The Employment Impact of Motor Vehicle Assembly Plant Openings*

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Abstract

Local governments often offer motor vehicle assembly plants large subsidies to locate in their jurisdiction. A frequent justification is that an assembly plant will attract upstream parts suppliers to locate nearby and provide manufacturing jobs. Using propensity score matching, I find that an assembly plant brings an average of 500 additional parts suppliers jobs beyond the employment gains the region would have experienced without the assembly plant. This increase is far less than predicted by the input-output models that state development agencies often employ.

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1 Introduction

Local, state, and provincial governments in North America commonly use subsidies to attract employers to their jurisdictions. Motor vehicle assembly plants are one class of employers that has received particular attention and large incentive packages, often valued at hundreds of millions of dollars per plant opening. At assembly plants carmakers, such as Ford and Toyota, combine thousands of components produced by parts suppliers, such as Denso or American Axle, to produce a finished car. Assembly plants typically hire two thousand to four thousand employees, so an assembly plant that had no economic spillovers would imply subsidies of tens of thousands or hundreds of thousands of dollars per worker. Policymakers instead justify the subsidies to carmakers with claims that their assembly plants will spur indirect jobs, particularly by causing parts suppliers to locate nearby and increase local employment.

Evidence on the ability of new assembly plants to attract parts suppliers is mixed. In April 2002, Hyundai announced Montgomery, Alabama as the site for its first North American assembly plant. The plant opened in May 2005 and eventually hired 3,000 employees. In 2003, even before Hyundai began production, Halla Climate Control opened a car air conditioning factory which grew to employ 500 workers in the nearby town of Shorter. Dozens of suppliers did likewise. Overall, parts supplier employment within a 100 kilometer radius of Montgomery grew from 772 in 2002 to 4,008 in 2008. That experience of growth contrasts with Alabama's first assembly plant, which Daimler opened in 1993 and which builds Mercedes sport utility vehicles in Vance. Although axle, dashboard, and automotive seating suppliers now have factories in the same county, the parts supplier employment in the region actually declined in the six years after the plant's announcement. Moreover, the region in North Carolina that Daimler reportedly considered before deciding on Vance gained parts supplier jobs even without an assembly plant.

Daimler and Hyundai were persuaded to open in Alabama in part because of rich incentive packages. Press accounts value the offer Daimler received at $250 million and the subsidies Hyundai received at $118 million.[1] Alabama is far from alone in offering such large subsidies to automakers. The builder of the most recent North American assembly plant, Volkswagen, is reportedly benefiting from a $500 million package of subsidies financed by the State of Tennessee and local governments around

[1] A combination of the State of Alabama, city of Tuscaloosa, Tuscaloosa County, City of Birmingham, and Jefferson County finance the incentive package Daimler received. Much of it was the in the form of property tax breaks, but it also included immediate costs, such as $30 million to purchase a 1,000 acre site. (Cooper and Ruffenach 1993) Some contemporary press accounts estimated Daimler's incentives to be worth $300 million, others at "more than $100 million." Hyundai chose Alabama over Kentucky, which had offered a slightly larger $123 million incentive package. (Lyne 2002)

Chattanooga. An accurate estimate of the indirect jobs brought by the assembly plant is necessary to assess the benefits associated with such large public outlays.

This article analyzes the impact of assembly plant openings on local employment using a direct measure of parts supplier employment. It compares the employment gains in regions that landed assembly plants with those in comparable regions that did not. Using such a control group is necessary, because assembly plants are not placed at random. Instead carmakers build at locations they consider to be especially favorable to manufacturing plants and at times in the business cycle when they need additional capacity. Because of these advantages, the sites chosen for assembly plants might attract parts suppliers even without the assembly plant. The additional parts supplier jobs caused by an assembly plant can be estimated from employment gains above what were experienced in a control group with no assembly plants. I construct two control groups. The first comprises sites that narrowly lost bids to host new assembly plants. Carmakers usually select two to five finalist sites, which sometimes become publicly known, from dozens of candidate locations before announcing one of the finalists as the winning site. The losing finalist sites are thus a collection of locations carmakers themselves consider most similar to the selected site in manufacturing plant profitability.

The second and main control group is generated from propensity score matches to assembly plant sites. These sites appear from observable variables to have been just as likely to receive assembly plants as those that actually did. The main difference, then, is the opening of an assembly plant. The differences in employment growth between the winning region and its propensity score matches are estimates of the structural effect of receiving an assembly plant. Not all new assembly plants have known losing finalist sites, but every assembly plant has propensity score matches. Propensity score matching allows for a large set of comparisons, and this leads to more precise estimates of the effects of assembly plant placement on parts supplier employment.

The impact of a new assembly plant is estimated to be moderate: in addition to the employment at the assembly plant itself, after five years an average of 500 additional parts supplier jobs are found within 100 kilometers of a new assembly plant. At a wider range or with longer periods after the announcement, the employment impact is even larger. The distance range of the assembly plant employment impacts give insight into why and how assembly plants bring indirect jobs. The net employment gains accrue to locations within 200 kilometers of the assembly plant site. This radius is further than the distances usually associated with labor market pooling or knowledge spillovers from personal contacts. The dispersion of the additional parts suppliers also means county governments

providing subsidies will not internalize all the benefits. Furthermore, only when an assembly plant opens near the center of large state can state governments capture most of the jobs created by their financial incentives.

1.1 Literature Review

The moderate impact found in this article contrasts with huge impacts implied by some policymakers and predicted by some impact assessments. For example, Illinois state officials projected that Mitsubishi's arrival in Bloomington would bring 1,100 part suppliers jobs to McLean County and 8,000 to Central Illinois(Chapman, Elhance, and Wenum 1995). More recently, following the Volkswagen announcement, the local press reported Tennessee's "Governor Bredesen said the 2,000 direct jobs at VW are 'the tip of the iceberg' " (Pare 2008). Connaughton and Madsen (2001) reviews two projections based on input-output studies. The South Carolina Development Office used RIMS II multipliers to predict their BMW assembly plant would attract 2,793 direct supplier jobs and 5,444 jobs in other sectors. Alabama commissioned a study based on IMPLANS multipliers that projected that Daimler's Vance assembly plant would bring 2,875 direct supply chain jobs and 5,200 jobs in other sectors. While different industry definitions or different geographical regions (such as using state boundaries instead of a 100 kilometer radius) may cause some of apparent differences with the smaller employment gains observed in this article, the optimistic forecasts of policymakers may reflect the limitations of the input-output framework. Many impact assessment models are calibrated based on the observed patterns of colocation between industries, but they are unable to differentiate between suppliers being attracted to assembly plants, supplier being attracted to the same business environment that attracted the assembly plants, and suppliers being attracted to other suppliers already near the assembly plant site. This article, in contrast, uses a direct measure of how many suppliers a new assembly bring.

Discrete choice studies of parts suppliers location choice decisions show assembly plants have only moderate influence on the placement of parts suppliers. The locations parts suppliers select reveals the preferences for location characteristics, so variations of logit and multinomial logit estimation can show how important assembly plant proximity is relative to other considerations. Rosenbaum (2013) finds that 1,000 miles of distance to an assembly plant has less influence on supplier location than a right-to-work law. Smith and Florida (1994) and Klier and McMillen (2008) both find suppliers slightly more likely to enter counties close to assembly plants, but the presence of an interstate highway is as important as 200 miles of distance to the nearest assembly plant. The low priority part suppliers

place on locating near an assembly plant suggests a low parts supplier employment impact from a new assembly plant, but the existing literature on part supplier employment does not estimate that number. Adams (2015) considers counterfactual placement of assembly plants using a dynamic entry and exit model and finds small changes in the number of supplier plants near new assembly plant sites.

Previous work has studied the impact of large plant openings generally on employment (Edmiston 2004), income (Fox and Murray 2004), land values (Greenstone and Moretti 2004), and incumbent plant productivity (Greenstone, Hornbeck, and Moretti 2010). However, employment multiplier effects vary widely across industries (Moretti 2010). Thus industry-specific analyses (such as Artz, Orazem, and Otto (2007) for meat-packing or Munasib and Rickman (2015) for oil extraction) are needed for industry-specific policy recommendations. This work contributes an industry specific analysis for motor vehicle manufacturing, which generates especially large subsidies and policy interest. Because assembly plants are consistent in size and function, the numerical magnitudes have meaning more specific than what a "large plant" might bring.

2 Data

My source for parts supplier employment is the United States Census's County Business Patterns. For each county, County Business Patterns annually reports the number of plants and the total number of employees (full-time and part-time) in each industry. The Census censors (by zeroing out) many of the total employment numbers at the county level to protect confidentiality when only a few plants of the industry are present. County Business Patterns also reports the number of plants in each of twelve employment size classes in every industry. I construct an estimate of the censored employment numbers by multiplying the number of plants in each size class with the average employment of that size class for that industry in that state (or nation, if state employment for the size class is also censored). The panel of estimated employment totals runs from 1977 to 2013, and I use it to analyze the impact of new assembly plant announced from 1980 to 2008.

