$$y_{it} = \alpha_i + \delta_t + \sum_{j=-5}^{11} (treated_i * d_j) + \epsilon_{it}. \tag{2}$$

The generalized difference-in-differences model also controls for time and state fixed effects and clusters standard errors at the state level. The leads and lags in equation 2 are dummy variables set to one for South Carolina and zero for the control states.

4 Results

4.1 Difference-in-Differences

The results from my difference-in-differences are presented in Table 4, which suggest a positive treatment effect of the Boeing assembly plant on South Carolina's aerospace industry. My results suggest that the plant resulted in a 563 percent[4] However, the results from my dynamic difference-in-differences model in Figure 1 suggest that the parallel trends condition is not met for the employment or establishment models since several of the lead coefficients in each of the two models are statistically significant from their control groups. These statistically significant lead coefficients indicate that the employment and establishment levels

[4] I use the formula $100 * (e^{\beta} - 1)$ to obtain the percentage increase treatment effect for each logged transformed variable from coefficient β. increase in employment, a 10 percent increase in wages, and a 145 percent increase in establishments.

in the control group were much higher than South Carolina's in the pre-treatment period which is likely resulting in biased treatment effects for those two models. This finding is consistent with most of the control states' aerospace industries (except for perhaps North Carolina) having established aerospace industries. However, the parallel trends condition appears to not be violated for the wage model. In order to address the potential bias arising from the parallel trends violation for the employment and establishments models, I run synthetic difference-in-differences models on those dependent variables.

Table 4: Difference-in-Differences Results for SC's Aerospace Industry (NAICS 3364)

	Employment	Wages	Establishments
D	1.892***	0.092*	0.897***
	(0.132)	(0.024)	(0.071)
N	102	102	102
R^2	0.815	0.888	0.620

Standard errors in parentheses. Source: QCEW.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.2 Synthetic Difference-in-Differences (SDiD)

I run the Arkhangelsky et al. (2021) synthetic difference-in-differences (SDiD) estimator to allow for potentially different pre-trends among the treated and control units for the employment and establishment models. Additionally, I expand the donor pool of the control units to all U.S. states with available aerospace employment, establishment, and wage series.[5] The donor pool expansion addresses the potential confounding issue that the runner-up states' aerospace industries were affected by South Carolina's treatment due to Boeing's existing plants in four (California, Kansas, Texas, Washington) of the five states. it seems especially plausible that Boeing's existing 787 assembly plant in Washington redirected jobs to South Carolina during the treatment period. The SDiD estimator optimizes the selection of a comparison group for South Carolina by re-weighting the state and time weights in

[5]The SDiD analysis excludes 13 states without available series due to censoring: Alaska, Delaware, District of Columbia, Hawaii, Iowa, Louisiana, Maine, Minnesota, North Dakota, Rhode Island, South Dakota, Vermont, and Wyoming.

