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"FULL-UTILIZATION LEARNING LEAN" IN COMPONENT MANUFACTURING: A NEW INDUSTRIAL MODEL FOR MATURE REGIONS, & LABOR'S STAKE IN ITS SUCCESS

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Understanding The Critical Issues That Affect Business and Commerce Today

"Full-Utilization Learning Lean" in Component Manufacturing: A New Industrial Model for Mature Regions, & Labor's Stake in Its Success

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Executive Summary

Between 1978 and 1998, manufacturing shed three million US jobs, but output rose by nearly 40 percent. In just the seven years since 1998, the sector has shed four million more jobs, and output is only slightly higher. We unambiguously deplore these losses, both for the pain they have brought to millions of displaced workers, their families, and communities, and for their implications for majority living standards. Absent an unlikely revolution in U.S. trade policy that materially redirects large firms' sourcing, high-wage American manufacturing seems destined to continue to stagnate or shrink, perhaps quite rapidly. Millions of the jobs it still provides may be driven to extinction by lower-wage domestic production, or by low-price alternatives abroad.

Our work convinces us that, even absent trade policy friendlier to onshore production, a large number of high-wage, family-supporting factory jobs can and should be saved. (We recognize that many manufacturing jobs are not good jobs, and indeed argue for paying *less* attention to the companies that offer such employment.) We believe that we discern the outlines of an industrial model – encompassing manufacturing economics, the tools of lean manufacturing, and public and private purchasing policy – that stands a chance of helping many manufacturing companies increase productivity by enough to afford the skilled, empowered labor that the model requires and to succeed onshore. For want of a better term, we call this new model "full-utilization learning lean," or "FULL." The phrase is meant to connote:

- ***Full utilization***: High and relatively steady demand that permits expensive, high-precision machinery to be kept busy a high proportion of the 8,760 hours in a year
- An emphasis on ***learning***, i.e., the process is designed to increase knowledge and embed decision-making and authority in the hands of hourly workers. This learning aspect of "FULL" has sometimes been referred to as high-performance work organization (HPWO); indeed, we use the term "learning/HPWO" in our case studies and international union discussion later in this paper.
- The thoroughgoing use of the full toolkit of ***lean*** manufacturing methods[2] – from 5S to visual management to value-stream mapping to one-piece flow

[1] The authors acknowledge the generous support of the Alfred P. Sloan Foundation and, for the modeling work underlying the regional trade analysis, the Ford Foundation. Views expressed are those of the primary authors alone.

[2] We recognize that the term "lean" is unpopular in some union circles. But we believe that leanness is increasingly a ticket to play in manufacturing, and hence not an option. As we demonstrate, non-union plants – including some with low and moderate wages – can do quite nicely with a top-down, low-

This FULL model can, and sometimes does, confer an advantage for unionized manufacturers; indeed, we argue that international unions and central labor councils need to understand, support, and promulgate replicable models for their locals to use in implementing FULL.

Based on nearly 100 case studies, including 17 conducted exclusively for this project, we have concluded that "the thoroughgoing use of the full lean toolkit" is most effective when the workforce is skilled and empowered. Because of advantages in skill, collective voice, and protection against arbitrary discipline and discharge, unionized plants could enjoy a marked advantage in implementing and sustaining FULL manufacturing[3], particularly if they are competently supported by regional, national, and international union bodies.

We think the best opportunity to try this new model is in the component sector, and that the best place to do so is in the Great Lakes region that hosts the largest proportion of high-wage component jobs.

The very fact that a relatively high-wage component sector continues to exist in this region offers a basis for hoping that the sector can be even more successful in the future, if and as its better firms upgrade. And many of them need to do so. Much of the appearance of a strong rebound in manufacturing productivity growth comes from sharp increases in output per hour worked in a few electronics-intensive subsectors. Much of component manufacturing continues to have productivity that is too low, and not growing fast enough. Companies and unions both have to address this fact.

We call on local unions to insist that their employers upgrade, and that they do so in ways that embed knowledge and authority in the workers. We call on international unions to champion employer upgrading following the "FULL" model, to advocate that their locals be active in such upgrading, and to have staff expertise to support locals engaged in it.

We propose bold new policy initiatives for Great Lakes region governors, state legislators, county commissioners, and mayors in this region that provide, we argue, a far superior alternative to the smokestack-chasing, high tech-mongering, and accelerating sprawl to which past economic development models have led. By focusing on the minority of firms that demonstrate a commitment to large productivity growth, scarce state resources can still generate large returns. Focusing further on firms paying higher wages also makes good fiscal sense, as labor income is far less subject than profits or dividends to "leaking" out of the region.

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participation version of lean. Our task is not to disparage a proven set of techniques, but to apply them better while mobilizing politically to reserve more of demand for higher-wage companies.

[3] See Sandra E. Black and Lisa M. Lynch, "How to Compete: The Impact of Workplace Practices and Information Technology on Productivity," *Review of Economics and Statistics*, vol. 83, no. 3 (August 2001), pp. 434-445.

We propose a sharp increase in the provision and funding of direct training and technical assistance supports to high-paying employers that purchase heavily within the region. In addition, we call for tax incentives to be restructured and reserved for such firms.

Our approach offers a way forward:

- For international unions: Stymied in their attempts to "level the playing field" in national trade policy, the FULL model offers them at the state and regional level a proven model for firm upgrading and a labor-friendly agenda for governors and state legislators. It also demands that they understand what constitutes real upgrading in the manufacturing sectors in which their members work, and thereby offer more real value to employers in those sectors.
- For local unions: A state and regional agenda, across unions, and a set of blueprints for making their members' jobs more secure and their companies better-run
- For state and local governments: A far higher return on the economic development dollar, as unaffordable across-the-board tax incentives are replaced by targeted assistance to only the best employers that is tied to in-region purchasing and other standards of behavior.

Introduction

The Advanced Manufacturing Project (AMP), working with a grant from the Alfred P. Sloan Foundation, was originally created to research the changing relationships among manufacturing firms. As indicated in their final report to the Sloan Foundation, "Component Manufacturing: Creating an Advanced Manufacturing Sector" (March 2004), AMP researchers documented evolving strategies of original equipment manufacturers (OEMs) with respect to their suppliers, as well as the responses of these suppliers to the actions of their usually larger and more powerful customers. We believe that these suppliers, many of which are so-called small and medium-sized enterprises (SMEs), constitute their own sector of the economy. Not only is this "components sector" where many of the jobs and much of the manufacturing output in the economy are located, but it is also the most newly and profoundly exposed to global competition. While OEMs often benefit from global sourcing by getting lower-cost inputs (including from former US suppliers that those customers have insisted develop a "more global footprint"), most component suppliers in the US are small and lack the desire or capability to manage offshore operations. As the globalization process continues apace, the US components sector continues to restructure as suppliers struggle to maintain or, in many cases, regain global competitiveness. In conjunction with the AFL-CIO Working for America Institute (WAI), AMP returned to the Sloan Foundation to examine the impact of component-sector restructuring on workers and unions, and to try to understand the roles that unions have played, and could play in the future, in promoting forms of restructuring that foster stable or growing high-productivity businesses offering high-wage jobs.

Since this project began, the situation facing many onshore manufacturers has gone from challenging to dire. As noted, just since 1998, the sector has shed four million more jobs – a shocking 23 percent of the total in just seven years -- while onshore output has stagnated. Many more jobs are on the chopping block but, we believe, can still be saved.

The balance of this paper explores what it would take to revitalize the component manufacturing sector of the economy, starting in its most important region, and make it work for workers, unions, and communities.

The Component Sector

Most assemblers of complex products – from cars to computers – buy at least half the value of their products from component suppliers. In terms of manufactured content, the component portion is often much higher: for example, a $500 Dell PC includes about $300 in purchased components. For a $3,000 John Deere lawn tractor, such components approach $1,800. In a $25,000 Ford truck, they account for about $14,500.

AMP researchers spent considerable time sorting the US SIC and NAICS systems into five buckets, including components. Our basic definition was simple: if input-output data

show clearly that most of an industry's output is bought not by the wholesale or retail sectors but by other manufacturers, then that industry is either in materials or in components. Appendix 1 shows our sort of the US SIC system, including our detailed definition of the component sector. (Note: A few of the subsectors counted in "components" in Appendix 1 are not included in our analyses based on Current Population Survey [CPS] data, which include only component industries in SIC codes 301-3769. Much of what is excluded – apparel, paper and wood, printing, chemicals, and instruments – are sectors in which components have a low weight, or in which the SIC and NAICS definitions make it impossible to separate components from finished goods.)

To return to the Dell PC example, besides its $300 in components, it embodies about $100 in marketing, distribution, and technical support cost, but less than $25 in Dell manufacturing labor and overhead. It is also worth noting that more than $150 of the $300 in purchased components come from offshore, with the a majority of the rest coming from Intel chipsets that embody heavy foreign content.[6]

In contrast, mechanical (as opposed to electrical/electronic) components, partly because their typical lower value-to-weight ratios are lower than for electronic components, tend to remain clustered in the same areas as the customers that buy them, though global sourcing is making this less and less true. In contrast to Dell's PCs, the assembly plants of Caterpillar, John Deere, and the US-based automakers remain a huge market for onshore component producers. A US-assembled car gets more than 60 percent of its value from component suppliers (many selling parts into the subassembly facilities of huge "tier one" suppliers), and nearly 75 percent of that 60 percent comes from US component suppliers. (Much of the other 25 percent comes from southern Ontario -- which from an economic geography standpoint, should probably be thought of as a US state – and from the Mexican plants of GM's former parts division, Delphi.)

Thus, on a dollar basis, the onshore component sector is dominated by mechanical components. The firms in this sector are concentrated in three regions:

1. The swath of real estate within about an hour's drive of the line between Boston and Philadelphia;
2. The Upper Great Lakes states (Wisconsin, Illinois, Indiana, Ohio, and Michigan, plus southern Ontario, extreme western New York, slices of Iowa and Missouri on Illinois' western border, and metropolitan Louisville); and
3. A large portion of the southeast, including the Carolinas, Georgia, northern Alabama and Mississippi, Tennessee, and the balance of Kentucky.

In the first of these, the sector is a declining share of manufacturing and the economy, and there is relatively little sectoral specialization. In the third, the sector is growing rapidly and, quite intentionally, in precisely the subsectors in which the Upper Great Lakes region has long specialized: **auto parts** (including engines, transmissions, axles, and stampings)[7] and a sector we will simply call "**equipment**," which is made up of construction, farm, and garden equipment and their parts, plus machinery used in

[6] In this context, consider how little a governor would really get for his or her state in winning the next Dell, Gateway, HP, or eMachines warehouse/assembly plant.
[7] NAICS code 3363

manufacturing metal and plastic products.[8] Thus, in addition to the challenges faced by component manufacturers by the growing capacity and capability of low-wage offshore producers, there is intense inter-regional rivalry within the US. As we shall soon see, retaining and growing a high-productivity, high-wage US component sector will require policies that directly confront this domestic rivalry which, as we shall also see, is a metropolitan versus rural as well as a Great Lakes states versus upper southeast competition. The "upper southeast" is making a play to replace the Upper Great Lakes in their core sectors, and is doing so by playing on its lower wages, lower unionization, and lower concern with regulations.

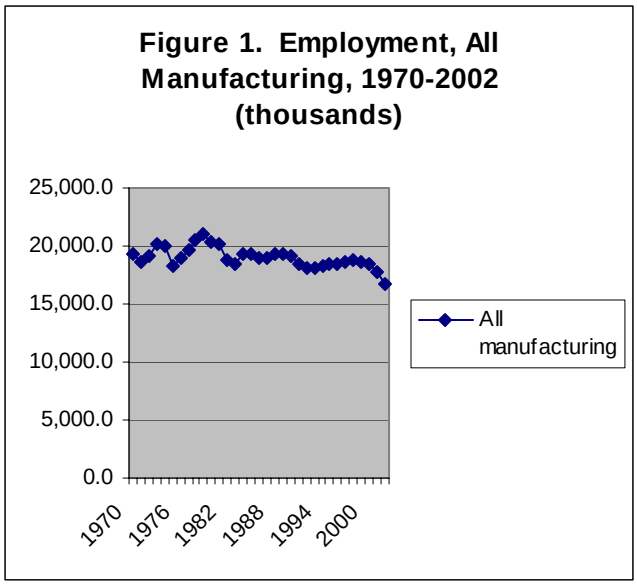
Employment, Union Presence and Productivity in US Component Manufacturing

Employment Trends in Components and in Manufacturing As a Whole

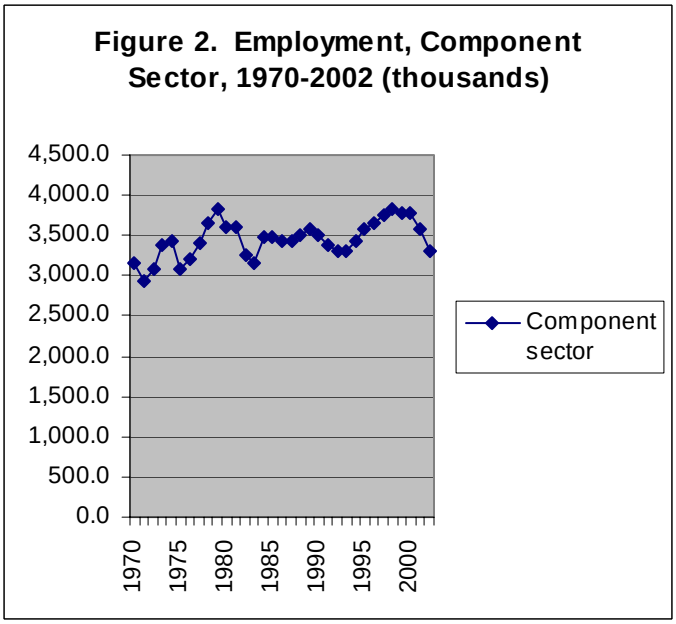
Employment in component manufacturing has grown more rapidly than overall manufacturing employment since the 1970s (figures 1 and 2). Indeed, component sector employment grew by 5 percent between 1970 and 2002, while manufacturing employment as a whole fell by 13.7 percent. In 1970, 16.3 percent of all manufacturing workers were employed in components, while by 2002 that figure had risen to 19.8 percent (figure 3). Despite all the talk about outsourcing of parts by large companies, as of 2002 more of this had occurred in those large companies' assembly operations than in intermediate goods. This makes components a somewhat better bet for an upgrading strategy than trying to save, or win new, assembly facilities.

Since 1998, it appears, even though many large firms have continued to "unbundle" non-core activities and devolve them to component supply firms, this effect has been more than offset by increased offshore sourcing. One telltale sign: the number of US manufacturing plants rose every year from 1967-1998 but has fallen every year since.

[8] NAICS codes 3331 (agricultural, construction, and mining equipment), 3332 (industrial machinery), 3333 (service industry machinery), 3334 (heating and cooling equipment), 3335 (metalworking equipment, including tooling and machine tools), and 3336 (engines and turbines, including all diesel engines). The inclusion of NAICS codes 3333-3334 is somewhat off target analytically, but both trade statistics and the REMI model – about which much more below – aggregate the sector in a way that forces us to include them.



Source: Authors' analysis of Bureau of Labor Statistics Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com.



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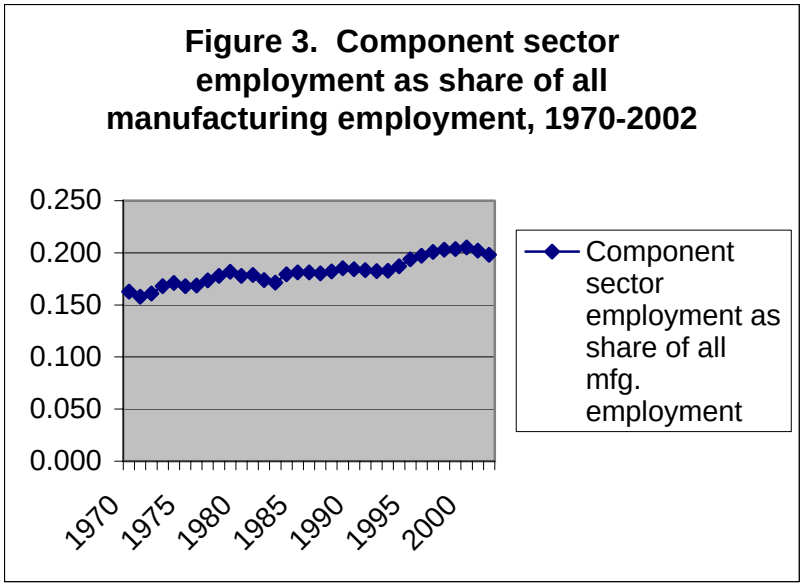


Source: Authors' analysis of Bureau of Labor Statistics Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com

Comparing business cycle peak years during this period, component sector employment always outperformed manufacturing employment as a whole. Employment in component manufacturing rose more rapidly than employment in all manufacturing from 1972-79, fell at a slower rate than all manufacturing employment from 1979-89, and rose from 1989-2000 while overall manufacturing employment fell (table 2).

Table 2. Percentage Change in Employment between Business Cycle Peak Years, 1970-2002

	1972-1979	1979-1989	1989-2000
All Manufacturing	9.9%	-7.9%	-4.7
Component Manufacturing	24.0	-6.1	5.6

Source: Authors' analysis of Bureau of Labor Statistics, Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com

Prior to 1979, business cycles and changes in the US trade position had most of their impact on finished goods and raw materials. But since 1979 employment in component manufacturing has been more sensitive to business cycles and trade than manufacturing as a whole. Comparing peak and trough employment years for manufacturing as a whole, component employment fell by the same percentage as overall manufacturing employment during the 1973-75 recession but fell by a greater percentage than overall manufacturing employment during the 1979-83 and 1989-93 periods (both of which included recessions) and during 1998-2002, when a rising dollar contributed to losses of U.S. manufacturing jobs (table 3). The component sector suffered greater percentage job losses during the latter two periods, though component employment began to recover earlier than overall manufacturing employment during both of those periods.

Table 3. Percentage Change in Employment Between Peak and Trough Employment Years for All Manufacturing

	1973-1975	1979-1983	1989-1993	1998-2002
All Manufacturing	-9.1%	-12.4%	-6.8%	-11.1%
Component Manufacturing	-9.1	-17.4	-7.9	-13.2

Source: Authors' analysis of Bureau of Labor Statistics Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com

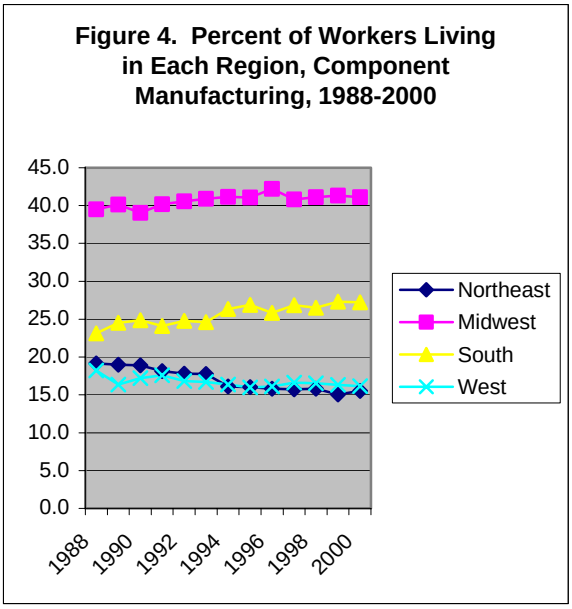
We read this to mean that, while component sector output was of course closely tied to its customers' sales, starting in 1979 and accelerating sharply starting in 1998 the sector found itself (and not just its customers) much more exposed to global competition.

Comparing Tables 2 and 3 makes clear that components' growing share of manufacturing employment is tied to the sector's better performance in the periods from cyclical troughs to peaks – 1975-79, 1983-89, and 1994-98. When demand is growing briskly, large companies turn (perhaps because they must) to domestic component-makers.

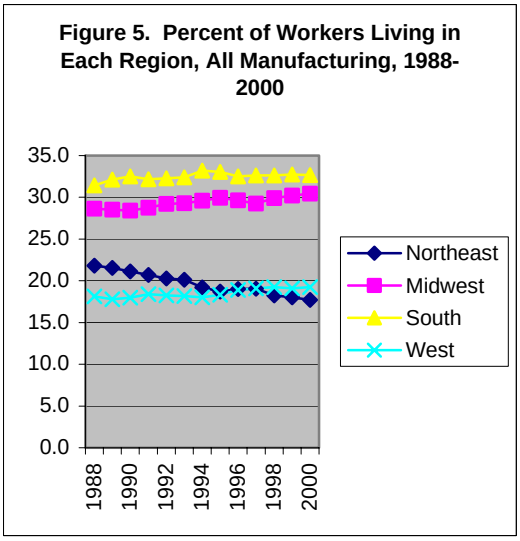
Broad Regional Trends in Employment

Compared to all manufacturing, component manufacturing is much more concentrated in the Midwest[9] and less concentrated in each of the other large regions. In 2000, more than 40 percent of component sector workers lived in the Midwest, while just over a quarter lived in the South, and less than a fifth lived in the Northeast and West, respectively (figure 4). In contrast, just under a third of all manufacturing workers lived in the South, about 30 percent in the Midwest, nearly a fifth in the West, and less than a fifth in the Northeast (figure 5). Although these data are based on workers' residences rather than their places of employment, the distributions of residence and employment are similar for such broadly defined regions.

[9] In this section, we use standard Census region definitions.



Source: Authors' analysis of Current Population Survey data. Component sector employment was estimated using the method described in Appendix 3.

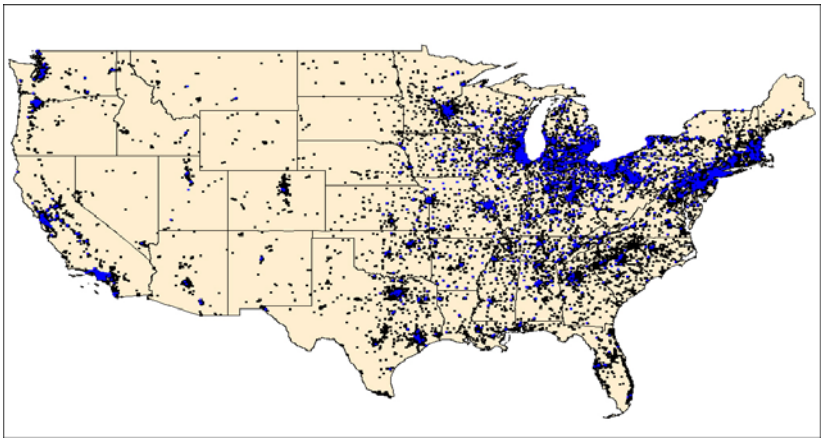


Source: Authors' analysis of Current Population Survey data

The percentage of component sector workers living in the sector's core Midwest region increased from 39.5 percent in 1988 to 41.1 percent in 2000. The share of component sector workers living in the South grew more dramatically, rising from 23.1 percent to 27.2 percent. Similar trends occurred in manufacturing as a whole, but the increase in the Midwest's share of component workers was proportionally smaller than the increase in its share of all manufacturing workers, while the South's gain in its share of component workers was proportionally larger than the increase in its share of all manufacturing workers. Therefore, compared to manufacturing as a whole, component manufacturing became less concentrated in the Midwest and more concentrated in the South.

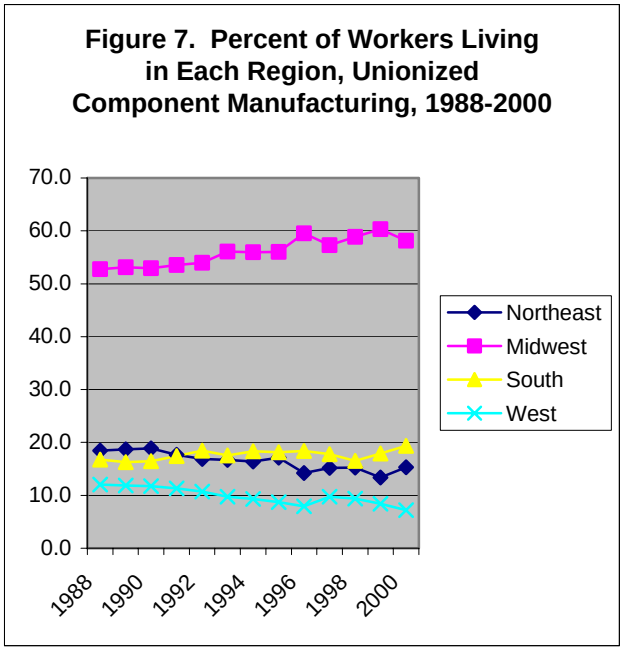
As we will see later in this paper, component manufacturing is relatively high-wage, with average annual earnings exceeding $45,000. It is even higher, on average, in the Midwest, thanks in part to relatively high rates of sector unionization in that region In 2000, the Midwest was home to nearly 60 percent of all unionized component sector workers even though only about 40 percent of all component sector workers lived in that region (figure 6).