Carmakers announced and built new motor vehicle assembly plants in the United States throughout this time period. Some of these plants replaced decommissioned plants, but between 1980 and 2008 18 plants were new investments in an area, opening in a location that had not previously had any car assembly within fifty kilometers. These new investments are the openings studied here. Table 1 lists the site, announcement year, and opening year for the new assembly plants. The period of study starts at the beginning of an era in which most new assembly plants were instances of foreign

direct investment. All but two of these new assembly plants were "transplants," being opened by firms headquartered in Germany, Japan, and South Korea. [2]

I adopt the Standard Industry Classification (SIC) code of 3714 as my definition for parts supplier. Starting in 1999, County Business Patterns used the North American Industry Classification System (NAICS) instead of the SIC codes it previously used. Fortunately, the SIC 3714 category matches almost exactly with the combination of five six-digit NAICS industries: 336312 - Gasoline Engine and Engine Parts Manufacturing, 336330 - Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing, 336340 - Motor Vehicle Brake System Manufacturing, 336350 - Motor Vehicle Transmission and Power Train Parts Manufacturing, and 336399 - All Other Motor Vehicle Parts Manufacturing. I use a simple bridge between the two reporting systems, taking the four-digit SIC observations prior to 1999 and summing the corresponding six-digit NAICS observations in 1999 and later.[3] This definition omits seating, windows, and electrical components, but contains almost half of the inputs motor vehicle assemblers use.[4]

For 12 of the 18 new assembly plants studied, the locations of the other sites that were finalists in assembler's selection process have been made public. This article will use the losing finalists as a first control group for verification, as in Greenstone and Moretti (2004) and Greenstone, Hornbeck, and Moretti (2010). Two of the assembly plants are even in their sample, which uses a list of alternate sites printed in the trade journal *Site Selection*. Other contemporary news accounts provide lists of finalist sites for 10 more plants. Because multiple finalists are sometimes reported, I have 22 sites that almost were awarded assembly plants. Greenstone and Moretti (2004) and Greenstone, Hornbeck, and Moretti (2010) show that finalist sites have similar observed characteristics as selected sites. This article will join with them in assuming that finalist and selected sites have comparable unobserved characteristics.

A second control group is composed of propensity score matches. The Census County Business

[2]Nearly all of the replacement plants were opened by Ford or General Motors. AutoAlliance, a joint venture of Ford and Mazda, opened a plant in Michigan near enough to existing plants not to be counted as a new opening in this study. Honda built a second assembly plant, its East Liberty plant, adjacent to its Marysville, Ohio plant. I do not count the East Liberty plant (announced in 1987 and opened in 1989) as a new opening; rather I classify it as an a expansion of the original Marysville plant. The only instance of a foreign carmaker opening an assembly plant prior to 1980 was at a Pennsylvania site. Volkswagen completed the plant that Chrysler had selected before abandoning construction.

[3]The SIC 3714 industry also contains a small portion of NAICS industry 336211 (23 plants nationally at the time of conversion accounting for 0.2% of the SIC code's employment) and NAICS industry 336322 (193 plants nationally at the time of the conversion accounting for 6.2% of the SIC code's employment). The five NAICS industries are wholly contained in SIC 3714, except for NAICS 336399 code, where 7 plants employing 869 were classified as internal combustion engine manufacturing in the SIC system (U.S. Census Bureau 2000). The simple crosswalk I use treats these exceptions as negligible.

[4]The BEA Input-Output Accounts Use Table for 2007 shows 41.6% of the intermediate inputs for NAICS 336111 as being provided by the five NAICS industries listed above.

Patterns and USA Counties database provide a panel of county characteristics used to estimate the likelihood of a new assembly plant entering each county.

3 Evidence from new openings

The regions around new assembly plants lost parts supplier employment after the new plants were announced, by an average of 112 employees after 5 years.[5] Table 2 shows the employment gains and losses around each selected site announced between 1980 and 2008. The small average employment loss is coupled with high variance. Four new assembly plant sites gained over a thousand parts supplier jobs, and five sites lost over a thousand parts supplier jobs.

This small decrease in supplier employment occurred during decades where supplier employment (and manufacturing employment generally) contracted nationally, but carmakers are more likely to open assembly plants when they expect demand for cars and the size of the industry to grow. Assembly plants are not placed at random, but rather in places attractive to manufacturers, so growth rates or simple comparisons with national averages do not give the causal impact of attracting an assembly plant.

3.1 Econometric Model

To find the causal impact of a new assembly plant on parts supplier employment, the outcome in selected sites must be compared against outcomes in locations that differ from the selected sites only in that they did not receive assembly plants. A randomized control trial building assembly plants at different locations is obviously impractical. Instead, I use two control groups. The first is based on the natural experiment inherent in an assembler's site selection process; the second comprises propensity score matches.

The employment gains seen around a new assembly plant are a combination of the gains caused by the new plant and the employment gains that would have come to the area without a new assembly plant. A valid control group should experience the same magnitude of those second type of gains. The control groups are designed to have sites that part suppliers would find equally appealing as the sites with new assembly plant had the assembly plants not been built. The control group observations should match temporally with the observations of sites treated with a new assembly plant.

[5]More precisely, this is the change in employment in SIC 3714 for counties with a geographic centroid within 100 kilometers of the assembly plant's address.

Table 1: US assembly plants in new areas announced, 1980-2008

Assembler	Site	Date of site announcement	Opening Date
Honda	Marysville, Ohio	1980	1982
Nissan	Smyrna, Tennessee	1980	1983
General Motors	Roanoke, Indiana	1984	1986
General Motors	Spring Hill, Tennessee	1985	1990
Mitsubishi	Normal, Illinois	1985	1988
Toyota	Georgetown, Kentucky	1986	1987
Subaru	Lafayette, Indiana	1986	1989
BMW	Greer, South Carolina	1992	1994
Daimler	Vance, Alabama	1993	1997
Toyota	Princeton, Indiana	1995	1996
Honda	Lincoln, Alabama	1999	2001
Nissan	Canton, Mississippi	2000	2003
Hyundai	Montgomery, Alabama	2002	2005
Toyota	San Antonio, Texas	2003	2006
Honda	Greensburg, Indiana	2006	2008
Kia	West Point, Georgia	2006	2009
Toyota	Blue Springs, Mississippi	2007	2011
Volkswagen	Chattanooga, Tennessee	2008	2011

Sources: *Site Selection* magazine and other contemporaneous press accounts.

Table 2: Area parts supplier employment at and after the location decision

Assembler	Announcement Year	Selected site	Employment at announcement	Employment after 5 yrs	Employment Growth
Honda	1980	Marysville, OH	24,724	21,359	-3,365
Nissan	1980	Smyrna, TN	5,901	5,449	-451
General Motors	1984	Roanoke, IN	18,253	22,149	3,896
General Motors	1985	Spring Hill, TN	3,487	4,328	841
Mitsubishi Motors	1985	Normal, IL	819	1,311	492
Subaru	1986	Lafayette, IN	10,241	10,355	114
Toyota	1986	Georgetown, KY	5,081	5,028	-53
BMW	1992	Greer, SC	5,152	8,675	3,523
Daimler AG	1993	Vance, AL	1,354	496	-858
Toyota	1995	Princeton, IN	6,197	4,454	-1,743
Honda	1999	Lincoln, AL	654	978	324
Nissan	2000	Canton, MS	1,085	429	-656
Hyundai	2002	Montgomery, AL	772	2,582	1,811
Toyota	2003	San Antonio, TX	85	503	418
Honda	2006	Greensburg, IN	19,886	15,122	-4,763
Kia Motors	2006	West Point, GA	1,940	3,737	1,797
Toyota	2007	Blue Springs, MS	1,613	513	-1,100
Volkswagen	2008	Chattanooga, TN	5,202	2,965	-2,237
Average			6,247	6,135	-112

Employment totals are at plants in SIC 3714 in counties within 100 km of the assembly plant.

Let $y_{\ell t}$ be the employment in location ℓ in year t. If an assembly plant in location i was announced in year d_i, then the difference $y_{id_i+x} - yid_i$ represents the employment growth in the x years following the announcement. Let location j be a control group location matched to location i. The quantity $(y_{jd_i+x} - y_{jd_i}) - (y_{jd_i+x} - y_{jd_i})$ represents the location i's employment growth relative to its control group match, which isolates the causal effect of the assembly plant. Motor vehicle manufacturing is a highly cyclic industry, so $y_{id_i+x} - y_{id_i}$ may be sensitive to where the years d_i and $d_i + x$ in a business cycle. The control groups are designed to not be systematically different than the selected sites, so on average they should be in equally recession-sensitive areas and on average they should have the same initial supplier employment at risk. Because the difference $y_{jd_i+x} - y_{jd_i}$ covers the same time periods, the effect of recessions will on average be canceled out in $(y_{jd_i+x} - y_{jd_i}) - (y_{jd_i+x} - y_{jd_i})$.