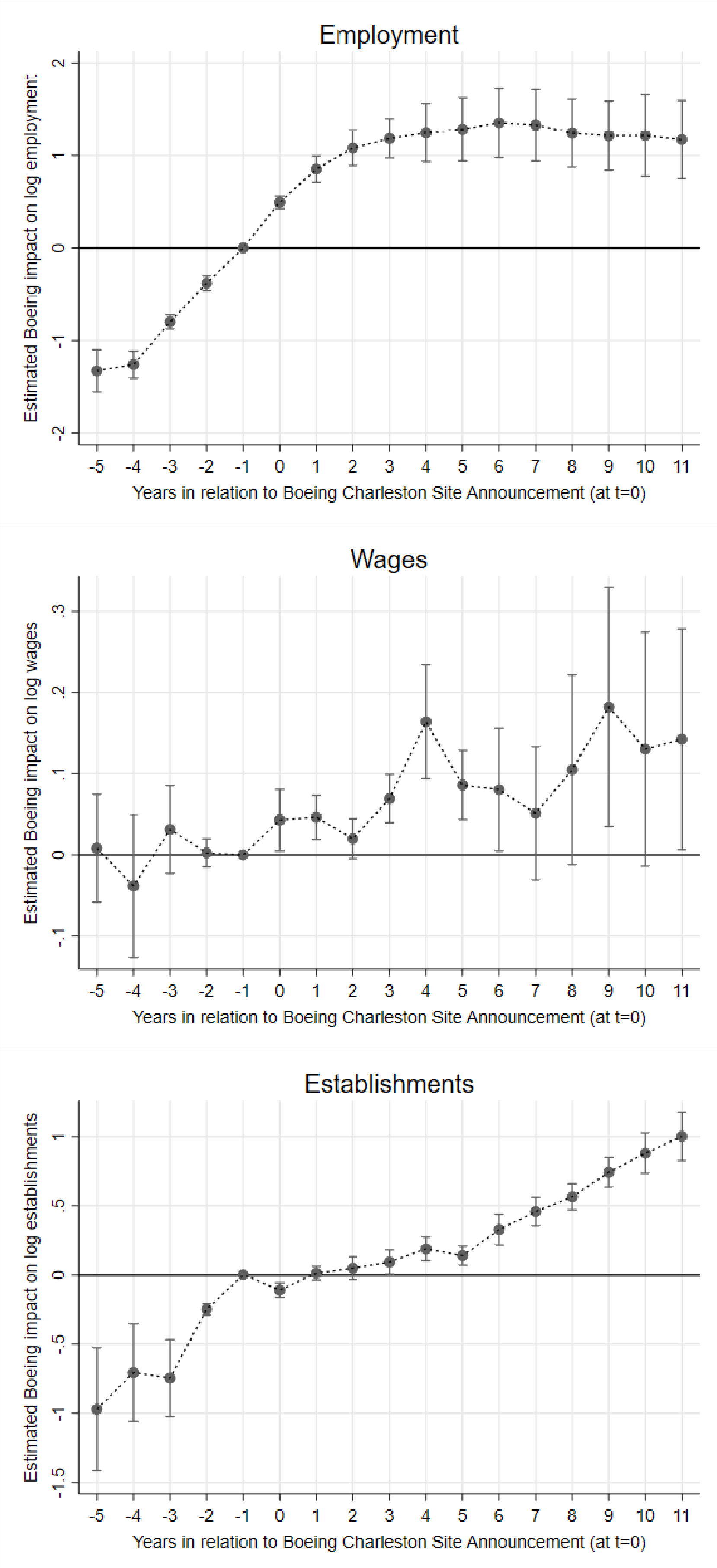

Figure 1: Lead and Lag Effects of the Boeing Assembly Plant Announcement. Black dots represent point estimates and vertical lines are 95% confidence intervals of plant's impact on employment, wages, and establishments at the year of announcement (t=0 represents year 2010).

Equation 1 by pre-treatment observable characteristics[6] This method forces pre-treatment outcomes for control units to be approximately parallel to pre-treatment outcomes for the treated unit on average such "the average post-treatment outcome for the control units will differ by a constant amount from the weighted average of the pre-treatment outcomes for the same control units" (Arkhangelsky et al., 2021, pp.4090). The SDiD standard errors are constructed using the placebo method, which is recommended to minimize Type-I error when the number of treated units is small (Cunningham, 2021). The placebo method estimates treatment to each of the control units in the donor pool, places each in a vector, and calculates its variance.

We report the outcome trends for the two models in Figure 2 and the SDiD treatment effects, compared against the likely-biased difference-in-differences estimates, in Figure 3. The parallel trends assumption does not appear to be violated in the establishment model (right), but may still be violated in the employment model (left). However, the pre-treatment trends are better matched by the counterfactuals than in the difference-in-differences estimates.

The differences between the standard and synthetic difference-in-differences models in Figure 3 suggest that differential pre-trends resulted in upward biases in the former models for employment and establishments. The SDiD coefficient estimator suggests a 311 percent increase in employment compared to the simple differences in differences estimate of 563 percent. Additionally, the SDiD estimator indicates a 44 percent positive treatment effect for establishments compared to the simple difference-in-differences estimate of 145 percent. I therefore disregard the likely biased difference-in-differences estimates for aerospace employment and establishments in favor of using the SDiD estimates as upper-bound Boeing treatment effects.

4.3 Metro-Level Analysis

While the state-level analysis can aid in the assessment of the Boeing plant's impact on South Carolina's aerospace industry, it would also be helpful to know how the plant affected its

[6] The selected donor areas with nonzero weights for the SDID employment estimator are Idaho (76%) and Nevada (24%). The nonzero donor weights for the SDID establishment estimator are Kentucky (4%), New Mexico (17%), and North Carolina (79%).