Figure 6. Union (blue) & Non-Union Plants in Component Manufacturing



Source: WAI analysis of proprietary AFL-CIO data on locations of unionized plants

Moreover, the percentage of unionized manufacturing workers living in the Midwest rose between 1988 and 2000, and this increase was more rapid than the increase in the percentages of all component sector workers and all manufacturing workers living in the Midwest. Therefore, unionized component manufacturing became more concentrated in the Midwest relative to both all component manufacturing and all manufacturing. The percentage of unionized component sector workers also rose in the South between 1988 and 2000; this increase was more rapid than that of manufacturing as a whole but less rapid than that of the component sector as a whole. Therefore, unionized component manufacturing became more concentrated in the South relative to all manufacturing but less concentrated relative to all component manufacturing.



Source: Authors' analysis of Current Population Survey data

Sleeping with the Enemy? Component Sector Firms and Their Key Customers

There is a huge debate within manufacturing about why, despite the sector's relative growth in the 1980s and 1990s, so many component sector firms are shrinking and/or unprofitable. This debate has well-nigh split big-tent cross-sector groups like the National Association of Manufacturers or, at the least, created two camps, one of associations representing large, often multinational firms and the other of associations of (typically smaller) component-makers. It is clear that many members of the latter increasingly view their customers as a big part of their problems: they recognize that they are not only losing orders, and/or opportunities to win new ones, to autonomous competitors in China, India, and Eastern Europe, but at least as much to offshore "firms" either set up, or closely directed, by their customers. These new competitors not only supply those customers' offshore plants, but also export back into the US.

At the same time, global competition is also driving component suppliers to unprecedented levels of customer knowledge and "intimacy." Many component suppliers are being asked, and agreeing, to assume new costs and responsibilities. In AMP's major survey conducted by the Performance Benchmarking Service (PBS) for Case Western Reserve University in late 2003 surveyed 270 manufacturing plants with 20-499 employees, including 186 in the states of Wisconsin, Illinois, Indiana, Ohio, and Michigan.[10] 48 percent reported that they now hold inventory that their largest customers

[10] The Michigan Manufacturing Technology Center (MMTC) has maintained its Performance Benchmarking Service (PBS) database since 1993. In the 13 years since then, it has collected detailed nearly 9,000 plant records. Because many plants have participated in multiple years, the number of distinct plants in the database is only about 4,500. While the dataset is not in any way a full and accurate

used to hold. 55 percent reported that they had needed to purchase equipment that would be of no value except for jobs they currently had from their single largest customer. 51 percent reported having taken a larger role in product design than in the past.

Many researchers have seen, quite correctly, potentially positive aspects of these new supplier roles. They have argued, and some component suppliers agree, that customers are now more dependent on suppliers, and no longer view them as simply overflow capacity or a dumping-ground for "commodity" work. Indeed, our survey found that 61 percent of suppliers had gotten work from at least one of their four largest customers in the past three years without having to bid against competitors; 44 percent had gotten no-bid work from their largest customer.

At the same time that many suppliers are more in bed with key customers than ever before, they are also wary of them, and with good reason. Component suppliers reported that close ties were not generally enough to keep their customers from demanding price cuts and actively considering moving work to lower-price competitors.

- 56 percent reported that none of their four largest customers had ever helped them meet or beat a competitor's lower bid.
- 59 percent were not confident that their largest customer would not share confidential information with competitors. As a result, no doubt, only 28 percent reported sharing detailed cost information with that largest customer, and just 40 percent said they shared such information with any of their four largest customers.
- While 51 percent stated that their largest customer "understands that we need to make a decent return," 60 percent reported that their largest customer was not "open to counter-arguments about price reductions." For the 270 respondents as a group, the median price reduction granted was 3.7 percent, and fewer than one in five was able to hold the line on, or raise, prices.

More optimistic scholars than we have also noted that, even as customers have asked more of some of their suppliers, yet also expected price cuts, they have also given things in return, including sole-source and/or long-term contracts and, perhaps most important, the time and expertise of their own engineers to help their key suppliers improve their performance. Indeed, 56 percent of our respondents reported having participated in the *supplier development* program of at least one of their four largest customers; 41 percent said they'd done this with their largest customer. But the data strongly suggest that most of this supplier development was in the area of quality, rather than in areas that support helping the supplier raise productivity and make money. In brief, while 42 percent reported that at least one of their four largest customers had helped them improve quality,

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representation of US manufacturing – e.g., it oversamples mechanical components, the Upper Midwest region, and small and medium-sized plants – it yields percentile cutpoints (10^{th}, 25^{th}, median, 75^{th}, 90^{th}) that closely match the Census of Manufactures' cutpoints on shared metrics, including labor productivity (value-added per employee) and inventory turnover. These same caveats about the PBS dataset should be borne in mind when we use it later in this paper to discuss the erosion in the union pay premium.

only 22 percent said they'd helped with inventory reduction and just 16 percent with setup-time reduction.[11]

While many component suppliers remain hopeful that they will continue to be valued by their key customers, they clearly sense that many of their customers are increasingly buying on price and becoming decreasingly loyal to onshore, and home-region, production.

- 86 percent reported that at least one of their four largest customers had moved work that traditionally belonged to the supplier to competitors because of price; 79 percent said their largest customer had done this.
- Many reported customers moving that traditional work to low-wage countries: Mexico, 44 percent; Asia, 39 percent; and Eastern Europe 17 percent. Much of this is explained, no doubt, by the fact that the customers themselves are moving out to these locations. 36 percent of our respondents reported that their largest customer was moving capacity to Asia, 23 percent to Mexico, and 20 percent to Eastern Europe. Only 14 percent reported having been asked to move with their largest customer, and only 23 percent with any of their four largest customers. (We suspect that an update to 2005 would show big jumps in most of the numbers in this bullet point.)

Thus, while "globalization" is a very real threat to onshore component-makers, for now relatively few of them are moving offshore. Most think that they will still get some work for their customers, at least from the customers' locations that are not moved south and offshore. 64 percent say that their proximity to key customers counts for something with those customers. But with customer behavior in pricing, sourcing, and location clearly perceived as a challenge, many suppliers report believing that, within 20 if not just ten years, they will either have to close or move. 78 percent reported being "very confident" they'd still be in business "at this location" in three years. Looking out 10 years, only 48 percent were confident they'd still be where they are (or anywhere). Twenty years out, just 23 percent were very confident of staying put.

In short, not only are most component suppliers feeling somewhat abused by their customers, they see those customers as less and less supplier-, region-, and US-loyal. ***Many suppliers apparently see themselves nearing a tipping-point moment*** on the question of staying where they are. Happily, most cite ties to nearby customers and suppliers, obligations to their current workforce, the owner's ties to the community, and their large sunk investment as binding them to staying put. Not surprisingly, the first of these – ties to customers – is the weakest, with 35 percent saying it plays little or no role in keeping them where they are. Still, the fact that 65 percent still credit those ties with helping hold them where they makes a hopeful point: there are some customers that will stay and fight and that, with the right policy and political supports, may be induced to

[11] This is a perplexing finding, since customers presumably stand to gain more in the way of lower quotes from leanness than from improved quality. Our educated guess is that the generalization of lean has coincided with a continuing erosion in customers' activism in helping their suppliers. Increasingly, customers' attitude is that "I can get parts anywhere in the world. It's *your* job – not mine -- to make your parts the ones I prefer to buy."

make common cause with their suppliers, who overwhelmingly want to stay where they are.

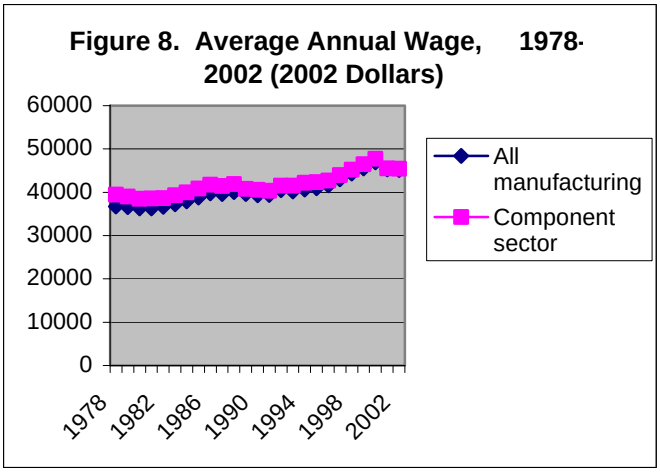
Faced with pricing pressure and new and costly demands, yet generally committed to staying where they are, suppliers are following a variety of strategies. Many reported continuing to invest in their workers (46 percent), facilities (38 percent), and equipment (48 percent). A comfortingly low nine percent reported a strong inclination to "move to recipes requiring many fewer skilled workers," but another *55 percent would not rule it out*. Even more comforting, just nine percent anticipated moving work to low-wage regions, and only another 21 percent would not rule it out. Clearly, most component suppliers want to "stay and fight," even if their customers are making their lives miserable. A heartening 44 percent reported having refused to lower prices to at least one of their four largest customers, and 23 percent reported refusing to quote work to at least one. 52 percent said they had "fired" a customer in the past two years. In a nutshell, some are fighting. But the terms of the fight will have a lot to do with the recipes – and hence the wages, conditions, and productivity – they employ.

There is little reason to think that most of the respondents' customers are likely to become more, rather than less, loyal to their in-region suppliers – unless they have significant incentives to do so. As we will see, there are revenue-neutral state policies that hold reasonable promise to provide such incentives. As we'll also see, implementing such policies not state-by-state but on a regional basis will be much more efficient and effective.

Wages in Components and in Manufacturing As a Whole

Since at least the late 1970s component sector workers' average annual wage has exceeded that of all manufacturing workers (figure 8).[12] In 2002, component sector workers were paid an average of $45,419 per year (in 2002 dollars), 0.5 percent higher than the all-manufacturing average of $45,174 per year. However, the component sector's average-wage advantage over manufacturing as a whole eroded substantially between since 1978, when component sector workers earned an average of 7.3 percent more per year than manufacturing workers as a whole. The erosion occurred because the real average wage rose more slowly in components than in manufacturing as a whole. From 1978-2002 the component sector's real average annual wage increased by 21.1 percent while the real average annual wage in manufacturing as a whole grew by 27.7 percent.

[12] These data may be confusing to some readers accustomed to thinking of component suppliers as small, usually non-union plants, relative to other, larger non-component firms more likely to be unionized. What is really at play here is the different subsectoral composition of the two groups. Non-component manufacturers include many low-wage nondurable manufacturers (e.g., apparel-makers), as well as durable goods-making GM and Caterpillar plants. Component suppliers include tool and die shops paying workers $25-30 an hour as well as low-wage wiring harness-makers.

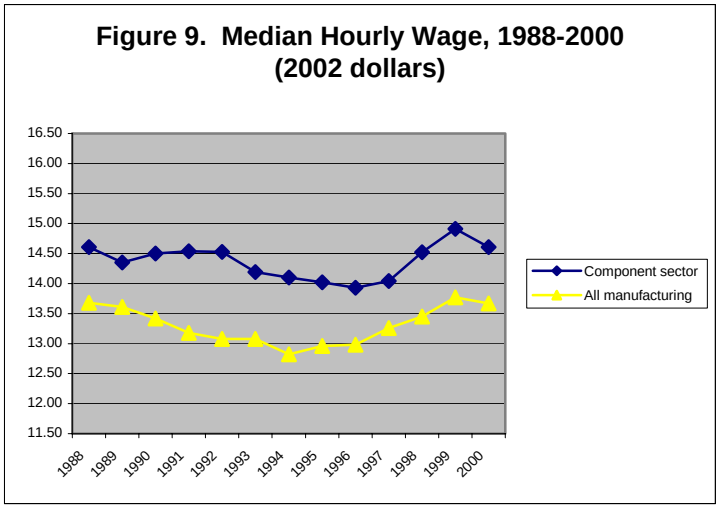


Source: Authors' analysis of Bureau of Labor Statistics, Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com

An examination of median hourly wages tells a somewhat different story (figure 9). Component sector workers had a higher median hourly wage than all manufacturing workers throughout the 1988-2000 period. In 2000, component sector workers' median wage was $14.61 (in 2002 dollars), 6.9 percent higher than the $13.67 median hourly wage of all manufacturing workers.[13] But component sector workers' median hourly wage, unlike their average annual wage, neither rose in absolute terms nor fell relative to that of all manufacturing workers during this period. Instead, there was no trend in component workers' absolute or relative median hourly wage. The component sector median wage generally fell from 1988-1996, rose substantially from 1997-99, and then fell again somewhat from 1999-2000, leaving component workers as well off in 2000 as in 1988. Relative to the median wage in all manufacturing the component sector median wage rose from 1988-92, fell from 1993-97, rose from 1998-99, and fell in 2000, leaving component sector workers in about the same relative position in 2000 as in 1988.[14]

[13] Component sector workers also has a higher median hourly wage than all durable manufacturing workers throughout the 1988-2000 period, although their wage advantage over all durable manufacturing workers was smaller than their wage advantage over all manufacturing workers. Component sector workers' 2000 median wage was 1.5 percent higher than the $14.39 median hourly wage of all durable manufacturing workers.

[14] The differences between the median hourly and average annual wage results could be the result of several factors: changes in work hours in components and all manufacturing, changes in wages among high-wage workers within individual industries within components and within all manufacturing, changes in the industrial composition of employment within components and within all manufacturing, sampling and non-sampling error in the Current Population Survey (the source of the data from which median wages were estimated), and error in identifying the component sector in the Current Population Survey.



Source: Authors' analysis of Current Population Survey data

Productivity in Components and in Manufacturing As a Whole

Since at least the late 1980s, productivity growth in component manufacturing has lagged behind that of other manufacturing. From 1987-2000, 23 separate SIC component industries had slower productivity growth (as measured by the Bureau of Labor Statistics) than the three-digit SIC industries of which they were a part, while only 15 had faster productivity growth. (table 4).[15] Thirty-three of the component sector industries had slower productivity growth than manufacturing as a whole, while 12 had faster productivity growth. The contrast with durable manufacturing, manufacturing's productivity leader during this period, is even more striking. Thirty-nine component sector industries had slower productivity growth than durable manufacturing as a whole, while only six had faster productivity growth. The aggregate component sector also had much slower productivity growth (43.7 percent) during this period than all manufacturing (52.8 percent) and all durable manufacturing (70.5 percent).

[15] Seven component industries were identical to three-digit SIC industries, so this comparison is not applicable to them.

Table 4. Percentage Change in Productivity in Components, 1987-2000

SIC	Industry	Percentage change in productivity, 1987-2000
3679	Electronic components, n.e.c.	195.0
3671	Electron tubes	188.7
3493	Steel springs, except wire	140.6
3675	Electronic capacitors	92.1
3594	Fluid power pumps and motors	91.7
3672	Printed circuit boards	72.9
	AGGREGATE DURABLE GOODS MFG	**70.5**
3519	Internal combustion engines, n.e.c.	66.2
345	Screw machine products, bolts, etc.	59.8
362	Electrical industrial apparatus	57.0
3593	Fluid power cylinders and actuators	54.7
3691	Storage batteries	53.9
	AGGREGATE MANUFACTURING	**52.8**
3061	Mechanical rubber goods	52.8
3592	Carburetors, pistons, rings, and valves	52.4
3089	Plastics products, n.e.c.	51.9
3613	Switchgear and switchboard apparatus	49.2
3714	Motor vehicle parts and accessories	46.9
301	Tires and inner tubes	45.9
	AGGREGATE COMPONENT SECTOR	**43.7**
3545	Machine tool accessories	43.6
3491	Industrial valves	39.1
3599	Industrial machinery, n.e.c.	37.8
3317	Steel pipe and tubes	35.7
3495	Wire springs	35.5
3315	Steel wire and related products	34.3
3492	Fluid power valves and hose fittings	34.1
3084	Plastics pipe	33.3
332	Iron and steel foundries	32.1
3544	Special dies, tools, jigs, and fixtures	30.3
346	Metal forgings and stampings	29.8
336	Nonferrous foundries (castings)	29.7
3543	Industrial patterns	25.2
3677	Electronic coils and transformers	24.6
3647	Vehicular lighting equipment	19.2
3498	Fabricated pipe and fittings	18.0
3728	Aircraft parts and equipment, n.e.c.	17.5
305	Hose and belting and gaskets and packing	15.4
3676	Electronic resistors	14.4
3562	Ball and roller bearings	11.2
3566	Speed changers, drives, and gears	10.3
3769	Space vehicle equipment, n.e.c.	9.7
3443	Fabricated plate work (boiler shops)	7.4
3724	Aircraft engines and engine parts	3.9
3764	Space propulsion units and parts	-7.0
3494	Valves and pipe fittings, n.e.c.	-17.9
3499	Fabricated metal products, n.e.c.	-25.7
3678	Electronic connectors	-30.7

Source: Authors' analysis of published and unpublished Bureau of Labor Statistics data

It is important not to be impressed with some of the large figures in table 4: remember that, thanks to compounding, three percent annual productivity growth comes to 47 percent in the 13-year period. Thus only 15 of the 45 subsectors beat that 3 percent-per-year benchmark, and six of those 15 were electrical/electronic (as opposed to mechanical) components. The 43.7 percent figure for the sector as a whole is only 2.8 percent per year. For the 1997-2003 period, annual productivity growth was even lower for many component sectors.[16]

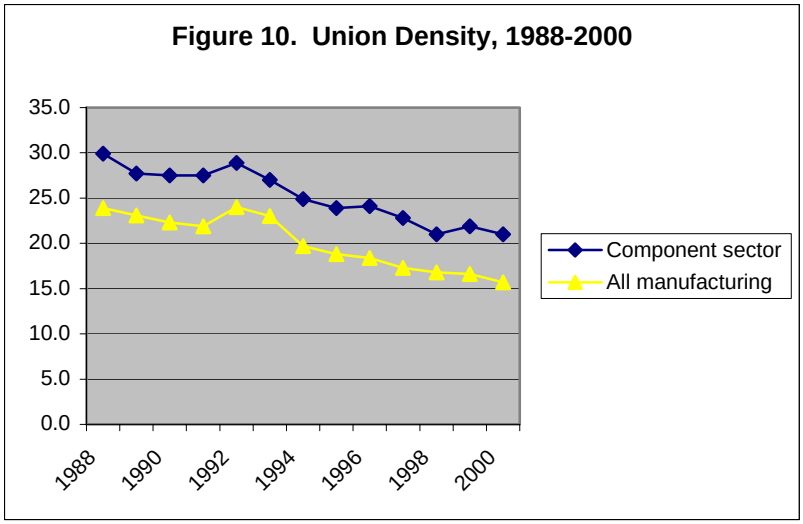
In a traded-goods world in which some competitors enjoy a 15, 20, or even 30 percent landed cost advantage vis-à-vis onshore producers, **for many firms a qualitative leap – on the order of 3-5 years of 7-10 percent productivity gain, will be required**. Because many offshore plants are not standing still either, the true requirement may be on the order of 10-15 percent per year. Performance Benchmarking Service data show that something like one in seven US firms achieves 10 percent-plus annual gains in any given two year period. As we will see, however, for a region to be world-competitive it will have to find effective ways to have a larger proportion of the manufacturers within its borders make this leap. And because not all firms can (or even want) to do so, states and regions will have to focus their resources on the minority of firms that are willing and capable, and whose success promises the highest return on the public investment. Most such firms are high-wage and many, albeit it a shrinking minority, are unionized.

Union Density and Presence

Since 1988, union density has been higher in component manufacturing than in manufacturing as a whole (figure 10). In 2000, unions represented 21 percent of component sector workers, but only 15.7 percent of all manufacturing workers. However, union density in both components and all manufacturing fell from 1988-2000. The relative decline was smaller in components (where union density was 29.9 percent in 1988) than in all manufacturing (where union density was 23.9 percent in 1988). Moreover, component sector union density appears to have stabilized from 1998-2000, while union density in manufacturing as a whole continued to fall.

The better relative survival of unions in components should be intuitive. Component manufacturing is typically higher-skill than final-goods production. While kitting, "screwdriver," and other assembly operations are strewn across the globe – with companies often favoring greenfield sites away from large labor markets, on a regional and national basis component manufacturing remains more metropolitan and more spatially concentrated. These are also the locations in which manufacturing-sector unions historically have thrived (or, lately, shrunk the least).

[16] See "US Factories: Falling Behind," *Business Week*, May 24, 2004, pp. 94-96.



Source: Authors' analysis of Current Population Survey data

Of the approximately 54,262 business establishments in the component sector, about 3,862 (or 7.1 percent) have some unionized employees.[17] Because the percentage of component sector establishments with a union presence is much smaller than the percentage of component sector workers represented by unions, unionized establishments in this sector must be much larger on average than nonunion establishments.

The twelve unions that represent the largest number of component manufacturing plants are the United Automobile Workers; International Association of Machinists; United Steel Workers of America; International Brotherhood of Teamsters; Glass Molders and Pottery Workers; Communications Workers of America; International Brotherhood of Electrical Workers; Paper, Allied-Industrial, Chemical, and Energy Workers; International Brotherhood of Boilermakers; United Food and Commercial Workers; UNITE HERE (the union that formed when the Union of Needletrades, Industrial and Textile Employees and the Hotel Employees and Restaurant Employees International Union merged in 2004); and the Novelty Production Workers. One or more unions may be present in a single establishment, as different unions may represent different groups of workers in the establishment.

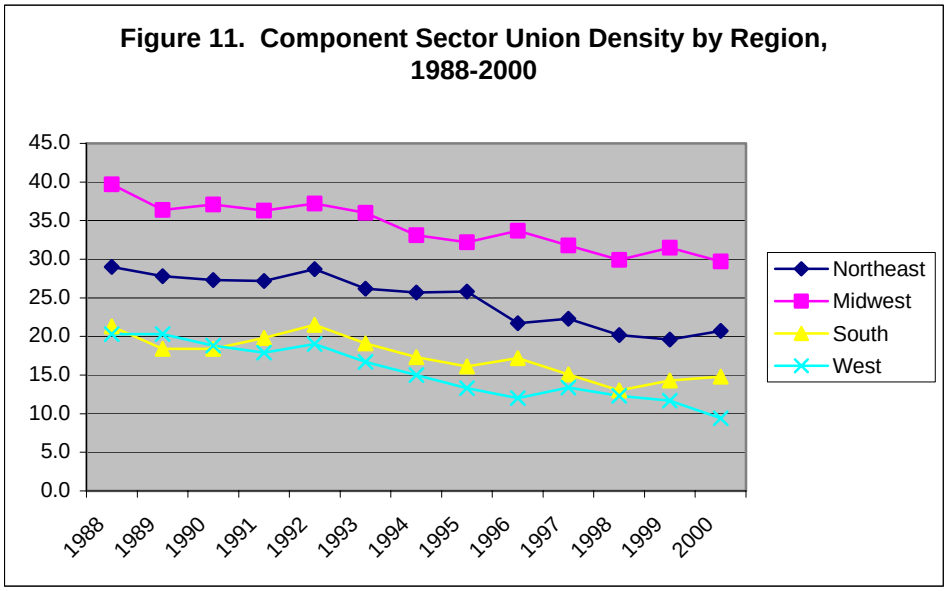
Regional Patterns of Union Density and Presence

Union density in components is highest in Midwest (where unions represented 29.7 percent of all component sector workers in 2000), then in the Northeast (20.7 percent), and is much lower in the South (14.8 percent) and West (9.4 percent). Union density declined in all regions from 1988-1998 (figure 11). From 1998-2000, it stabilized in the Midwest and Northeast, rose in the South, and continued to fall in the West. During the entire period 1988-2000, the relative decline in union density was smallest in the Midwest (where density declined by about a quarter), then in the Northeast (where it fell

[17] This estimate was derived from proprietary AFL-CIO data.

by about 29 percent) and South (31 percent drop), and greatest in the West (where density fell by more than half).

Figure 11. Component Sector Union Density by Region, 1988-2000

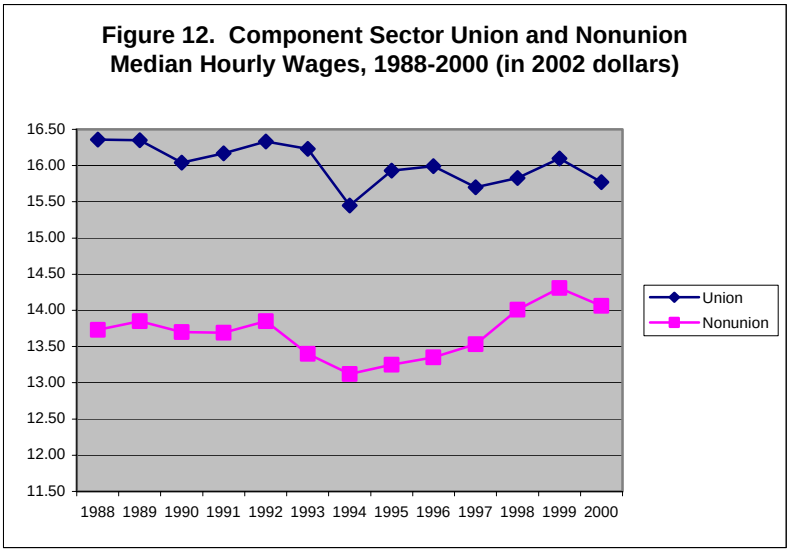


Source: Authors' analysis of Current Population Survey data

Unionized component sector plants are heavily concentrated in the urban areas on or near the Great Lakes and between Boston and Philadelphia, with smaller concentrations in major West Coast cities, and some presence in the South Central portion of the country (see figure 6). Nonunion component plants are much more evenly spread throughout the nation, though the major centers of unionized component manufacturing are also major centers of nonunion component manufacturing. However, there are also important concentrations of nonunion plants in the Carolinas, the Atlanta area, the major metropolitan areas of Texas, and Tennessee. Within the core component manufacturing areas of the Midwest, Northeast, and upper South, unionized plants are generally located closer to the centers of major metropolitan areas than are nonunion plants.