This difference-in-differences approach can be implemented with simple regressions. Let X_ℓ be 1 if the location is selected for an assembly plant and 0 if the location is in the control group and does not get an assembly plant. Let the announcement date for the location be denoted d_ℓ if the site is selected for an assembly plant. For notational convenience, when ℓ is a location in the control group, let d_ℓ be the announcement date of the plant with which it is matched. Assume

$$y_{\ell t} = \sum_{\tau=-25}^{25} \beta_{S\tau} I[X_\ell = 1] I[t - d_\ell = \tau] + \sum_{\tau=-25}^{25} \beta_{N\tau} I[X_\ell = 0] I[t - d_\ell = \tau] + \epsilon_{\ell t}$$

where $I[\cdot]$ is the indicator function and $\epsilon_{\ell t}$ is an independent, identically distributed error term. The coefficient $\beta_{S\tau}$ will give the average outcome conditional on the location being selected for an assembly plant announced τ years previously; $\beta_{N\tau}$ will give the average outcome conditional on the location being a finalist not selected for an assembly plant announced τ years previously. The difference will identify the average causal impact of adding an assembly plant for each year after the announcement. An equivalent regression equation

$$y_{\ell t} = \sum_{\tau=-26}^{26} \beta_{S\tau} I[t - d_\ell = \tau] - \sum_{\tau=-26}^{26} (\beta_{S\tau} - \beta_{N\tau}) I[X_\ell = 0] I[t - d_\ell = \tau] + \epsilon_{\ell t}$$

is estimated to find the standard errors on the differences, $\beta_{S\tau} - \beta_{N\tau}$. A treatment effect that is not year-specific can be estimated from a similar regression model:

$$y_{\ell t} - y_{\ell 0} = \alpha_0 + \gamma_0 I[t > d_\ell] + \alpha_1 I[X_\ell = 1] + \gamma_1 I[X_\ell = 1] I[t > d_\ell] + \epsilon_{\ell t}$$

where γ_1 is equivalent of a pooled $\beta_{S\tau} - \beta_{N\tau}$ for $\tau > 0$.

4 Site Selection Finalists as a Control Group

The sites that were finalists in an assembler's selection process are used as a control group for comparison, as in Greenstone, Hornbeck, and Moretti (2010). The locations of the new assembly plants are selected carefully. All of the new assembly plants in the United States are in the Midwest or Southeast. The process of selecting a location for a new assembly plant is involved. A first stage screens hundreds of potential locations for inclusion on a short list of two to five finalists. The sites on this list sometimes, but not always, become public. Assemblers compare specific sites and subsidy offers from the respective state and local government, then announce the location of their new assembly plant.

Parts suppliers are far less likely to receive massive subsidies, so a major difference between winning and losing finalist sites for assemblers is not an important variable to parts suppliers. Instead, the finalist sites are a list of places with similar overall favorability to auto manufacturing sites, and so could be expected to attract the same number of parts supplier jobs if assembly plants had no effect on supplier location decisions.

Table 3 lists the finalist sites along with their parts supplier employment at six years after not being chosen for an assembly plant. They are matched and compared to the site where the assembly plant was built. After six years, the areas within 100 kilometers of the new assembly plants that could be matched lost an average of 1,030 parts supplier jobs. The areas around the losing finalists lost slightly more, an average of 1,111 supplier jobs. The causal effect of the assembly plant on parts supplier employment after six years is thus estimated at only 81 jobs.

I highlight results for five years following the assembler announcements, because that is the longest time frame in which there are employment estimates for all assembly plants. Table 4 charts the effects for different durations using the same regressions to estimate $\beta_{S\tau}$, $\beta_{N\tau}$, and $\beta_{S\tau} - \beta_{N\tau}$. (The same information is graphed in figures 1 and 2.) No period shows assembly plants having a statistically significant effect on parts supplier employment. Seven years after the announcement the effect of the assembly plant even appears negative. This suggests assembly plants may crowd out parts suppliers, perhaps because the increased competition for manufacturing workers outweighs the advantages to the parts suppliers of being near their customers.

The standard errors on all the estimated effects are quite large. This is driven by the small number of observations. For periods more than seven years after the announcement the number of observations

Table 3: Area parts supplier employment at and after the location decision

Assembler	Ancmnt. Date	Selected site	Emp. at anncmt. (1)	Employ. after 5 yrs (2)	Employ. Growth (3)	Alternative site	Emp. at anncmt. (4)	Employ. after 5 yrs (5)	Employ. Growth (6)	Growth Difference (7)
Nissan	1980	Smyrna, TN	5,901	5,449	-451	Atlanta, GA	762	1,589	827	-1,278
GM	1985	Spring Hill, TN	3,487	4,328	841	*(Average losing finalist)*	6,695	8,073	1,378	-536
						Grayson Co, TX	1,507	1,548	41	
						Kalamazoo Co, MI	15,730	18,250	2,520	
						Shelby Co, KY	2,847	4,420	1,573	
Mitsubishi	1985	Normal, IL	819	1,311	492	Lafayette, IN	10,477	11,308	831	-339
Toyota	1986	Georgetown, KY	5,081	5,028	-53	*(Average losing finalist)*	160	154	-7	-46
						Wilson Co, TN	0	0	0	
						Wyandotte Co, KS	321	307	-13	
BMW	1992	Greer, SC	5,152	8,675	3,523	Omaha, NE	687	1,085	398	3,125
Daimler	1993	Vance, AL	1,354	496	-858	*(Average losing finalist)*	2,638	2,681	43	-902
						Mebane, NC	2,323	2,824	501	
						Summerville, SC	2,952	2,538	-414	
Hyundai	2002	Montgomery, AL	772	2,582	1,811	Glendale, KY	7,587	9,253	1,666	145
Toyota	2003	San Antonio, TX	85	503	418	*(Average losing finalist)*	1,830	2,806	976	-558
						Como, MS	1,083	1,808	725	
						Fackler, AL	4,617	7,703	3,086	
						Jackson, MS	270	182	-88	
						West Memphis, AR	1,349	1,531	182	
Honda	2006	Greensburg, IN	19,886	15,122	-4,763	*(Average losing finalist)*	13,288	8,399	-4,889	125
						Fithian, IL	3,502	3,192	-309	
						Van Wert, OH	23,075	13,606	-9,468	
Kia	2006	West Point, GA	1,940	3,737	1,797	*(Average losing finalist)*	518	508	-10	1,807
						Kewanee, MS	55	0	-55	
						Lowndes Co, MS	981	1,015	34	
Toyota	2007	Blue Springs, MS	1,613	513	-1,100	*(Average losing finalist)*	2,880	989	-1,891	791
						Chattanooga, TN	4,700	1,427	-3,273	
						Marion, AR	1,060	551	-508	
Volkswagen	2008	Chattanooga, TN	5,202	2,965	-2,237	Huntsville, AL	7,338	1,095	-6,243	4,006
Weighted Average			4,274	4,226	-48		4,572	3,995	-577	528

Employment totals are for plants in SIC 3714 in counties within 100 km of the assembly plant or the losing finalist in the site selection process. The weighted averages include only plants with known site selection finalist sites. The averages for alternate sites are inversely weighted by the number of known finalist sites. Note that column (3) is the difference of columns (1) and (2), and its average corresponds to the estimate of β_{S5} in Table 4. Column (6) is the difference of columns (4) and (5), and its average corresponds to β_{N5} in Table 4. Column (7) is the difference of columns (3) and (6), and its average corresponds to $\beta_{S5} - \beta_{N5}$ in Table 4.

becomes even smaller since only seven years separate the Toyota and Kia announcements from the end of parts supplier panel. (This is why standard errors for β_{S8} are larger than for β_{S7}.) So even the most optimistic or pessimistic hypotheses for the indirect employment contribution of assembly plants cannot be rejected. A different method for selecting a control group is needed so that none of the precious few assembly plants observations are discarded.

5 Propensity Score Matching

To get a control group of comparable sites for all the new assembly plants, I use propensity score matching.[6] Sites that, based on observable characteristics, are just as likely to receive assembly plants should offer the same advantages to parts suppliers apart from the realized assembly plants themselves. The propensity score used here will be derived from a probit regression of assembly plant selection on observable location characteristics. Specifically, let a location be a county, and let its characteristics include whether the county has an interstate highway, whether it is in a right-to-work state, the county's population, the proportion of county employment in manufacturing plants, the parts supplier employment count, the distance to Detroit, the proportion of the population that holds a college degree, and the proportion of the population that is over 65 years old.

Perrucci (1994) highlights auto supplier infrastructure and the number of parts suppliers as the most important determinants of motor vehicle assembly plant locations. Assemblers, particularly assemblers running a just-in-time production system, benefit from having a predictable source of inputs nearby. In Holmes (2004) there are diminishing benefits from additional suppliers nearby; to have some suppliers near is essential, but other factors are more decisive once a sufficient supplier base is present. The main specifications of the propensity regression include a county's parts supplier employment and its square as measures of auto supplier infrastructure. Parts supplier employment will also be used as a dependent variable in the second stage, but only its value in the year the plant was announced influences the composition of the control group.

