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# Configuration of the North American and European auto industries – a comparison of trends

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The sharp economic downturn that began at the end of 2007 severely impacted the auto industries on both sides of the Atlantic. The paper summarizes changes in the industry footprint for both North America and Europe. In North America the current geography came about through a dramatic reallocation of market share and subsequent plant turnover. In Europe an expansion of the industry footprint was motivated by the opening of Eastern European countries and markets. Only in North America did the recent recession significantly reduce production capacity. The locations of parts producers are closely tied to assembly locations in both regions to support just-in-time production. Yet, the supply base appears more spatially concentrated in Europe.

Automobile Industry, Geography, Locations, Carmakers, Suppliers, USA, Europe

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## 1. Introduction

The evolving structure and geography of the auto sector in both North America and Europe has been a topic of steady interest over the years. Subsequent to the arrival of just in time production methods, Estall (1985) surmised about the impact on the footprint of the industry. Rubenstein (1992) documented the rise and fall of the branch assembly plant system and the subsequent re-concentration of auto assembly in the center of the U.S. Klier and Rubenstein (2008, 2010) have written extensively on the emergence of auto alley as a north-south oriented auto region in North America. Analysis of spatial trends for the European region concentrated on regional changes, such as the opening of assembly plants in southwestern Europe during the 80s, as well as the eastward expansion of the auto industry subsequent to the fall of the iron curtain in the early 90s (see Lung (2003), Domanski and Lung (2009), Domanski and Gwosdz (2009), and most recently Jürgens and Krzywdzinski (2010)).

The substantial downturn experienced by the auto industry around the world in 2008 and 2009 as well as the fact that many vehicle and parts producers have become truly globalized in their operations prompted us to compare the footprint of the auto industry in North America and Europe. Both common and unique influences are expected to shape the industry's footprint in each region. We expect the spatial influences of just-in-time manufacturing, a production system that has been applied around the world, to show similar effects in both regions. Yet important differences exist between both regions, such as the role of national economic policies as well as the timing and extent of economic integration. Several recent papers look at the policy response to the crisis (Coffey and Pardi (2010), Pavlinek and Zenka (2010), and Klier and Rubenstein (2011)). This paper represents a first attempt to take stock of location trends of this industry for both North America and Europe in comparative fashion.

## 2. Data

The paper draws on a comprehensive data set of assembly plant locations in both North America and Europe. The information on assembly plant locations represents panel data; it covers all large (output of at least 100,000 units a year) assembly plants producing light vehicles going back to 1980. Data for North America were obtained from the Ward's database "autoinfobank", as well as the Ward's Industry Yearbooks for the first half of the 1980s. Data for assembly plant locations in Europe were obtained from the European Automobile Manufacturers Association (ACEA) as well as from company websites.

Information on the location of plants producing motor vehicle parts was obtained via company websites for the year 2010. For both North America and Europe we started with a list of the largest supplier companies by revenue.<sup>1</sup> For each of those companies we compiled a current list of production facilities from the company websites. Our list focuses on production establishments and, when possible, only includes locations that produce at least some of the output for automotive applications.

## 3. Assembly footprint

### a. North America<sup>2</sup>

At the end of 2010 vehicles were assembled at 62 final assembly plants in North America (see table 1).<sup>3</sup> The three Detroit-based carmakers (Chrysler, Ford, and GM)

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<sup>1</sup> Automotive News, Top 150 suppliers supplement, May 24, 2010. To compile the list of supplier companies for Europe we started with a list of the global 100 largest suppliers. We sorted by revenue in Europe (excluding the ones that don't do business in Europe) and cross-referenced with a list of the 30 largest motor vehicle parts suppliers in Europe. We end up with a list of 94 companies.

<sup>2</sup> This section draws heavily on Klier and Rubenstein 2010.

<sup>3</sup> Figures on plants in operation exclude those that are idled or announced for closure in 2011 or 2012. Also excluded are assembly plants designed for annual capacity of less than 100,000 vehicles, such as GM's Corvette facility in Bowling Green, Kentucky. A handful of assembly plants, such as Honda's at Marysville and Toyota's at Georgetown, contain two independent final assembly lines; in this analysis these facilities are counted only once. By the same token, plants under construction in 2010 are included in the count (e.g. Toyota Mississippi and VW Tennessee).

owned 36 of the plants and the 10 foreign-headquartered companies owned the other 26.