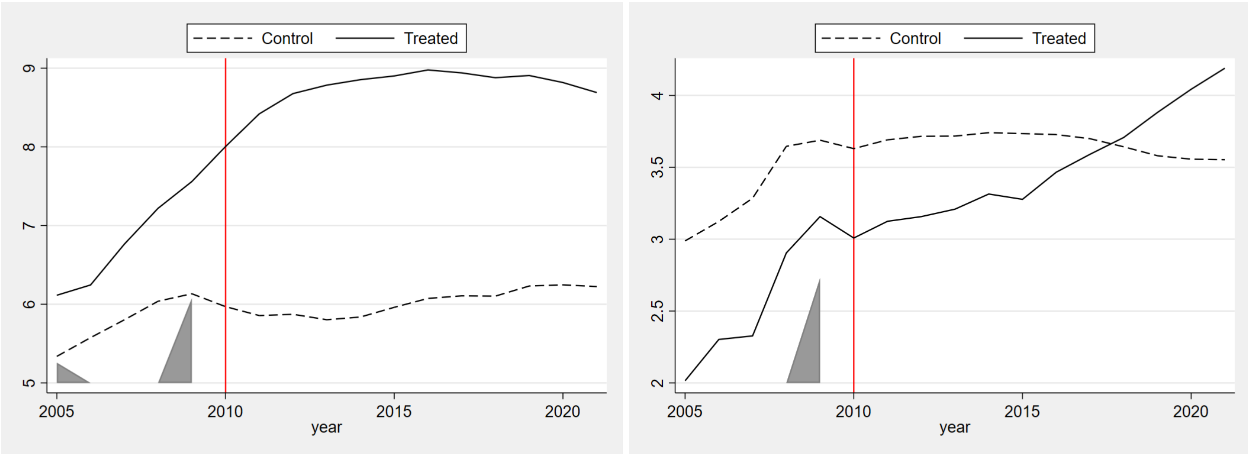

Figure 2: Synthetic Difference-in-Differences Outcome Trends for South Carolina's aerospace employment (left) and establishments (right)

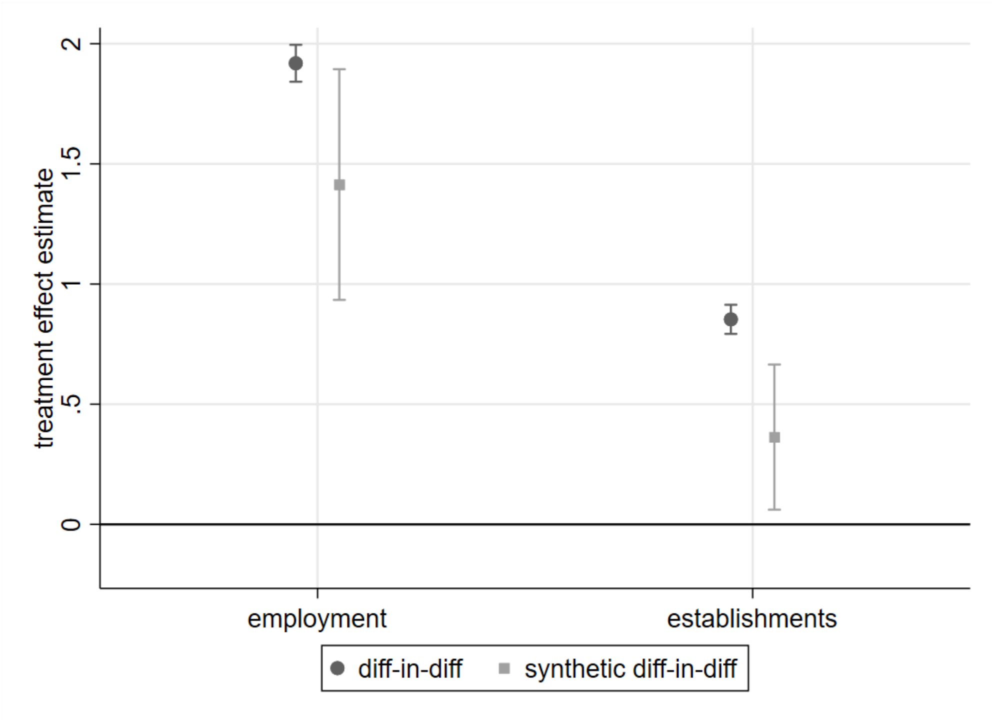

Figure 3: Point estimates and 95% confidence intervals of the simple and synthetic diff-in-diff models for employment and establishments

local area beyond its own industry. In order to assess the local impact of North Charleston's 787 plant, I run difference-in-differences and generalized difference-in-differences models at the metro level. These models should capture any local multiplier effects arising from the plant, or in other words, the degree to which Boeing employees' spending in the community created jobs or increased wages in the Charleston Metro Area.