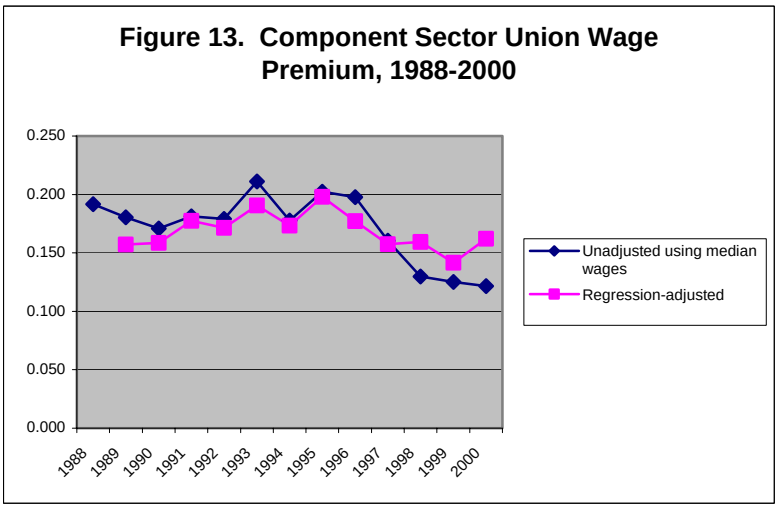
Union-Nonunion Wage Differentials in Component Manufacturing: Evidence from the Current Population Survey (CPS)

In 1988, component sector workers' median hourly wage was $16.36, while in 2000 it was $15.77. Nonunion workers' median wage was $13.73 in 1988 and $14.06 in 2000. (All wages are expressed in constant 2002 dollars.) Wages for both union and nonunion workers generally fell from 1988-94 and rose after that (except in 2000, when both union and nonunion wages fell) (figure 12).



Source: Authors' analysis of Current Population Survey data

Unionized component sector workers earn more than their nonunion counterparts. In 2000 the median wage of unionized workers in the sector was 12.2 percent higher than that of nonunion component sector workers. The differential between the union and nonunion median wages in component manufacturing displayed a modest upward trend during the early 1990s but fell from 1996-2000, with especially large drops in 1997 and 1998 (figure 13). Over the entire period 1988-2000, union workers' wage premium eroded substantially. The 12.2 percent union-nonunion median wage differential in 2000 was well below 1988's differential of 19.2 percent.



Source: Authors' analysis of Current Population Survey data

Union and nonunion workers differ in a variety of ways, apart from union status, that may affect their wages. Regression analysis was used to isolate the effect of union status

on component sector workers' average wages.[18] The results of the analysis show broad trends similar to those reported above for the union-nonunion median wage differential. The regression-based union-nonunion wage differential trended upward from 1989-1995, then fell substantially from 1996-1999. Because of a large jump in the regression-adjusted union-nonunion differential in 2000, the differential was actually higher in 2000 (when it was 16.2 percent) than in 1989 (when it was 15.7 percent). But if the year 2000 is excluded, then the regression-adjusted differential fell substantially since 1989 (to 14.2 percent in 1999). Thus, the regression analysis generally supports the main findings from the comparison of unadjusted median hourly wages: (1) the union wage premium in component manufacturing generally fell from the late 1980s through the end of the 1990s, (2) there was a slight upward trend in the union wage premium from the late 1980s through the mid-1990s, and (3) there was a dramatic fall in the union wage premium in the late 1990s though, as we will see, this was significantly offset by a growing "premium" in health insurance coverage.

The Employment-Wage-Productivity Connection

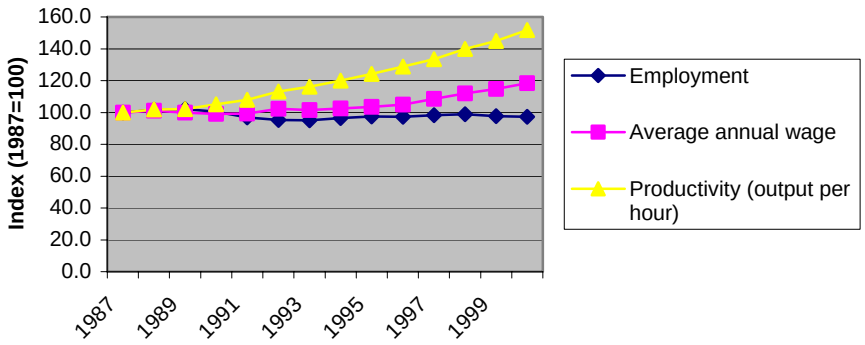
If the unionized component sector is to grow (or even stabilize), and if the size of its wage premium over the nonunion sector is to be restored, then its productivity growth rate must rise. Rapid productivity growth does not ensure wage and job growth, especially not in the short term. But rapid, sustainable long-term growth in wages and employment cannot occur without it. Wage growth can, of course, occur because of a redistribution of value-added from profits to wages, but even if pattern bargaining can be reconstructed in the component sector such a redistribution cannot continue indefinitely. And competition from the nonunion component sector, both domestically and in low-wage countries, prevents the unionized component sector from growing as long as the unionized component sector's unit labor costs (the ratio of its labor costs to its productivity) are at or above those of the nonunion sector. (The PBS evidence presented above suggests that unit labor costs are now similar in the unionized and nonunion component sectors in the U.S. once the cost of employer-provided health insurance is taken into account.)

Some union members may fear that more rapid productivity growth will lead only to more rapid job loss. An analysis of the relationship between productivity growth and job growth in the post-World War II period has shown that, although the U.S. manufacturing industries with the fastest productivity growth once had the fastest job growth (as productivity growth led to the expansion of product markets and, hence, of domestic jobs), in more recent years the manufacturing industries with the most rapid productivity growth had the most rapid job losses (as the job-expanding growth of product markets

[18] For each year from 1989-2000, the natural logarithm of the hourly wage was regressed on age, age squared, race, sex, education, marital status, region, metropolitan, broad occupation, and union representation, using data on individual component sector workers from the merged outgoing rotation groups of the Current Population Survey. The component sector was imputed using the method described in Appendix 3. The union-nonunion wage differential, d, for each year was derived from that year's estimated coefficient on union representation, c, using the approximation $d=e^{c}-1$.

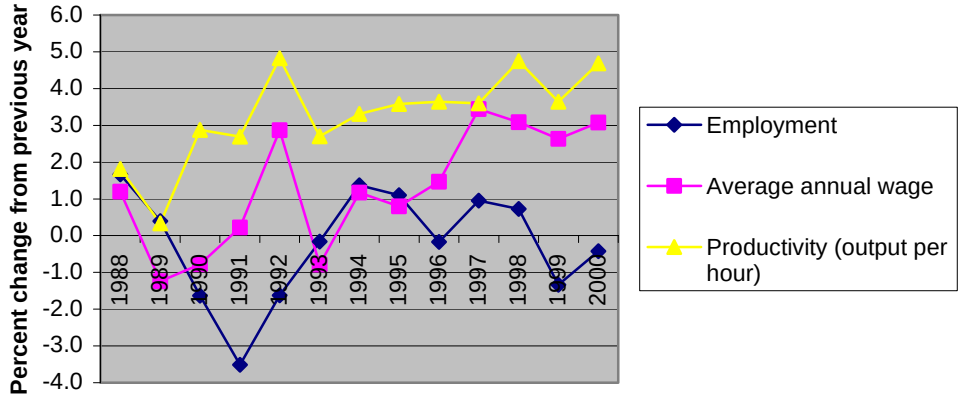
failed to make up for the labor-saving effects of productivity growth).[19] Moreover, as figures 14 and 15 show, U.S. manufacturing as a whole experienced rapid productivity growth from 1987-2000, but during the 1990s it lost jobs and its wage growth failed to keep pace with its productivity growth.

Figure 14. Employment, Wages, and Productivity in All U.S. Manufacturing, 1987-2000



Source: Authors' analysis of Bureau of Labor Statistics Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com, and authors' analysis of published Bureau of Labor Statistics productivity data

Figure 15. Annual Percent Change in Employment, Wages, and Productivity in All U.S. Manufacturing, 1988-2000



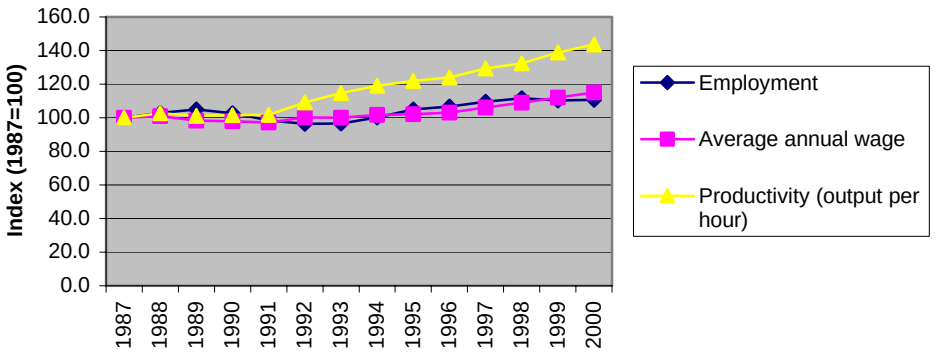
Source: Authors' analysis of Bureau of Labor Statistics Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com, and authors' analysis of published Bureau of Labor Statistics productivity data

But **the component sector's productivity, job, and wage performance during the same period gives some cause for optimism**. Despite a drop in employment during the

[19] Eileen Appelbaum and Ronald Schettkat, "Employment and Productivity in Industrialized Economies," *International Labour Review*, vol.134 (1995), pp. 605-623.

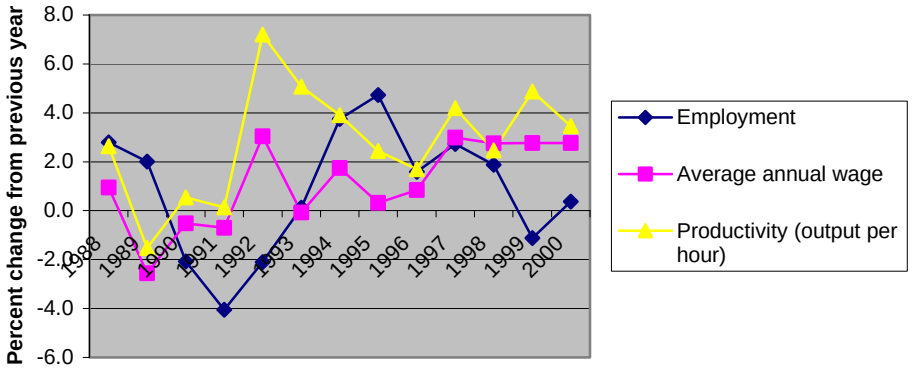
recession and jobless recovery of the early 1990s, the component sector gained jobs during the entire 1987-2000 period even as its productivity rose, and its wage growth fell short of its productivity growth by less than was the case in manufacturing as a whole (figures 16 and 17).

Figure 16. Employment, Wage, and Productivity in Component Manufacturing, 1987-2000



Source: Authors' analysis of Bureau of Labor Statistics Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com, and authors' analysis of published Bureau of Labor Statistics productivity data

Figure 17. Annual Percent Change in Employment, Wages, and Productivity in Component Manufacturing, 1988-2000



Source: Authors' analysis of Bureau of Labor Statistics Quarterly Census of Employment and Wages, with all data converted to an approximate NAICS basis by Economy.com, and authors' analysis of published Bureau of Labor Statistics productivity data

Even so, the most relevant comparison for purposes of union (and public) policy is not the comparison between recent years and the past; nor is it the comparison among productivity growth, wage growth, and job losses during the 1990s. Rather, the issue is the gap between what will happen to the unionized component sector in the future if productivity continues to grow slowly and what will happen if productivity starts to grow more rapidly. Because rapid growth of union jobs and a restoration of the union wage

premium cannot be sustained in components without more rapid productivity growth, an increase in productivity growth would be necessary even if the short-term future relationships among productivity, employment, and wages in components were to resemble those of manufacturing as a whole rather than those of the component sector in the recent past. In short, without sharp and sustained productivity growth, there is no way forward for unions. That is why we have concluded that there is no alternative to getting lean; the only debate is how and on what terms.

The Disappearing Union Advantage: PBS Data

In both wages and productivity, unionized firms have historically outperformed their non-union counterparts. But publicly available data do not shed much light on the forces behind the relative performance of unions and nonunion facilities. Fortunately, the PBS dataset is dominated by component manufacturers. Although PBS is much smaller and less nationally representative than the CPS, it does not require the definition of the component sector to be imputed and it contains a wealth of detailed information about establishment characteristics. Appendices 4-5 provide details on the statistical analyses we performed using PBS data.

As recently as 1997-98, PBS participants exhibited a significant compensation gap between union and non-union plants. Union shops averaged $13.11 per hour -- fully $1.69 more per hour than the $11.42 paid by non-union shops -- representing a wage premium of nearly 15 percent.

Further, this *wage gap* was accompanied by a *productivity and performance gap.* Among PBS participants, union shops averaged 12.7 percent higher labor productivity (value-added per FTE of $72,600 versus $64,400 for non-union shops); provided 46.6 percent more capital equipment to their employees ($56,900 worth of equipment per worker versus $38,800); and achieved 30 percent lower employee turnover (22.7 percent annual turnover versus 32.3 percent). Union shops in the PBS sample also tended to be larger (averaging 213 employees, versus 108), and sold a higher proportion of their output to customers in the automotive industry (49.5 percent versus 34.0 percent).

By 2002-03, however, the union shops no longer paid significantly more than their non-union counterparts. The union average wage had risen by just over $1 per hour, to $14.17. But the non-union average had risen by $2.35, to $13.77 per hour. The gap had thus shrunk to only $0.40 per hour, and was no longer statistically significant.[20]

[20] These findings hold under a variety of analytical techniques. The gaps reported here (and in Appendix 2) come from analysis of variance (ANOVA) of all PBS participants in 1997-98, and all participants in 2002-03. These are not identical samples, which raises the question of whether the disappearing union wage gap could be the result of changes in the groups of participants. Thus we replicated the analysis for just those plants that were PBS participants in *both* periods. Results were essentially identical, with a strong wage gap in 1997-98 and no wage gap in 2002-03.

An important limitation of the ANOVA approach is that it considers only one variable at a time. Thus we also performed regression analysis, to allow us to look at several factors that determine wages – such as industry mix, capital intensity, productivity, etc. – as well as unionization. Results were that even when

Perhaps even more important, *non-union shops had virtually closed the labor productivity gap.* Value-added per FTE among union shops now averaged $75,000, or an increase of 3.3 percent since 1998-99. But among non-union shops, value-added per FTE rose by 12.7 percent, to $69,400. The resulting productivity differential of $5,400 was no longer statistically significant. Average equipment value per worker at non-union shops had increased by 52 percent to $59,100 – slightly exceeding the union average of $58,700. Further, while employee turnover rates increased for both groups, the turnover differential also lost statistical significance.

PBS data do indicate the existence of a "health coverage gap" between union and non-union components plants, and this gap persists. Specifically, for PBS 1997-98, an average of 88 percent of shop floor employees in union plants were covered by substantially-employer-paid health benefits, versus only 71 percent of shop floor employees in non-union plants. The coverage gap was thus 16 percentage points. In 2002-03, coverage for both groups fell slightly, to 84 percent for union shops and 69 percent for non-union shops, implying a gap of 15 percentage points. These union/non-union differences were statistically significant in both years. Published data indicate that the value of these benefits to workers added roughly $.30-$.90 to the hourly wage gap for 1997-98, and between $.45-$1.15 to the wage gap for 2002-03.[21]

The strong probability that, among small and medium-sized US component manufacturers, the union productivity and pay premium has substantially eroded – and the fact that it has done so even though the vast majority of (mainly non-union) component-makers have not achieved robust annual productivity growth rates – suggests a clear imperative. For component sector firms and the unions representing workers in some of those firms, effective and rapid productivity boosts are necessary to a continued onshore presence at family-supporting wage levels. We turn now to 17 detailed case studies of how component firms, some unionized and some not, are adjusting to the new competitive realities. As we have already stated, "getting leaner" is a ticket to play. Not

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controlling for these other factors, the union effect among PBS participants was strong at $.92/hr in 1997-98 (and highly statistically significant), falling to only $.18/hr in 2002-03 (and not significant). These results also appear in Appendices 4-5.

[21] Data on the costs of employer-provided health coverage come from two sources. The first is the Mercer National Survey of Employer-Sponsored Health Plans. It indicates that the average cost per insured employee was roughly $3800 in 1997-98, rising to $6000 for 2002-03. Applying these average costs to PBS data on coverage rates (in 1997-98, 88% union and 71% non-union; in 2002-03, 84% union and 69% non-union), and assuming 2000 working hours per year, implies a "hourly equivalent health insurance gap" of $.32/hr in 1997-98, rising to $.45/hr in 2002-03.

The second source is the BLS series on Employer Costs for Employee Compensation. BLS reports that Total Insurance (not just health insurance, but also FICA, unemployment insurance, and life insurance) cost an average of $2.21/hr among unionized manufacturing plants in 1997-98, rising to $2.98/hr in 2002-03. (Note that BLS figures include total insurance costs per all hours worked by all employees – that is, per hour costs represent an average for *all* workers, not just *covered* workers.) Among non-union shops, the cost was $1.31/hr in 1997-98, rising to $1.72/hr in 2002-03. BLS data also indicate that health insurance costs fairly consistently represent roughly 90% of total insurance costs. Thus the average health insurance gap based on BLS data was $.83 per hour in 1997-98, rising to $1.15 per hour in 2002-03.

all companies are doing this, and many that are trying to do so are doing it in ways that are not likely to be effective or sustainable. The approaches that work best have, we believe, important implications for human resource management and for the programs of labor unions at the local, regional, and international levels.

Case Studies on Work Organization and Plant Performance

A High-Performance Work Organization model

Many US component manufacturers cannot compete on cost alone. No amount of regulatory "reform" to reduce structural costs and "level the playing field" will make most US suppliers price-competitive with suppliers in hyper-low-wage regions.[22] What better US suppliers must do instead is turn their higher wage costs into a competitive *advantage* by pursuing our FULL approach , which combines low-waste manufacturing practices ("lean") with an involved, empowered, and prepared workforce focused on innovativeness and organizational flexibility ("learning")[23] As we have noted, learning lean firms must be able to count on staying reasonably busy: without full utilization, their fixed costs will result in severe competitive penalties. Indeed, high-wage firms tend to be more capital-intensive than their colleagues and competitors, making high utilization of capacity even more important for them.

We strongly believe that the FULL approach can produce benefits for firms as well as workers. Using the Performance Benchmarking Service's dataset (about which more later), we have tried to predict which manufacturers are most profitable.[24] Controlling for industry sector, we have found that labor productivity is predicted by a firm being both *fully utilized* (measured as the proportion of the hours in a year that machines are running) and *lean* (imperfectly measured as inventory turns). With the same control variables, we found that only being highly utilized predicts pre-tax profitability. We interpret these results to mean that being lean has become a ticket to play for companies that require high productivity if they are to afford to pay good wages and benefits, but that firms must be running at or near full capacity to make money. For the substantial proportion of companies that are neither lean nor fully utilized, we believe, getting lean is

[22] Cost reduction and leveling the playing field are two key planks in NAM's "Campaign for Growth and Manufacturing Renewal" (http://www.nam.org/s_nam/sec.asp?CID=229&DID=227). For many products, a 25-30% drop in the dollar or a 15-25% increase in productivity would be required to make most US components-makers cost-competitive on a piece-price basis. The other two NAM planks are to "promote innovation, investment and productivity," and "ensure an adequate supply of skilled workers." While we agree in principle with these latter two emphases, we see them as indirect. The core strategy, we believe, must focus on directly upgrading manufacturing capability and performance at the firm level and will, we show, work best if performed on a regional basis.

[23] Note that we are not saying that these firms will need to abandon high-volume, repetitive, "routine" parts and products to "China." In real-world manufacturing, most firms do a mix of hard-to-make, "distinctive" work along with some "routine" work. Economists' consensus -- argued perhaps most cogently in Robert Reich's work in the 1970s and 1980s – to the contrary, the composition of US manufactured imports (cars, machine tools, plasma screens) does not look a whit more routine than our largest exports (chemicals, paper and pulp, and – to be fair – Boeing aircraft and Caterpillar construction equipment).

[24] Regression results are presented in Appendix 2.

an essential means to harvest resources now being wasted to invest in acquiring enough new business to increase utilization.

High productivity allows manufacturers to pay higher wages, in addition to reducing costs by doing more with less, while innovativeness and flexibility lead to growth in market share as firms are able to satisfy OEM customer's demands for suppliers that provide solutions, not just parts. But no matter how fast and flexible firms become, unless they can "level" production at a high level, high fixed costs will render them uncompetitive. As we will show, new regional policies have a critical role to play in reserving demand for in-region firms seeking to follow the new recipe.

Before turning to the role of regional policy, we want to focus closely on what is known about how manufacturing companies reach qualitatively higher performance. There is broad agreement in the academic literature that firm performance is most dramatically improved when a package of *complementary* manufacturing and HR practices is implemented – that is, when certain manufacturing and/or HR practices are implemented together as a system, rather than in isolation.[27] In terms of manufacturing practices, we are convinced by our reading of the academic literature and our work in the field with manufacturers that lean production techniques can provide substantial performance improvements in terms of reduced waste and increased flexibility and productivity. It is possible, however, for manufacturers to focus on the technical elements of lean production and see significant performance improvements without modifying HR practices and workplace 'culture' to encourage high levels of involvement from workers. While firms can see significant improvements in productivity by implementing lean production in this partial and limited way, we believe that higher-wage firms can achieve world-class performance only if they also properly implement high-involvement HR practices and focus on cultural change, where the latter includes transforming conceptual frameworks, social relations and routines that may have developed into more-or-less rigid patterns through historical repetition.

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[25] Regression results are presented in Appendix 2.

[26] We are aware that there is a large literature about firms, particularly in Europe, succeeding by being specialized and agile at redefining slices, or niches, of markets and serving those niches through craft production. While that works for some companies, the vast majority of the traded-goods economy is made up of products produced at substantial scale on a repetitive basis. Even for "high-end" craft-oriented shops, high machine utilization increasingly requires that they take on at least some "commodity" work to keep their capital equipment highly deployed.

[27] Peter Cappelli, Laurie Bassi, Harry Katz, David Knoke, Paul Osterman, and Michael Useem, *Change at Work*, Oxford, Oxford University Press (1997); Casey Ichniowski, Thomas A. Kochan, David Levine, Craig Olson, and Goerge Strauss "What Works at Work: Overview and Assessment," *Industrial Relations* 35 (1996); Jeffrey Kling, "High-performance Work Systems and Firm Performance," *Monthly Labor Review* May (1995); David I. Levine and Laura D'Andrea Tyson "Participation, Productivity, and the Firm's Environment," in A. S. Blinder (ed.) *Paying for Productivity: A Look at the Evidence*, Washington, D.C., Brookings Institution (1990). John Paul MacDuffie, "Human Resource Bundles and Manufacturing Performance: Organizational Logic and Flexible Production Systems in the World Auto Industry," *Industrial and Labor Relations Review* 48 (1995). One article that does not find evidence supporting the complementarities or synergies hypothesis is Peter Cappelli and David Neumark, "Do 'High-Performance' Work Practices Improve Establishment-Level Outcomes," *Industrial and Labor Relations Review* 54, 4 (2001).

Lean efforts focus on the reduction of buffers and the reorganization of the factory to improve product flow, product quality and overall process operation. In addition to making the system more fragile and vulnerable to breakdown, the environment of lean production is much more demanding in general. While managers can obtain some of the benefits of lean production without engaging workers in substantive participation in problem solving and decision-making, a lean system will really only hum if it is driven by engaged workers. We distinguish a high-involvement, "learning" model of lean – sometimes called (in our view, confusing "recipe" with outcome) "high-performance work organization" (HPWO) -- from what we call the *lean standardization model*. The latter focuses largely on inventory reduction and process standardization and improvement without substantive worker participation. While workers may be consulted and some continuous improvement achieved, we find much efforts at lean standardization without much change in terms of HR practices or workplace culture.