Table 1. Light vehicle assembly plants in North America, 1980-2010

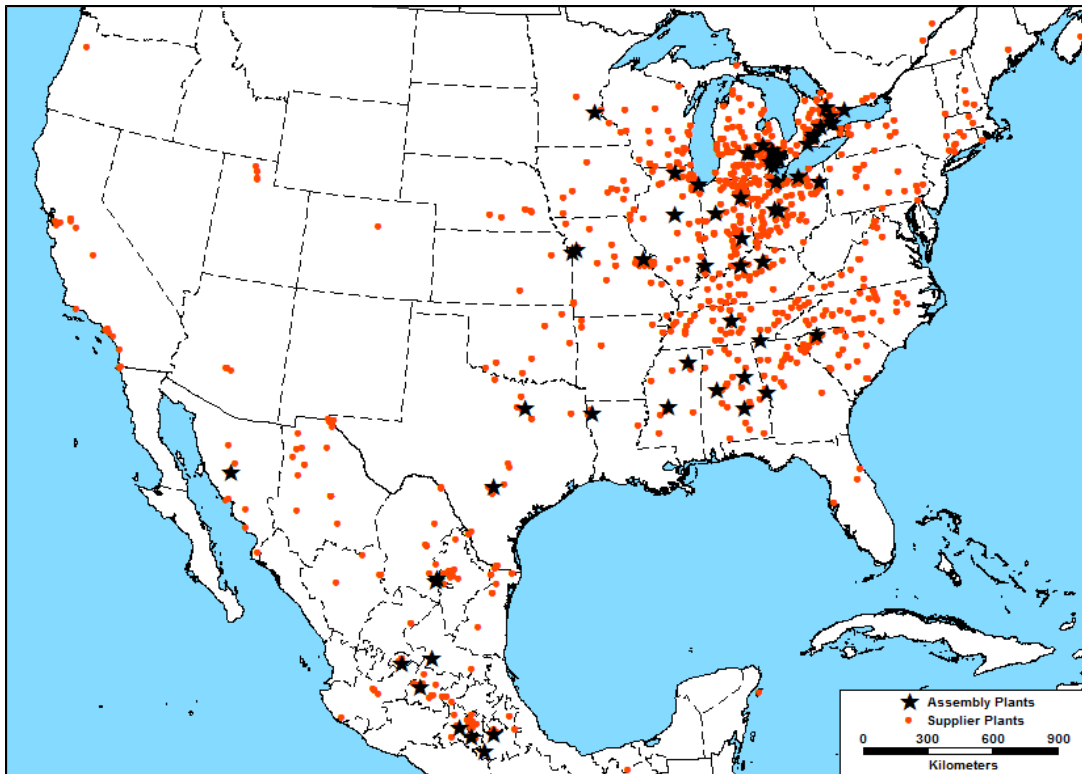
	Detroit 3		Other carmakers		Total	
	1980	2010	1980	2010	1980	2010
US	55	24	1	18	56	42
Canada	10	5	0	5	10	10
Mexico	4	7	2	3	6	10
Total	69	36	3	26	72	62

Note: 2010 is forward looking in this table; it includes three plants scheduled to close (Ford's St. Paul plant in 2011, St. Therese, Ontario, in 2011, and GM's Shreveport plant in 2012) and two plants that opened in 2011 (VW in Chattanooga and Toyota in Blue Springs). The table also includes GM's Spring Hill plant, as it will re-open in 2012 according to the 2011 labor contract between the UAW and GM.

Source: authors' database

Most of the North American motor vehicle industry is highly concentrated in a region known as auto alley (see Figure 1). Auto alley refers to a narrow corridor, roughly 1,100 km long and often less than 160 km wide, in the interior of the US between the Great Lakes and the Gulf of Mexico, extending northeast along highway 401 into southwestern Ontario, Canada. The U.S. portion of auto alley is framed by two parallel north-south interstate highways, I-65 and I-75. East-west highways, including I-40, I-64, and I-70, connect the two north-south routes like rungs on a ladder. The concentrated footprint of this industry reflects both the interdependence of suppliers and assemblers and the importance of transportation infrastructure.

Figure 1. North America – motor vehicle industry footprint, 2010



The largest number of North American motor vehicle production facilities outside of auto alley is located in Mexico. Most of these are situated in central Mexico, near Mexico City, the country's largest market.<sup>4</sup> Several are located in northern Mexico, roughly 200 km south of the U.S. border.

Auto alley began to take shape during the 1980s. Two main factors drove the change in the footprint of motor vehicle production in North America: the construction of North American assembly plants by foreign-headquartered carmakers and the restructuring of the Detroit-based carmakers.<sup>5</sup> By the end of the first decade of the 21<sup>st</sup> century auto alley was firmly established as the dominant auto region. Figure 2 illustrates the rather dramatic re-orientation of the industry's footprint during the last 30 years.

