Federal Reserve Bank of Chicago

Comparing location decisions of domestic and foreign auto supplier plants

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WP 2004-27

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Abstract

Plant locations in the U.S. auto industry have been moving southward for some time now. This paper utilizes a comprehensive dataset of the U.S. auto industry and focuses on plant location decisions of auto supplier plants that were opened less than 15 years ago in the U.S. We find that agglomeration continues to matter: suppliers want to be close to each other as well as to their assembly plant customers. We also find evidence of differences in location factors for domestic and foreign suppliers. Foreign suppliers exhibit a stronger preference to be near highways, other foreign suppliers and foreign assembly plants. That helps explain the different location patterns observed for these two groups within the auto region.

JEL codes: R12, R30, L62

Key words: auto supplier industry; plant locations; agglomeration

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The authors would like to thank Cole Bolton and Alexei Zelenev for excellent research assistance.

Motivation

The auto supplier industry in North America has been remarkably concentrated for a long time (see Klier 2000). Since the mid-70s the spatial configuration of this industry has been changing (Rubenstein 1992). While originally oriented east-west, extending from Chicago to New York, the industry is now concentrated in a north-south extension. Detroit remains the hub of this so-called auto corridor, which extends southward to Kentucky and Tennessee with fingers reaching into Mexico and Canada. Yet within this auto region, one can find distinctly different location patterns for domestic and foreign assembly as well as supplier plants. Specifically, most foreign-owned assembly plants in North America tend to be located further south than the assembly plants of domestic producers. In fact the most recently opened light vehicle[1] assembly plants, such as the Honda plant in Lincoln, Alabama and the Nissan plant in Canton, Mississippi, have been situated in the far south of the auto region. The southward shift in the industry's location has been reinforced by the ongoing loss of market share by domestic producers, both through imports as well as production in the U.S. (Klier 2004). Between 2000 and October 2004 the Big Three market share in the U.S. has fallen from 64.8% to 56.5%. While some of that market share loss is attributable to a rise in imports, it is largely explained by increased U.S. production of foreign-owned assembly facilities.

Therefore one might wonder whether Detroit can continue to be the hub of this industry over the medium term horizon.[2] The public policy issues of a changing location pattern in the auto sector are huge.[3] This paper focuses on plant location decisions of auto supplier

[1] The term light vehicle refers to cars and light trucks. Light trucks include sport utility vehicles and minivans.

[2] The northern end of the auto corridor is currently home to over half of all light vehicle assembly plants in the U.S., 81% of these are Big Three facilities. Conversely, the southern end of the auto region is home to about 20% of all light vehicle assembly plants; half of these are foreign producer facilities.

[3] See for example the speech of Michigan's Governor Granholm from August 4 2004 in which she outlines a framework on how Michigan should respond to the current challenges facing its most important sector. Related to the issue of plant location is the role of the border. Post 9/11, elevated national security concerns have exacerbated demands on the already strained border infrastructure between the U.S. and Canada, potentially affecting plant location decisions in an industry that continues to be very tightly integrated and has straddled both sides of the border for many years (see Klier 2003).

plants that were opened less than 15 years ago in the U.S. It addresses the question to what extent agglomeration issues influence plant location in this industry. The comprehensive data includes observations on both domestic and foreign owned plants. In combining plant and county-level data we can therefore test if the location decisions of these two types of plants are influenced by different factors.

Literature

The literature on agglomeration is very large (see for example: Krugman 1991, and Ellison and Glaeser 1997). A number of papers have addressed the question of location choices of new plants in the manufacturing sector. Generally the analysis has been performed for data pertaining to foreign plants locating in the U.S. Ondrich and Wasylenko (1993) estimate multinomial logit models on 1,197 new manufacturing plants built by foreign investing firms in the U.S. between 1978 and 1987. Both Woodward (1992) and Smith and Florida (1994) find that newly established foreign manufacturing plants gravitate to manufacturing intensive counties with good access to highway transportation. Woodward (1992) estimates the location decision of newly established Japanese manufacturing plants in the U.S. For 540 plants that opened during the 80s he estimates conditional logit models both at the state and county level. Smith and Florida (1994) analyze data of more than 400 Japanese automotive-related establishments in the U.S. Neither paper can utilize data on plant-level characteristics. List et al. (2004) model the location decisions of nearly 900 manufacturing plants opened during the 80s in the state of New York. 17% of the sample represents foreign plants, which allows the authors to compare the effects of environmental regulation on plant location by nationality of plant.