I use data from the U.S. Census' County Business Patterns at the metropolitan statistical area (MSA) level on employment and wages from 2007 through 2021. My employment variable is "Total Mid-March Employees," and wages is measured as the average weekly wage series which is constructed by dividing the quotient of "Total First Quarter Payroll" to "Total Mid-March Employees" by thirteen. I run models on employment and wages at the three-digit NAICS level (336 - Transportation Equipment Manufacturing), two-digit NAICS level (31 - Manufacturing), and across all industries.

My analysis uses the equations 1 and 2 for the difference-in-difference and generalized difference-in-differences models respectively. While the time units are years ranging from 2007 through 2021 with 2011 as year of treatment, the area units of analysis are metropolitan statistical areas. The treated unit is the Charleston-North Charleston-Summerville, South Carolina MSA. All standard errors are clustered at the MSA level. The control units are identified as MSAs that had a location quotient[7] of at least two in 2010 for Aerospace Product and Parts Manufacturing (NAICS 3364). I run models to assess the five- and ten-year impacts of the Boeing plant. Therefore, my controls are identified as metro areas that had twice the concentration of the U.S. in aerospace product and parts manufacturing in 2010. Therefore, the identifying assumption is these metro areas with high concentrations of aerospace parts manufacturing form a valid counterfactual for the Charleston MSA after conditioning on differences in preexisting trends, MSA fixed effects, and year fixed effects. I am able to identify eleven control MSAs with available data, which are: Chambersburg-Waynesboro, PA, Cincinnati, OH-KY-IN, Columbus, GA-AL, Dallas-Fort Worth-Arlington, TX, Muskegon-Norton Shores, MI, Palm Bay-Melbourne-Titusville, FL, Phoenix-Mesa-Scottsdale, AZ, Rockford, IL, San Diego-Carlsbad, CA, Tulsa, OK, Wichita, KS. Three of the eleven metro areas in my control group are in runner-up states for the Boeing 787 plant (Dallas, San Diego, Wichita).

The results from my generalized difference-in-differences models are presented in Figure 4. The results do not indicate issues with the common trends assumption such that no leads are significantly different from zero. My results from the five-year impact models at the metro level are presented in Table 5. These results suggest that transportation

[7] A location quotient is a ratio that measures an area's industrial concentration relative to the nation.