Assemblers, particularly the foreign direct investors, were thought to pay particular attention to the age, education, and quality of their workforce. Chapman, Elhance, and Wenum (1995) notes that an educated labor pool is one of factors Mitsubishi publicly emphasized when it announced its assembly plant site in 1984. Rinehart, Huxley, and Robertson (1997) describes the careful screening

[6]Propensity score matching originated in the biomedical literature (Rosenbaum and Rubin 1983), but has been applied widely in regional science (for example Bondonio and Engberg (2000), McMillen and McDonald (2002), and List, Millimet, Fredriksson, and McHone (2003)).

Table 4: Effect of Assembly Plant Selection on Parts Suppliers Employment within 100km Using Finalist Sites

	$\beta_{S\tau}$	$\beta_{N\tau}$	$\beta_{S\tau} - \beta_{N\tau}$
$\tau = -10$	-117.1	381.6	-498.7
	(2539.6)	(2539.6)	(3591.5)
$\tau = -5$	-382.9	947.8	-1330.7
	(2322.5)	(2322.5)	(3284.5)
$\tau = -3$	-192.5	16.9	-209.5
	(2271.5)	(2271.5)	(3212.3)
$\tau = -2$	-146.4	-151.7	5.4
	(2271.5)	(2271.5)	(3212.3)
$\tau = -1$	13.5	-21.6	35.0
	(2271.5)	(2271.5)	(3212.3)
$\tau = 0$	0	0	0
$\tau = 1$	396.7	53.7	343.0
	(2271.5)	(2271.5)	(3212.3)
$\tau = 2$	97.9	-479.0	576.9
	(2271.5)	(2271.5)	(3212.3)
$\tau = 3$	58.1	-273.3	331.4
	(2271.5)	(2271.5)	(3212.3)
$\tau = 4$	49.5	-580.2	629.7
	(2271.5)	(2271.5)	(3212.3)
$\tau = 5$	-48.3	-576.6	528.3
	(2271.5)	(2271.5)	(3212.3)
$\tau = 6$	-486.2	-927.6	441.4
	(2322.5)	(2322.5)	(3284.5)
$\tau = 7$	179.9	-543.4	723.3
	(2382.3)	(2382.3)	(3369.1)
$\tau = 8$	-70.5	932.8	-1003.3
	(2539.6)	(2539.6)	(3591.5)
$\tau = 9$	-12.6	958.9	-971.5
	(2539.6)	(2539.6)	(3591.5)
$\tau = 10$	-99.5	1084.5	-1183.9
	(2539.6)	(2539.6)	(3591.5)

Standard errors in parentheses.

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

Figure 1: Changes in parts supplier employment since assembly plant selection announcement of sites selected and losing finalists sites

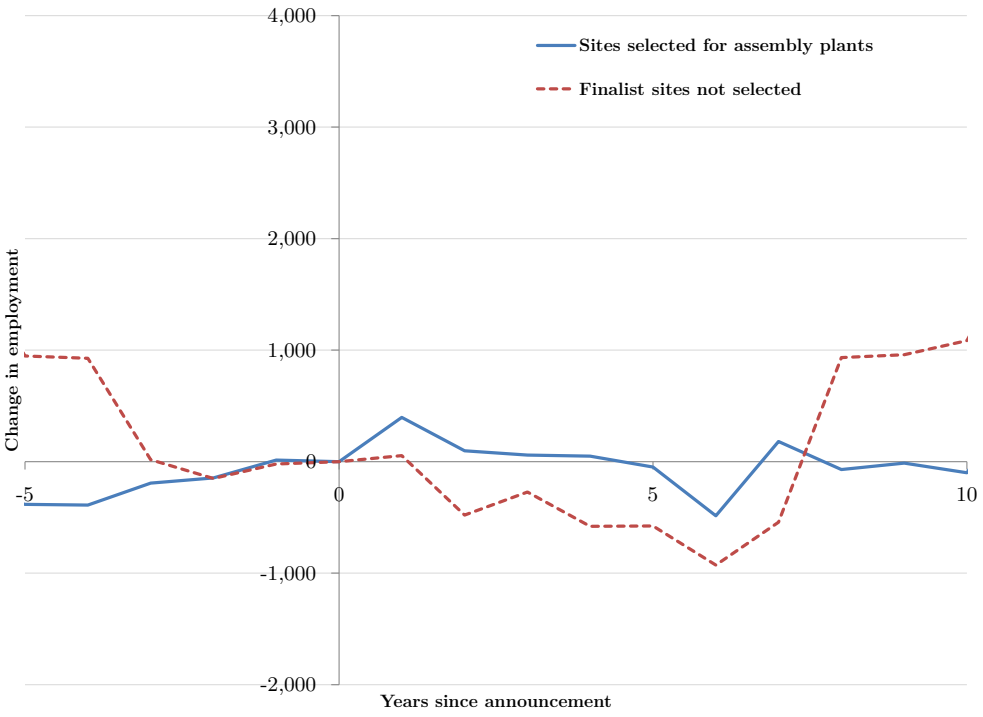
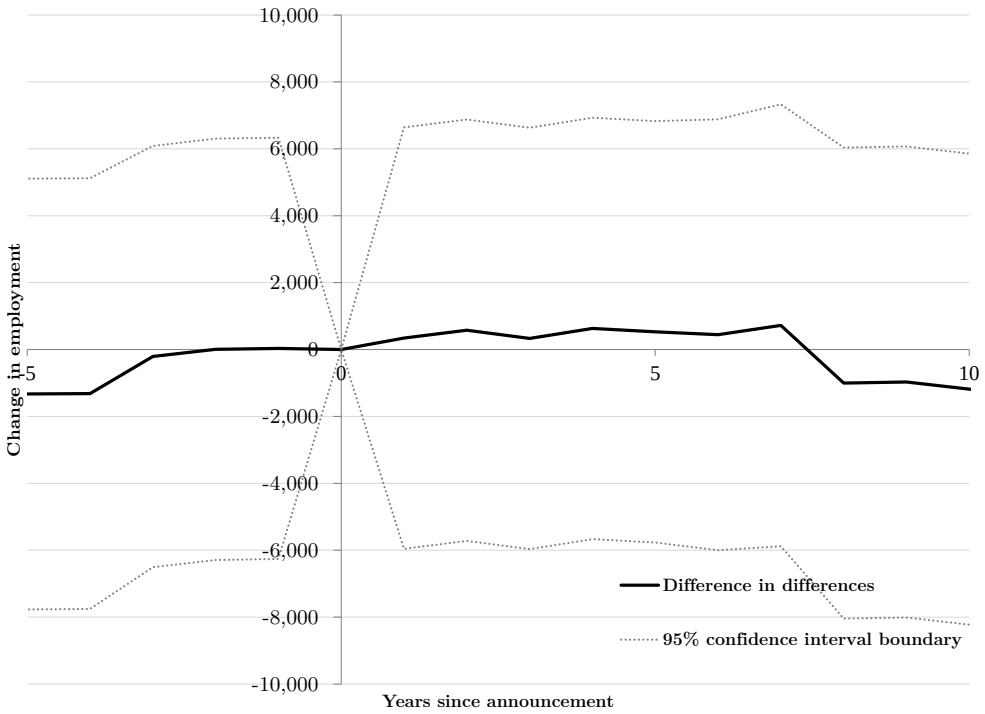


Figure 2: Difference in parts supplier employment changes between selected sites and and losing finalists sites



a Toyota-led joint venture in Ontario used and the young labor force that resulted. The proportion of the population holding a college degree and the proportion of the population that is over 65 years old are included as proxies for the overall education and age of a labor force. College graduation might seem an unlikely measure of the relevant human capital in these manufacturing plants, but its effects appeared stronger and more consistent in regression specifications than the proportion of the population holding a high school diploma.

Previous literature has debated the extent to which foreign assemblers consider union avoidance in their location decisions. Some have suggested that they avoid traditional manufacturing centers because of unions. The manufacturing share of employment, however, has positive coefficients in my propensity regressions. Holmes (1998) shows manufacturers generally consider state policies as measured by a "right-to-work law" in their location choices, and so an indicator for locations in right-to-work states are included. Rubenstein (1991) notes that Japanese assemblers were sometimes alleged to deliberately locate away from minority communities, but in a regression specifications with population density and manufacture employment share, the Black population share has a positive, though statistically insignificant, coefficient.

Table 5 reports the coefficient estimates from three specifications. The signs on all coefficients are intuitive: assembly plants are more likely to locate in counties with an interstate highway, in larger counties, near auto alley and Detroit, and in right-to-work states. Only a few coefficient estimates are statistically significant from zero, but the likelihood ratio test upholds their joint significance at the 2% level.