Data

The analysis of auto supplier plants presented in this paper is based on data acquired from ELM International, a Michigan-based vendor. While not designed with research applications in mind, the ELM database intends to cover the auto supplier industry in

North America in its entirety. Data are available at the plant and company level. However, plants producing primarily for the aftermarket are not part of the database, neither are plants that produce machine tools or raw materials, such as steel and paint.[4]

The ELM data were purchased at the end of 2003. The database provides 3,542 plant-level records. Included is information on a plant's address, products, employment, parts produced, customer(s), union status, as well as square footage. In order to clean up the data, several operations were performed. First, records were cross-checked with state manufacturing directories to obtain information on the plant's age.[5] Information on captive plants was obtained from Harbour (2003). We also appended information on the nationality of the company to the record of each plant from the ELM company-level data.[6] For the 150 largest supplier companies, the accuracy and completeness of ELM's plant listings, that is the number of plants as well as their location, was cross-checked with the individual company's website when possible.[7] Overall that resulted in a net addition of 335 records. Finally, the accuracy of the employment for the largest plants (employment greater 2,000) was also checked with company websites or phone calls. After this preparation the data consists of 4,478 observations of auto supplier plants located in North America.[8] To our knowledge, this may well be the most accurate plant-level description of the North American auto supplier industry currently available.

Four maps describe the spatial characteristics of this industry. Map 1 presents a bird's eye view of the North American auto industry. It shows the location of all supplier and light vehicle assembly plants operational in 2003. The coordinates of individual plants are measured at the zipcode level of detail. The symbols in the map are scaled to reflect the density of plant locations. Most noticeable about this industry is its degree of spatial concentration. It centers around Detroit and extends south as well as northeast into

[4] The data include information on the so-called captive supplier plants. These are parts operations that are owned and operated by the assemblers themselves, such as engine and stamping facilities.
[5] Plants for which no matching records were found were contacted by phone.
[6] We distinguish North American (U.S., Canadian, or Mexican-owned plants), Japanese plants, as well as other foreign-owned plants.
[7] Thanks to Jim Rubenstein who shared his plant-level data for the 150 largest supplier companies. The 150 largest supplier companies are listed annually in the industry weekly Automotive News.

Canada and west to Chicago. Most of the assembly plants currently in operation are situated in the interior of the country. A sizeable piece of this industry is located in Mexico, which is home to 13 assembly and over 600 supplier plants. Some of these are located right at the Mexico-US border (see Winter 1992 on these so-called maquilasora plants).

Map 2 shows only the young supplier plants, that is plants that opened in 1991 or more recently and survived through 2003. We plot only U.S. plant locations, as the formal model will not utilize Canadian and Mexican data. 432 auto supplier plants were opened in the U.S. since 1990 and survived through 2003. These plants are located in 245 different counties. 294 of these "young" auto supplier plants are domestic (they are located in 189 counties), the remaining 138 are foreign (located in 108 counties). Map 2 also shows the location of domestic and foreign light vehicle assembly plants operational as of 2003. Of the 59 light vehicle assembly plants that operated in the U.S., 45 are domestic and 14 are foreign.[9] On a very general level, the sample of plants shown in map 2 seems to concentrate in an area very similar to the one shown in map 1. Maps 3 and 4 then break up the young auto supplier plants shown on map 2 into domestic (map 3) and foreign (map 4) supplier plants. Common to both maps is the importance of the highway infrastructure: plants often are arrayed along interstate highways like pearls on a string. Foreign young suppliers clearly choose locations on average further south than domestic young suppliers.

Model

In order to estimate the plant location model we utilize a tobit model (see Smith and Florida, 1994). It allows us to keep information on counties that received no plants during the observation period. In the model an observation is a county. The dependent variable is the number of young auto supplier plants in a county. Since we have plant-specific

[8] 3,416 suppliers are located in the U.S., 461 in Canada and 601 in Mexico. The Mexican data have not yet been scrutinized to the same extent.