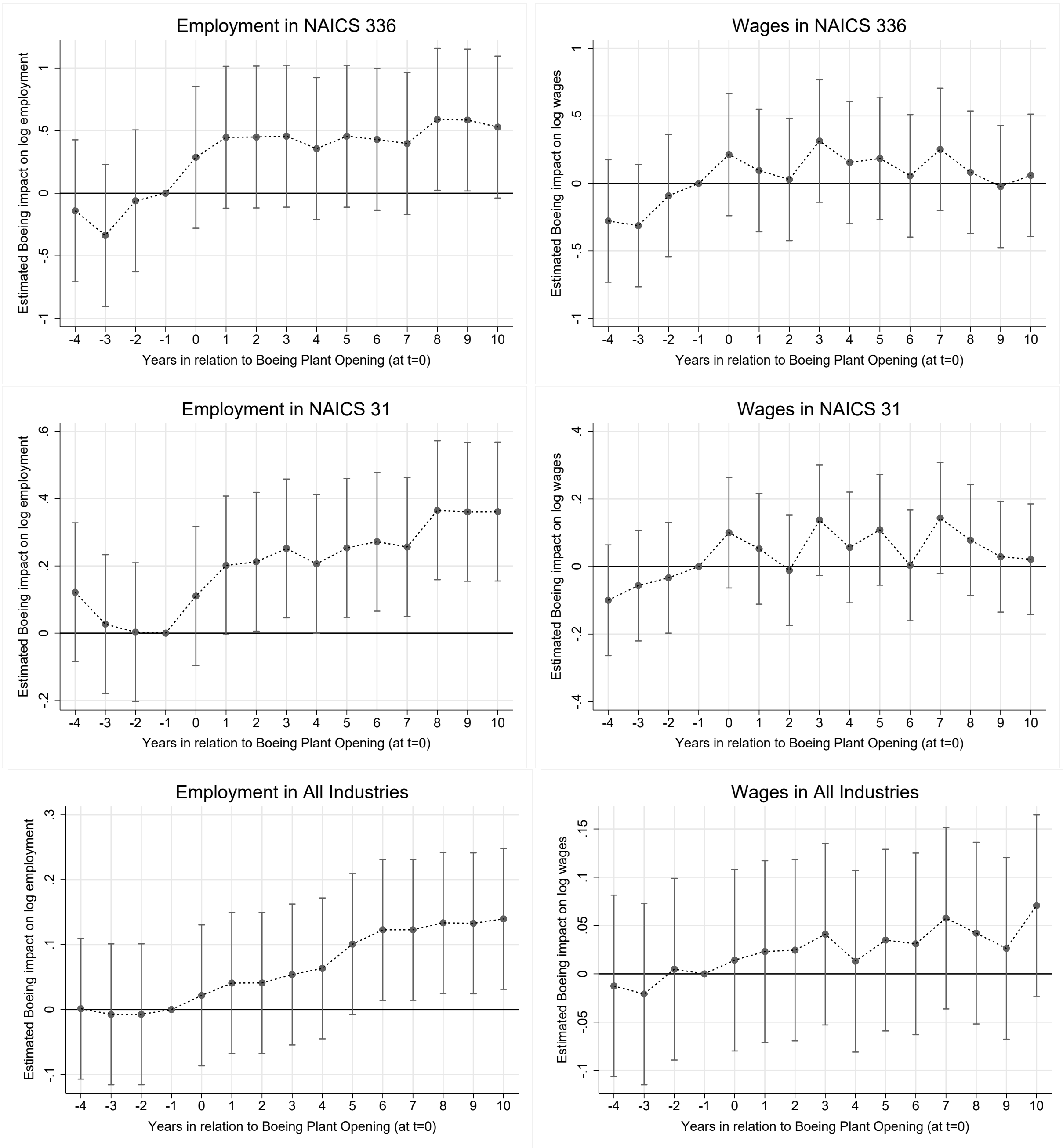

Figure 4: Metro-Level Generalized Difference-in-Differences Results for Employment and Wages, 3-Digit NAICS (top), 2-Digit NAICS (middle), and All Industries (bottom)

Table 5: Difference-in-Differences MSA 5-Year Results

	Emp (3-Digit)	Wages (3-Digit)	Emp (2-Digit)	Wages (2-Digit)	Emp (All)	Wages (All)
D	0.543***	0.336***	0.168***	0.121***	0.057***	0.032**
	(0.066)	(0.038)	(0.021)	(0.015)	(0.011)	(0.008)
N	120	120	120	120	120	120
R^2	0.006	0.07	0.0001	0.306	0.0001	0.174

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Difference-in-Differences MSA 10-Year Results

	Emp (3-Digit)	Wages (3-Digit)	Emp (2-Digit)	Wages (2-Digit)	Emp (All)	Wages (All)
D	0.587***	0.30***	0.221***	0.113***	0.092***	0.042**
	(0.072)	(0.031)	(0.025)	(0.015)	(0.015)	(0.012)
N	180	180	180	180	180	180
R^2	0.01	0.153	0.002	0.46	0.0004	0.406

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

equipment manufacturing employment (NAICS 336) in the Charleston MSA increased 72 percent from 2011 to 2016 and wages increased 40 percent. Additionally, manufacturing employment (NAICS 31) increased 18 percent while wages increased 13 percent. Overall employment increased 6 percent and wages rose by 3 percent. The results imply a five-year three-digit NAICS (transportation equipment manufacturing) impact of 4,500 jobs and total employment impact of 13,700. Using Boeing's 3,800 promised jobs as the denominator, my analysis implies a local employment multiplier effect on the order of 2.6 ((13,700/3,800)-1)[8]. This result is consistent with Moretti (2010) who finds that for each skilled job created in the manufacturing sector, 2.5 additional jobs are generated in the same city through an increase in the local demand for goods and services. Additionally, Bartik & Sotherland (2019) find that local job multipliers for certain high-tech industries, such as transportation equipment manufacturing, may be close to 3.