We think that *the learning/HPWO model* generates better manufacturing performance than the lean standardization model, for three reasons. First, continuous innovation is needed because plants face an unending task of handling more variety and falling average order sizes as they try to stay busy in an environment in which the highest-volume orders are the most likely to be competed away. Second, routine high self-management is needed, because high-pay lean shops cannot afford to carry as much overhead. Third, and perhaps most important, if "continuous improvement" of manufacturing processes is really to be continuous – for instance, when process maps are changed at regular intervals, rather than as a one-off effort – such restructuring will be best guided and driven by those who have both the tacit, expert knowledge and the practical, experiential knowledge that only direct workers have. The model we articulate utilizes a high-involvement, high-skill labor force engaged in continuous improvement of (lean) manufacturing techniques to reduce waste and improve process control in the context of strong demand.

Our learning/HPWO model shares with the lean standardization model a core focus on improved flow through repeatable processes via a transformation of the organization of production from a functional layout based on batching and queuing to a product-focused layout based on continuous flow principles. Traditional mass production is based on forecasted demand; work is scheduled at individual work stations and pushed through the shop. The result is a disjointed system with cost drivers hidden by the buffers of large work in process (WIP) inventories, an army of indirect labor, and long lead times. Using lean techniques, in contrast, parts with similar processes and routines are mapped into families so that the shop layout can be reorganized into product-focused cells (work areas) and lines that are scheduled *at a single point* in a continuous-flow sequence, based on customer demand. Work is *pulled* through the factory with operations connected into continuous flow and production and inventory control based on visual signals (*kanbans*), so that queue time, WIP, machine setups, inventory turns and, ultimately, product costs and lead times are reduced to a minimum.[28]

[28] Note that pulling product through the process need not imply single-piece batches and the complete elimination of buffers. In many cases, the "piece" in single-piece flow may be composed of 10, or 100, or

There are core lean tools that many managers are familiar with, which can significantly "lean up" a workplace, such as value-stream mapping, setup reduction and standardization and quality control techniques including 5S and total productive maintenance (TPM).[29] Our research has revealed that some of these practices can be implemented without much regular, substantive participation by workers, yet with some degree of continuous improvement, so long as the management and engineering staff are diligent about working out the kinks and making periodic alterations to production processes. When managers focus largely on these lean manufacturing practices – under a regime of consultative participation or, even less effectively, with essentially imposed participation – plants can become relatively lean, yielding significant performance improvements in terms of reduced inventory and improved quality and productivity. Under consultative participation workers may be asked their opinions but problem solving and decision-making authority have not been fully or effectively devolved to the workforce. To reap the full benefits of moving to a bufferless, continuous-flow system requires the successful implementation of a HR practices and cultural change that *sustain* an engaged, high-involvement workforce. When successfully implemented, such a system will include substantive participation from a large portion of the workforce. Given that sustained continuous improvement requires the regular flow of information – practical, experiential knowledge and tacit, expert knowledge – from workers, active, substantive participation is required to make the system hum. In this case plants should see even more significant performance improvements, not only in terms of productivity and quality but also in terms of flexibility and delivery, as workers drive lead time reduction through continuous process improvement. Shorter lead times improve the ability to increase product variety with given resources and timeframes.

From the HR side, the most basic component of a learning/HPWO is adequate training of the workforce, including training in problem-solving and decision-making, in addition to multiskilling through cross training. Training should be considered an ongoing process, rather than a one-off effort – for example, giving workers a half-day training in lean principles is not sufficient. Further, workers need to be given adequate resources to take on their new roles, including access to information and the skills of experts. Care must be taken to assure that other aspects of the work system – such as pressures to keep a line going and/or to meet certain efficiency targets – do not interfere or conflict with the enlarged roles of workers. Workers should be organized into teams, including online teams organized around work groups and offline teams that meet for problem-solving and continuous-improvement planning. Authority to make decisions and engage in problem solving activities must be given to workers in a way that encourages these behaviors.

Because more is being asked of workers, they should be compensated accordingly.Appropriate contingent pay schemes – pay for skill or knowledge,

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even 1000 units. And modest buffers, often called "supermarkets," may be appropriate to help keep production level and flowing.

[29] 5S is a methodology for improving workplace efficiency and safety, based on Japanese techniques, which is roughly translated as sort, set in order, shine, standardize, and sustain.

gainsharing, profit- sharing – should be tailored to fit a given situation. Equally important, the value of communication cannot be overstated: many attempts are workplace restructuring are stalled or failed because of a reticence and resistance by the workforce, much of which results from a lack of communication combined with improper financial incentives. Thus, it should be communicated to the workforce that the change expected is quite dramatic, including much more expected of the workers. This communication needs to be not only consistent, but consistently backed by deeds, including appropriate compensation. Asking more of workers and making their jobs more stressful without increasing compensation is a recipe for failure.

Ultimately, to sustain this type of cultural change, in addition to better communication and increased compensation, three ingredients are necessary: upper management must be fully supportive of the initiative; trust must be built through deeds (or made unnecessary by clear worker protections and legal and contractual safeguards), including successful efforts with new routines; and workers must be sure of their own job security (and, preferably, see a way to capture some of the financial gains of higher productivity). For example, plant mangers must be given enough leeway to implement organizational changes, such as improved process flow to reduce lead time, that often do not result in immediate results as measured by traditional cost accounting metrics; or they should be encouraged to engage workers in "offline" continuous improvement activities even though these may conflict with traditional cost accounting metrics such as labor utilization. Managers should begin with simpler projects that have a high probability of success – such as a 5S event in a particularly cluttered workspace or a setup reduction on a particularly long setup, rather than, say, attempting a first value stream map a complicated product family – so that they can demonstrate the effectiveness of a given organizational change and then document and communicate the success story.

The cases

Our qualitative analysis is based on in-depth, open-ended interviews in 17 plants, including six union shops and eleven nonunion shops. In each case we spoke with a plant manager. In addition, we spoke with between four and six workers in as many of the cases as we could, though we were not able to speak with workers in every plant because some plants were too busy to provide so much time. We collected internal company documents and data on wages, productivity and other performance metrics where possible. Given the sensitive and sometimes incomplete nature of some of this data for particular firms, however, we are unable to conduct any systematic quantitative analysis of performance outcomes. These data are still quite useful in our overall assessment of the plants in the qualitative analysis.

All of the plants included in our analysis are in the component manufacturing sector. They supply metal and plastic parts and subassemblies to OEMs or their first-tier suppliers; thus, some of the cases here are first-tier suppliers and others are lower-tier suppliers. One of the plants supplies wire wheels for industrial welding and also supplies this product directly to consumers as an OEM product. Another plant is partially an internal supplier to a parent firm that sells an OEM product. Most of the plants are small

or medium-sized enterprises (SMEs), employing between 50 and 500 workers; only a few are large organizations employing over 500 workers.

Using the learning/HPWO model presented above as a framework to orient our analysis, we provide a brief overview of the cases, first for the nonunion plants then for the union plants. This overview sets up the core of our qualitative analysis, a cross-case comparison of union versus nonunion shops for our 12 high-wage plants, and then a comparison of high-wage versus low-wage shops for our 11 nonunion plants.[31] We also distinguish high- and low-productivity plants, using the measure value-added per employee as a stratifier. Table 5 presents the distribution of plants based on these criteria.

Table 5. Our Case Studies

	High-wage		**Low-wage**	
	High Value-Added per Employee	*Low Value-Added per Employee*	*High Value-Added per Employee*	*Low Value-Added per Employee*
Nonunion	Industrial Pumps Auto Stampings Cat Gears	Tubefab Integrated Metalfab	Midwest 2nd Tier Plastic Grilles Standard Sensors	Suburban Midget Rubber Products
Union	Second Tier Custom Seats Sealmaster Aircraft Parts Auto Moldings Mini OE			

We think that the more technical aspects of lean production methods are relatively straightforward – though by no means unproblematic – to implement when compared with the more social aspects regarding worker participation and cultural change. As mentioned, there is a "toolbox" of lean techniques – cells, JIT and continuous flow; *kanban* and other visual control systems; 5S and TPM standardization methods; setup reduction – which can be implemented in varying combinations to provide substantial performance improvements. The 58 centers of NIST's Manufacturing Extension Partnership (MEP) offer training and consulting on this toolkit in all 50 US states. While proper implementation of these techniques can be quite demanding, even more challenging and troublesome is the successful transformation of HR systems and workplace culture to include sustained, substantive participation of the workforce. (Here, there is far less available and competent help, either from MEP and MEP-like programs or from international unions. Unions are much more active in this field in northern Europe.)

[31] Ideally we would provide a comparison of all four possible cells in the high-wage/low-wage, union/nonunion matrix. However, as we were unable to gain access to any low-wage union shops, we focus only on the two comparisons.

Nonunion plants

Of the six high-wage nonunion plants we observed, only one – Industrial Pumps – successfully implemented learning/HPWO, *including both the system-wide transformation to lean production techniques and the continuous improvement culture based on substantive participation by parts of its workforce.* Here, the skill content of many jobs has increased, and high wages and high productivity are closely linked. In two other plants, Auto Stampings and Cat Gears, a culture of continuous improvement with some degree of substantive participation – though participation in decision-making remained consultative – was implemented *despite* a lack of lean practices in terms of waste reduction and process standardization. At Auto Stampings, high productivity was supported by a focus on quality improvement by skilled workers – operating within the context of a very informal small shop – combined with high automation and high uptime; in this case high wages and productivity were closely linked. This case demonstrates the effectiveness of workers engaged in substantive participation to continuously improve processes and product quality. At Cat Gears, high productivity was supported by high levels of investment in automation, high asset utilization, and a dedicated workforce.

In the three other high-wage nonunion plants – Tubefab, Integrated, and Metalfab – relatively high wages were supported despite having mid-level productivity. The plants were able to get a good quality product out the door at competitive price, but each fell short of approaching the low-waste, high-performance ideal; daily routines of workers and workplace culture are largely the same. These plants approximate a lean standardization model, using some combination of lean methods within a framework of consultative participation. While some significant performance improvements were achieved, each retained a relatively traditional authority structure rather than a worker-driven, vibrant culture of continuous improvement.

Of the five low-wage nonunion plants we observed, two have implemented a lean standardization approach, selectively combining some elements of lean with more traditional manufacturing prowess to yield relatively high productivity. These plants – Midwest Second Tier and Plastic Grilles – have combined some technical elements of lean production with a particular expertise – innovative, complex tooling with high-skilled craft workers and good cost knowledge with adept product selection – to support high productivity in a low-wage environment of minimal participation. These cases exemplify the benefits of stable, high-volume demand allowing investment in high-quality assets and high asset utilization. For operators and other production workers, skill profiles and daily routines have changed little. A third case, Standard Sensors, is similar to the first two but with low wages. Sensors is an archetypical case of the lean standardization strategy: very lean on many technical aspects but within a regime of consultative participation with little effective input from the workforce. They also provide a good example of a how lack of support by upper management can block efforts to push lean toward a high-performance model; in this case, perhaps, an active local union could have played a role in helping to bring upper management ‘on board’ in this regard. The final two low-wage firms, Suburban Midget and Rubber Products, are cases

of the low-cost strategy, with little or no implementation of lean practices or worker involvement.

We briefly discuss each of these cases in turn. Readers will note that in only the first of these 11 nonunion plants (Industrial Pumps) do we see anything that deserves to be called "learning lean." Many of the other ten increased their inventory turns, but mainly by discovering that they did not need to fully replenish raw and finished goods stocks. For many, work-in-process (WIP) inventory (which maps directly to manufacturing lead time and which, we have found, is where worker knowledge is often most critical) showed a much smaller decline.

Industrial Pumps restructured from an extremely disconnected system in which each operation was scheduled independently of the others; they worked from forecasts, making dozens of parts for each final assembly with pallets of parts scattered everywhere. Two full-time expeditors spend "all day, every day, walking three or four different parts through the plant just to get a couple orders off." Having moved away from forecasting, they now make only what they have orders for. Since implementing a number of lean practices with the help of the Wisconsin Manufacturing Extension Program (WMEP), Industrial is dramatically more flexible. For example, on their CNC machining centers, setup has gone from an hour and 15 minutes to 10 minutes or less. Five years ago they were quoting lead times at two weeks and typically shipping in about four weeks. Now they're quoting one to two weeks and shipping in about four days. On time delivery has gone from 30 percent to about 90 percent. Inventory turns have improved, from below two up to around eight. Though far from world-class, Industrial Pumps expects to see continued improvements in turns as it continues to focus on reduction of lead times and WIP inventories.

Some amount of substantive empowerment has been achieved at Industrial, particularly with in terms of some real problem-solving opportunities, of which *some* workers have taken advantage. The main form of substantive participation is through offline teams, including 5S, setup reduction, and VSM continuous improvement teams. While many workers did not experience much opportunity to participate in decision-making and problem solving, management did appear to be successfully working toward sustained cultural change, taking things slowly and building support and trust through designing effective projects. For instance, in a 5S event workers realized they had seven sets of Craftsman tools, each with a full set of metric and English wrenches. Yet they did not even need a wrench in the cell.

Auto Stampings is a single-plant firm that used to be a supplier to the toy industry, but has reinvented itself as an auto supplier. At the time of our visit, the firm was in the middle of a generational transition. We talked to the son, who had many ideas he was trying to pursue simultaneously: get out of tool and die because it was cheaper to outsource it, buy expensive CNC equipment and expand the tool and die offerings, do assembly as well as stamping of parts, and find a Mexican or Korean partner to do production. The company was 40 percent employee owned, and the employees would own a majority (part of their

pay was in stock) in a few years, but he did not think this would lead to a change in direction for the company.

Most of the workers at Auto Stampings are highly skilled operators, most of whom have gone through an apprenticeship program, setting up and running stamping presses. The factory seemed a blend of deep craft knowledge with a fair amount of new fangled TQM. While workers seemed to have a fair amount of influence and autonomy based on their individual technical knowledge, their authority was limited to quality, and did not extend to making decisions about waste reduction and improved product flow. Their efforts on TQM resulted in standardization of processes for installing and storing dies, for example, but there was also great emphasis on discovering the root causes of problems. While they did not have standardized work diagrams hanging from their machines, as is typical of TQM, they effectively do continuous improvement through a sustained focus on investigating procedures to see if they are the best ones and trying to get workers to follow the procedures.

Auto Stampings was not very lean in terms of implementing things such as visual controls, cells, or JIT. However, they do effectively implement continuous improvement with some degree of substantive worker participation, though this takes place within a traditional authority framework. Based on their craft knowledge, and within definite limits, workers were actively engaged in problem solving. In terms of decision-making participation remained consultative. This relentless focus on quality improvement by skilled workers – operating within the context of a very informal small shop – combined with high automation and high uptime, results in high productivity. This plant illustrates the benefits of having highly skilled workers and a relatively high degree of worker participation in problem solving and continuous improvement, even without the other elements of lean production. At the same time, however, this lack of standardization and codification of procedures may be problematic for plant management in the long term if such craft knowledge remains tacit.

Cat Gears is a supplier virtually 100 percent dedicated to Caterpillar. Cat Gears was privately held until 1996, when it was purchased as a wholly owned subsidiary of Okubo Gear in Japan. Until the firm moved into a new facility in 1997, the parts Cat Gears made were virtually all mid-sized gears, made by standard gear-cutting processes. At about that time, Cat Gears made a strategic decision to move into producing significantly larger, more complex parts. Besides their complexity, the sheer size of these parts affords Cat Gears some protection against offshore competition.

Cat Gears is active in trying to get high school students to see that gear-making is high-pay, high-skill work. It maintains functional departments (machining centers, lathes, etc.) and designates a group of five “leaders,” the most vital people, who do and oversee setups, and make sure their department is in order. The leaders earn $18-20 per hour, while the other shop floor people – operators, machinists and setup people – range from $12 to $16. Everyone who demonstrates the aptitude and the willingness to seek out opportunities has a chance to move up. Since they have been and continue on a growth path, Cat Gears is always looking for good people and is always interested in pushing

people up the skill curve. Employees at Cat Gears work very hard, but the work is varied and challenging.

A typical new hire may run one of the gear-cutting or other machines that only requires monitoring one tool at a time. As workers progress, they move to machines that have more expensive tooling (and where mistakes are therefore costlier) and/or have multiple tools that require them to be monitoring and measuring more things. Operators do their own inspection. Cat Gears' view is that, even with its skill and investment, it could not survive if it were a full-blown craft shop that paid all of its workers $18-30 an hour. Its "HR innovation" is its pay-tiering in the presence of steady sales growth: it makes highly complex parts even though 45 of its 50 shop workers make less than $16 per hour. Growth means steady pay progression for those that stay, even though there is a wall for most at $16.

There are no cells and Cat Gears' president scoffs at talk of "lean production." An ex-gear-cutter himself, he views it as a silly formalization of common sense: "Don't waste time and if you can run three machines instead of two, then do it. Inspect your own work, and clean up your own mess." This same anti-waste attitude extends to material: inventory turns are above 15, placing Cat Gears in the 85th percentile for its industry.

Tubefab originally located in a rural area to take advantage of low wages, but now has the highest wages in its area because suburban sprawl has put it in competition with nearby urban labor markets. In much of the plant, Tubefab has become relatively lean by implementing JIT routines. They have moved from having separate functional departments for tube bending, tube finishing, and tube assembly to having all of operations combined in a single fabrication department composed of product-focused cells. Inventory buffers have been reduced and batch production has been replaced with continuous flow in tube fabrication. Tubefab maintains a separate press department, in large part because of some huge 400-ton straight-side presses that would be "a logistical nightmare" to move. As the plant manager noted, their highest-volume cell runs 140 parts an hour, versus 2000 parts an hour on their largest presses.

Rather than tackling the problem directly, by focusing on setup reductions and process mapping and engaging workers to find innovative ways to work out it out, management is preoccupied with traditional mass-production metrics such as direct labor utilization. Tubefab is doing well in terms of profits, customers, and quality; since they have implemented their limited, selective version of lean production, their ppm's – defective parts per million, a key quality measure for large volume producers – have gone from around 1500 to around 100 and on-time delivery has gone from below 90 percent to about 98 percent. Yet Tubefab has fallen far short of its productive potential, in part because it has focused on the technical aspects of lean without moving toward substantive participation and cultural change necessary to implement continuous improvement to more effectively use labor and eliminate unnecessary activities.

Note that effective use of labor may be different than the "efficient" use of labor in the traditional cost accounting sense: the former includes use of workers in ways that may

conflict with the latter, such as for brainstorming and problem solving even if on paper those reduce direct labor utilization. In Tubefab's case, technical problems and an emphasis on particular metrics such as inventory reduction and on-time delivery – rather than efforts on training workers to be broadly skilled problem-solvers – dominate the agenda. While employee input is actively solicited and workers' ideas are often tried, this process operates within the framework of a traditional authority hierarchy – topics and goals are defined by management, employee autonomy is severely restricted, and deliberation and decision-making are limited. The mechanisms of EI here function to extract workers' ideas for continuous improvement without devolving authority. The process is directed and controlled by managers and engineers. Furthermore, the extent of EI is limited not only in depth but in breadth. Offline teams are staffed by a limited group of volunteers and the tendency not to "pull them off the line" further limits the breadth of EI. As one worker indicated, "We have a few meetings. You know they've got meetings where you can put your input in. If something gets done or not is another story, but they do let you put your input in."

Integrated is a classic example of a hybrid organizational form: some of the work is organized into functional departments and other work is organized into product-focused departments that largely cellularized. The division of labor includes highly detailed job classifications (of standardized and often rote tasks) organized into online work teams that are involved in continuous improvement activities, as well as offline quality and process improvement teams in each department. Integrated claimed to be running small lot sizes and doing JIT, though it was not clear to how thoroughly and effectively they had implemented these practices; observations during a plant tour suggested that there may be some serious problems with haphazard product routings and work flow. Nonetheless, they have implemented continuous flow principles with pull systems in certain areas and claim that on-time delivery, quality, and inventory management have been steadily improving, though we were unable to get any specifics.

While engineers and managers at Integrated are constantly tinkering with the production process and standardizing better methods, they do so without much substantive involvement of front-line workers. While workers are offered the opportunity – indeed, highly encouraged – to give their ideas about process improvement, their jobs are in general highly regimented and traditionally organized. With their online teams of cross-trained workers Integrated had achieved a substantial amount of functional flexibility in their ability to deploy the same labor for different product lines and task mixes. They are relatively lean in terms of practices like point of use production, smaller lot sizes, and less work-in-progress (WIP) inventory. Yet aside from rotation among highly regimented and rote jobs and the opportunity to give ideas, workers have not seen much change in daily routines or "job enrichment" in terms of substantive participation; wages have not been affected by restructuring to lean production methods.[32]

[32] We do not wish to equate the opportunity or obligation to participation, let alone the existence of lean production methods, with job enrichment. While we do think that under the right conditions opportunities for substantive participation in problem solving and decision-making may lead to job enrichment through multiskilling and increased authority and autonomy, we also recognize that lean production can lead to job intensification and speedup, and that certain individuals may prefer a traditional mass production

Metalfab Plus is an ESOP that does sheet metal fabrication and is trying to turn into a "solutions" provider for customers, taking on more assembly, painting and quick-turn prototyping work. Metalfab claimed to be about 90 percent complete on a full plant re-layout. Business had grown in phases, adding capacity in functional chunks, with no regard for flow; now, the firm is going to point-of-use and better flow. While they thought they had become lean, there are still some serious problems with the layout and organization. Metalfab has some quasi-cells, with lasers feeding work to press brakes and then welding, but there are also functional areas, with areas for stamping, machining and welding. There is also a lot of relatively large batch processing. Only five to ten percent of their products are on a *kanban* system. They are still working on this and on setup time reduction, problems with which are making them hold a lot of WIP. They have nominal teams organized around departments or areas, but they meet quarterly at most. They want to get to having them meet at least once per week, but do not seem to have much notion of systematic, substantive participation of the workforce. Basically, they do triage job rotation, but nothing formal, though there are plans to set up a formal cross training program. Metalfab had essentially done process mapping "on a hunch," and were really just groping around without an clear vision of manufacturing excellence. Restructuring has not affected job content or wages really at all. Despite these problems with workflow and relatively high WIP, Metalfab has seen inventory turns improve to around 10 due to better management of raw- and final-goods inventories.

Midwest Second Tier, a deep-draw stamping outfit, specializes in high-tolerance parts which require expensive tooling and high volumes. This has made them more dependent on the auto industry than they would like to be. They have been trying to diversify, but found that their niche is getting automotive customers tooling for which "they're willing to pay the bigger buck ..." In addition to doing complex, tight-tolerance parts, their strategy has been to try to do everything "in the press," meaning that they minimize secondary operations by trying to work them into the press operation. With their core specialty essentially being do-it-all-in-the-press, they are heavily dependent on the toolmakers. They are an interesting case because they show that what is often alleged to be the case in craft-led union shops, can apply in non-union shops, too: a conflict between craft domination and the standardized work components of lean production.

Midwest has implemented lean practices in a piecemeal and selective fashion. Their own particular version of lean is focused on 5S standardization efforts for regular operators and improved product flow. They have done some work with cells but are making excuses for why they cannot adopt a systematic and comprehensive package of lean practices – primarily in terms of their situation as a contract manufacturer with highly variable demand and complex tooling. The overall system has been rationalized and partially restructured based on flow principles, though inventories have not really been reduced. Part of their ability to do innovative things with tooling comes from the fact

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environment with its various buffers to the more demanding environment of lean production which, with its increased responsibilities may be perceived by many as more stressful (see Matt Vidal, "Lean Production, Worker 'Empowerment,' and Job Satisfaction: A Qualitative Analysis and Critique," mimeo, University of Wisconsin-Madison, 2004).

that they have their toolmakers spend a lot of time out in the floor helping with the setups. Operators run two to three presses at a time but do not do any formal job rotation or cross training beyond that. Participation is on an individual basis and is consultative, other than the direct input into tool design given by toolmakers. The teams do not do much other than work around the same set of presses together. They do not have any offline teams, though it appears that these could be very useful – e.g., increasing communication between toolmakers (team leads) and quality engineers to do root cause analysis or standardizing best practice across cells. For regular operators, wages and job content have not been changed by the lean restructuring. A lot of the problems discussed were "depends on the person" type problems, where creative and motivated individuals would do troubleshooting and problem solving in a fire-fighting, very un-lean way. Substantive participation and a sustained focus on cultural change could probably improve their flexibility and productivity, though they have achieved relatively high productivity through a traditional focus on high utilization combined with investment in high-quality, innovative tooling.

Plastic Grilles is quite similar to Midwest, with its focus on innovating tooling and high-volume, high-utilization manufacturing. Plastic Grilles' owners began as mold brokers in Portugal, and firmly believe that, in molding, tooling is the basis of the business. Being 90-95 percent automotive-dependent, Plastic Grilles has only recently tried to come up with proprietary products for, among others, the hand-tool (hammer handle covers) and consumer goods (spatulas) markets. In the tooling business, work is organized in functional departments, the largest of which houses more than a dozen CNC mills used for making and repairing molds. In the molding business, the shop is organized into cells by product line and, within speaker covers, by customer; more than 80 percent of the workforce is Hispanic. In the tooling business the machinists work with the family-member owner/managers to decide how work is organized, while in the molding business, the managers – many of whom speak little or no Spanish – decide.