[9] The Chrysler assembly plants are coded as domestic, whereas the Mercedes assembly plant in Alabama is coded as foreign.

information, we also estimate models for just the foreign and domestic young supplier plants (see table 1 for summary statistics).

The independent variables fall into two groups: measures of industry agglomeration and county-level control variables. Ellison and Glaeser 1997 showed that the auto industry is highly clustered. We try to account for agglomeration effects on supplier plant location by way of the following variables. These are all measured from within the auto supplier data based and refer to information from 2003. First, we measure the location of a county relative to auto assembly plants. We measure the straight-line distance between the centroid of a county and the centroid of the zipcode of the nearest domestic (foreign) light vehicle assembly plant. That way we account for the preference of suppliers to be located close to individual auto assembly plants. In addition, suppliers also would like to locate such that they have multiple customers they can deliver to. We therefore count the number of assembly plants (foreign and domestic ones separately) within a 450 mile radius of a county's centroid. Within the industry a 450 mile radius corresponds to the distance one can cover reliably to a customer in order to assure reliable delivery within the same day (Klier 2000). In counting the number of potential assembly plant customers within that radius we account for the size of the market for suppliers that locate in a county. The larger the market, the more supplier plants it can support. Secondly, agglomeration might also matter among suppliers themselves. We measure agglomeration among suppliers within a county by counting the stock of existing supplier plants at the end of 1990. Again, we distinguish domestic from foreign supplier plants.

The remainder of the variables control for county-specific conditions potentially relevant to the location decision. They all represent information from the year 1990, prior to when the plants in our sample opened. We measure if the county is in a right to work state. Highway connection in county is a dummy that is set to 1 if an interstate highway runs through a county. Population density, percent of workforce with at least high-school education, and the share of the white population in a county control for demographic factors. Finally, we also control for the county-level crime rate, the importance of the

manufacturing sector, as well as the distance of the county to Detroit, the center of the auto industry.

Results

Table 2 reports the results of the tobit estimations.[10] We report two different specifications: columns 1-3 estimate the location model that includes a dummy variable to account for the right-to-work law states. Columns 4-6 instead incorporate state-fixed effects. Within these two specifications the first column (1 and 4) reports the estimation for the number of all young supplier plants opened. Subsequently we break out the domestic and foreign young supplier plants to allow for differences in the size and direction of the independent variables.

First, the presence of an interstate highway in a county exhibits a strong positive effect on the number of new supplier plants locating in a county. That effect holds up consistently across all specifications estimated. Furthermore, the presence of transportation infrastructure in a county is twice as important to foreign suppliers as compared to domestic suppliers. We also find evidence of agglomeration for this industry. This plays out at two different levels. Young supplier plants want to locate in counties that already have supplier plants in them. Specifically, the attraction of existing foreign supplier plants is larger than that of existing domestic suppliers. Columns 2 and 3 (and 5 and 6) show that domestic young suppliers plants are attracted to both domestic and foreign existing suppliers in the same county. Conversely, foreign young suppliers are attracted only to existing foreign suppliers. Furthermore, the impact of existing foreign suppliers on new plant locations of foreign suppliers in the same county is twice as large as that of existing domestic suppliers on new domestic supplier plants.

The presence of assembly plants also matters for the location decision of supplier plants. We included two aspects of this effect: the role of the nearest assembly plant as well as

[10] Since the dependent variable is a count variable, we also estimated a poisson model for this relationship. The results reported in table 2 were found to be robust.

the size of the market (measured as the number of assembly plants) that can be served from a given county in a just-in-time fashion. Even after controlling for right-to-work states as well as the distance to Detroit, a larger number of foreign assembly plants within a day's drive of a county significantly increases the number of young foreign suppliers in that county. No such effect is found for the presence of domestic assembly plants. As for the distance to the nearest assembly plant, we find it is important for young domestic suppliers to be near a domestic assembly plant. Vice versa, foreign young supplier plants like to be near a foreign assembly plant. Here again, the effect of the presence of a foreign nearest assembly plant neighbor is found to be stronger than that of a domestic assembly plant neighbor.

As for the county-level control variables, we find that domestic young suppliers want to locate in counties with an educated workforce. Both domestic and foreign young suppliers prefer to locate in counties that have a concentration in manufacturing activities.