A nearest neighbor matching procedure uses fitted probabilities from the third specification in table 5 to build a control group. One complication is that the analysis will compare regional employment (usually summing all the counties with centroids within 100 kilometers) while the propensity regressions reported in table 5 have county-years as their observational unit. The potential control group observations are therefore regions around counties not selected for assembly in the same year as the announced site with which they are matched. I only use the observations from the same year in the selection of propensity score matches. I exclude counties that are 100 kilometers from the matched announced site to limit the comparison of overlapping regions.

I also require that matches have similar initial parts supplier employment to the announced sites with which they are matched. Specifically, parts supplier employment within 100 kilometers must differ from the selected site by no more than 300 employees or 20%. With a larger sample, this last filter

Table 5: County propensity to gain a new assembly plant

	(1)	(2)	(3)
Distance from Detroit	-0.505*	-0.248	-0.0649
(thousand km)	(0.206)	(0.222)	(0.244)
Interstate Highway	0.653**	0.627**	0.556*
	(0.200)	(0.205)	(0.220)
Population density	-0.0592	-0.0927	0.978
(thousand/km^2)	(0.277)	(0.361)	(1.978)
Squared population density			-2.227
			(3.410)
Right to Work law	0.382*	0.470*	0.398
	(0.181)	(0.201)	(0.236)
Manufacturing share		-0.104	0.369
of employment		(0.555)	(0.650)
Parts supplier employment		0.0772*	0.0301
within 100 km (thousands)		(0.0349)	(0.0488)
Squared parts supplier emp.		-0.00196	-0.000781
within 100 km		(0.00126)	(0.00132)
Parts supplier employment			0.0310
within 200 km (thousands)			(0.0194)
Squared Parts supplier emp.			-0.000259
within 200 km			(0.000171)
Black			0.805
(share of population)			(0.505)
College graduates			3.227*
(share of population)			(1.443)
Resident over 65 year			-1.146
(percent of population)			(2.974)
Per capita income			-0.0444
(thousand $US)			(0.0405)
Year Fixed Effects	Yes	Yes	Yes
N	42860	42809	42328
pseudo R^2	0.092	0.114	0.160

An observation is a county-year, and the dependent variable is whether a motor vehicle manufacturer announced during the year that it would open a new assembly plant in the county. Specification (3) is used to find propensity score matches. The table reports probit coefficients. Standard errors are in parentheses.

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

would be unnecessary. If the matching procedure identifies regions that are truly comparable to the treated set, then those matches should in expectation have the same initial supplier bases. However, in a small samples such as this, even one instance of a site with many parts suppliers being matched with a region with few can cause outlier effects. During recessions, the site that began with few suppliers will have a small reduction in part supplier employment simply because it had fewer jobs to lose.

For each assembly plant announcement, propensity score matches are the three regions around candidate counties that have an estimated propensity for a new assembly plant nearest to the estimated propensity for the county actually selected for the new plant.

Because only 18 counties were selected in over 40,000 county-year observations and because of the dispersion in the characteristics of sites chosen, the predicted probability of any county becoming the site for a new assembly plant in a particular year is under 3%. Nevertheless, all 18 were estimated to be more likely than the median county to receive an assembly plant, and 13 of the 18 sites selected were in the top decile of estimated propensity scores. This, again, confirms that assembly plant sites differ from a typical county even before the plant announcement.

One selected site, Lafayette, Indiana where Subaru built, had a higher predicted probability than any other region in 1986 with similar parts supplier employment. This is the only instance where the support condition fails to hold, as for all other plants several sites with similar supplier employment that were not selected had higher propensity score.

Table 6 lists each selected site and its three propensity score matches. The employment gains after five years in the area around each site and each propensity score match are listed along with the difference in these gains. The average employment gains around the selected sites is $\widehat{\beta_{S\tau}}$ for $\tau = 5$. The average employment around the control group sites is $\widehat{\beta_{N5}}$. The difference-in-differences, $\widehat{\beta_{S5}} - \widehat{\beta_{N5}}$, is the estimated causal impact of the assembly plant six years after the announcement. The estimated gains of 500 are sizable, but modest in comparison to some predictions.

Table 7 and Figures 3 and 4 show the average employment gains and differences in employment gains for a range of durations. The sites eventually selected and their propensity matches should experience similar changes in parts supplier employment before the assembly plant is announced, so $\widehat{\beta_{S\tau}} - \widehat{\beta_{N\tau}}$ should be near zero for $\tau < 0$. The selected sites appear to outgrow the control group in the decade before the assembly plant announcement, but this pretrend is not statistically significant or even uniform in its sign in the years prior to the announcement.

The average differences in parts supplier employment between treatment and control groups are

Table 6: Area parts supplier employment at and after the location decision for propensity score matches

Selected site / Assembler / Date	Emp. at anncmt. (1)	Employ. after 5 yrs (2)	Employ. Growth (3)	Propensity match (County)	Emp. at anncmt. (4)	Employ. after 5 yrs (5)	Employ. Growth (6)	Growth Difference (7)
Marysville, OH	24,724	21,359	-3,365	Bay, MI	29,720	27,176	-2,544	-821
Honda / 1980				Geauga, OH	24,423	16,189	-8,234	4,869
				Randolph, IN	21,386	20,561	-825	-2,540
Smyrna, TN	5,901	5,449	-451	Fairfield, OH	5,044	5,082	38	-490
Nissan / 1980				Licking, OH	6,528	7,422	893	-1,345
				Wayne, OH	6,607	6,902	295	-747
Roanoke, IN	18,253	22,149	3,896	Miami, OH	20,711	19,652	-1,060	4,955
GM / 1984				Racine, WI	18,098	15,074	-3,024	6,920
				Summit, OH	17,038	12,880	-4,158	8,053
Normal, IL	819	1,311	492	Coles, IL	986	1,949	963	-471
Mitsubishi / 1985				Spotsylvania, VA	1,690	1,072	-619	1,111
				Vermillion, IN	750	1,025	276	216
Spring Hill, TN	3,487	4,328	841	Copiah, MS	3,636	3,400	-236	1,077
GM / 1985				Davie, NC	4,095	4,295	199	642
				McMinn, TN	3,837	2,317	-1,520	2,362
Lafayette, IN	10,241	10,355	114	Berrien, MI	10,121	11,124	1,003	-889
Subaru / 1986				Kent, MI	9,074	10,197	1,122	-1,008
				Madison, AL	9,320	8,139	-1,180	1,294
Georgetown, KY	5,081	5,028	-53	Cumberland, TN	4,913	5,671	758	-811
Toyota / 1986				Scott, IN	4,837	5,575	738	-791
				Smith, TN	5,079	8,732	3,652	-3,705
Greer, SC	5,152	8,675	3,523	Oldham, KY	5,501	12,975	7,474	-3,951
BMW / 1992				Wayne, OH	4,709	6,555	1,846	1,677
				Yazoo, MS	4,558	4,645	87	3,436
Vance, AL	1,354	496	-858	Greene, GA	1,351	1,464	114	-972
Daimler / 1993				Rowan, KY	1,458	1,253	-205	-653
				Whitfield, GA	1,427	1,469	42	-900
Princeton, IN	6,197	4,454	-1,743	Boyle, KY	7,248	7,633	384	-2,128
Toyota / 1995				Effingham, IL	5,252	3,200	-2,052	309
				Holmes, OH	7,273	7,213	-60	-1,684
Lincoln, AL	654	978	324	Johnson, KS	771	1,142	371	-47
Honda / 1999				Leavenworth, KS	771	1,141	370	-46
				McDuffie, GA	545	1,034	489	-165
Canton, MS	1,085	429	-656	Aiken, SC	1,007	1,216	209	-865
Nissan / 2000				Bibb, GA	825	1,440	615	-1,272
				Florence, SC	1,016	2,281	1,264	-1,921
Montgomery, AL	772	2,582	1,811	Aiken, SC	980	1,310	330	1,481
Hyundai / 2002				Holmes, MS	558	141	-417	2,227
				Madison, MS	621	492	-129	1,940
San Antonio, TX	85	503	418	Brule, SD	50	147	97	321
Toyota / 2003				Miller, AR	121	736	615	-196
				Sharkey, MS	127	127	0	418
West Point, GA	1,940	3,737	1,797	Dane, WI	2,189	3,060	871	925
Kia / 2006				Haywood, TN	2,028	1,502	-526	2,323
				Warren, NC	1,934	1,331	-603	2,400
Greensburg, IN	19,886	15,122	-4,763	Hancock, OH	19,919	14,064	-5,855	1,092
Honda / 2006				Huntington, IN	21,922	12,444	-9,478	4,714
				Miami, OH	17,017	11,431	-5,586	823
Blue Springs, MS	1,613	513	-1,100	Hartford, CT	1,621	896	-725	-374
Toyota / 2007				Putnam, GA	1,522	376	-1,147	47
				Webster, MO	1,723	892	-831	-269
Chattanooga, TN	5,202	2,965	-2,237	Clarke, GA	5,804	2,029	-3,775	1,538
Volkswagen / 2008				Guilford, NC	5,090	3,234	-1,856	-381
				Wake, NC	4,728	3,222	-1,506	-731
Average	6247	6135	-112		6288	5676	-612	500

Employment totals are at plants in SIC 3714 in counties within 100 km of the assembly plant or the centroid of the propensity score match. Note that column (3) is the difference of columns (1) and (2), and its average corresponds to the estimate of β_{S5} in Table 7. Column (6) is the difference of columns (4) and (5), and its average corresponds to β_{N5} in Table 7. Column (7) is the difference of columns (3) and (6), and its average corresponds to $\beta_{S5} - \beta_{N5}$ in Table 7.

modest in the five years following the announcement. The larger employment impact, by far, is at the assembly plants themselves, which consistently employ around two thousand. The indirect jobs at parts suppliers that are created sum to less than half that. Year by year the effect of the assembly plant is not significant even at the 10% level, but there is enough statistical power to reject some of the optimistic claims of what an assembly plant brings. An average impact of six thousand parts supplier jobs after five years can be rejected at the 2.1% significance level by a one-sided t test; an average impact of eight jobs can be rejected at 0.4% level.