Figure 2a. Assembly plants in U.S. and Ontario, 1980 (several plants are located off the map)

<sup>4</sup> See Carillo (2000) and Covarrubias (2011) on the location and specialization of assembly plants in Mexico.

<sup>5</sup> For more detail on the changes between 1980 and 2010 see Klier and Rubenstein (2010).

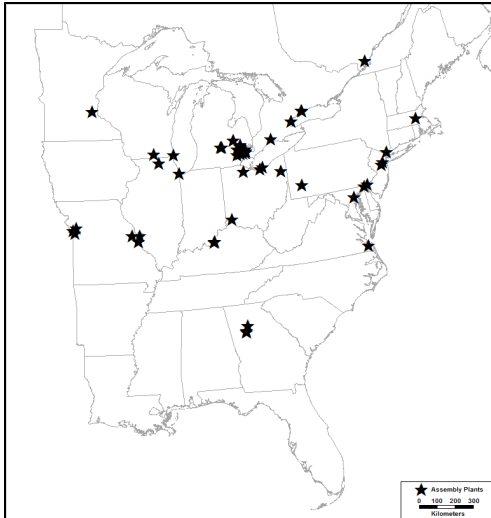
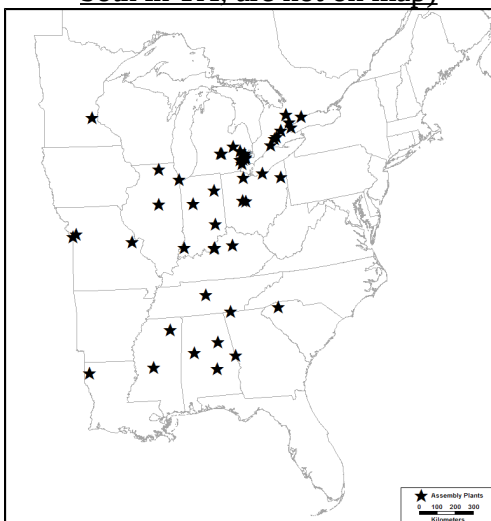


Figure 2b. Assembly plants in U.S. and Canada, 2010 (only 2 plants, both in TX, are not on map)



Mexico has a long history of foreign-headquartered companies producing vehicles there. Both GM and Chrysler started production in Mexico in the 1930s. Overseas producers VW and Nissan chose Mexico as their first entry point to North America during the 1960s. At the time the footprint of vehicle assembly in Mexico was very much concentrated around Mexico City. That pattern continued well into the 1980s. During the last 3 decades Mexico saw new investment into vehicle assembly, increasing its total of light vehicle assembly plants from 6 to 10.<sup>6</sup> In fact, by 2010 Mexico had opened up a noticeable gap over Canada in light vehicle production.

As the size of Mexico's industry grew, its footprint became more dispersed (see figure 3). Yet to date Mexico's motor vehicle industry exists as a mostly separate production region within North America, without being tightly integrated geographically into auto alley. Nevertheless, the vast majority of Mexico's light vehicle production is being exported (Mexico's export share was 83% in 2010);

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<sup>6</sup> Honda's and Toyota's Mexican assembly plants not included here, as to date neither company has produced more than 100,000 units a year in Mexico.

most of the exports are headed to the US and Canada<sup>7</sup>. Lower Mexican labor costs are more than offsetting the additional costs of shipping finished cars to the north.

Figure 3a. Assembly plants in Mexico, 1980



Figure 3b. Assembly plants in Mexico, 2010



The massive capacity reduction that occurred during the sharp recession between 2007 and 2009 (the Detroit carmakers closed a dozen assembly plants in the U.S. and one each in Canada and Mexico) represents the most recent change to the industry's footprint. The plant closures left the Detroit Three with 19 US assembly plants in auto alley and only 4 elsewhere. By the end of 2010 both the east and west coasts were empty of assembly plants (30 years ago they were home to 12 plants). Within the U.S. the Detroit 3 had shrunk considerably during the previous three decades. In 2010 they were operating final assembly plants in only eight states, compared to 19 in 1980.<sup>8</sup>

To recap, the assembly footprint in North America changed quite dramatically over the last three decades. The two main forces were the dismantling of the Detroit carmakers' branch assembly plant system, as well as the arrival of foreign headquartered carmakers.<sup>9</sup> As a result, vehicle assembly activity re-concentrated in the center of the U.S. In addition, the desire by foreign producers to hire a workforce with little automotive experience, as well as avoid overlapping labor sheds for

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<sup>7</sup> 56% of Mexico's vehicle production was exported to the U.S. in 2010 (Automotive News, 2011, p. 25).