Summary and Conclusions

Consistent with earlier literature and with the importance of supply chain management in the auto industry, we find that access to highway transportation is an important location factor for plants in the auto supplier industry. In addition, we find evidence of agglomeration. The presence of other suppliers as well as the proximity to assembly plants of the same nationality matters in the location decision of auto supplier plants. Unlike previous work on this industry, we were able to distinguish location factors for domestic and foreign auto supplier plants. We find that domestic and foreign supplier plants follow different location patterns: foreign suppliers show a stronger highway effect, possibly indicating a greater importance if just-in-time production constraints in choosing plant locations for that group. They also show a stronger preference to locate near other foreign suppliers and close to foreign assembly plants than exhibited by domestic suppliers (both to domestic suppliers and domestic assemblers). That helps explain the different location patterns observed for these two groups within the auto

region. Future work will formally link company- and county-level data.

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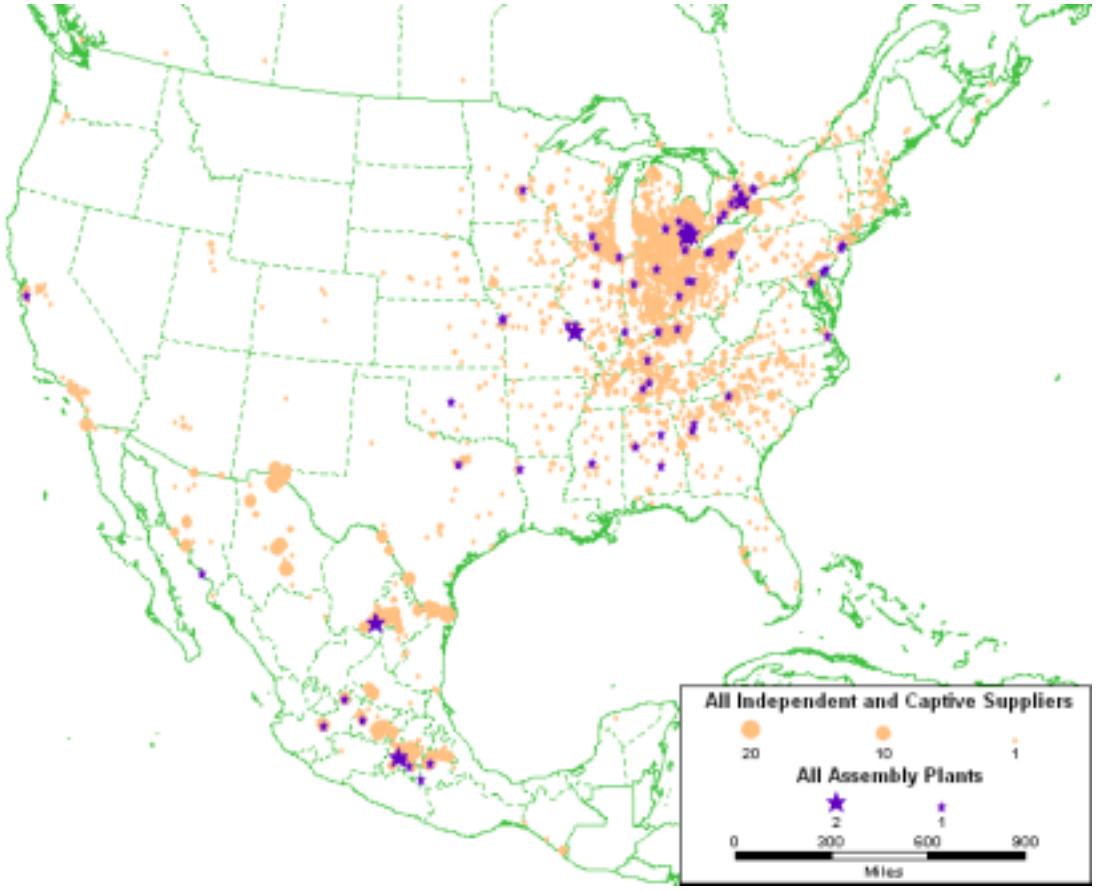
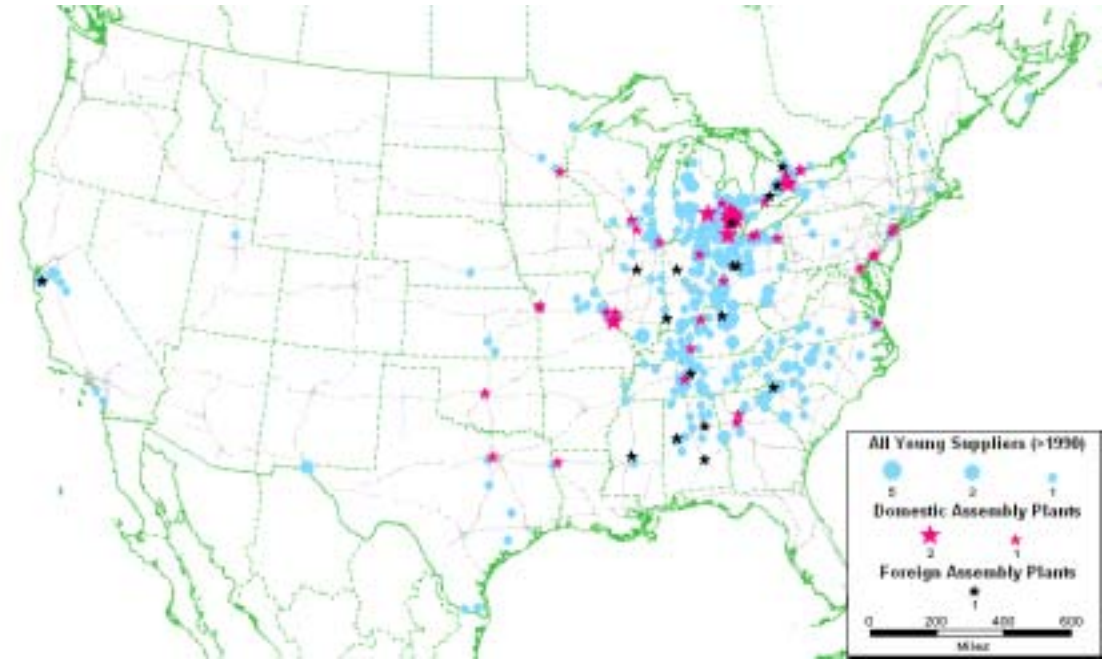
Tables/Charts