The employment effect of a new assembly plant grows even a decade after the site of the assembly plant is first announced. Only plants announced before year $2013-\tau$ are used in estimating $\widehat{\beta_{S\tau}}-\widehat{\beta_{N\tau}}$, the effect τ years after the announcement. But the areas around those early assembly plants outperformed their propensity score matches by thousand of jobs in the decades after the announcement. The gradual divergence is consistent with the oft hypothesized agglomeration effects between parts suppliers (see, for example, Smith and Florida (1994) or Adams (2015)) where an assembly plant attracts a few suppliers, but later additional suppliers are attracted by those suppliers, rather than by the assembly plant directly.

The estimated impact is robust to which specification of the probit regression in Table 5 is used to find propensity score matches. The control group generated using specification (1) lose an average of 864 parts supplier jobs in the five years after their matches are selected for an assembly plant. Since the selected site lose only 112 jobs, the estimated impact of the assembly plant on parts supplier employment is 752. The matches found by specification (2) lose an average of 442 part supplier jobs, making the estimated casual impact of an assembly plant 330 parts supplier jobs.

Table 8 reports the difference-in-difference regression results when years are pooled together. The overall effect of an assembly plant is estimated to be 2,198 parts supplier jobs, and the effect is significant at the 1% level. This larger number is elevated by the gains at the early assembly plant sites that are realized decades after the announcement. Estimation from a balance panel requires using only plants that were announced sufficient period after 1980 and a sufficient period before 2013. For the balanced panel to include observations for 5 years before and after the announcement, only the 15 plants announced between 1985 and 2008 can be used. For a balanced panel to included observations for 10 years before and after the announcement, only the 7 plants announced between 1990 and 2003 can be used. These estimates are reported in columns (2) and (3) of Table 8. Notably, the estimated impact of assembly plants on parts supplier employment is neither positive nor significant for those

Figure 3: Changes in parts supplier employment since assembly plant selection announcement of sites selected and their propensity score matches

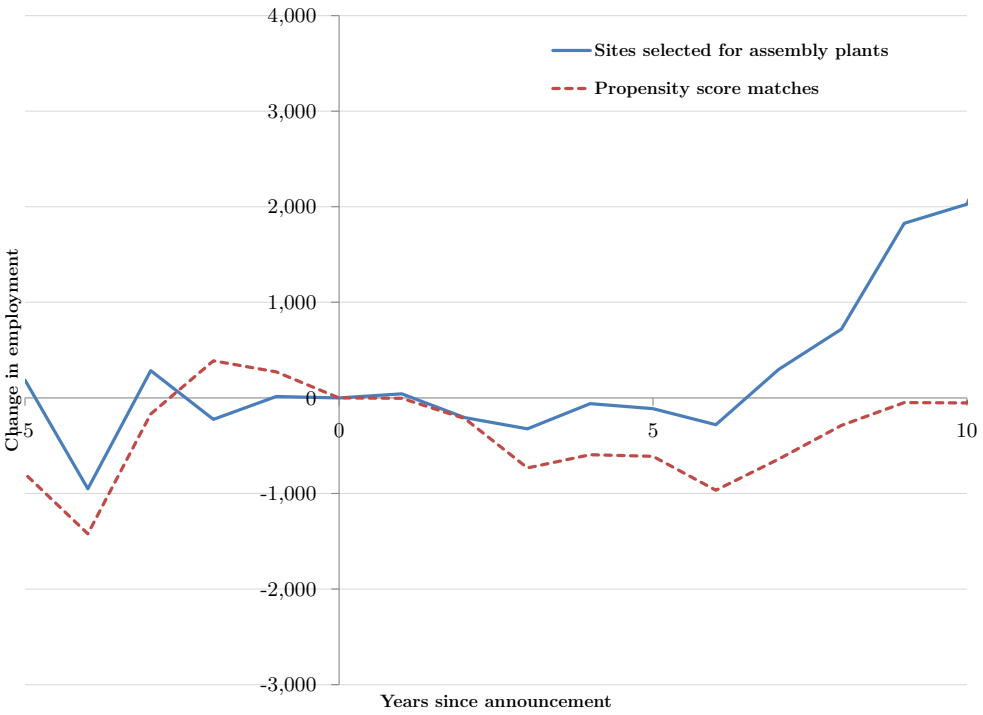


Figure 4: Difference in parts supplier employment changes between selected sites and propensity score matches

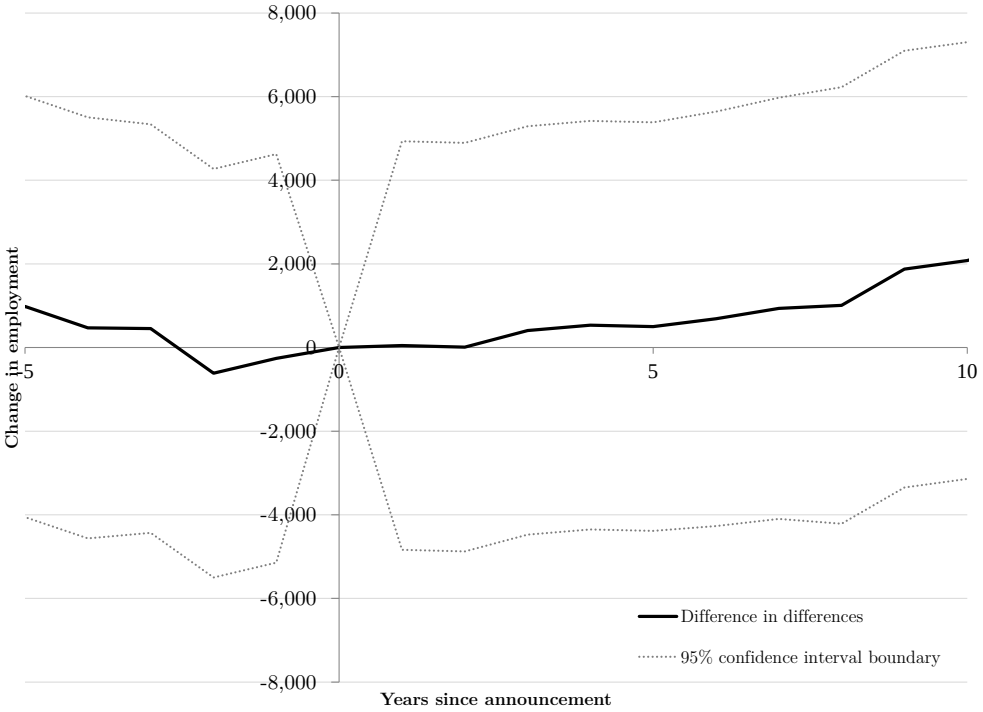


Table 7: Effect of Assembly Plant Selection on Parts Suppliers Employment within 100 km Using Propensity Score Matching

	$\beta_{S\tau}$	$\beta_{N\tau}$	$\beta_{S\tau} - \beta_{N\tau}$
$\tau = -10$	-2414.0	-1668.1	-745.9
	(2023.0)	(2023.0)	(2861.0)
$\tau = -5$	186.2	-794.4	980.6
	(1816.3)	(1816.3)	(2568.6)
$\tau = -3$	285.6	-168.1	453.7
	(1762.0)	(1762.0)	(2491.9))
$\tau = -2$	-225.0	387.8	-612.9
	(1762.0)	(1762.0)	(2491.9)
$\tau = -1$	14.9	273.2	-258.3
	(1762.0)	(1762.0)	(2491.9)
$\tau = 0$	0	0	0
$\tau = 1$	42.9	-3.3	46.3
	(1762.0)	(1762.0)	(2491.9)
$\tau = 2$	-204.9	-214.3	9.4
	(1762.0)	(1762.0)	(2491.9)
$\tau = 3$	-323.6	-731.8	408.2
	(1762.0)	(1762.0)	(2491.9)
$\tau = 4$	-60.1	-594.5	534.4
	(1762.0)	(1762.0)	(2491.9)
$\tau = 5$	-111.7	-611.7	500.0
	(1762.0)	(1762.0)	(2491.9)
$\tau = 6$	-279.9	-966.9	687.0
	(1787.8)	(1787.8)	(2528.3)
$\tau = 7$	297.5	-640.3	937.8
	(1816.3)	(1816.3)	(2568.6)
$\tau = 8$	718.6	-287.9	1006.5
	(1883.7)	(1883.7)	(2663.9)
$\tau = 9$	1826.3	-48.3	1874.6
	(1883.7)	(1883.7)	(2663.9)
$\tau = 10$	2026.3	-52.5	2078.7
	(1883.7)	(1883.7)	(2663.9)

Standard errors in parentheses.