<sup>8</sup> On the other hand, the foreign-headquartered producers grew their presence from just one state in 1980 to 10 in 2010.

<sup>9</sup> In 1980 foreign-headquartered producers operated 1 assembly plant in the U.S. and 2 in Mexico. By 2010, foreign-headquartered producers represented 42% of all assembly plants producing light vehicles in North America.

competing assembly facilities resulted in the opening of many greenfield locations, most of which were located south of the traditional auto region.

## b. Europe<sup>10</sup>

At first glance, Europe's experience seems rather similar to the one in North America (see Figure 4 for the 2010 footprint). Just like in North America, the assembly footprint expanded (here to the east, in North America to the south) (see Figure 5). Both expansions were directed toward low wage countries/regions. In fact, in both cases the assembly footprint expanded by around 700 km. Only in Europe, however, did this change in geography represent a net industry expansion. In the U.S. and Canada the auto industry footprint pivoted around Detroit, extending further south in the process and at the same time shrinking in the east-west dimension.

Figure 4. Europe – motor vehicle industry footprint, 2010

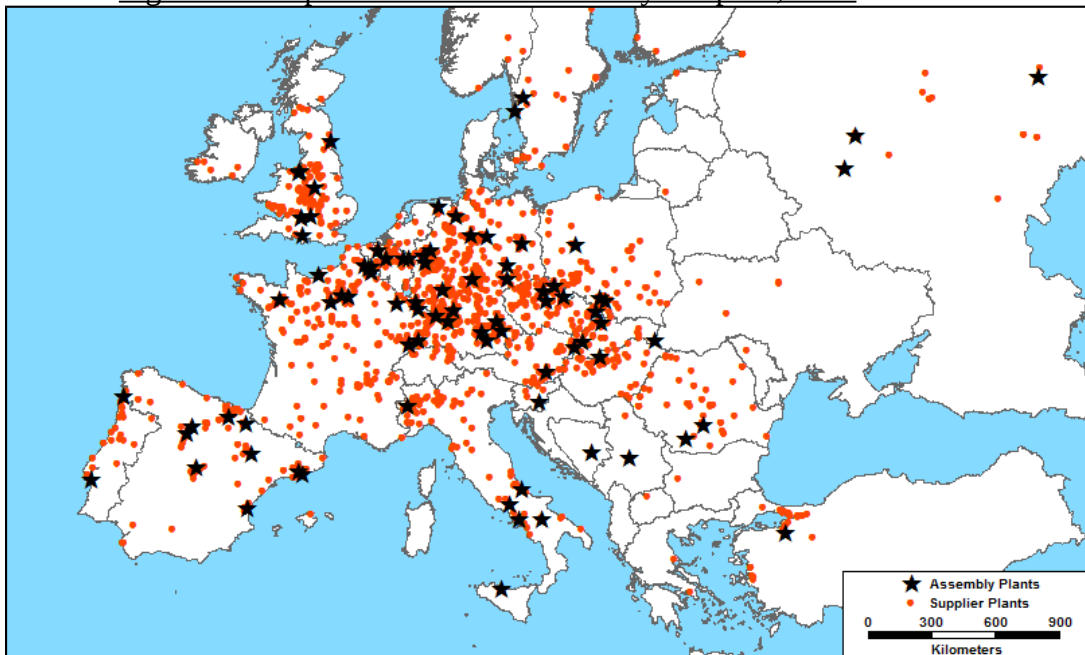


Figure 5a. Assembly plants in Europe, 1980

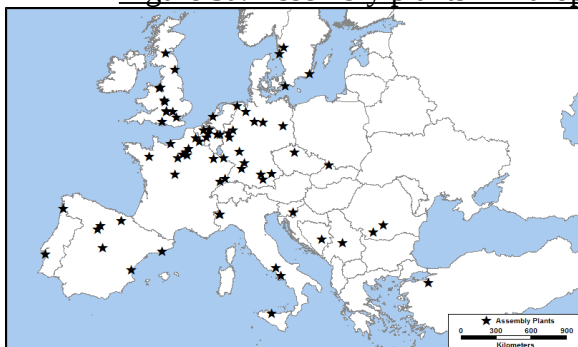
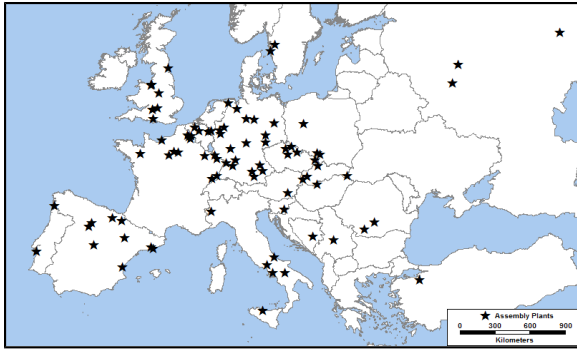


Figure 5b. Assembly plants in Europe, 2010

<sup>10</sup> This section draws heavily on Jürgens and Krzywdzinski (2010).