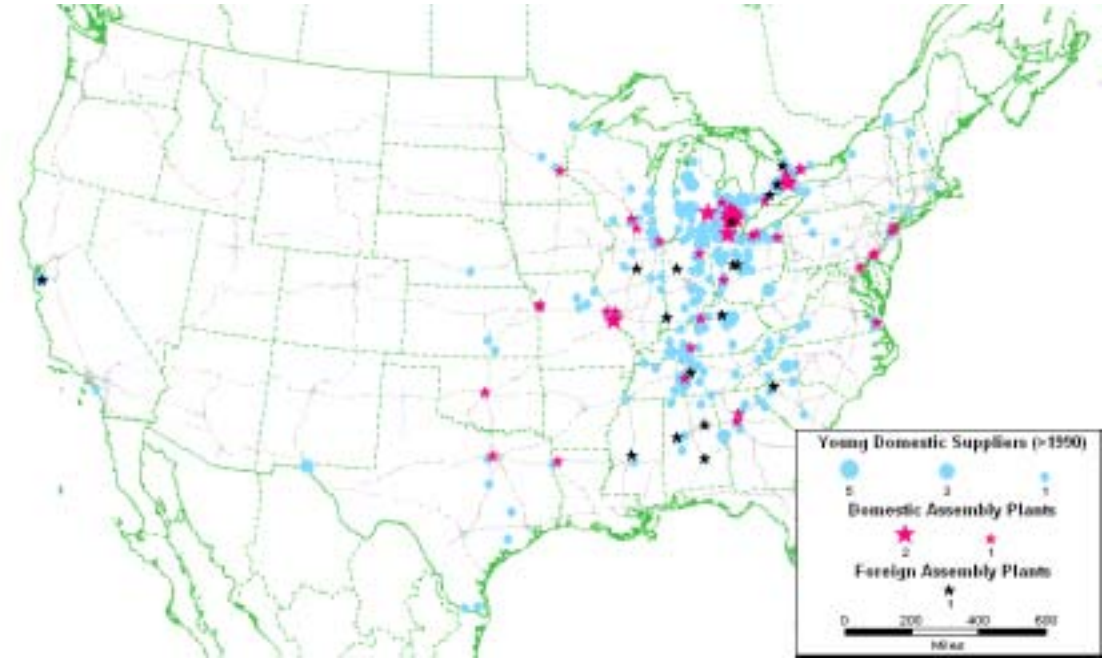
Map 1: The North American auto industry, 2003