Plastic Grilles' high productivity owes mightily to successful management of rapid growth. Between 1996 and 2004, sales more than quadrupled, while employment only rose 144 percent from 45 to 110. In 2000, value-added per FTE stood at $75,670, solidly in the top quartile for injection molders serving automotive. This solid productivity showing partly reflects a good knowledge of costs, plus the confidence to walk away from money-losing jobs: more than once, Plastic Grilles has called a customer and told it to come pick up the mold(s) for a job it had decided to drop. Productivity has also been enhanced by Plastic Grilles' ambitious migration from producing speaker covers into making *all* of the plastic parts within a speaker assembly.

But in some areas that could raise productivity, Plastic Grilles performs at or below industry average levels. Inventory turns are stuck in the 7-8 range, well below the automotive injection-molder norm of 10-13. The difference reflects roughly $750,000 tied up in excess inventory. Some of this is justified by the need to hold some finished goods inventories in low-volume parts, but most reflects a failure to get lean. Efforts in this direction seem blocked, partly because the workforce is not consulted and partly because the owners' real focus is on toolmaking. Management hopes and anticipates that

the move to the new, larger facility will improve flow, but there is little basis for this faith.

From the standpoint of job quality and its relationship to manufacturing performance, Plastic Grilles follows a familiar dualistic pattern. It values its managerial and tooling/repair personnel and pays them well, but is at best a mid-wage, mid-commitment employer for semi-skilled labor.

In any case, Plastic Grilles' approaches seem to support fast growth and solid productivity. Its struggles to achieve compliance with the QS 9000 quality standard, to reduce turnover and inventories, and address uneven machine uptime collectively raise the issue whether a learning/HPWO strategy might work even better. Ironically, good tool-making, marketing, sales, and product lines have reduced the pressure to get lean. A view of injection molding as routine work has bred inattention to the low-wage immigrant workforce, creating a culture in which lean techniques might be hard to implement.

Standard Sensors has four US plants that make similar products: relatively complicated assemblies of sensors and actuators for automobiles. Two of their plants were organized almost exclusively into cells while the other two, recently acquired from a different company, were not as extensively organized into cells. The two more fully cellularized plants were impressive in their adoption of the many technical aspects of lean – there were many special jigs and fixtures to make it hard to create a defect, and products were designed for manufacturing to facilitate this sort of thing. The plants were spotless and defects were relatively few. Despite being quite lean in these respects, worker involvement in continuous improvement activities was amazingly small; the workers in the cells largely followed the standardized work practices. Engineers designed all the jigs and occasionally they would consult a worker at the station they were improving, but this was difficult in two of the plants because most workers there did not speak much English.

However, workers did build up skill in their jobs, due to long tenure. Keeping this workforce was a key consideration when growing sales dictated a new plant. The company's board (located in Ohio) wanted the plant in Ohio, but the plant manager convinced them that it should be within commuting distance of the old one.

One of the less cellularized plants had some attempts at continuous improvement driven by a real lean fanatic who was given a title "Wizard of WOW", where WOW was war on waste. He had implemented one cell, with the help of the Toyota Supplier Support Center, who had organized a team of workers to give input, in a consultative fashion. While some of the workers did express that they felt empowered by this (and a few later promoted to supervisor), this big push seemed to have been a kind of one-time thing. The Wizard of WOW seemed to have a good rapport with material handlers and supervisors at the plant, but did not involve operators in continuous improvement. Operators very definitely felt that the company did not listen to their ideas in general. Further, the Wizard complained that he could not get much budget to do his projects, even though he had carefully documented the savings. The new owners removed him from the executive

bonus plan, which caused a significant hit to his pay and self-image. The Sensors case provides a good example of the role a union may be able to play in pushing lean toward a high-performance model. In this case, despite the vigorous attempts of a lean guru to convince upper management to embrace the continuous improvement side of lean, management was satisfied with its one big push toward lean standardization.

Suburban Midget, a small nonunion shop with around 30 employees, is a former military contractor that has diversified into automotive aftermarket, transportation and telecommunications markets. They do job shop stamping and are focusing more on terminals and connectors (for electronic wiring). To become competitive in what they consider a niche market, they consulted the local MEP center, the Chicago Manufacturing Center. "What we learned along the way was that we really needed to become a world-class competitor and maintain our small company competitive financial structure. The best way for us has been to bring in people who understand and can help us make selections about world-class software, quality training, and market research."

Midget's is a straightforward low-cost producer strategy: "Our big approach is, don't put any money into engineering this thing because there is no value-added. Let us be price-competitive and we know how to make the thing to your requirements." The company is a process specialist that focuses on tool design as a source of cost reduction. Because they are in the auto and OEM side of the business, rather than the electronics side, their volumes are low. This has kept them from feeling "brutal and massive competition" but has also not allowed them to justify potential cost-saving automation. Moreover, their inventory turns have actually declined, due to a conscious decision to increase finished goods inventory from four to six weeks' worth to improve responsiveness to key customers.

There are 20 direct production workers. With a fair number of quality people and supervisors monitoring a low-paid Hispanic workforce, Midget is not very lean. Part of their ability to be price-competitive comes from the fact that they are a dual-language facility (the owner speaks Spanish). They do internal English for Speakers of Other Languages (ESOL) and technical training using subsidized consultants, so they are able to get good workers who earn more than they would elsewhere yet are cheaper than the skilled workers that Midget would otherwise have to hire on the outside. There are a few each of tooling machinists, painters, quality inspectors, and material handlers; the rest are press operators. In addition to ESL, their training is in "the procedures necessary to comply with ISO … [and] also with labor reporting. Our employees take their badge and the work order and scan them across a scanner, so we can tell at all times who is where and allocate labor." In short, they are keeping the shop running competitively by having workers with "excellent mechanical skills" who are "really focused on the job." The manager also notes that, while "[a]t times, we have had difficulty getting them to be more creative and risk-taking … part of that has been addressed through the training process." Essentially, while a few dedicated "core" employees do most of the problem-solving, in general there is not much involvement of operators in decision-making or deliberation about continuous improvement.

Rubber Products is a single-plant firm that was also undergoing a generational transition when we visited. The father had bought the company in the 80s. The company managed to produce okay quality despite hiring temps from an agency. The lack of standardized work was evident with the temps, who were visibly bored, and not doing things the same way even twice. Turnover was very high, and there was no involvement in decision-making by workers. The owner seemed mostly to want to hold on until his last college tuition bill was paid. He was a smart, urbane guy, but his business and technical knowledge was all self-taught. We watched as he faxed hand-written design changes back and forth to his customer. He had also spent "hundreds of thousands of dollars" in a successful fight to prevent the just-arrived UAW from getting a first contract. "We made a mistake in who we let in – we didn't screen carefully enough -- and so we got ourselves a union." The owner was viscerally angry about the union and did not deny that he had spent far more than the profit-maximizing amount on endless NLRB challenges, "but it's *my* business, and if I'm going to have a partner I will choose that partner."

The owner said that he needed to get his quality up and, to do that, needed to pay more. The day of our interview, he welcomed his first intern from a university in Michigan that has a program in rubber manufacturing. He planned to have several interns, as a way of upgrading quality and design. The son, who has a Harvard MBA, is increasingly taking a more active role. It looks as though the firm is growing – it had about 50 employees in 2001, shrank to 30 in 2002, and is now up to 70.

Union plants

Of the six union plants – all high-wage and high-productivity – three had made significant progress toward a learning/HPWO that also includes key features of lean production. With Second Tier Specialist and Custom Seats, management and the union were in a labor-management partnership explicitly conceived to include a highly skilled workforce engaged in substantive participation to achieve continuous improvement. Mini OE also engaged its union in such a partnership, though it had gotten less far in the process due to its having to start with a radically mismanaged workplace. This case is interesting, because it was the local union leadership that contacted corporate management requesting a new plant management team that would be willing to work with the union toward a learning/HPWO approach. In the first two cases, lean methods and high-performance HR practices were being implemented in what was already a highly disciplined and motivated workforce that had seen high productivity. Further benefits were reaped by becoming a learning/HPWO in terms of improved lead times, quality and delivery. In the case of Mini OE, a low-productivity plant was transformed into a relatively high-productivity plant through the implementation of lean methods. They expect to see further improvements as they continue their journey toward learning/HPWO.

Each of the other three union shops differs in its own way. Aircraft Parts has achieved high productivity with a highly skilled workforce and is now pursing a lean standardization strategy. This case is interesting because it illustrates the complexity of

truly engaging a workforce in high involvement and highlights the issue of union reticence based on long experience with past failures in management-initiated programs. The company does not appear to want the union to be too involved because it wants to keep its options open regarding the future of the facility. Management worries that, were it to invite the union to be a full partner, the union would then want to be part of such a decision. The union leadership would be more involved if the company would listen more. The local plant manager would like to move forward with the FULL approach but is not sure the union wants or understands it, while the corporate division sees unions as an obstacle to flexibility and is trying to figure out a future operations plan and probably does not want full-fledged involvement that would necessitate sharing information about future options that the union might not like. Both of the other two plants had achieved relatively high productivity through high asset utilization and a disciplined workforce. In the case of Sealmaster, the plant was bought by a parent company unconcerned with the workforce; this parent has essentially abandoned the plant and is likely soon to spin it off. In the case of Engineered Plastic Products, management is pursing a strategy of lean standardization with little participation from the workforce.

Second Tier Specialist has, with the help of its parent company, completed value stream mapping on *all* of its products and reorganized the whole shop into three cells. Generally, the company has made great strides away from having high waste and a splintered organizational structure. Lead time has been reduced on two common cylinders from 18 days to 8 and 5, respectively, and the firm expects further dramatic improvements. On-time delivery has moved from 27 percent to the 80s in the two years. Inventory turns had actually fallen recently to 4.4, in part because of falling sales during the recession but also because of the firm's decision to hold "a little" extra inventory to be responsive during the restructuring process. Presumably, this problem will be addressed when it begins to focus systematically on setup reduction.

The workforce is mainly white, male skilled machinists who are slowly moving from a much more adversarial stance to accepting, and in some cases embracing, a high-performance work organization model. At Second Tier, they are struggling with the cross-training issue, working with a pretty restrictive contract with over 50 job classifications and a traditional union culture with long average tenure (22 years). Worker resistance to cross-training and job "enrichment" has been a serious obstacle, though they've had some help with people working outside classifications; otherwise, moving to cells would have been "a real mess." The plant manager discussed how prior management hit a brick wall as they attempted to impose lean production and continuous improvement from above. The new manager is focusing instead on a slower process of education and training, and enlisting the union into a labor management partnership.

As the union president notes, even though the union has formally signed on to a partnership, it is a struggle, even with some members of the shop committee. However, the labor-management partnership has been instrumental in establishing a framework for engaging the workforce in substantive participation. A partnership based around a labor-management committee helps to move labor-management relations beyond an adversarial model and to formalize a framework for collaboration. By providing a framework for

formal power sharing and deliberation, such a framework may facilitate a substantive participation.

At Second Tier many of the workers had mastered one particular machine and had become accustomed to coming in every day and working only on this one machine. Most of the workers had a deep craft pride in their work, and expressed keen interest in the performance of the plant as a whole. Yet their understanding of *their* work was very much based in and around the routine they had developed by working on a single machine. They were not interested in cross training and job rotation; their work values were based in doing one thing and doing it well. For these workers new routines and responsibilities required a substantial reorganization of work arrangements they had appropriated as their own and solidified in a union contract.

The workforce consists of operators with varying skill levels and highly skilled machinists. The opportunities for cross training and multiskilling in cells can be seen as positive for some of the lower-skilled operators, though the general restructuring was highly contested by some and tepidly received by others. The effect of restructuring on wages was unclear at the time of our interviews and had yet to be resolved through contract negotiations. The parent of the local union has national-level department that has been instrumental in aiding and driving the transition to learning/HPWO.

Custom Seats also has nearly all of its production organized into cells. Inventory turns have improved dramatically, from six at the beginning of their reorganization up to 20, going up “three to five turns a year every year, since the cellularization effort.”. On-time delivery in their oldest cell has gone from 92 percent at best before to a consistent near 100 percent. One of the main jobs in the shop, sewing, is a highly skill position which takes a minimum of twelve weeks to be fully trained on; workers use leather and vinyl with very tight seam allowances. There was a lot of craft knowledge possessed only by the workers, and the production process was often completely dependent on individual experts. Managers discussed in detail how the cells have been used as an opportunity to continuing to break down the tasks into smaller parts that can be standardized and the tacit knowledge more easily transferred.

At the same time, Custom had in many ways attempted to engage their workforce in substantive participation, including broadened responsibilities with increased authority in other areas. Thus while deskilled in part through a standardization process workers were also reskilled through cross training and given substantially more authority and responsibility, which generated role conflict and stress, making some workers feel paralyzed. Both the union and management are hoping that when the kinks get worked out of the system, the workers will do well with base wages, pay-for-skill and gainsharing. At this point, however, the employees are bitter about the gainsharing system too, because it applies to cross-shift teams, and workers are really attached to the *individual* incentives that had long been in place. This shift from individual to group incentives, along with the Taylorization of craft jobs has made the process of cultural transformation highly politicized and problematic, even though the impact on earnings has been essentially neutral.

In this case, despite the serious efforts of management at decentralizing authority and problem-solving responsibilities, empowerment has largely been aborted or stalled due to resistance from the union rank and file. The union leadership has been helpful in the transition but has also ran into serious problems with resistance from rank and file members. This is particularly the case for workers in some areas where the aforementioned problems have been particularly acute. Yet, despite these problems, other areas of the shop where the cells have been around longer and demand is both stable and high, productivity has been quite good. The international union has apparently not offered much assistance in terms of learning/HPWO.

Aircraft Parts has 400 unionized employees making highly technical, extremely expensive parts in an urban plant belonging to a multinational firm. The parts arrive as room-sized castings (costing in excess of $100,000). The plant machines the castings and adds electronic and other assemblies. Asked whether there was pressure from management to work faster, workers laughed, saying, "And wreck a $100,000 part?" The workers earn $19-20 per hour; many have completed a four-year apprenticeship.

When the company seeks to make changes, the union committee is informed and, in many cases, makes a counterproposal. Still, the union noted that it is often consulted too late in the process, and that its counterproposals – some of which are designed to minimize employee resistance – are sometimes ignored. A classic example of this is the story of Aircraft Parts' implementation of work cells. Aircraft Parts has dramatically reduced its inventory in the last five years by moving to work cells. Moving to cells took about one year to negotiate with the union, and is now part of the contract. With the new cellular structure, the number of job classifications has been reduced and cell members are expected to be multi-skilled to run a number of operations such as lathes, drill presses and boring mills. The union had suggested that the company geographically locate the cells and move workers when necessary but leave the present occupations alone, but the company did not agree and organized these cells around the main products. The union recommended that the cells be given generic names such as A, B or C but the company created them around product names, resulting in workers identifying with cells and the work performed in them. When the company moved work from one cell to another, cell members viewed it as "taking our work." This raised touchy issues, including overtime and bumping rights. A grievance was filed over this. Because the plant has departmental rather than plant-wide seniority, the issue of where work is performed is very important. There are no cell leaders. A ten-minute meeting is held before each shift by managers and engineers to review non-conformance issues, but the company says it is trying to get more hourly involvement.

This story, and others like it, have shaped the union's view of the company's adoption of lean. What could have been a more substantively participative role has become more reactive, though not obstructionist.

Nevertheless, the expense and quality sensitivity of the product line give workers a fair amount of power in the plant's day to day operations. The existence of other company

plants with similar capacity give it many options to move the work, however. That has resulted in a power imbalance that frustrates union leadership considerably. Although the local union believes that it generally has a good relationship with the company and works with it to attract additional work into the plant, it feels that it is constantly threatened with job loss or downsizing if it does not accept the company's proposals—both during contract negotiations and during the life of the contract. The resulting climate of constant negotiation over changes, while facing an ever-cocked gun to the head—especially when some of the union's most important recommendations are not heeded—has intensified union discomfort. This is particularly infuriating because the union sees itself as being at least as, if not more, committed than management to keeping the local operation profitable and productive. For example, a little over a decade ago, a union-backed plant-closing assistance group put together a multi-million dollar package of financial assistance from the city, county, and state that funded capital improvements and training.

In addition to negotiating with the union for operational and contractual changes, the plant has engaged extensively over the past few years in efforts to become more lean, utilizing a combination of its own standardized lean training program (developed by the University of Texas for worldwide company use) and large customer-driven approaches. Its largest customer, for example, provided consultants and ran problem-solving and training sessions in the plant. In 2003, the company held 48 such sessions. But union leadership believes that many of these sessions are held only to please these large customers rather than to improve plant operation.

The international union has had only modest involvement, partly because the local – which only affiliated with an international about ten years ago – remains fiercely independent.

Auto Moldings is an auto supplier that makes fairly large interior trim parts, including some that customers see, making visual quality and color consistency critical, and requiring skills and technology that would be expensive for many would-be competitors to duplicate. "Added-value" parts – involving multiple steps (adding foam, clips, ribbing) – are where Auto Moldings makes the most money. Relatively high wages for the molding sector ($12-16 per hour) clearly create an incentive to have a lot of newer molding machines and keep them running. Machine operators do not have any real responsibility for the machine *settings*, but only for machine *monitoring*, load/unload, assembly, packaging, and shipping

This arrangement has caused some friction with the union. Despite Auto Moldings' desire to be lean and have "standard work," the union feels that a lot of "feel" is required to be a good tradesperson (e.g., hotter plant temperatures in the summer require different adjustments to molding machines) and wants more recognition for these skills. Instead, the company calls most of these jobs "machine adjusters" and pays them less than the jobs in what it views as the critical trades. Requirements for becoming a machine adjuster are about six months of on-the-job training "shadowing" and at least five years of experience. Machine adjusters do fine-tuning of temperatures, water levels, etc., and certify jobs as being ready to run. Supervisors can fill in when these adjusters are not

available. The two diesetters (first shift only) and the two maintenance people (first shift, but can be called in on other shifts) are viewed as the critical trades, and they are paid up to $25/hour.

Essentially, Auto Moldings does what some of the other nonunion plants do: focus on the technical aspects of lean production within a framework of consultative participation. This resulted in an increase from fewer than 10 to 14.3 inventory turns between 1999 and 2003, but no progress since then. A new set of managers reorganized the shop floor in 2000, adding new injection molding machines and robotics to remove parts from the molds. Most of the plant is laid out in cells, with a clear parent company-driven lean approach in mind. While relations with the union and the workforce appear positive, the new equipment and its layout are management-driven, with the workforce lightly consulted both directly (meetings with the tradespeople) and via the union. The regional and International unions have played no discernible role in any of the restructuring at Auto Moldings.

Mini OE is almost fully cellularized with 16 assembly cells constituting four teams. Their manufacturing process is quite simple and variations on three basic designs are made. With the implementation of cells, lead times have been reduced dramatically from three days down to hours. The company does not have much by way of other performance metrics, however, because they were not documented until the new management came in the year before our interviews. However, with the cells, training, better scheduling, material handling, and product flow, they have increased output 18 percent with 17 percent less workers (though attrition) over the year. Being a make-to-stock manufacturer, Mini OE has not reduced its final-goods inventories, though it has seen overall inventory turns improve.

While Mini OE has not yet actually gotten to the point of having much substantive participation, this case is instructive for its determined attempt to become a "high-performance work organization," understood explicitly by management and the union as a high-involvement model. Mini OE has done extensive training in literacy and numeracy, including blueprint reading and measurement, and they understand this training, explicitly as a first step toward empowering the workforce on the road to learning/HPWO. The Wisconsin Regional Training Partnership (WRTP) has facilitated the development of a labor-management partnership at Mini OE, including helping them formulate a core labor-management "leadership" team along with subcommittees including a revived a training committee. The WRTP has also helped them formulate modules for incumbent worker training and consistent criteria for pre-employment screening. Direct employee classifications have been reduced from four to a single job classification and all employees moved up to a single pay rate. Due in large part to low average tenure in the shop resulting from relatively high past employee turnover, Mini OE experienced little resistance to work restructuring from the rank and file. Mini OE also differs from many union shops in having had less detailed job classifications to begin with.

The workforce is highly diverse, with many Asian and black workers. Jobs are well paid, and there are additional opportunities through the pay-for-knowledge program. Moreover, once Mini OE gets the kinks worked out and is back to profitability, a gainsharing program will raise incomes further. An employee suggestion program was a big success, with $4,700 distributed in the first round. Beyond this, however, they have not had much success in getting employee input on improving processes in the cells, other than with a few highly dedicated and engaged union activists. While local union leadership is playing a key role in the move toward a high-performance version of lean, the international has not provided any assistance.

Sealmaster is our worst case scenario for union shops: a company that relied on a traditional HR management and authority framework to get leaner, along with a very traditional union that displayed little interest in playing a role in operational change. Bought by a rootless, disloyal corporate parent, managers got them as lean as they could via better process control and improved product flow and other JIT methods, Sealmaster may still not be lean enough to survive. To make matters worse, it now appears likely that the parent company will divest completely from the plant and relocate its work. The international union has chosen not to intercede as of this writing, apparently preferring simply to protect its most senior members until they reach retirement.

Union/nonunion comparison: high-wage plants

As should be clear from the foregoing, we observed different methods of achieving high productivity and wide variety in how plants reorganized to become leaner. Notably, two of the case study firms, Auto Stampings and Cat Gears, do not credit their high productivity to lean methods. While their performance is quite lean, they describe their recipe as combining a dedicated workforce with high levels of investment, automation, and asset utilization. Focusing on the other ten high-wage plants, the methods of becoming leaner fall into the two basic categories articulated above as alternative models. Importantly, these categories were observed in both the union and nonunion cases. First, using a ***lean standardization approach***, some plants are able to see significant improvements in quality, delivery and price by focusing on technical aspects of lean production such as value stream mapping to implement a pull system based on continuous flow and JIT principles, implementing standardization techniques such as 5S and TPM, and using other lean tools such as setup reduction and *kanban* visual controls. Yet, using this approach to lean each fell short of approaching the low-waste, high-performance ideal. In this model some combination of lean methods are implemented within a framework of consultative participation. While some significant performance improvements were achieved, each retained a relatively traditional authority structure rather than a worker-driven, active culture of continuous improvement. For the most part, the daily routines of workers remain the same and workers are unlikely to see any improvements in compensation that would – or should – potentially come along with increased investments in training, decision-making authority, and other changes to HR management.

This model of lean can be contrasted with a second, ***learning lean*** model, which combines technical elements of lean production with a systematic focus on a culture of substantive participation and continuous improvement. In this model, the emphasis on extensive employee involvement and the transformation of workplace culture overrides tendencies to remain stuck in the conceptual framework of traditional cost accounting, with its emphasis on labor utilization, that is characteristic of the lean standardization model.[34] In the latter, which we observed in both union and nonunion shops, worker participation often takes a back seat to other concerns; while workers are asked for their ideas they are not systematically engaged in regular and routine problem solving and decision-making. The learning lean model, on the other hand, sees investment in workers and the engagement of workers in actual *deliberation* about problem solving and continuous improvement as a source of competitive advantage. Implementing systemic change and working all the kinks out is a highly demanding process. Engaging workers in substantive participation and cultural change is necessary both to provide the best information possible about what are often confusing and complicated problems, and to ensure that management and workers do not slip back into old and familiar routines.

In short, there is nothing better or worse about union involvement per se. Restructuring to learning/HPWO – beyond lean standardization efforts – is a complicated and problematic endeavor, whether or not a union is present. Nonunion shops can face obstacles which, while not identical to those in union shops, can be equally formidable. Indeed, some of the obstacles are the same: worker reticence, lack of support by upper management, lack of vision by plant management, focus on traditional cost accounting metrics, trying to implement change too fast, not properly implementing the right complementary changes.

Unions can play a decisive role in either direction. When management approaches organizational change in the wrong way, unions can provide formidable resistance. Local workplace cultures can be very idiosyncratic and tenacious; despite education and training workplace cultures can be very hard to change. Unions can exacerbate these problems to the extent that they provide a source of identity and/or power for workers. At the same time, however, unions can provide employers with a unique source of competitive advantage in moving toward extensive substantive participation.

Our observations suggest that unions may help in four ways. First, union governance may provide a framework for the substantive devolution of authority to make decisions and share power. In three of our cases, labor-management committees provided and, indeed, formalized this institutional framework. Second, the informal camaraderie and solidarity

[34] Standard cost accounting uses metrics such as labor efficiency, machine downtime, and cost variances that are designed for a traditional mass production environment. Lean production, which achieves economies by flowing a greater variety and volume of products through a given set of resources, uses metrics such as lead time reduction and inventory turns. Implementing lean and HPWO practices may, in many cases, show up negatively in standard costing. See Bruce Baggaley, "Solving the Standard Costing Problem," Northwest Lean Networks Feature Article, August 2003, http://www.nwlean.net/article0803.htm. In our cases we saw managers using a lean standardization approach focus on traditional cost accounting metrics while those implementing HPWO were more focused on system-wide change and thus were less likely to see allow standard costing metrics to get in the way of efforts at high-performance lean.

of a union, where and to the extent it is present, may help management organize the workforce to bring them on board. In two of our cases union leadership played a key role in organizing support of learning/HPWO among the rank and file. Third, the protection of a union contract may embolden workers to say what they think and feel, rather than what they think management wants to hear. Fourth, a union leadership dedicated to HWPO may actually help organize management and keep it committed to a more participatory version of lean production – in effect, pushing management beyond the lean standardization model to the high-performance lean model. We saw this in one of our cases, where management, discouraged by worker resistance and reticence, may have backed off pursing a more extensive system of employee involvement were it not for the prodding of union leadership. In another case, it was union initiative that began the process of restructuring to learning/HPWO.