The eastward expansion of the European auto region took place in the wake of the fall of the iron curtain. The move into Eastern Europe was motivated by a desire to access the newly opened local markets as well as to draw on substantially lower labor costs. Between 1980 and 2010 the number of assembly plants in Eastern Europe rose from 6 to 21. Two thirds of the additional plants are located in just four countries: the Czech Republic, Poland, Slovakia, and Russia. Prior to that, the lower wage countries in Western Europe, primarily Spain and Portugal, were the main beneficiaries of new automotive investment, following the political liberalization of these two countries during the 70s and their subsequent integration into what was then the European Economic Union.

On net, the last 15 years have seen a noticeable expansion in the number of light vehicle assembly plants in Europe, all of them in eastern Europe (see Table 2). Western Europe's count of assembly plants remained stable at 65 between 1980 and 2010. Yet that stability masks a noticeable reallocation of plants within that region. By all accounts the UK experienced the largest turnover. It gained four new plants, all by Asian headquartered carmakers who chose the UK as their entry point to Europe. By 2010 the UK was home to nearly 60% of all Asian headquartered assembly plants in Western Europe. During the same time period the country also experienced a loss of eight assembly plants owned by European carmakers. Germany, the country with the largest concentration of assembly plants in 1980 increased its plant count by 30%. Two of the four plants opened since 1990 are located in former East Germany. Finally, a number of smaller countries experienced a decline in their auto assembly activity, either due to the decline of the national carmaker (Volvo and Saab each closed a plant in Sweden), or because the country did not have a national carmaker (Renault closed a plant each in Belgium and Portugal, Ford closed a plant in the Netherlands, and GM closed a plant in Belgium).

Table 2. Light vehicle assembly plants in Europe, 1980-2010

	Europeans		Other carmakers		Total	
	1980	2010	1980	2010	1980	2010
<b>Western Europe</b>	<b>65</b>	<b>58</b>	<b>0</b>	<b>7</b>	<b>65</b>	<b>65</b>
UK	12	4	0	4	12	8
Italy	5	5	0	0	5	5
France	12	12	0	1	12	13
Germany	15	20	0	0	15	20(a)

Spain	7	9	0	1	7	10
Other WE	14	8	0	1	14	9
<b>Eastern Europe</b>	<b>6</b>	<b>15</b>	<b>0</b>	<b>6</b>	<b>6</b>	<b>21</b>
Czech R.	2	3	0	2	2	5
Poland	0	3	0	0	0	3
Russia	0	1	0	2	0	3
Slovakia	1	2	0	1	1	3
Other EE	3	6	0	1	3	7
<b>TOTAL</b>	<b>71</b>	<b>73</b>	<b>0</b>	<b>13</b>	<b>71</b>	<b>86</b>

Note: European vehicle producers include Opel and Ford. Europe includes Russia but not Turkey in this table.

2010 is forward looking in this table. It includes a plant scheduled to open in 2012; it also incorporates a closure scheduled for the same year.

(a) Four of the 5 new plants built in Germany since 1980 opened after 1990, two of four are located in former East Germany

Source: authors' database

Jürgens and Krzywdzinski (2010) distinguish three phases of automotive investment into Eastern Europe. Between 1990 and 1995 companies like Volkswagen, Fiat, Renault and Daewoo set up operations with the intent of opening up local markets. The main recipient countries of the investments were the Czech Republic, Hungary, and Poland. It turned out that the expectations for local demand growth were overly optimistic at the time. The assembly companies subsequently focused on being able to produce with a lower cost-structure. The second investment phase extended from 1995 to 1998. During that time GM built a new assembly plant in Poland, Renault took over a former Dacia plant in Romania and turned it into a crucial site for its small car strategy<sup>11</sup>. In addition, a number of captive engine and transmission plants were also opened in Eastern Europe (by VW, Audi, GM, and Toyota). The main recipients of investment during that phase were Poland, the Czech Republic, and Hungary. The third phase played out in the first decade of the 21<sup>st</sup> century as cost reduction continued to be the main driver of investment. This phase also saw a wave of supplier plants following the assembly investments. The main recipient countries were the Czech Republic, Slovakia, Romania, and Poland.