Map 2: Supplier plant opened since 1991



Map 3: Domestic supplier plants opened since 1991



Map 4: Foreign supplier plants opened since 1991

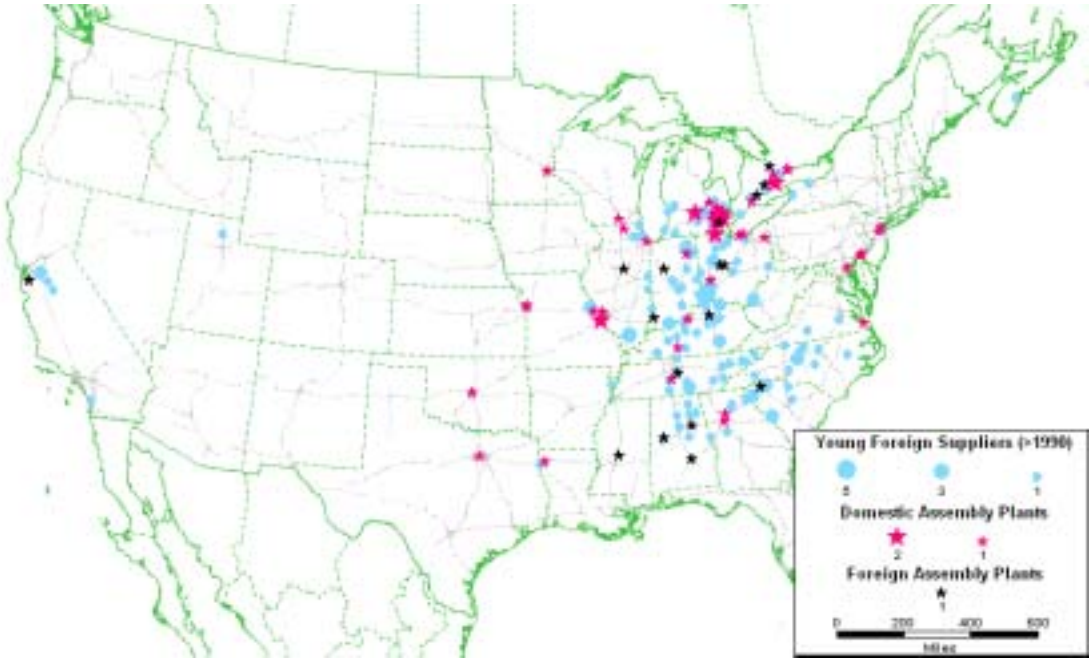


Table 1: Summary statistics

VARIABLE	N	MEAN	SD	MIN	MAX
# YOUNG SUPPLIER PLANTS	3136	0.1	0.8	0.0	20.0
# YOUNG DOMESTIC SUPPLIER PLANTS	3136	0.1	0.6	0.0	18.0
# YOUNG FOREIGN SUPPLIER PLANTS	3136	0.0	0.3	0.0	5.0
HIGHWAY DUMMY	3136	0.4	0.5	0.0	1.0
NEAREST DOMESTIC ASSEMBLER	3136	278.7	391.2	1.4	3816.8
NEAREST FOREIGN ASSEMBLER	3136	341.9	292.6	1.2	2540.1
# F W/450 miles	3136	5.0	4.7	0.0	14.0
# D W/450 miles	3136	14.3	13.8	0.0	45.0
# EXISITING DOMESTIC SUPPL.	3136	0.8	3.6	0.0	102.0
# EXISTING FOREIGN SUPPL.	3136	0.2	0.8	0.0	23.0
RIGHT TO WORK	3136	0.6	0.5	0.0	1.0
POPULATION DENSITY	3136	216.3	1428.1	0.1	53126.3
PERCENT WHITE	3136	0.9	0.2	0.1	1.0
PERCENT HIGH SCHOOL	3136	69.6	10.4	31.6	95.5
MFG EMPLOYMENT PERCENT	3136	18.5	10.6	0.0	53.7
VIOLENT CRIME RATE	3136	279.5	322.3	0.0	3449.1
PROPERTY CRIME RATE	3136	2641.5	1998.0	0.0	20557.4
DISTANCE DETROIT	3136	762.5	499.6	12.9	4542.3