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

Table 8: Effect of Assembly Plant Selection on Parts Suppliers Employment within 100 km Using Propensity Score Matching

	(1) full, unbalanced panel	(2) balanced panel $\lvert t - d_\ell \rvert < 5$	(3) balanced panel $\lvert t - d_\ell \rvert < 10$
after	-1254.5***	30.62	603.2***
$(I[t > d_\ell])$	(212.3)	(171.6)	(172.9)
selected	-31.73	398.5*	201.0
$(I[X_\ell = 1])$	(213.6)	(163.6)	(168.7)
afterselected	2198.1***	-80.67	-156.2
$(I[X_\ell = 1] \cdot I[t > d_\ell])$	(300.2)	(242.7)	(244.5)
constant	40.64	-262.1*	-285.9*
	(151.0)	(115.7)	(119.3)
N	2664	660	588

Column (1) reports regression results using all observations with employment counts from 1980 to 2013 for selected site and propensity score matches. Because announcement dates are spread across that time period, the panel is unbalanced when indexed by time to or since the announcement. Column (2) reports a regression that uses only the 15 plants announced between 1985 and 2008 and their employment totals within 5 years of the announcement date. Column (3) reports a regression that uses the 7 plants announced between 1990 and 2003 and their employment totals within 10 years of the announcement date.

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

subsets.

5.1 Distance Range of Assembly Plant Effects

How far spillovers from an assembly plant extend matters to policymakers. If assembly plants promote employment only in their immediate neighborhoods, then state subsidies serve to redistribute wealth between regions within a state. If assembly plants promote employment in a much wider radius, then the state subsidizing the assembly plant is not capturing all the benefits, some of which accrue to neighboring states.

The same difference-in-differences methodology is used where the outcome variable is the parts supplier employment in circles of various radii around the assembly plants. Table 9 shows the results. Doubling the radius of the study regions quadruples their area. Nearly all of the additional parts supplier plants an assembly plant attracts will locate within 200 kilometers. For a state like Alabama, the additional parts supplier employment caused by a plant opening would be spread throughout the state, yet the state would internalize most but not all of the benefits from its subsidy. The earliest assembly plants from foreign direct investment were indeed placed near the center of their host state and also near the state capital. The BMW plant in Greer, South Carolina and the Toyota plant in Princeton, Indiana were the first to break that pattern. Plants near state borders or plants in oblong states like Tennessee would confer additional part suppliers to states that had not contributed to their subsidies.

Klier (2000) reports that one quarter of suppliers (as measured by count or employment) for newly built assembly plants are within 160 kilometers of the assembly plants. Around three-quarters are within 640 kilometers. Many suppliers ship to multiple assembly plants. Some parts supplier factories predate their closest assembly plant and would be supplying other assembler from the same location if the neighboring assembly plant had instead located elsewhere. Nevertheless, the raw distribution of part suppliers around the assembly plants they supply supports the plausibility of agglomeration forces extending out 200 kilometers.

5.2 Subsample results and discussion

The assembly plant sites in the South generally added more part supplier jobs than those in the Midwest. Three of the four largest gains in Table 2 belonged to Southern sites, in particular to Greer, South Carolina; Montgomery, Alabama; and West Point, Georgia. The 100 kilometer regions around

the twelve assembly plants that opened in the South added an average 280 parts supplier jobs in the five years following the site selection announcement.

Yet, most of the increase in parts supplier employment would have happened even without the assembly plant. Comparable regions without assembly plants added almost as much parts supplier employment. Supplier employment in the propensity score matches for the Southern plants increased by 219 in the same time periods. Thus, the estimated causal effect of the assembly plant was only 61 parts supplier jobs. These results are reported in Table 10.

Sites in the Midwest, often lost part suppliers after a new assembly plant was announced. The region around Marysville, Ohio lost 3,365 parts supplier jobs between 1980 and 1985. Supplier employment in Greensburg, Indiana declined 4,763 in the five years after Honda announced its new plant in 2006. Yet, both these sites lost fewer supplier jobs than their propensity score matches did. Overall, the six Midwestern sites experienced an average decrease of 895 jobs in the five years after their new assembly plant announcements, which is 1,331 fewer than comparable locations did in the same period. New assembly plants in the Midwest thus made the reductions in part supplier employment that would have otherwise occurred substantially less severe.

The difference in effects is not statistically significant. This is due to so few new Midwestern plants and to a prominent outlier: the region near Roanoke, Indiana that added 3,896 part supplier jobs after General Motors selected it for assembly plant in 1984. Lower variability in outcomes in the South gives the estimated impact a lower standard error for the specification that includes just the 12 Southern plants than even for the main specification. In the South, an average impact higher than 2,000 supplier jobs may be rejected by a one-tailed t-test at the 5% significance level. Thus, in the South, the direct effects of employment at the assembly plant are greater than the indirect effects of employment at added part suppliers. (In the language of input-output analysis, a type I employment multiplier of more than 2 may be rejected at the 5% significance level.)

Regions that had many incumbent part suppliers when selected for a new assembly plant experienced a net loss in part supplier employment after the announcement, but the losses were less severe than they otherwise would have been. Regions with few part suppliers at the time a new assembly plant was built, on average, experience a small increase in parts supplier employment. Table 11 reports specifications where regions within 100 kilometers of the assembly plant and their propensity score matches are compared separately based on whether the selected region had fewer than 2,000, 2,000 to 10,000, or more than 10,000 parts suppliers when the assembly plant was announced. The

eight plants located in regions with low part supplier employment added an average of 278 parts supplier jobs, outgrowing their propensity score matches by 219 jobs. Regions with between 2,000 and 10,000 experienced almost no change in parts supplier employment in the five years following their designation as an assembly plant site, while the corresponding control group sites added several hundred jobs. The regions with the largest part supplier sector experienced a contraction of the sector after the assembly plant announcement by an average of 1,030 jobs. Yet, sites with similar initial part supplier employment that seemed equally likely to host a new assembly plant had a decrease in part supplier employment of 3,318, suggesting that the new assembly plants mitigated the decline in parts supplier employment by an average of 2,289.

The results in Table 11 are similar to the geographic specifications of Table 10, and indeed the four selected regions with high parts supplier employment are all in the Midwest. To determine whether differences in the assembly plant impacts are explained by the initial size of the parts supplier base or on other differences between the Midwest and South, more variation in assembly plant locations would be needed. The Midwest had only one opening in an area without a large supplier base. Mitsubishi opened an assembly plant in Normal, Illinois. The growth in part supplier employment of 492 and outperformace of propensity score matches are similar to those experienced by isolated Southern plants. No assembly plants in the South had more than 6,000 part supplier employees working within 100 kilometers at the time of the announcement. Nevertheless, the Southern regions with the largest supplier base generally behaved like the Midwestern regions, with declines in part supplier employment that were smaller than those experienced by corresponding propensity score matches.[7]

The study period was a time of change for motor vehicle manufacturing and manufacturing generally. In the decade following 2000, manufacturing employment nationally declined by almost a third, so it is unsurprising that parts supplier employment declined even around newly announced assembly plant sites, as reported in Table 12. The decline at those sites was only half as severe as at control group sites, implying that a new assembly plant preserved an average of 678 supplier jobs. In the two previous decades, new assembly plant sites on average added parts supplier employment in the five years after the announcement, although during the 1990s the gains were less than the control group matches experienced. In the 1980s Japanese carmakers were building their first North American

[7]This pattern holds for Georgetown, Kentucky after Toyota's announcement and Chattanooga, Tennessee after Volkswagen's announcement. Smyrna, Tennessee lost more parts suppliers than its propensity score matches, while Greer, South Carolina added part supplier employment. See Table 6 for details.