Yet, upon closer inspection, some fundamental differences emerge between the industry evolution in Europe and North America. While in North America the industry footprint was re-shaped in rather dramatic fashion, resulting in the disappearance of all coastal plants at the same time as the north-south oriented auto alley emerged, in Europe the industry footprint expanded, primarily to the east. Consistent with that, there was much less turnover among individual assembly plants in Europe than in North America during those three decades. Indicative of the difference in industry restructuring is the relative share of Asian- headquartered producers in both regions. In North America they grew to represent 37% of all light vehicle production by 2010 from 3% in 1985. In Europe, on the other hand, Asian-headquartered vehicle assemblers play a much smaller role. Nissan was first to start

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<sup>11</sup> It is the production site for the "Logan".

production in Europe among Asian-headquartered car producers; it opened a plant in the UK in 1986 and one in Spain the following year.<sup>12</sup> By 2010 there were only 13 assembly plants located in Europe that were operated by Asian-headquartered producers. Four of these plants were structured as joint ventures with European carmakers.

During the Great Recession Europe's auto sector hardly cut back production capacity despite experiencing a similarly large downturn as North America.<sup>13</sup> By 2010 the number of assembly plants had risen considerably from 67 in 1980 to 83.<sup>14</sup>

To summarize, unlike North America's, Europe's assembly footprint expanded during the last 30 years by extending eastward subsequent to the fall of the iron curtain. It is possible that the expansion of the last decade and a half presages a future consolidation. Noteworthy as well is the substantially smaller role that Asian-headquartered vehicle producers play in Europe.

## 4. Parts production footprint

### a. North America

The geography of motor vehicle parts production in North America has been little changed over many decades (Klier and McMillen, 2006). Because it was cheaper to ship parts than finished vehicles across the country, parts production facilities tended to stay in the historic center of the North American automobile industry, in the Midwest. Over time, a number of factors pulled locations further apart, both within North America as well as globally. However the parts sector footprint remains noticeably clustered and is tightly linked with assembly locations (see Figure 1).

Klier and Rubenstein (2008) detail some of the centrifugal forces on the distribution of parts production by discussing in great detail the distribution of locations by major automobile subsystem. They find that electronics parts, in particular, tend to be produced farthest away from Detroit, which continues to be the center of North America's auto industry. Many electronics parts in fact are being imported from overseas. The maquiladora plants just inside Mexico, visible in Figure 6, initially pulled south production of labor intensive parts, such as wiring harnesses, as early as during the 1980s. That marked the first step of a steady increase in Mexico's role as a low-cost location of parts production. Finally, as foreign-headquartered motor vehicle assemblers extended the southern end of auto

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<sup>12</sup> Nissan was also the first Asian producer in North America, opening its Cuernavaca assembly plant in Mexico in 1966.

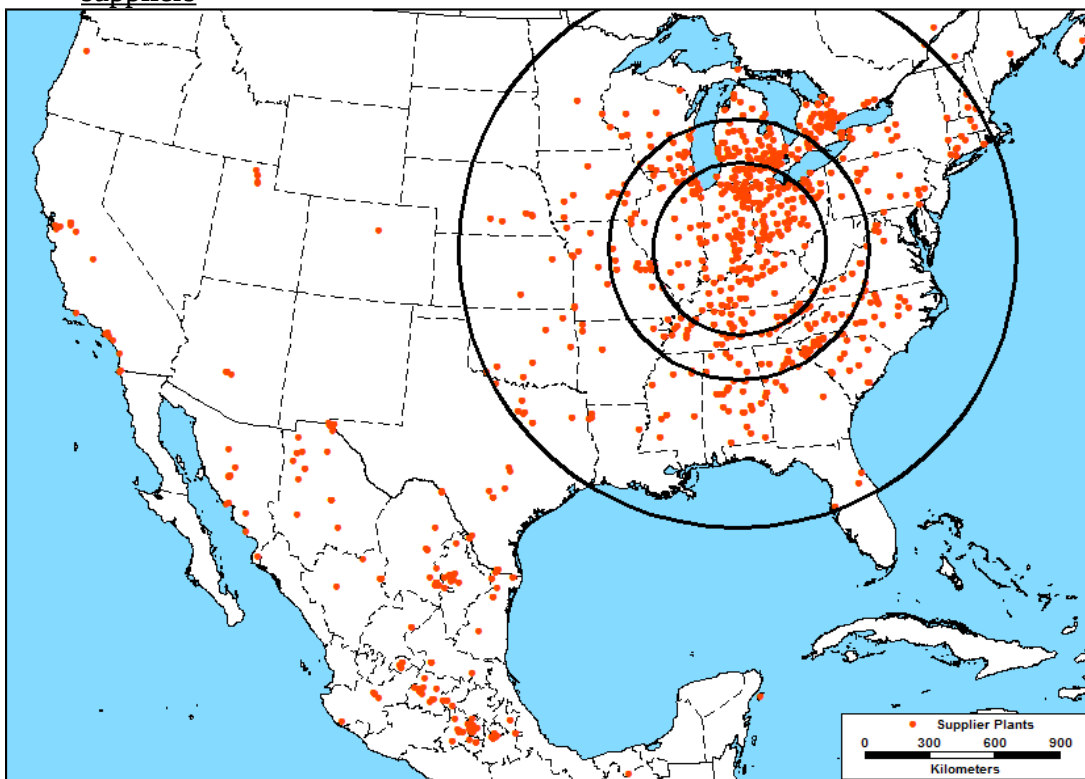
<sup>13</sup> Only one plant was closed between 2008 and 2010 – GM's Antwerp assembly plant, in 2010. In addition, Fiat announced the closure of its Termini Imerese plant for 2011. The relatively small capacity adjustment in Europe is consistent with the fact the eleven European countries instituted short-term stimulus programs to promote motor vehicle sales.