In sum, the role of unions in restructuring to lean production is indeterminate, depending on the position of the local union, local management, workplace culture, and – as we will soon see – the level of support from the international union. When a local union leadership is supportive of learning lean, and particularly where there is a labor-management committee, unions can play a pivotal role in the extent and success of workplace restructuring. However, the local union is just one among many factors affecting the outcome of efforts at restructuring. In both union and nonunion cases, support of upper management and the extent and tenacity of plant management's vision is key. Where management retains a conceptual framework in which traditional cost accounting metrics remain important, it may tend to focus more narrowly on lean standardization to the neglect of more thorough high-performance lean based on substantive participation and cultural change. Further, management may not have all of the technical and experiential knowledge required to successfully implement system-wide change. For instance, changes in HR system such as training and contingent compensation programs may be improperly designed or neglected. Here, again, unions may advocate for their members in this regard.

High-wage/low-wage comparison: nonunion plants

Within each wage category of nonunion plants – high-wage and low-wage – there is variation in terms of productivity. Within the high-wage category, Industrial pumps, Auto Stampings and Cat Gears are high-productivity shops, while Tubefab, Integrated and Metalfab are in the mid- to low-range. Integrated and Metalfab are united by an explicit attempt to be "good employers," providing stable jobs with decent wages. Tubefab differs somewhat in that it attempted to pursue a low-wage strategy but was forced into paying higher wages based on labor market pressures. Standard Sensors is a low-wage plant that has achieved high productivity through a lean standardization approach. The other low-wage plants all focus directly on low wages as a cost-control strategy. Midwest and Plastic Grilles are able to implement this strategy and achieve high productivity through a high-utilization strategy with a dogged focus on innovative tooling. While some highly skilled and well-compensated toolmakers are needed for this strategy, the majority of the workforce remains in relatively low-skill operator positions. Suburban Midget and

Rubber Products focus exclusively on a low-cost producer strategy, competing on low prices but at the expense of low productivity.

Lessons from the Cases

We draw four lessons from the comparison of manufacturing practices across the varying wage and employment strategies of the union and nonunion plants. First, a low-cost producer strategy may well be viable, as demonstrated by Suburban Midget and Rubber Products. Given the right product and labor market conditions – sufficient demand for low value-added, high-volume parts and a marginalized-but-hardworking labor force – a low-wage strategy can be workable. This model, of course, is precisely the opposite of the one advocated here; while it may work for employers, it cannot provide a basis for family-supporting jobs nor for progressive regional economic development.

Second, asset quality and utilization are key. The higher-wage, less productive plants demonstrate that sufficient demand to sustain high asset utilization can provide a basis for relatively high wages when employers are so willing. In particular, Integrated and Metalfab are able to provide secure jobs with decent compensation, maintaining good enough quality, delivery and price competitiveness, while being lean in some respects but without substantive participation (another basis for high wages). At the same time, three of the lower-wage, more productive plants – Midwest, Plastic Grilles, and Sensors – demonstrate that investment in high asset quality combined with high asset utilization can permit relatively high productivity in the absence of high wages and jobs "enriched" through substantive participation. These plants provide another *alternative to the lean route to improved productivity*, but at the expense of good wages. Here all of the investment is in a core of craft toolmakers and the assets to develop highly innovative and productive tooling, while the majority of the workforce remains in low-skill, low-wage operator positions. Similarly, Cat Gears illustrates the benefits of high asset quality and utilization – but in this case with high productivity linked to relatively high wages – even in the absence of many technical elements of lean production, such as product-focused layout, process standardization, or pull systems.

Third, the case of Auto Stampings demonstrates that a culture of continuous improvement with some degree of substantive participation can help generate high productivity *despite* a lack of lean practices in terms of waste reduction and process standardization. This plant illustrates the benefits of having highly skilled workers and a relatively high degree of worker participation in problem solving and continuous improvement, even without many of the technical elements of lean production (again in terms of layout, standardization, etc.). This lack of standardization and codification of procedures, however, may be problematic for plant management in the long term if such craft knowledge cannot be transmitted to other workers or to the plant's institutional memory.

Fourth, the high-wage, high-productivity strategy is best achieved through approximating as closely as possible the low-waste, high-performance model sketched above. In

particular, the strategy, which we advocate, must combine four things, as exemplified by Industrial Pumps:

- A relentless focus on getting right the technical aspects of lean production, including process mapping aimed at achieving a pull system based on continuous flow
- The substantive participation of the workforce (and all of the necessary concomitant changes in HR management)
- Cultural change to sustain continuous improvement
- Sufficient demand to allow high asset utilization.

When these four features are present, the FULL model can be realized. In the best case, the resulting improvement in lead time permits the supplier to get paid for its enhanced responsiveness to customers. This kind of organizational flexibility supported by flawless process control is not captured by traditional performance measures even in many firms claiming to be "lean."

Throughout our summary of the union cases, and in our union/non-union comparisons, we have treated "union" to mean only the local union operating at the particular facility. As we will see, however, whether, to what extent, how, and how well local unions lead, mold, or participate in efforts to make their companies leaner and more effective depends in part on the attitude of their union's international toward lean and learning/HPWO, and on whether the international provides expertise, encouragement, and guidance.

International Unions and the FULL Recipe

In the United States system of industrial relations, bargaining and other workplace industrial relations matters are highly decentralized, with power conferred to both the local plant management and the local union leader. Although in some large, multi-plant companies, "headquarters" has assumed that power for management, unions by and large have not centralized their operations in such a way. Although some national manufacturing unions assume contract-negotiating responsibility for all their signatory employers (particularly on wages and benefits, in pursuit of a national pattern), others do not and, in any case, any bargaining on working conditions is the responsibility of the local leaders. This is especially true with regard to smaller unionized employers, which are of course the norm in the components industry. This may need to change: internationals may need to invest in staff that are trained to support local unions in "FULL" implementation.

Interviews were conducted with staff from seven international unions (identified here as A, B, C, D, E, F, and G, to preserve confidentiality) that have a large presence in the component sector.[35] These seven unions are among the eleven unions with the largest

[35] An "international" is a union that represents workers throughout the U.S. and Canada. A "local" union, usually coextensive with a bargaining unit, is an affiliate of an international union that represents workers at the plant, sub-plant, or sometimes local multi-plant level. Some international unions also have regional bodies that operate on a geographic scale intermediate between those of the local and the international. (For example, a regional body might cover the Midwest.) The division of power and responsibility,

numbers of bargaining units in the component sector.[36] Because all these unions represent workers outside the component sector as well as within it (and some also represent workers outside of manufacturing), the staff members interviewed were those believed to be most knowledgeable about the union's representation of component sector workers.[37] Each interview was semi-structured and lasted between 1.5 and three hours. In addition to the interviews, the international unions provided WAI with documents related to their component sector practice with regard to lean and learning/HPWO. Although the interviews covered a wide range of topics in component sector work organization, technology, union structure, and industrial relations, the most important interview results concerned the internationals' stances toward learning/HPWO in the component sector, the extent to which they actively promoted learning/HPWO in the component sector, and the degree to which their component sector learning/HPWO activities were centralized at the international union level or decentralized to local unions or regional bodies. Table 6 characterizes each of the seven unions along each of these three dimensions.[38] (Note: In tables 6-7, we abbreviate learning/HPWO as "L/H.")

- **L/H stance** refers to the international union's general attitude toward learning/HPWO. All but one of the seven unions interviewed expressed some degree of support for learning/HPWO, believing it to be necessary to improve productivity and preserve union jobs. (Union A has locals and regional bodies that favor learning/HPWO but the international union appears neutral toward it.) Union C appears to be the most enthusiastic about learning/HPWO but will only assist its local unions and employers with learning/HPWO if the employer signs a formal agreement with the international; the agreement requires extensive information- and power-sharing between the employer and the union, including ongoing consultation with the international and substantive participation in learning/HPWO decision-making by international and local union representatives. (Few employers have been willing to sign such an agreement because they were unwilling to share information and decision-making power to the extent that the agreement requires. The case study firm Second Tier Specialist, however, does have a formal learning/HPWO agreement with union C.)

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including power and responsibility for HPWO activities, between the international, local, and regional bodies varies among international unions.

[36] Data were obtained from AFL-CIO proprietary sources. The number of bargaining units in which a union represents workers is likely to be highly correlated with but not necessarily the same as the number of plants at which it represents workers, since a union may have more than one bargaining unit in a plant. The number of bargaining units in which a union represents workers also bears only a loose relationship to the number of workers it represents, as bargaining units may vary in size. In some plants, different groups of unionized workers may be represented by different international unions. It was not feasible, given the available data, to estimate the number of component sector workers that each union represents. There were also a few international unions with a large component sector presence with which it was not feasible to conduct interviews.

[37] This determination was made on the basis of WAI's contacts with the international unions.

[38] An international union may treat HPWO differently in the component sector than in other sectors in which it represents workers. For example, union A, which has a neutral stance toward HPWO in the component sector, has a positive stance toward HPWO in another of its industries. In this report all references to international unions' involvement with HPWO refer only to the component sector.

- **L/H activity** refers to the extent to which an international union actively formulates and promotes a learning/HPWO strategy among its locals and employers. Not all internationals that favor learning/HPWO are active in promoting it. Union G and, to some extent, union E support learning/HPWO but do not actively promote it. Both of these internationals have staff who are knowledgeable about learning/HPWO and have assembled materials to assist their locals in deciding how to approach it. However, both internationals serve as resources for their local unions on learning/HPWO issues rather than as catalysts for such activity. If a local union is interested in trying persuade an employer to adopt learning/HPWO or in responding to an employer's desire to adopt a consultative version of lean production, the international will provide advice and assistance, but the local, not the international, makes the first move within the union structure.

Union B is something of a special case because its international is organized in a way that reflects the union mergers of which it is a product. Union B at one time represented workers primarily within a single core component industry, but over time it absorbed other international unions that represented workers in other industries. The union B international maintains separate divisions for each of these industries and these divisions vary in the extent to which they promote learning/HPWO.[39] The division of union B in which the workers of the case study firm Mini OE are included is pro-active toward learning/HPWO.

- **L/H centralization** refers to the extent to which a union's learning/HPWO activity takes place at the international level ("centralized") relative to the local level ("decentralized").
    - In unions A and G, the locals do all or most of the work of formulating and implementing the union's learning/HPWO policy. (In union G the international provides advice and assistance to locals that want to deal with learning/HPWO and consultative lean production issues. In union A, learning/HPWO appears to be left entirely to locals or regional bodies.)
    - In union F the international's staff responsible for the union's component sector industries has taken the lead on learning/HPWO.
    - In union B the degree to which learning/HPWO activity is centralized varies by industry division. Mini OE's division appears to be relatively centralized in its approach to learning/HPWO.
    - Union C takes a highly centralized approach to learning/HPWO if an employer has signed a formal learning/HPWO agreement with the union; in such cases the international sets and drives the implementation of learning/HPWO policy (although it consults with the local union on the details of implementation). If union C does not have a formal learning/HPWO agreement with an employer then its locals may still engage with employers around learning/HPWO or consultative lean

[39] Many other international unions are also the product of mergers. Some of these maintain separate industry divisions at the international level while others, such as union D, do not. Union B is unique among the interviewed unions in that its HPWO activity varies by industry division.

production but the international will neither support nor hinder the locals in doing so.

- Union D has a unique hybrid of centralized and decentralized learning/HPWO activity; the international union first signs a formal learning/HPWO agreement with an employer but it then leaves the implementation of that agreement largely in the hands of its locals, providing them with advice and assistance but not becoming involved in the details of implementation. The result appears to be that that learning/HPWO activity varies considerably among locals, much as it would in a purely decentralized structure.
- Union E gives locals some autonomy in the implementation of learning/HPWO but implementation is nevertheless done under the guidance of the international union. This arrangement represents a degree of centralization intermediate between those of unions C and D.

Table 6. Summary: International Unions & Learning/HPWO (L/H)

Union	L/H stance	L/H activity	L/H centralization
A	0	0	D
B	+	Varies by division (+ for division relevant to case study firm Mini OE)	Varies by division (+ for division relevant to case study firm Mini OE)
C	++ if formal partnership, else 0	++ if formal partnership, else 0	C if formal partnership, else D
D	+	+	D on implementation after C agreement
E	+	+	C with some local autonomy in implementation but implementation is centrally guided
F	+	+	C
G	+	0	D

Key: L/H stance=international union's general attitude toward learning/HPWO
L/H activity=International union's degree of involvement in actively supporting L/H
L/H centralization=Extent to which international union's activities in support of L/Hare centrally driven by international officers or staff versus being driven by requests from locals
- =very negative, - =negative, 0 =neutral, + =positive, ++ =very positive
C=centralized, D=decentralized

These results suggest that international unions are most able to formulate and promote a learning/HPWO strategy if they centralize their learning/HPWO activities at the international level. Unions C, D, E, and F, which centralize learning/HPWO to the greatest extent among the interviewed unions, appear to be most active in supporting learning/HPWO. Union G, in which most learning/HPWO activity is decentralized to locals and the international serves only as a resource to locals, is less active in supporting learning/HPWO and does not appear to have a strategy for it. Union B is active and strategic about learning/HPWO in those industry divisions in which learning/HPWO activity is centralized but less active and strategic about it in those industry divisions in which learning/HPWO is decentralized.

The policy implication of this analysis for international unions is that if an international union wants to support the adoption of learning/HPWO in the plants in which it

represents workers it is likely to be most effective in doing so if it maintains strong central control over the formulation and implementation of learning/HPWO strategy. This does not mean that local unions need be uninvolved in implementing learning/HPWO; indeed, they must be involved because learning/HPWO consists of changes in work organization and decision-making at the plant level. But internationals that are serious about learning/HPWO cannot leave decisions about whether or how to engage employers to their locals.

International union policy toward learning/HPWO, of course, is not the only determinant of whether learning/HPWO is adopted at the plant level. The six unionized plants described in our case studies illustrate that local union policy toward learning/HPWO, rank-and-file worker attitudes, and management behavior also affect the implementation of learning/HPWO (or of less extensive "lean enough" production methods). Table 7 summarizes these findings.

At Second Tier, which has implemented learning/HPWO more extensively than any other case study plant, both the international and local actively support learning/HPWO. The international and corporate management have a formal learning/HPWO agreement that requires substantial information- and power-sharing.

At the opposite extreme, the three plants at which union A represents workers have seen either no change in traditional U.S. manufacturing production methods or the implementation of a low-involvement, consultative "lean enough" production system reminiscent of that found in many of our nonunion case study plants. In the union A plants, the absence of international union involvement in work reorganization, coupled with either an absence of local union involvement or a cautious and reactive stance on the part of the local union, seems to have given management (at the plant and/or corporate level) the ability to implement the kind of work reorganization (or lack of work reorganization) that it desires.

At the remaining two plants, Custom Seats and Mini OE, learning/HPWO is being implemented, albeit less extensively than at Second Tier. Moreover, this is occurring with the support of the local unions but without any active support by the internationals (despite the fact that the relevant internationals generally are active in support of learning HPWO and that one of them has a centralized approach to it). At Custom Seats, substantial rank-and-file worker resistance to learning/HPWO may be preventing the local union and management from moving forward with more extensive learning/HPWO reforms.

Table 7. Summary of International and Local Unions and L/H Implementation at Unionized Case Study Plants

Case study plant	International union	International union L/H activity at plant	Local union L/H activity at plant	L/H implementation	Other influences on plant-level L/H
Second Tier	C	++	+	Extensive L/H	International and corporate management have formal L/H agreement
Custom Seats	D	0	+	L/H being implemented	Serious rank & file worker resistance to L/H
Sealmaster	A	0	0	None	Management not interested in L/H or lean production
Engineered Plastic Products	A	0	0	Lean-enough production being implemented	Management driving changes in production and work organization
Mini OE	B	0	+	L/H being implemented	
Aircraft Parts	A	0	0 to +, but cautious & reactive	Lean-enough production being implemented	Plant management favors more extensive L/H but corporate management prefers less information-sharing and worker involvement

Key: International union L/H activity at plant=international union's degree of involvement in actively supporting L/H at case study plant.

Local union L/H activity at plant=international union's degree of involvement in actively supporting L/H at case study plant.

L/H implementation= extent and nature of learning/HPWO or other changes in production methods and work organization at case study plant

-- =very negative, - =negative, 0 =neutral, + =positive, ++ =very positive

Although the six plants are a small sample and may not be representative of the unionized component sector as a whole, the case studies suggest the following hypotheses about the

relationships among international unions, local unions, and the implementation of work reorganization.

- At the plant level:
    - Both the international union and the local union must be actively involved in supporting learning/HPWO if it is to be implemented in the most thoroughgoing manner.
    - If neither the international nor the local actively supports learning/HPWO, then management will determine the nature of work reorganization. Extensive learning/HPWO is unlikely but "lean enough" production is likely, just as in nonunion plants.
    - If the local union is actively involved in supporting learning/HPWO but the international is not, then learning/HPWO is possible, although it is not likely to be is thoroughgoing as it would be if the international were also actively involved.[40]
- At the international union level:
    - An international that centralizes its learning/HPWO activity is likely to have more widespread and more thoroughgoing adoption of it—*and higher productivity*—in its plants than one that takes a decentralized approach to learning/HPWO. This will create the conditions necessary (although not sufficient) to maintain high wages and benefits and to maintain or recreate some version of pattern bargaining.
    - An international that does not actively support learning/HPWO is likely to be making a *de facto* choice in favor of management-determined work reorganization in its plants, making it likelier that lean initiatives will not be worker-friendly in design and result. Learning/HPWO will be uncommon in these plants. Either traditional U.S. work organization or "lean enough" production" will prevail in such a union's plants. Because patterns of work organization will resemble those found in nonunion plants, the union's ability to maintain high wages and benefits will depend largely on firms' ability (and willingness) to find other relatively durable sources of competitive advantage. There will be downward pressure on wages and benefits in plants where firms are unable pr unwilling to find such sources of competitive advantage. At the extreme, the international's ability (or desire) to maintain some version of pattern bargaining could be compromised or threatened.

[40] None of our case study plants had an international actively supporting HPWO combined with a local not actively supporting it. In such a situation, the outcome may depend on the extent to which the international centralizes control over HPWO and is able to overcome local union reticence or resistance.

- An international that actively supports learning/HPWO but implements it in a relatively decentralized way is likely to produce work organization, productivity, and wage and benefit outcomes that are intermediate between the preceding two extremes. Plant-level work organization, productivity, and wage and benefit outcomes will be more varied and learning/HPWO (where it exists) less thoroughgoing than in an international with a more centralized approach to learning/HPWO, but learning/HPWO will be more widespread than in an international that does not actively support it. Variation in plant-level outcomes may threaten attempts to maintain or re-create some version of pattern bargaining, but cross-plant average levels of productivity, wages, and benefits are likely to be higher than in an international that does not actively support learning/HPWO.

- International union *policy* toward learning/HPWO does not necessarily translate into corresponding international union *practice* with respect to learning/HPWO. Internationals that actively support learning/HPWO should strive for a consistent set of plant-level support activities.

In sum, if we are right that a substantive-empowerment learning/HPWO version of lean, in the context of our "FULL" model, is the best road to firm performance and survival, unions at every level – local, regional (e.g., central labor councils), and international – need consistent policies and practice to advocate for, train about, and support its widespread implementation. Unions may want to consider having regional "learning lean squads" (with a better name!), and/or demand that publicly funded entities such as Manufacturing Extension Program (MEP) centers in states with many union plants retain union-sensitive specialists using union-backed "FULL" approaches.[41] Indeed, such squads (or unions' ability to mobilize low-cost service providers such as MEP centers) could begin to make unionized status a competitive advantage for firms. It should also be understood that learning/HPWO lean affects not only the factory but also the office, which usually contributes much of the excess lead time that makes many manufacturers less-than-ideally responsive to their customers.

Regional Trade Policy

Thus far, we have emphasized the union policies and practices that support the "learning" and "lean" aspects of our FULL model. In this section, we turn to public policies that can support "full-utilization."

Earlier in this paper, we defined the three core regions for component manufacturing: the Boston-Philadelphia corridor, the Great Lakes states of the eastern Midwest, and the upper part of the Southeast. We noted that the first of these is relatively diverse in its component endowment, while the latter two are heavily concentrated in the web of

[41] The perception that MEP centers are not sufficiently union plant-focused is generally a misreading. Any international union, or regional office of such a union, that brought a large number of prospective customers to an MEP center could expect to get a delighted reception.

sectors tied to "auto" and "equipment." "Equipment" is defined to include both metalworking machinery and construction, farm, and garden equipment. Aided by additional funding from the Ford Foundation, the AMP team did substantial new research for this project to define these two regions with considerable precision, and to understand their interaction and their places in the US economy.

We used brute force – detailed examination of employment and gross state product data at the state and county level – to determine where the bulk of component manufacturing is occurring within the two regions. This work brought us to construct and commission input-output modeling on two precisely defined regions:

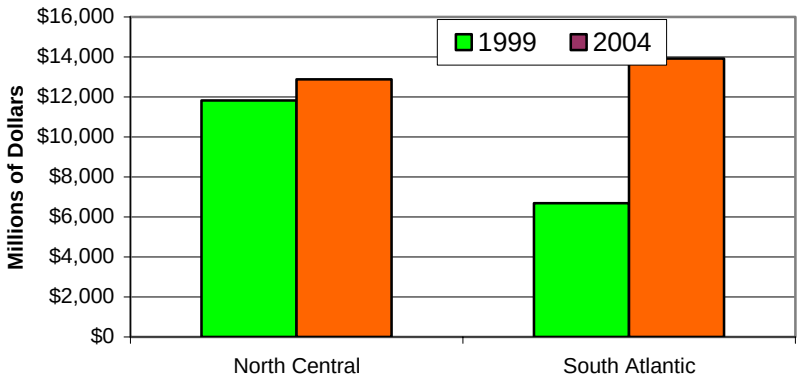
- A Great Lakes region made up of the entire states of Wisconsin, Illinois, Indiana, Ohio, and Michigan, supplemented by 20 Iowa counties bordering Illinois, seven Missouri counties (essentially metropolitan St. Louis) also bordering Illinois, three Kentucky counties (basically, metro Louisville) bordering Indiana, and three counties in extreme western New York, bordering the Hamilton-St. Catharines industrial corridor in Ontario. (More of Ontario – especially that corridor plus metropolitan Windsor, which borders metro Detroit – belongs in the region; however, our modeling service, Regional Economic Models, Inc. ("REMI"), does not yet have access to input-output and transportation flow data for Canadian provinces at the sub-province level.)
- An "Upper Southeast Competitor Region," made up of the entire states of North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, and all but three counties of Kentucky. The states of this region have made a clear push to attract new automotive investment, with incentives justified by claims that subsidies would be more than repaid by an influx of component manufacturers arriving to supply the new greenfield assembly facilities. In a sense, all seek an industry mix with less emphasis on agriculture, textile, and apparel, i.e., one that looks more like that of the Great Lakes region. All but Georgia have landed at least one Japan-, Korea-, or Europe-based based auto assembly facility, and many have had some success in growing their component supply bases as well.

The Great Lakes region we have defined has lost some of its pre-1979 and pre-1998 preeminence.[42] One way to think about a region's competitiveness is using a trade model: a competitive region exports a lot of its output beyond its borders and, by making most of the parts that go into the products it exports, gets to keep within the region most of what the world pays for those products. While the regional definitions are not a perfect match to ours, the export performance of the Great Lakes and Upper Southeast regions can be roughly gauged using International Trade Administration data for the "North Central" (our region, minus Wisconsin and plus Pennsylvania and the rest of New York) and "South Atlantic" (including our Tennessee, the Carolinas, and Alabama, but

[42] As we have noted, 1979 is a watershed year. In most durable manufacturing industries, 1978 was the peak output and market share year for domestic production. Most onshore plants suffered from 1979 through 1986, when the plunge in the dollar brought a period of relative stability until the so-called Asian financial crisis of 1998 caused the decline to resume with a vengeance. The recessions of 1980-82 and 1990-92 hid the secular nature of the slide, as did as the apparent stability of the 1983-89 and 1993-98 recoveries.

minus Georgia, Mississippi, and the rest of Kentucky, and plus Virginia) regions. Figures 18-19 show exports beyond the US, Canada, and Mexico for the auto and equipment sectors. We exclude Canada and Mexico from exports because of the dominant role of intra-company trade, especially in automotive.