Table 9: Parts supplier employment growth after five years within various radii

	within 50 km	within 100 km	within 200 km	within 300 km	within 400 km	within 500 km
Employment change near selected sites (β_{S5})	-91	-112	-751	-3154	-6094	-8505
	(546)	(1762)	(6231)	(12609)	(16794)	(19810)
Employment change near propensity score matches (β_{N5})	-216	-612	-3120	-5174	-6375	-7495
	(512)	(1762)	(6231)	(12609)	(16794)	(19810)
Difference ($\beta_{S5} - \beta_{N5}$)	125	500	2370	2020	280	-1009
	(748)	(2492)	(8812)	(17832)	(23750)	(28015)

Table 10: Parts supplier employment growth after five years in different regions

	All	Midwest	South
	(1)	(2)	(3)
β_{S5}	-112	-895	280
	(1792)	(3778)	(728)
β_{N5}	-612	-2274	219
	(1792)	(3778)	(728)
$\beta_{S5} - \beta_{N5}$	500	1331	61
	(2492)	(5343)	(1029)
Assembly openings	18	6	12

Table 11: Parts supplier employment growth after five years separated by initial levels

		Initial supplier employment		
	All	> 2000	2000 to 10000	< 10000
	(1)	(2)	(3)	(4)
β_{S5}	-112	278	-20	-1030
	(1792)	(412)	(1017)	(3015)
β_{N5}	-612	59	298	-3318
	(1792)	(412)	(1017)	(3015)
$\beta_{S5} - \beta_{N5}$	500	219	-318	2289
	(2492)	(583)	(1438)	(4264)
Assembly openings	18	8	6	4

plants and often requiring supplier partners to build North American plants as well. Perhaps because this first wave of foreign direct investment involved new supplier plants closely tied to downstream assemblers, assembly plants seem to have had the largest causal impact in the 1980s.

5.3 Impact on Other Industries

The Census changed the industry classification it used for County Business Patterns in 1997 from the SIC to NAICS systems. While a simple bridge between the two system was possible for parts suppliers, for many industries such a bridge is not possible. Thus, separate analyses are run for the two systems. For selected SIC industries, Table 13 reports the employment gains after five years and eight years within 100 kilometers of sites where assembly plants were announced between 1980 and 1997. Both the absolute change in employment (in columns 1 and 3) and the employment change relative to the site's propensity score matches (columns 2 and 4) are reported. Table 14 reports the same information for selected NAICS industries in regions where assembly plants were announced between 1998 and 2008.

Automotive assembly employment, of course, increased as a result of a new assembly plant. The earlier assembly plants employed more. Later plants used more capital and less labor, and often, as their companies' second or third North American plants, were designed for less output. Thus, the plants announced before 1997 added 4,117 jobs while plants announced after 1997 added only 2,508.

Automotive stampings (SIC 3465) and Engine Electrical Equipment (SIC 3694) are classified as separate industries from automotive part suppliers. Automotive stamping was simply reclassified as NAICS 336370. In neither the SIC period or the NAICS period was the effect of a new assembly plant on stamping plant employment statistically significant. In the SIC data, a new assembly plant increased employment at stamping factories by 228 relative to the gains in control group sites; in the NAICS data, the relative gains were 91 employees. In the SIC period, the apparent effect of a new assembly plant on employment in engine electrical equipment plants was large, 2,248 more employees than the control group gained five years after the announcement, but not statistical significant. The difference was only half as large after eight years. The reclassification to NAICS codes merged SIC 3694 with fractions of other SIC industries to form NAICS 336322. During the NAICS period, this industry did not experience greater employment losses at new announced assembly plant sites than at control group sites.

Similarly, other industries with large or significant employment changes in one classification period usually did not have notable changes in the corresponding industry code in the other period. Textile

milling was an exception with large, statistically significant declines in employment around new assembly plants in the SIC period, and large (but not significant) declines during the NAICS period. Perhaps assembly plants disproportionately entered locations with a declining textile industry, or perhaps the assembly plants drove up wages to which textile mills were sensitive.

The impact of assembly plant announcements on total civilian employment or total manufacturing employment is not significant, and during the longer SIC classification period is even negative.

6 Conclusion

Parts supplier jobs follow assembly plants only in small numbers, at least at first. The subsidies that bring assembly plants initially bring more direct assembly plant jobs than indirect parts supplier jobs to their region. While some proponents of targeted incentives overstate the importance of assembly plants in the location decisions parts suppliers make, simple averages understate the impact of assembly plants. The average loss in parts supplier employment of 112 in the five years following the announcement is less than the 612 lost jobs in the average comparable site in the same period. The net causal effect of assembly plant then averages to 500 parts supplier jobs after five years.

At longer time frames, the impact appears more substantial. Perhaps assembly plants can trigger a self reinforcing cluster of auto parts suppliers. Even then the estimated impact of only several thousand additional parts supplier jobs should give pause to even the most patient policymakers considering dispersing hundreds of millions of dollars in subsidies.

Table 12: Parts supplier employment growth after five years in different decades

		Announcement date		
	All	1980 to 1989	1990 to 1999	2000 to 2008
	(1)	(2)	(3)	(4)
β_{S5}	-112	211	311	-676
	(1792)	(3043)	(1473)	(2870)
β_{N5}	-612	-641	738	-1354
	(1792)	(3043)	(1473)	(2870)
$\beta_{S5} - \beta_{N5}$	500	852	-427	678
	(2492)	(4304)	(2084)	(4059)
Assembly openings	18	7	4	7

Table 13: Employment growth after plant announcement in different SIC industries

Industry [SIC code]	β_{S5} (1)	$\beta_{S5} - \beta_{N5}$ (2)	β_{S8} (3)	$\beta_{S8} - \beta_{N8}$ (4)
All industries [—-]	133,483	-31,939	172,772	-62,701
	(186,468)	(263,706)	(193,727)	(273,971)
Chemical and fertilizer minerals [1470]	-311***	-315***	-413***	-407***
	(88)	(95)	(88)	(96)
Construction [15–]	5,416	-3,192	4,549	-4,137
	(8,132)	(11,501)	(8,449)	(11,948)
Manufacturing [20–]	44,832	-61,423	49,913	-55,443
	(72,232)	(102,152)	(70,491)	(99,690)
Nonwoven Textile Milling [2297]	-1,649***	-1,682***	-2,475***	-2,540***
	(301)	(319)	(286)	(308)
Aluminum Die-castings [3363]	-147	-804	-327	-1,015
	(413)	(571)	(400)	(556)
Automotive Stamping [3465]	814	228	825	396
	(1,453)	(1,983)	(1,504)	(2,058)
Metal Foil & Leaf [3497]	-566*	-575*	-661**	-676*
	(242)	(270)	(241)	(273)
Refrigeration & Heating Equipment [3585]	724	754	930	811
	(1,014)	(1,433)	(1,053)	(1,489)
Engine Electrical Equipment [3694]	2,268*	2,248	1,309	1,087
	(905)	(1,177)	(905)	(1,203)
Motor Vehicles & Passenger Car Bodies [3711]	4,117*	3,814	5,838***	6,301**
	(1,653)	(2,338)	(1,717)	(2,429)
Motor Homes [3716]	-1,522	-1,544	-2,486*	-2,790*
	(1,164)	(1,241)	(1,127)	(1,216)
Tanks and Tank Components [3795]	2,869***	2,736***	2,755***	2,724***
	(494)	(512)	(494)	(514)
Services [70–]	51,324	-19,762	76,010	-38,318
	(54,550)	(77,145)	(56,673)	(80,148)
Child Day Care Services [8350]	842	-300	1,380	103
	(1,206)	(1,705)	(1,177)	(1,664)

Table 14: Employment growth after plant announcement in different NAICS industries

Industry [NAICS code]	β_{S5} (1)	$\beta_{S5} - \beta_{N5}$ (2)	β_{S8} (3)	$\beta_{S8} - \beta_{N8}$ (4)
All industries [——]	-16,331	16,028	-129,619	196,715
	(202,613)	(286,538)	(248,150)	(350,937)
Construction [23—-]	-1,586	6,295	-1,893	15,493
	(10,442)	(14,767)	(12,788)	(18,086)
Manufacturing [31—-]	-16,367	5,265	-44,696	18,098
	(27,325)	(38,643)	(33,466)	(47,327)
Fiber, Yarn, and Thread Mills [3131–]	-2,593*	-2,418	-2,895*	-2,608
	(1,023)	(1,256)	(1,373)	(1,624)
Automobile & Light Duty Motor Vehicle Manufacturing [33611-]	2508*	2221	3072**	3088*
	(981)	(1282)	(1154)	(1544)
Motor Vehicle Parts Manufacturing [3363–]	-984	905	-4091	1042
	(3907)	(5525)	(4785)	(6767)
Other Motor Vehicle Electrical Equipment Manufacturing [336322]	-257	-358	-421	-173
	(385)	(544)	(436)	(617)
Motor Vehicle Steering & Suspension Components Manufacturing [336330]	-572.7	-545.0	-1271.6*	-985.3
	(454.6)	(558.0)	(537.9)	(670.2)
Motor Vehicle Seating & Interior Trim Manufacturing [336360]	354	321	369	417
	(273)	(376)	(330)	(459)
Motor Vehicle Metal Stamping [336370]	-156	91	-450	283
	(727)	(959)	(843)	(1152)
Motor Vehicle Air-Conditioning Manufacturing [336391]	-649	-517	-705	-562
	(534)	(601)	(716)	(778)
Child Day Care Services [624410]	553	584	23	2639
	(1562)	(2209)	(1913)	(2706)

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