My results from the ten-year impact models indicate that the Boeing plant effect was sus-

[8] I am not able to estimate multipliers for all subsectors due to censoring within the County Business Patterns dataset.

tained through 2021 and even increased across most of the variables. The three-digit NAICS (transportation equipment manufacturing) impact over 10 years was 5,000 jobs and its total employment impact was 22,000 jobs. This implies that the local multiplier effect from the Boeing plant was 4.8 over 10 years ((22,000/3,800)-1). Other coincident economic drivers may have contributed to Charleston MSA's strong overall employment growth compared to the controls over the treatment period. Thus, these local multiplier estimates could be biased upward.

5 Discussion

I provide evidence on the impact of South Carolina's recruitment of Boeing on the state's aerospace industry by estimating treatment effects on payroll employment, wages, and establishments. I use public data from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages. I compare outcomes from 2010 through 2021 between South Carolina and five other states that were considered finalists for the Boeing 787 Dreamliner plant but ultimately lost their bids (California, Kansas, North Carolina, Texas, Washington) and find a positive impact on the state's aerospace wages (10 percent). Using a synthetic difference-in-differences approach[9]. with an expanded donor pool of control states, I find positive impacts on aerospace employment (311 percent) and establishments (44 percent). The overall results suggest that Boeing had an impact on South Carolina's burgeoning aerospace industry.

I estimate that Boeing generated approximately 6,000 aerospace jobs in South Carolina from 2010 through 2021 using the SDiD model estimate, which is 2,200 more than the 3,800 jobs that Boeing promised to bring to the state when the incentive package was codified into South Carolina state law (Kuker, 2011). The difference-in-differences results suggest that the Boeing plant increased wages in the South Carolina's aerospace industry by 10 percent on average over the treatment period, with much of the strongest gains coming in the last four years of the treatment period. Lastly, I find a 44 percent increase in aerospace

[9] I prefer the synthetic difference-in-differences result for establishments and employment, both of which I regard as upper-bound estimates for Boeing treatment

establishments on average over the treatment period with nearly all of the gains arising in the last 3 years of the treatment horizon. Kaglic (2014) argues that the weak initial growth in state aerospace establishments following the plant's announcement indicates that its impact on supplier firms is diluted due to increasingly globalized supply chains. Our findings could imply that supplier firms are slow to follow large assembly plants or that establishment growth late in the treatment horizon was not directly related to Boeing.

While the state's aerospace industry added firms in the decade following Boeing's recruitment, it is unclear how much of that growth had to do with Boeing or the state's low unionization rate. When we take a closer look at the growth in aerospace establishments over our treatment horizon, it appears that most of the growth occurs in the last six years (see Figure 2) with little of it geographically concentrated in the Charleston Metro Area counties of Berkeley, Charleston and Dorchester (see Table 7). Much of the growth in aerospace establishments occurred 200 miles away from Charleston in the Upstate counties of South Carolina (Greenville, Spartanburg, Anderson, Pickens, Oconee) (see Figure 5). This growth in the Upstate region of the state coincided with Lockheed Martin's decision to relocate its F-16 production line from Fort Worth to Greenville in 2017. Similar to Boeing, who shifted production away from its more unionized Washington plants, Lockheed Martin's Texas production plant utilized unionized labor while its South Carolina plant would not (Garrett, 2017). Additionally, it is possible that aerospace firms were drawn to Upstate South Carolina by its automotive cluster where they could benefit from adjacent related suppliers and a thick labor market for advanced manufacturing.

Given that Boeing had already started buying and consolidating existing 787 parts suppliers in the region (Boeing, 2009b; AP, 2008; Boeing, 2009a; Kaglic, 2014) and the state's low unionization rates, it seems likely that Boeing would have located to South Carolina without the large state incentive package. This is consistent with Bartik (2018), which suggests that the typical government incentive only tips between 2 and 25 percent of targeted firms toward their final location choice. Over a sample of 543 deals from 2002 to 2017, Slattery & Zidar (2020) estimate that firms receive roughly \$178.4 million in state and local incentives for 1,487 promised jobs at a cost of \$119,972 per job across all industries. However, their estimate of the average cost per promised aerospace manufacturing job is considerably higher at $214,237. Ignoring spillover effects to other industries, if we look at the cost of aerospace job generated based on the state-level estimate of 6,000 and using a conservative estimate of the South Carolina incentive package of $800 million, each job costed $133,333, much lower than the cost per promised job of $210,526. This suggests that the Boeing recruitment deal achieved good value for South Carolina taxpayers compared to other contemporary aerospace industrial recruitment deals.