Table 2: Regression results

	1	2	3	4	5	6
	RIGHT TO WORK			STATE FIXED EFFECTS		
	ALL YOUNG	D YOUNG	F YOUNG	ALL YOUNG	D YOUNG	F YOUNG
HIGHWAY CONNECTION IN COUNTY	0.70	0.46	1.05	0.73	0.51	1.03
	(0.000)***	(0.006)***	(0.000)***	(0.000)***	(0.003)***	(0.000)***
DISTANCE TO NEAREST D ASSEMBLER	0.00	0.00	0.00	0.00	0.00	-0.01
	-0.16	(0.007)***	-0.38	-0.57	-0.30	(0.061)*
DISTANCE TO NEAREST F ASSEMBLER	0.00	0.00	-0.01	0.00	0.00	-0.01
	(0.038)**	-0.79	(0.001)***	(0.088)*	-0.10	(0.029)**
# F ASSEMBLERS WITHIN 450 MILES	0.18	0.15	0.24	0.12	0.10	0.12
	(0.000)***	(0.000)***	(0.002)***	(0.070)*	-0.12	-0.23
# D ASSEMBLERS WITHIN 450 MILES	-0.01	-0.01	-0.01	-0.03	-0.03	0.00
	-0.49	-0.49	-0.66	-0.24	-0.20	-0.99
# EXISTING D SUPPLIERS	0.14	0.14	0.01	0.15	0.14	0.01
	(0.000)***	(0.000)***	-0.63	(0.000)***	(0.000)***	-0.72
# EXISTING F SUPPLIERS	0.44	0.36	0.26	0.37	0.32	0.19
	(0.000)***	(0.000)***	(0.004)***	(0.000)***	(0.000)***	(0.030)**
RIGHT TO WORK STATE	-0.51	-0.53	0.08			
	(0.036)**	(0.019)**	-0.85			
POPULATION DENSITY 1990	0.00	0.00	0.00	0.00	0.00	0.00
	-0.50	-0.59	-0.61	-0.33	-0.58	-0.45
PERCENT WHITE 1990	0.53	0.21	0.26	0.03	-0.21	-0.60
	-0.53	-0.80	-0.84	-0.98	-0.83	-0.68
PERCENT HIGH SCHOOL 1990	0.02	0.02	0.03	0.03	0.04	0.03
	(0.062)*	(0.032)**	-0.13	(0.014)**	(0.005)***	-0.18
PERCENT MFG EMPLOYMENT 1990	0.05	0.04	0.04	0.04	0.04	0.03
	(0.000)***	(0.000)***	(0.006)***	(0.000)***	(0.001)***	(0.077)*
VIOLENT CRIME RATE 1990	0.00	0.00	0.00	0.00	0.00	0.00
	-0.41	-0.42	-0.73	-0.21	-0.44	-0.26
PROPERTY CRIME RATE 1990	0.00	0.00	0.00	0.00	0.00	0.00
	(0.000)***	(0.000)***	(0.002)***	(0.000)***	(0.000)***	(0.004)***
DISTANCE TO DETROIT	0.00	0.00	0.00	0.00	0.00	0.00
	-0.49	-0.38	-0.81	-0.37	-0.74	-0.11
Constant	-7.79	-7.03	-9.28	-6.01	-6.66	-2.61
	(0.000)***	(0.000)***	(0.000)***	(0.003)***	(0.001)***	-0.40
Observations	3136	3136	3136	3136	3136	3136
LOG LIKELIHOOD	-878	-677	-448	-842	-643	-421
PSEUDO R2	.2994	.3221	.2506	.327	.3551	.2965
	p values in parentheses					
	* significant at 10%; ** significant at 5%; *** significant at 1%					

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