<sup>14</sup> It is possible that the different trend in assembly plants is supported by concomitant changes in vehicle sales (registrations). However, the data don't bear this out. North American light vehicle sales rose from about 10.5 million units in 1980 to 13.6 million units in 2010 (a 30% increase). For Europe a direct comparison is harder to come by due to the absence of data for the then Eastern Bloc countries. Light vehicle registrations for the seven E.C. countries Germany, Belgium, Denmark, France, UK, Italy, and the Netherlands rose by 40% from 8.4 to 11.6 million units between 1980 and 2010. 2010 registrations in the EU27 plus the four European Free Trade Association (EFTA) countries [Liechtenstein, Iceland, Norway and Switzerland] were 15.6 million units.

alley further south, especially during the 1990s, suppliers followed as needed to cover distance-sensitive operations. A disproportionate number of the suppliers that located in the southern half of auto alley are foreign-headquartered, consistent with the major presence of foreign-headquartered assemblers in that region.

Figure 6 illustrates the current spatial distribution of motor vehicle parts production in North America. It highlights 1,224 locations, representing production facilities of the 100 largest motor vehicle parts suppliers.<sup>15</sup> In addition, it shows the first three quartiles of locations as ranked by the distance to the centroid of the distribution of plants shown.<sup>16</sup> 1/2 of all plant locations are within 600 km of the centroid of the footprint. The third quartile extends out noticeably further due to the impact of the locations in Mexico.

Figure 6. North America – production plants of the 100 largest parts suppliers



Note: The radii for the first three quartiles drawn around the location centroid are: 392 km, 592 km, and 1,280 km, respectively.

## b. Europe

Several papers address the evolving footprint of motor vehicle parts production in Europe (see Sadler (1999), Frigant and Layan (2009), and Frigant (2009)). Frigant

<sup>15</sup> The list is compiled annually by the industry publication “Automotive News.” We used the most recent version (2009). The data shown in Figure 6 represent about 1/3 of the entire vehicle parts sector. We base this estimate on a comparison with our full database of parts production plants (see Klier and Rubenstein 2008 for a description of the data). The plant locations shown in Figure 6 are representative of the footprint of the larger data. We chose to restrict the presentation of North America to a set of data comparable to what is available to us for Europe.