When I assess the impact of the Boeing plant at the MSA level I find that the plant had a substantial multiplier effect on Charleston's metro area. Therefore, the state-level analysis may be obscuring the multiplier effects of the jobs generated indirectly from the Boeing plant. When I compare the Charleston MSA to a group of eleven control MSAs with high concentrations of employment in the aerospace parts industry, I find that the plant generated 4,500 transportation equipment manufacturing jobs over 5 years and an additional 9,200 jobs across other local industries. Using the 3,800 promised jobs from the tax incentive legislation, the 5-year multiplier effect is 2.6, which is consistent with results from the literature (Bartik & Sotherland, 2019; Moretti, 2010). Therefore, the benefits to the Charleston metro economy are substantially greater than the state-level aerospace industry results suggest. Ignoring local multiplier effects from industrial recruitment deals' promised jobs may inflate the perceived cost of industrial recruitment deals.

Table 7: South Carolina Aeropsace Establishments by County

State	Establishments at announcement (2009Q4)	Establishments ten years after plant opening (2021Q4)
South Carolina	24	69
Aiken	0	2
Anderson	0	3
Beaufort	1	2
Berkeley	0	2
Calhoun	0	1
Charleston	11	9
Chester	0	1
Chesterfield	1	0
Clarendon	0	1
Colleton	0	1
Greenville	2	11
Horry	1	2
Lexington	0	2
Oconee	1	2
Orangeburg	1	2
Pickens	0	2
Richland	2	1
Spartanburg	1	4
York	0	3
Unknown	3	18

Source: QCEW. Figures reflect NAICS 3364 establishments.

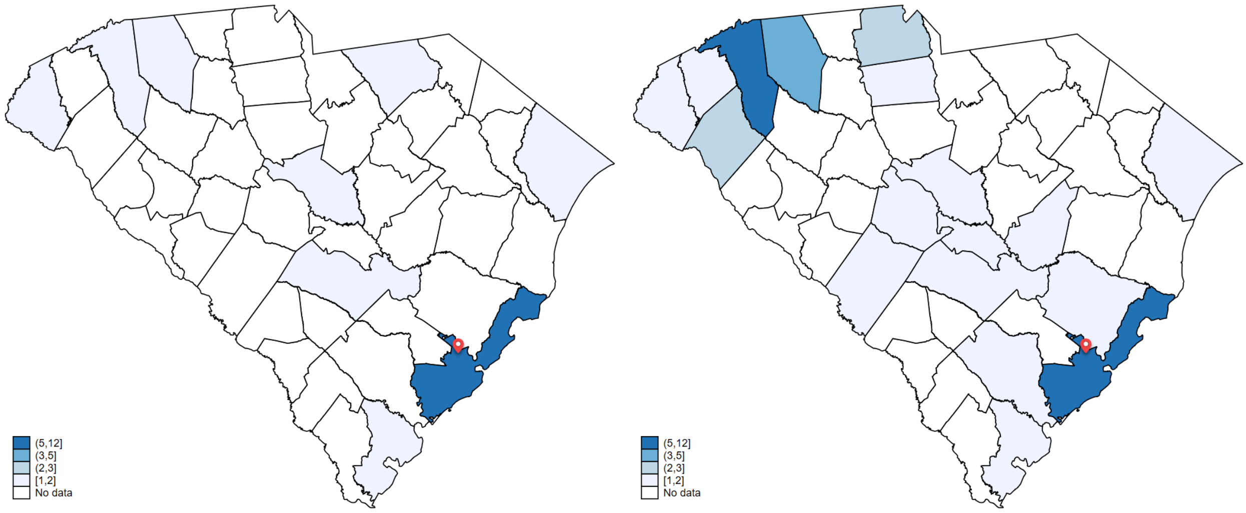

Figure 5: Maps of South Carolina Aerospace Establishments in 2009 (left) and 2021 (right). Shading reflects the number of NAICS 3364 establishments per county in each year. Red symbol marks site of Boeing plant in North Charleston. Source: QCEW.

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