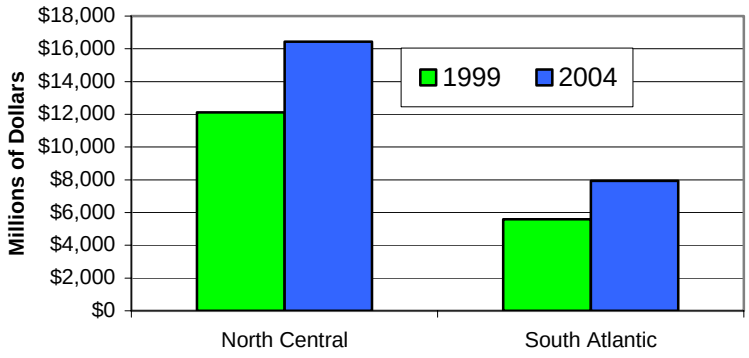
Figure 18. Auto Exports, excluding US, Canada, & Mexico



Source: International Trade Administration

In auto, the North Central region's beyond-NAFTA exports rose just nine percent between 1999 and 2004, from $11.8 to $12.9 billion; the entire increase, and more, can be explained by exports of Ohio-made Honda cars and minivans. In the South Atlantic, auto exports rose 108 percent, from $6.7 billion to $13.9 billion, powered of course by exports of Kentucky-made Toyotas and Tennessee-made Nissans. As we will understand better when soon we turn to inter-regional trade in auto *parts*, however, exports of finished vehicles are only about half of the five-year increase: exports of southeast-made auto parts into the Great Lakes states fully account for the other half.

Figure 19. Equipment Exports, excluding US, Canada, & Mexico



Source: International Trade Administration

In equipment, both regions have enjoyed solid beyond-NAFTA export growth: North Central's equipment exports rose 36 percent from $12.1 to $16.4 billion, while South Atlantic's rose 42 percent from $5.6 to $7.9 billion. But these figures disguise important subregional detail: about half of the $4.3-billion increase for North Central came from

Caterpillar construction equipment exports (Illinois) – with each piece of equipment embodying about 15 percent lower US-Canada content than a decade ago, according to its 10K filings with the SEC, or from exports from parts of New York not included in our definition of the Great Lakes region.

It is also worth noting that the competition is not just between like places in the two regions. In the Great Lakes region, the vast majority of manufacturing occurs in metropolitan areas. While we have not done the research to confirm this, abundant trade press reports suggest that a large proportion of auto parts and equipment plants in the upper Southeast are located in rural areas. The notion that relative manufacturing wages in the upper southeast lag behind, but will soon catch up to, those of its competitor region to the north is thus belied by the fact that much of the basis for the southeast's manufacturing attraction strategy plays on investors' post-1970s antipathy to certain features of northern urbanism (especially their high pay, blacks, and unions). It is thus not surprising that the southeast has done much less well attracting the design and technical sales centers of large manufacturing companies, which depend on the skills (and hence good wages) found almost exclusively in metropolitan areas.

Our sponsors, as well as the policy audience we hope to attract, may wonder why a particular region should be favored. There is a strong case for focusing our favored upgrading strategy in the sector's densest, highest-wage, and most-unionized location. We also admit to an underlying bias toward regional specialization, as readers will see in the trade model we present near the end of the paper.

- Regional specialization surely reflects some aspects of comparative advantage.
- Leaving states and regions entirely free to raid indiscriminately other regions' specialties distorts comparative advantage by shifting the basis of competition from true factor endowments to wage and benefit levels. If there were federal floors, surely they would block a region's attempts to compete away other regions' assets by promising lower standards.
- We read economic history as offering few compelling cases in which regions achieved prosperity by a smokestack-raiding approach.[43]
- It is arguably inefficient for states to induce investments than merely duplicate capacity recently put in place elsewhere.
- To the extent that regional competition based on wages reduces the effectiveness of unions, gains in the regions that get more investment and employment may be dwarfed by losses in other regions.

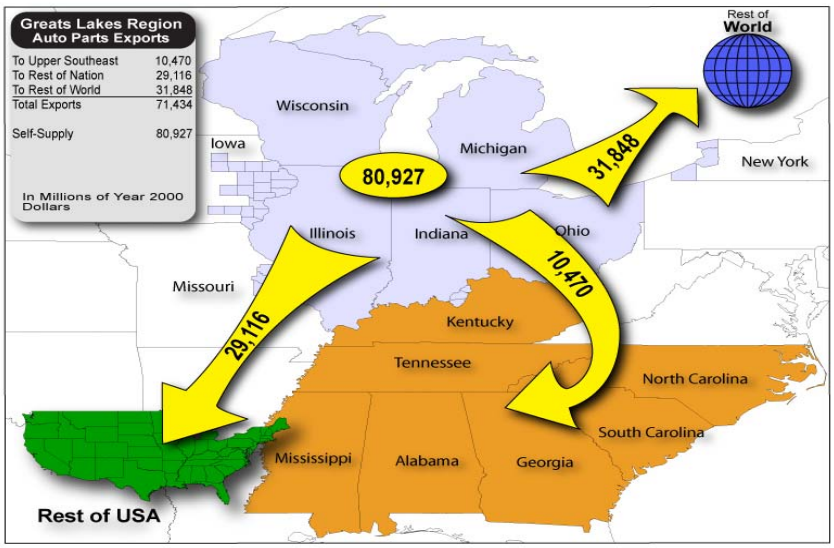
The Great Lakes region clearly remains an unequalled regional powerhouse. According to BEA data compiled by the Northeast-Midwest Institute, manufacturing accounted for 18.8 percent of gross state product (GSP) in 2003 in the "Midwest" (our region, plus

[43] According to Bureau of Labor Statistics National Compensation Survey data, the average blue-collar straight-time hourly wage in the East South Central Census region increased 28% from $11.21 in 1997 to $14.36 in 2004. In the East North Central Census region, the increase was 22%, from $15.15 to $17.97. While the difference – which amounts to roughly 23 cents per hour – appears to belie our contention, we suspect that much of the East South Central's larger average "wage gain" reflects the disappearance of fully half of its largest (and generally low-wage) sector -- textiles and apparel -- during the period.

Minnesota and the rest of Iowa, but minus metro Louisville and metro Buffalo), versus 12.8 percent for the US as a whole.[44] Looking at component sector employment at the Congressional district level as of 2004, the states of Wisconsin, Illinois, Indiana, Ohio, and Michigan were home to 9 of the 10 largest, 15 of the 20 largest, 24 of the 30 largest, and 31 of the 50 largest-component sector employment districts.

One leg of the regional competitiveness stool is exporting core products that fetch good prices. This brings other regions' and nations' income into a region. Figures 20-21, based on REMI runs done for this project, show the Great Lakes region's exports of manufactures in the auto and equipment sector. (An important data note: auto exports in Figure 20 are limited to parts, as they should be. Equipment exports include exports of finished graders, cranes, tractors, etc. and so give a somewhat distorted view of components trade. Unfortunately, input-output-based trade data for the sector do not allow parts to be broken out separately because finished equipment and their components are often in the same NAICS code.)

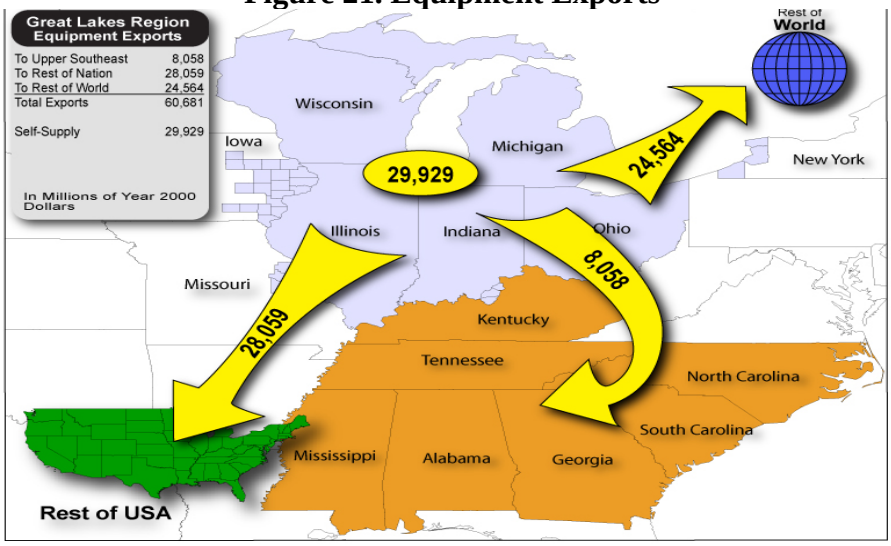
Figure 20. Auto Parts Exports



Source for figures 20-23: Custom runs by Regional Economic Models, Inc. (REMI)

[44] Despite sharp losses for the Carolinas in textiles and apparel, the region defined as Kentucky, Tennessee, the Carolinas, Georgia, Alabama, and Mississippi gained enough in auto and (to a lesser extent) equipment to hold manufacturing's weight in gross state product at 17% of GSP between 1993 and 2003. For the Midwest, manufacturing's weight in GSP fell from 20.2% in 1993 to 18.8% in 2003.

Figure 21. Equipment Exports



In 2004, the Great Lakes region produced a total of $152 billion worth of components in the motor vehicle sector. (All figures in this REMI-based analysis are in constant dollars of 2000.) Of this $152 billion, just under $81 billion, or approximately 53 percent, of this output is consumed by in-region firms, i.e., $71 billion – or 47 percent -- is exported beyond the region. Exporting is even more critical for the equipment sector. Out of the total $91 billion in output, $30 billion (or 33 percent) is consumed by firms within the region; two-thirds is exported out of the region. As we have noted, a competitive region is not just an export powerhouse; the products it exports must have high in-region content. We have established that the Great Lakes region is a major exporter in auto and equipment. We turn now to the region's imports.

Figure 22. Auto Parts Imports

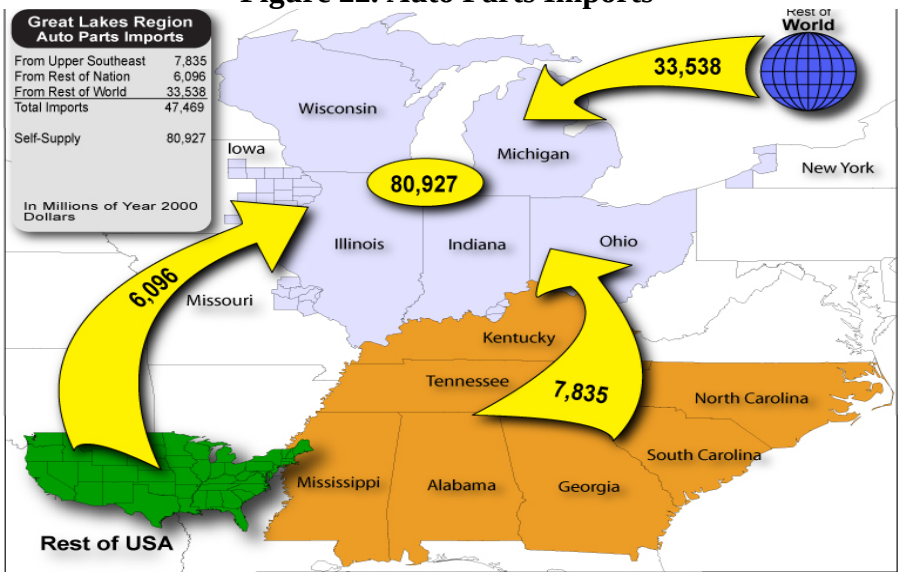
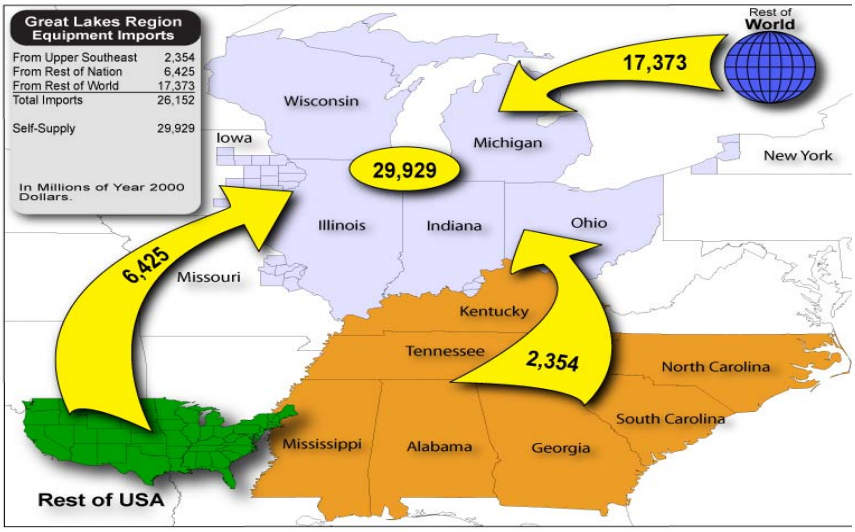


Figure 23. Equipment Imports



Figures 22-23 show that manufacturers in the Great Lakes region (as we have defined it) consume $128 billion of auto parts and $56 billion of equipment. But, as noted in the previous paragraph, the region self-supplies only $81 billion of auto and $30 billion of equipment. That means that ***the Great Lakes region imports from beyond its borders $47.5 billion in auto parts and $26 billion in equipment***.[45] Based on comparing *County Business Patterns* and the Commerce Department's International Trade Administration data for 1997, these 2004 figures -- calculated from runs commissioned for this project from REMI -- are up at least 50 percent from 1997.

What do $47.5 billion in auto components imports and $26 billion in equipment imports – or a total of **$73.5 billion** that **"leaks out" from the Great Lakes region's demand** – really mean? To make it clear, let's do some simple math. Manufacturing is 15 percent of a $12 trillion US economy.[46] That's $1.8 trillion. Dividing that by the 14.2 million people employed in the sector, we get $127,000 per employee. So, roughly speaking, if the Great Lakes region made rather than imported $73.5 billion, it could have about $73.5 billion / $127,000 = 578,000 more jobs in auto parts and equipment. Because the region pays better than the manufacturing average, perhaps a figure like 450,000 would be more realistic. And those are just the jobs in those two sectors. The region has a manufacturing multiplier effect of roughly three, according to the Bureau of Economic Analysis; so its "import leakage" really represents something like 1.3 million jobs. If $73.5 billion in imports means 1.3 million jobs, then every marginal $1 billion that the region can move from import to self-supplied translates into about 18,000 jobs. If each of those jobs pays $40,000 and if the region can capture even 10 percent of that amount

[45] Appendix 6 presents maps showing trade flows among the individual states of the Great Lakes region, documenting precisely how interdependent each dyad of states is in each of the two key component sectors – auto parts and equipment.

[46] Ideally, we would do the analysis on auto parts and equipment, but data on auto's weight in GDP do not consistently break out parts from vehicles, and our definition of the "equipment" sector is too idiosyncratic to match up to federal data.

in sales, excise, and income taxes, then any annual expenditure up to $72 million can be justified as a fair price for inducing $1 billion more in-region self-supply.

Note that we are not advocating autarky. There are gains to trade as well as "leakages." We believe that leakages are likely to be larger and the gains from imports lower when a high-wage region has large multipliers in its key industries, and when more and more of its imports in those industries come from countries or regions that compete on wages rather than on comparative advantage rooted in the quality of its labor, land, and capital.

For the Great Lakes region to remain a competitive powerhouse, it will either have to sharply increase its exports of auto and equipment – and, while doing so, stem the accelerating level on out-of-region content in those products -- and/or engage in what economists call "import substitution" and start to make some of the $73.5 billion it imports to supply its key export sectors.[47]

That's where our strategy comes in, and where the states in the Great Lakes region need to play a large and catalytic role. First, they must understand that they are part of a common competitive region.[48] They each live and die, though of course to different degrees, on how well the auto and equipment sectors export and how much they source their components within the region. No facile talk about diversification, high-tech, or the service economy can change this fact. In nearly every state in the region, these two sectors alone are at least 20 percent of manufacturing employment.[49] More important, the output of these sectors plays an even larger role in these states' exports – the way they get income from beyond their borders. Farm and construction equipment dominate Illinois' and Wisconsin's out-of-state shipments, while auto parts dominate Michigan's, Indiana's, and – to a lesser extent – Ohio's (see Appendix 6).

The companies that make up these core sectors make no distinction between Indianapolis and Louisville, Detroit and Toledo, Milwaukee and Chicago, St. Louis and Peoria, or Cleveland and Buffalo. Appendix 6 presents all of the trade flows in the two core sectors among the states of our Great Lakes region (remember: our "Illinois" contains metro St. Louis and 21 Iowa edge counties, and our "Indiana" includes the three counties that make up metro Louisville), and between those states and three competitor regions: (1) the upper southeast, (2) the rest of the US, and (3) the rest of the world. We can use a simple example to demonstrate the need for states to understand their economic region and its interests, and to craft cross-state policies to help the region out-compete other regions. A

[47] Gomory and Baumol (2000) show that higher-wage nations' ideal trading partners have wages of 25%-50% of their levels. But when the competitors' wages get closer, the regions shift from being just trading partners to being competitors. We believe that this analysis also applies to a high-wage region like the Great Lakes vis-à-vis the mid-wage upper Southeast. See R.E. Gomory and W.J. Baumol, *Global Trade and Conflicting National Interest* (Cambridge: MIT Press, 2000).

[48] The precise shape of the true industrial region varies by industry. Were we considering auto parts only, Illinois might well not quite make the cut. However, Illinois dominates the equipment sector, in which Ohio and Western New York are much smaller players.

[49] The two sectors as a proportion of total manufacturing employment range from 19.6% (Illinois) to 35.6% (Michigan), with the other three in-region states clustered tightly around 21% -- Wisconsin 20.9%, Indiana 21.3%, Ohio 21.5%.

Michigan automaker or auto supplier is considering sourcing $10 million worth of a component either in Michigan, to a supplier elsewhere in our Great Lakes region, to a location in the upper southeast competitor region, or to China. (We assume for purposes of exposition that each company is a representative slice of our sector-level statistics.)

Obviously, for any given state, winning the order for an in-state supplier is the best outcome. For starters, the typical manufactured component is about 35 percent value-added (on-site labor and overhead) and 65 percent purchased components. Thus an in-state source starts with $3.5 million of the $10 million. Based on the trade flow data, Table 8 below shows that – if the order is sourced to an out-of-state supplier -- it still makes a big difference where that supplier is located. Table 8, which views the calculation from the standpoint of one state in the Great Lakes region, Michigan, makes clear that plants in many in-region locations – notably Ohio and Wisconsin – source back to Michigan a large proportion of their total purchases.

Table 8. Michigan Proportion of Purchased Component Value

If $10-million Order is Sourced to:	Predicted Michigan Purchases Value is:
Michigan	$3,704,000
Ohio	1,687,000
Wisconsin	1,647,000
Indiana (incl. metro Louisville)	1,541,000
Illinois (incl. Iowa edge & metro St. Louis)	1,455,000
Upper SE	1,072,000
Upper SE net of GM/Delphi & Ford/Visteon	803,000
Offshore	161,000

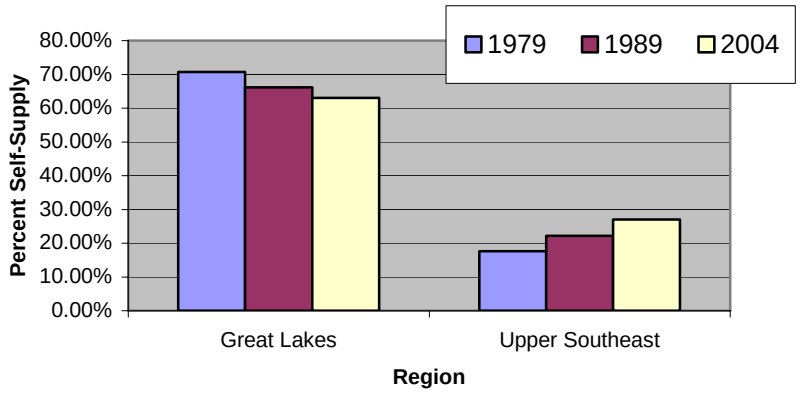
Source: REMI data applied to $6.5-million in purchased content

In fact, Table 8 almost certainly understates the Upper Great Lakes region's marginal propensity to buy in Michigan, while exaggerating other regions' propensity to shop there. REMI data tell us that the upper southeast buys more than 12.5 percent of its manufactured automotive parts from Michigan, but this figure includes massive exports of GM engines, transmissions, axles, and stampings to its assembly plants in Lakewood, GA and Spring Hill, TN and of other components to its electrical-parts plants in Athens and Tuscaloosa, AL and Meridien and Laurel, MS. Just pulling out $3,000 per vehicle in GM/Delphi supply to the Atlanta and Spring Hill plants reduces the Upper Southeast's entry in Table 8 above to 908,000. Doing the same for comparable "captive supply" by Ford/Visteon supplying Ford's Atlanta assembly plant and the number drops to 803,000, or less than half the average for the Great Lakes. In other words, if the $10-million order is not going to be sourced in Michigan, it is twice as good for Michigan if it goes to Sheboygan (WI) than if it goes to Shelbyville (TN), and 10 times better than if it goes to Shanghai.

For the Great Lakes region as a whole, the essential argument to grasp is this. In a country in which less than 13 percent of the jobs and 15 percent of the personal income is

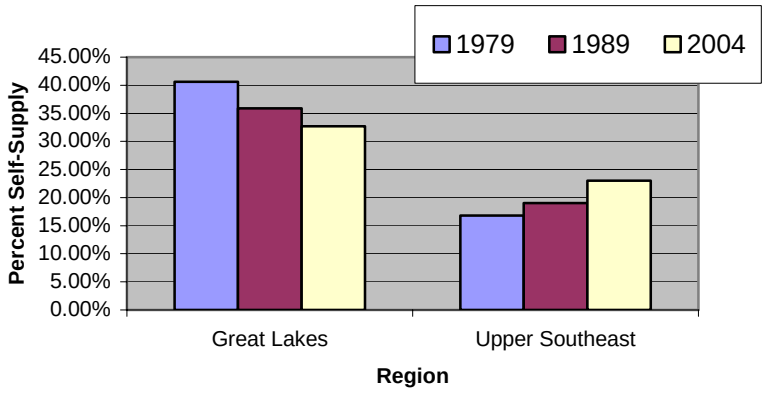
in manufacturing, the region owes 20 percent of its job and 30 percent of its personal income to the sector. Within that sector, it is uniquely focused in two subsectors – auto and equipment – in which traded products (vehicles and machinery) are heavily composed of components made under medium- to high-skill conditions. An adjoining region has played on lower rural labor costs – and on the political advantage to Japan-based automakers to locate assembly plants in states not dominated by US competitors in their industries – to make a move into these two industries, starting with assembly plants but increasingly in components as well. Thirty years into this regional competition, the Great Lakes region still leads in its ability to supply itself in these sectors, but its lead is eroding. Figures 24-25 below show each region's share of employment in the component SICs of the two sectors, based on *County Business Patterns* (1979, 1989) and our REMI runs for 2004.

Figure 24. Self-Supply in Auto, 1979, 1989, and 2004



Sources for Figures 24-25: *County Business Patterns* (1979, 1989), REMI (2004)

Figure 25. Self-Supply in Equipment, 1979, 1989, and 2004



While both regions have, in recent years, lost some self-supply to imports from outside the US, for the Great Lakes region the upper southeast's gain in self-supply has been just as important. Needless to say, concerted action by the Great Lakes region to counter the

rise of the upper southeast in the components that go into its largest export products makes strong economic sense. And with the high level of interdependence among the Great Lakes states in their core sectors' supply chains, replacing intra-regional competition with inter-state cooperation against the rest of the world is the obvious policy in a period of constrained public resources. Obviously, this task would be far easier for Great Lakes state legislators if there were national trade policies that made offshoring more difficult or less attractive, and/or that limited competition among the states. But there are not, nor are there likely to be in the future. While the recent fight over CAFTA shows that there are Republicans and Democrats alike with grave doubts about giving the multinationals a free ride, the leadership of both parties remains committed to proving that their parties are thoroughly business-friendly.

So where are we? Nearly every state in the Great Lakes region has a large structural fiscal deficit, which in some states has led, or may soon lead, to cuts in important services. A combination of political constraints and – relative to Pennsylvania and Virginia, where Democratic governors got taxes through Republican legislatures – undue political timidity have combined to "rule out" tax increases. Just as bad, this fiscal distress is invoked as a reason that little can be done to address economic development.

In fact, scarcer public resources present an opportunity to move from a costly "entitlements" system of business incentives to a more targeted, pay-only-for-what-you-get approach. As the work just described makes clear, incentives should be focused on higher-wage manufacturers that do substantial purchasing within the region. We also contend that the most efficient form of such incentives is the direct provision of services. This is better policy because it avoids redundancy and firm moral hazard in state supports, ensures greater accountability and quality control in state expenditures, and is more likely to be fiscally self-sustaining through resulting increases in in-state human capital and incomes. The services we have in mind include training on technical and work organization improvement, as well as consulting on the elements of the lean toolkit and on more active customer management to migrate away from the most price-competed products and markets. Rather than paying firms to do what they might already have done, using resources to pay for training or consulting directly tied to upgrading puts the money squarely on the problem. And, to the extent that the content of the services is an investment in people, the resulting skills are likely to remain within the state and region even if the advantaged firm exits in the future.

While direct service support is best, we recognize that state tax incentives are not going away any time soon. With regard to such incentives, the obvious play is to withdraw subsidies from sectors with small multiplier effects (including, in the Great Lakes region, insurance, finance, and retail development) and to switch them to sectors with much larger ones and, within those sectors, to firms paying high wages and doing most of their purchasing within the region.