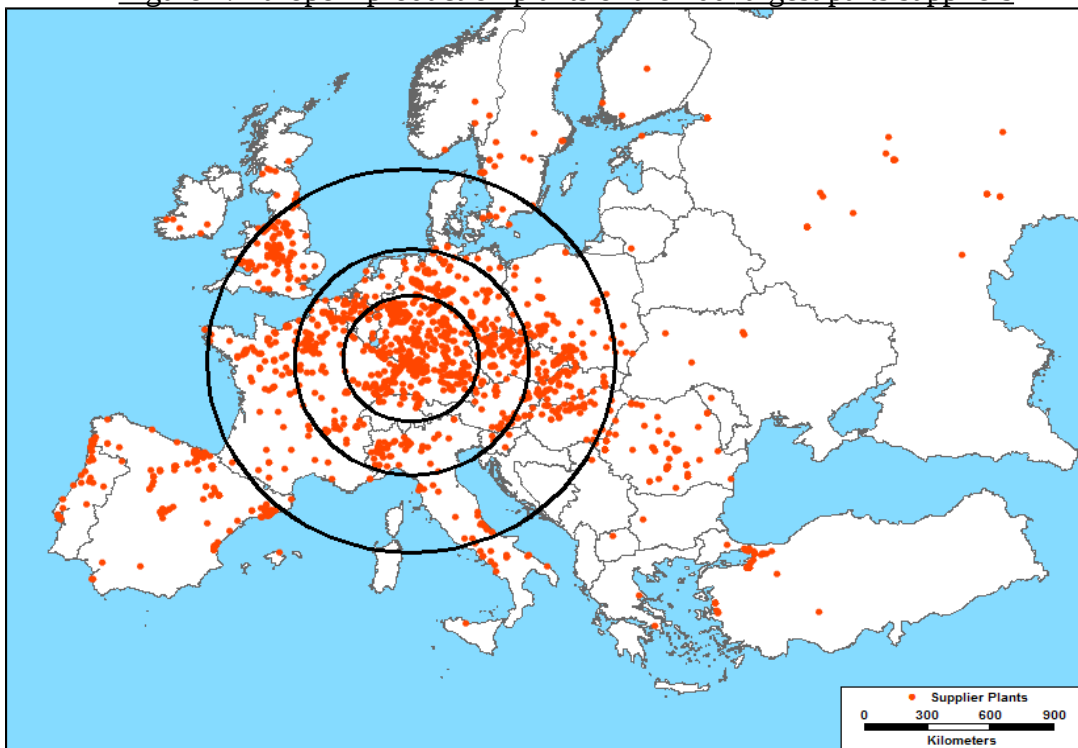
<sup>16</sup> The centroid is located in southeast Indiana.

(2009) suggests that “suppliers’ spatial reorganizations have occurred on a grand scale” (p. 433). He suggests that the pull of lower cost locations has been one of the dominant influences. However, he notes that “productive constraints limit the distance at which delocalization can occur” (p. 434).

Jürgens and Krzywdzinski (2010) find evidence of relocation of production activities from western to Eastern Europe. The authors identify three phases of development for the parts sector: During the mid-90s production locations were established for labor intensive parts. Production of parts often served local markets. During that time qualified local suppliers were scarce. From the mid-90s to early in the 21<sup>st</sup> century: more products as well as the capability to produce complex parts requiring skilled labor were added. At that time exports from eastern to western Europe grew rapidly, particularly to Germany. Later on some locations were taking on functions within the corporate structure of a company, e.g. IT services for all of central Europe. The authors find large R&D centers were rarely located in Eastern Europe.

Figure 7 presents the footprint of the production facilities of the largest motor vehicle parts suppliers present in Europe. The map shows 1,749 individual plants, representing 94 companies. Again we add quartile circles, drawn around the centroid of the plant locations.<sup>17</sup> In comparison with North America, the footprint of parts production in Europe is noticeably more compact. While the 2<sup>nd</sup> quartile is nearly equidistant to the centroid in both regions (550 km in Europe vs 600 km in North America), the third quartile is much more tightly defined in Europe.

Figure 7. Europe – production plants of the 100 largest parts suppliers



<sup>17</sup> The centroid for Figure 7 is located in southeastern Germany, near Stuttgart. Incidentally, that is nearly coincident with the population centroid of Europe.

Note: The radii for the first three quartiles drawn around the location centroid are: 315 km, 550 km, and 950 km, respectively.

## 5. Conclusion

The paper summarizes changes in industry footprint for both North America and Europe between 1980 and 2010. The last three decades have seen a dramatic shift in the footprint of vehicle assembly in North America. In Europe, the assembly footprint expanded by a similar distance as subsequent to the fall of the iron curtain the industry expanded eastward to enter those local markets. The prime beneficiaries seem to have been locations in the core of the auto region, noticeably Germany.

Yet these similarities are driven by fundamental differences in underlying trends. In North America the restructuring of the industry was part and parcel of a major reallocation of market share (and associated plant closings and openings). In Europe, on the other hand, there have been far fewer plant closings during the last three decades.

Adjustments to the crisis from 2008/2009 also played out quite differently in both regions: In North America, a substantial reduction in assembly capacity reinforced the dominant footprint of assembly in the industry (Klier and Rubenstein 2010). In Europe, on the other hand, there was very little reduction of assembly capacity in response to the crisis. In addition, a longer-term analysis of changes in the footprint of the European auto industry suggests a continuation of a multi-centered pattern, albeit with ongoing re-orientation to the east (Jürgens and Krzywdzinski, 2010).

The locations of parts producers are closely tied to assembly locations in both regions in support of just-in-time production. Yet, the supply base is noticeably more concentrated in Europe.

Going forward it seems if the eastward expansion in Europe will continue into the Ukraine and especially Russia that might result in the addition of further production capacity in Europe.

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