The politics play less obviously. The region is dominated by relatively junior Democratic governors facing off against Republican legislative majorities that favor across-the-board business tax cuts. Despite their differences, in the Great Lakes region both the Governors

and the state legislators badly need a stabilized manufacturing sector. Moreover, they have access to an impressive array of tools for helping their manufacturing sectors, including but not limited to:

- Requiring that the manufacturers that earn targeted subsidies agree to be benchmarked and, where performance deficits are uncovered, be sent to the front of the line for direct technical assistance services from programs (such as MEP centers) in which the states are co-investors
- Assembling groups of manufacturers for larger-pool health insurance purchasing[50]
- Encouraging health care coverage or contributions to a state fund for the uninsured (lest the State end up covering those costs via Medicaid)[51]
- Raising state minimum wage floors[52]
- Tying incentives to wage, export-from-the-region and, especially, in-region purchasing behavior.

None of these initiatives requires federal action,[53] and while all are better and more safely done politically on a multi-state basis, each can be pursued at the own-state level, often by fiat or regulatory rule-making rather than requiring a vote of the legislature.

Within manufacturing, the same math should hold: no more pork for every plant in the right NAICS code, but targeted relief to the subset of manufacturers whose behaviors promise their state, and their region, the highest return. (According to one close observer, just under three in 10 Great Lakes manufacturers are, or are approaching, "world-class." But one-third to one-half are not even improving in critical areas, e.g., 33 percent reported no reduction in lead times between 2001 and 2004, and 53 percent reported no

[50] Recall our discussion of the union-nonunion gap in health insurance coverage. Were insurance costs to drop, union would be in a better position to begin restoring their pay premium.

[51] Making provision of health insurance a condition of favored state treatment may raise questions under the commerce clause. Although ERISA preempts states from requiring health insurance as an employment benefit, it does not appear to bar them from enacting a tax on employers dedicated to achieving the same purpose and giving employers credit for coverage of their own employees' health care costs. Such a tax can distinguish employers by size, critical function, or other indicia. For example, in the Health Care for All plan under consideration in Maryland, all employers must make a "fair share" contribution – currently set at 4.5 percent of payroll for small employers and eight percent for large ones – toward health care costs. The contribution can be offset by employer coverage of health care costs, or deposited into a fund for the uninsured. Individuals and families are also free to join a small-group health insurance consortium, a quasi-public insurer, which gives them group buying power. Unfortunately from our perspective, the Maryland plan ties employers' contribution levels to *payroll*. This sends the wrong market signal on wages, effectively punishing employers who pay better. But this defect can certainly be remedied. What is important is that ERISA does not, for a competent legislature, appear to preclude state action directed at employers with the goal of extending the reach of health insurance, *a fortiori* giving favored treatment to employers that do so voluntarily.

[52] Only Illinois among the 13 states with minimums above the federal $5.15 floor is in the Great Lakes region; see *Business Week*, Nov. 29, 2004, page 70. We recognize that most manufacturers pay well above the federal minimum. But achieving the full utilization of equipment that our "FULL" recipe requires may make it necessary for better companies to take on some low-end work to cover fixed costs. If it is in the region's interest to have these better companies succeed, then logically it should not permit their competitors to offer wages below those that state legislatures require in 13 states.

[53] Obviously, federal policy changes with regard to trade, prescription drug pricing and importation, and Medicaid federalization would also be welcome.

increase in inventory turns.[54]) This is not the same thing as "picking winners" – which no one knows how to get right – but, rather, paying for performance. States already have criteria for certain programs (e.g to qualify for tax relief under the Michigan Economic Growth Act's high-tech program, a firm must spend at least a minimum proportion of sales on qualifying R&D and pay an average wage of at least three times the federal minimum.

Paying for performance must include economic development policy that speaks directly to the region's continuing reduction in self-supply. It is unconscionable that most, if not all, of the Great Lakes states routinely shovel tax breaks and training subsidies to large firms, imposing nary a *quid pro quo* on where they source the parts than go into their products. Imagine, going forward, that every Great Lakes governor were to make such incentives *more* generous but only for stable or rising in-region purchasing content. While doing this at the level of a state – e.g., Wisconsin tying its incentive to X% in-Wisconsin purchasing – might be viewed as business-unfriendly, doing it at the regional level would (as we demonstrated) be almost as effective and substantially less constraining for the affected firm.

Attaching sensible regional *quid pro quos* to state largesse also has a political payoff. Existing firms are rightly incensed to see their tax dollars go to attract and subsidize companies – some of whom may be their competitors – that have no track record of providing jobs or tax base in their state or region. Governors and legislatures should be able to tell those longtime employers that they will benefit from the additional purchases that the new entrants will make – and be able to say that not as a wishful prediction but as a statement of fact: *unless they buy more, they will not get your tax money or anyone else's*.

Preemption Concerns Overblown

Governors and legislators often fear better stewardship of incentives for a newer reason – the fear that even reasonable *quid pro quos* will be judged anti-competitive under the emerging legal regime. One such concern has been heightened in recent years by a Sixth Circuit decision -- recently accepted for review by the US Supreme Court -- regarding Ohio's use of income tax credits to spur DaimlerChrysler's investment to retool its Toledo Jeep facility.[55] The other broad area of concern is the provisions of post-1994 WTO and other agreements (in the US case, particularly NAFTA and the recent CAFTA) as they relate to the rights of signatory nations and their constituent "federated elements" (in the US case, states). NAFTA and CAFTA in particular restrict state government regulation, taxation, purchasing, and economic development policies that are regarded as non-tariff barriers to trade.

We have reviewed the key case law on these questions of federal and international preemption. We conclude that states' fears of encroachment on their traditional

[54] See "World-Class Profit Factors: Positioning Great Lakes Manufacturing in the Global Economy," presentation of John Brandt, The MPI Group, Detroit, March 4, 2005.
[55] *Cuno v. DaimlerChrysler, Inc*., 386 F.3d 738 (6th Cir. 2004).

sovereignty are understandable and justified, but that none of this developing law thwarts the design and implementation of the policies proposed here. On its face, *Cuno* only forbids *income* tax credits for businesses with prior presence in the state offering those credits. It affects no other use of tax incentives (indeed, it explicitly exempts the use of property tax-based incentives), and does not touch non-tax subsidies or direct cash grants of any kind. States wishing to produce the same results as Ohio did with its offending scheme in *Cuno* will thus easily be able to reach those results by other means.[56]

International trade agreements do threaten distinctive environmental or social regulation in states, but their effects on narrow economic development efforts are negligible. Nothing in the WTO prevents states from making vigorous attempts to grow their local value-added, to induce more regional coherence in their provision of in-kind development supports, to defend their existing tax bases by requiring that all firms operating within them assume their fair share of internationally common social standards, and to support such policies through state programs encouraging them. So long as, as in our suggestions, the particular encouragement is available to any company, wherever headquartered and wherever now doing business, that engages in the advantaged behavior, the legal case against those incentives is extremely weak on its merits, and in any case unlikely to be brought.[57]

Remember that our preferred approach for how states and regions should encourage the upgrading of firms with qualifying behaviors is by writing down the cost of high-quality direct services. This is both good policy and most clearly insulated from preemption concerns. In terms both of national and international law, in funding or providing such

New Associations: Organizing the Beneficiaries of Better Policy

Manufacturers have been among their own worst enemies in the 25-year skid in Great Lakes (not to mention national) manufacturing performance. The story we tell of manufacturing is not well known, and the conclusions for policy —quite different for firms pursuing our "FULL" recipe than for others — are not generally appreciated by the domestic firms and workers that public policy should serve. Business and trade associations tend naturally to construct their policy agendas from positions on which all members agree, accepting differences in strength of agreement, rather than from segmented pursuit of the interests of what are, after all, competing firms. Comparatively

[56] The doctrinal distinction drawn in *Cuno* between income tax incentives for firms with in-state presence and all other firms or incentive schemes for business location or expansion is thus vastly under-inclusive in preventing corporate whipsawing of states. But it is equally over-inclusive, potentially barring any change in state income tax law that advantages corporations with existing state presence. For these reasons, we consider it a bad reading of the Commerce Clause and bad policy for a new federalism. We think it unlikely to survive without at least partial reversal at the Supreme Court.

[57] A simple political way of thinking through the international law is this. In comparative terms, US programs in "industrial policy" are famously immature. Until states in the US begin to approach the sorts of state interventions routine in other advanced industrialized economies, they should not worry. And as they do approach that level, they will come to join any number of powerful nations that can be expected to resist WTO lowering of it.

speaking, and owing to the relatively weakness of labor in the US, there is also an unnatural degree of policy cohesion in the American business community, which further encourages suppression of differences in interest within it.[58]

Thus, even though the interests of high-productivity firms paying high wages and making large investments in training and new equipment are quite different from those of firms paying low wages and often investing far less in human or physical capital, they behave politically as if their interests were the same.

So long as this state of affairs continues, it will be impossible to get adequate business support for policies promoting high-productivity manufacturers, at least to the extent those policies pose any risk to their low-productivity colleagues. The fiscally rattled governors and legislatures of Great Lakes states desperately need higher-performing businesses – and, ideally, powerful associations representing them – to weigh in on the side of better, more targeted policy. As daunting as this prospect may seem, it is essential if higher-performing manufacturing is to have any serious chance of getting itself established as the norm, not the exception, in US manufacturing. Higher wage, benefit, environmental, product quality, and other standards are needed to clear out (*not* save) low-wage competition and to provide clearer rewards for higher-productivity firms.

Public policy also can and should support the "lean" aspect of the FULL recipe. In that context, we recommend direct technical support and other assistance to firms pursuing lean manufacturing as an element of the recipe. There is intriguing, though not unambiguous, evidence to suggest that such support is ideally organized regionally[59] in order to maximize inter-firm learning among companies facing common market conditions.[60] We also know that a typical MEP "treatment" of a firm yields a 3.4-16

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[58] It is a good sign that, in recent years, a small manufacturer axis has emerged as a counterpoint to NAM's pro-free trade member multinationals. Beyond the split in NAM, there are other associations and coalitions of associations – notably USBIC and NEOCAM – that are playing a commendable role in pointing out the insanity of saving manufacturing in "a race to the bottom." Alas, too many high-performing manufacturers don't make the leap from opposing the multinationals' trade agenda to the need to oppose their closely linked "deregulatory" agenda. With many of the better-performing small manufacturers being located in the Great Lakes region, the best prospect for a new associationism rooted in self-interest rather than putative class solidarity is probably in the regional caucuses of national trade associations. COWS and the MMTC are considering seeking foundation support to convene a council of high performers in which to vet the issue and, if enough companies risk membership, actually trying to launch a new group.

[59] We have no hard-and-fast concept of region, but would note that a natural economic region could be as small as an industry-dense area in a city, or as large as a five-state area. It is a more or less contiguous area, independent of state or metropolitan area political boundaries, that has a high concentration of employment and output in one or more sectors, and a large amount of internal trade in those sectors relative to its external trade.

[60] See, among others, S.J. Appold "Agglomeration, Interorganizational Networks, and Competitive Performance in the U.S. Metalworking Sector," *Economic Geography,* 71:1 (1995), pp. 27-54; P. Beeson, "Total Factor Productivity Growth and Agglomeration Economies in Manufacturing," *Journal of Regional Science,* 27:2 (1987), pp. 183-99; L. Dresser and J. Rogers, " Networks, Sectors, and Workforce Learning," in R. P. Giloth, Jobs and Economic Development: Strategies and Practices (Thousand Oaks: Sage, 1998), pp. 64-82; J.H. Fagan, "Do Northeast Ohio's Drivers Derive Competitive Advantage from Shared Labor?," *Economic Development Quarterly,* 14:1 (2000), pp. 111-125; Meric S. Gertler, "'Being There': Proximity,

percent productivity boost,[61] and we know from recent MMTC work that something on the order of a 15 percent increase in average productivity is what is needed to "catch" the Chinese competition now decimating component manufacturing in the Midwest.[62] An attractive project might be to concentrate MEP resources to produce that 15 percent hike in a large number of high-wage, rising-productivity firms in the region — in effect, a demonstration of scaled targeting of high-end assistance and its possible effects — and then document the consequences. This is, in any case, a better use of MEP resources than having them invest time in trying to keep "bottom-feeders" afloat.

A second regional direct-assistance initiative would be to systematically expand business consortia (such asthe Wisconsin Regional Training Partnership [WRTP] and the Wisconsin Manufacturers Development Consortium [WMDC]) dedicated to supplier upgrading, modernization, and the like. For fiscally strapped states, this can be done relatively cheaply, and has proven positive effects on performance. Northeast Ohio already has a promising young WRTP-like entity (though with much weaker ties to labor) that could be the nucleus of that state's play in such a project. These consortia will need to be organized with some sensitivity to local conditions. In Wisconsin, the WRTP and WMDC benefit enormously by having OEMs and many of their suppliers headquartered within the state. The same thing is true, though to a lesser (and declining) extent in both Michigan (in auto parts) and Illinois (in equipment parts). It is much less the case in Ohio and Indiana.

Organization, and Culture in the Development and Adoption of Advanced Manufacturing Technologies," *Economic Geography*, 71:1 (1995), pp. 1-26; Ben Harrison, M. R. Kelley, et al, "Innovative Firm Behavior and Local Milieu: Exploring the Intersection of Agglomeration, Firm Effects, and Technological Change," *Economic Geography* 72:3 (1996), pp. 233-258; E.W. Hilland J. F. Brennan, "A Methodology for Identifying the Drivers of Industrial Clusters: The Foundation of Regional Competitive Advantage," *Economic Development Quarterly*, 14:1 (2000), pp. 65-96; D. Luria and J. Rogers, Metro Futures: Economic Solutions for Cities and Their Suburbs (Boston: Beacon Press, 1999); National Governors Association, *A Governor's Guide to Cluster-Based Economic Development*, 2002; E. Parker and J. Rogers, "Sectoral Training Initiatives in the US: Building Blocks of a New Workforce Preparation System?," in P. Culpepper, The German Skills Machine: Sustaining Comparative Advantage in a Global Economy (New York: Berghahn Books, 1999), pp. 326-362; Michael E. Porter, "Location, Competition, and Economic Development: Local Clusters in a Global Economy," in *Economic Development Quarterly*, 14:1 (2000), pp. 15-34; M.J. Waits, "The Added Value of the Industrial Cluster Approach to Economic Analysis, Strategy Development, and Service Delivery," *Economic Development Quarterly*, 14:1 (2000), pp. 35-50; and Jonathon Zeitlin, "Industrial Districts and Local Economic Regeneration: Overview and Comment," in Frank Pyke and Werner Sengenberger, Industrial Districts and Local Economic Regeneration (Geneva: International Labour Organization, 1992), pp. 279-94..

[61] See Ron Jarmin, "Evaluating the Impact of Manufacturing Extension on Productivity Growth," *Journal of Policy Analysis and Management*, 18:1 (1999), and unpublished work by consultants Nexus & Associates that updates and extends Jarmin's methods for Pennsylvania MEP clients. See "Program evaluation of Pennsylvania's Industrial Resource Centers" at www.nexus-associates.com/Publications.

[62] Work on the tool, die, and mold industry performed by MMTC's PBS for the State of Michigan suggests that, when extra "overhead" costs such as travel, inventory financing, shipping, duty, expediting, and the onshore repair of offshore products are included, the vaunted 30-40% cost advantage of low-wage producers is typically reduced to the 7-25% range, with a median of about 15%. Some may object that offshore producers are also improving, but for China at least, the MPI study cited in footnote 54 suggests that only 40% of manufacturers there reduced costs between 2001 and 2004.

A useful demonstration project involving more than one contiguous state could map the consortia needed and begin to take them to scale. Promising staff ties among new governors in a number of fiscally stressed Great Lakes states may make this a propitious moment to move either the MEP-centered "catch China's costs" or consortial supplier upgrading demonstration projects.

Conclusion

Onshore manufacturing's weight in the economy may well shrink, perhaps sharply, in the years and decades ahead. The sector's size and, at least as important, its contribution to the economy will not be accidental outcomes: they can be influenced by actions that companies, unions, and governments take. We believe that, even in these trying times for the sector, there is a way forward for better companies.

We have presented a new model that ties employee authority, lean production, and region-favoring purchasing policy. We argue that this model can help willing and capable manufacturers remain profitable paying family-supporting wages in the US. We have proposed incentives policies and demonstration projects that arguably couldimplement the model at a cost well below the price tag of today's costly, untargeted state tax expenditure approach.[63]

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Appendices:

1. US Manufacturing SICs, as Sorted by AMP Researchers
2. Regression Analysis, "Busy" & "Lean" Effects on Productivity and Profitability
3. Estimating Component Sector Employment and Wages
4. Comparative Means, Union vs. Non-Union Plants, 1997-98 and 2002-03
5. Regression Analysis, Union/Non-Union Wage Gap
6. Trade Model Results, Five Upper Great Lakes States

[63] While many observers (including some economic development professionals) regret the practice of offering such tax breaks, most are not aware that their cumulative cost runs into the billions of dollars annually. See, among others, Greg LeRoy, The Great American Jobs Scam: Corporate Tax-Dodging and the Myth of Job Creation (Williston, VT: Berrett-Koehler, 2005).

Appendix 1. US Manufacturing SICs, as Sorted by AMP Researchers

(blue shading indicates treated as part of components sector for this study)

2-Digit(s)	Materials	Services	Components, including Tooling	Finished Goods	Capital Goods, excluding Tooling
Food				2011 thru 2038	
			2041, 2046	2043-44-45, 2047, 2048	
	207, 2097			205, 206, 208, 209 excl. 2097	
Tobacco			214	211 thru 213	
Textiles & Apparel			221 thru 224, 226, 228, 229	2391 thru 2394, 2399	
				225, 227	
			2395 thru 2397	23 excl 239	
Wood Products & Furniture	241-242, 2435 thru 2439, 2491, 2493		2431, 2441, 2448	2434, 2449, 245, 2499	
				25	
Paper & Pulp	261 thru 263, 2671-72		265, 2673-74	2675 thru 2679	
Printing		2791	2789, 2796	27 excl 279	
Chemicals	281-282, 2841-2-3, 285 thru 289			283, 2844	
	29				
Rubber & Plastic Products			3011	302	
			305		
			3061	3069	
	3081-82-83		3084, 3089	3085-86, 3088	
	3087				
Leather			311, 313	314 thru 319	
Stone, Clay, & Glass	321, 324, 325, 327, 329			322-323	
			3264, 328	326 excl 3264	
Primary Metals	331 excl 3315 & 3317, 333, 334, 335, 3399		3315, 3317		
			332		
		3398	336		
			341, 3432		
Fabricated Metal Products			3441-42-43-44	342, 343 excl 3432	
			3449	3446, 3448	
		347	345-346		
	3496-97		349 excl 3496-97	348	

(continued on the next page)

Non-Electrical Machinery, Machined Parts, & Tooling			3519	352	3511
			3543-4-5	3546	353, 3541-42
			3562, 3566		3547 thru 3561
				357 thru 3585 excl. 3582	3563-64-65, 3567-68-69, 3582, 3586, 3589
			359 excl 3596		3596
Electricals & Electronics					
			3613		3612
			362	363, 364 excl 3647, 365, 366	
			3647		
			367		
			3691, 3694	3692, 3695, 3699	
Transpor-tation Equipment			3714	3711, 3713, 3715, 3716, 3721, 373, 374, 375, 3761, 379	
			3724, 3728		
			3764, 3769		
Instruments				38	
Consumer Products			3915	391 excl 3915	
				393, 394, 395, 3961	
	3996		3965	399 excl 3996	

Appendix 2. Regression Results:
Full Utilization and LeanEffects on Productivity and Profitability

(PBS Data)

netprof - pretax profit rate
vafte - productivity as measured by value-added per FTE
el, ..., pp - industry dummies (one sector excluded)
runyr - hours per year typical production machine running parts
turns - inventory turns

regress vafte el lv mb mf mpa mep pp runyr turns

```
      Source |       SS       df       MS                  Number of obs =     428
-------------+------------------------------                F(  9,   418) =    5.62
       Model |  7.6239e+10     9  8.4710e+09                Prob > F      =  0.0000
    Residual |  6.2994e+11   418  1.5070e+09                R-squared     =  0.1080
-------------+------------------------------                Adj R-squared =  0.0888
       Total |  7.0618e+11   427  1.6538e+09                Root MSE      =   38821

------------------------------------------------------------------------------
       vafte |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          el |   -2278.004   9937.807    -0.23   0.819    -21812.31     17256.3
          lv |    13289.65    8245.18     1.61   0.108    -2917.535    29496.83
          mb |    36409.77   10996.31     3.31   0.001     14794.81    58024.72
          mf |    16951.02   6365.231     2.66   0.008     4439.167    29462.87
         mpa |    14145.66   6912.264     2.05   0.041     558.5354    27732.79
         mep |    16693.84   7253.489     2.30   0.022     2435.982     30951.7
          pp |   -727.6754   14190.76    -0.05   0.959    -28621.81    27166.46
       runyr |    438.7911   143.5394     3.06   0.002     156.6421    720.9401
       turns |    720.6688   151.6392     4.75   0.000     422.5984    1018.739
       _cons |    40302.84    7203.04     5.60   0.000     26144.15    54461.54
------------------------------------------------------------------------------
```

regress netprof el lv mb mf mpa pp mep runyr turns

```
      Source |       SS       df       MS                  Number of obs =     417
-------------+------------------------------                F(  9,   407) =    2.71
       Model |  4463.40652     9  495.934057                Prob > F      =  0.0044
    Residual |  74356.5471   407  182.694219                R-squared     =  0.0566
-------------+------------------------------                Adj R-squared =  0.0358
       Total |  78819.9536   416  189.471042                Root MSE      =  13.516

------------------------------------------------------------------------------
     netprof |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          el |    2.427704   3.520483     0.69   0.491    -4.492896    9.348303
          lv |   -3.380476   2.946311    -1.15   0.252    -9.172361    2.41141
          mb |   -12.37137   3.965751    -3.12   0.002    -20.16728   -4.575457
          mf |   -.8226913   2.293663    -0.36   0.720    -5.331596    3.686213
         mpa |   -.6170922   2.480792    -0.25   0.804    -5.493857    4.259672
          pp |     1.888     4.968782     0.38   0.704     -7.87968    11.65568
         mep |    1.180246   2.609491     0.45   0.651    -3.949515    6.310008
       runyr |    .1095473   .0507849     2.16   0.032     .0097139    .2093808
       turns |    .0235504   .0534371     0.44   0.660    -.0814968    .1285976
       _cons |    10.58021   2.620281     4.04   0.000     5.429231    15.73118
------------------------------------------------------------------------------
```

Appendix 3.
Estimating Component Sector Employment, Wages, and Unionization

The Current Population Survey (CPS) does not identify all the four-digit SIC codes that comprise the component sector as defined in this report. (For a list of those SIC codes, see Appendix 1.) Although CPS industry codes sometimes correspond exactly to a particular 3- or 4-digit SIC code, they are more often combinations of 3- or 4-digit SIC codes. (A Census Bureau crosswalk between CPS and SIC industry codes makes it possible to determine which SIC codes make up a particular CPS industry code.)

Therefore, the following method was used to estimate employment, wage, and unionization variables in cases in which the CPS was the preferred or only data source. For each year 1988-2000, the share of employment in each CPS industry code that consisted of component sector SIC codes was estimated using BLS ES-202 data, which include nationwide employment in all 3- and 4-digit SIC codes. CPS data for each of these years were then re-weighted by multiplying this share by the CPS weight for each observation.

Appendix 4.
Comparative Means, Union vs. Non-Union Plants
(PBS data)

Variables	1997-98 Average Values Union N=179	Non-Union N=937	Gap	2002-03 Average Values Union (N=87)	Non-Union (N=555)	Gap
Avg. shop floor hourly wage	$13.11	$11.42	$1.69 **	$14.17	$13.77	$0.40
Value-added (=sales less purchases) per full-time equivalent (2000 labor hours)	$72,600	$64,400	$8200 **	$75,000	$69,400	$5,600
$ Equipment per full-time equivalent (2000 labor hours)	$56,900	$38,800	$18,100 **	$58,700	$59,100	-$400
Employee turnover rate	22.70%	32.30%	-9.6% *	33.30%	40.10%	-6.80%
% Shop workers covered by employer-provided health insurance	88.00%	70.90%	17.1% **	82.20%	69.70%	12.5% **
Labor costs as a % of sales	27.70%	29.50%	-1.8% *	27.60%	33.30%	-5.7% **
Gross profits (sales less cost of goods sold) as % of sales	28.60%	32.40%	-3.8% **	23.50%	27.60%	-4.1% *
Costs for temps as % labor costs	1.80%	3.63%	-1.83% **	2.01%	2.96%	-0.95%
2-year % change in sales	18.10%	28.20%	-10.10%	-5.18%	-0.32%	-4.86%
Total employees	213	108	105 **	172	91	81**
% Sales to auto industry	49.50%	34.00%	15.5% **	64.10%	45.80%	18.3% **
% Sales from products of own design	30.70%	33.70%	-3.00%	23.30%	22.30%	1.00%
% Shop workers trained in statistical quality concepts	35.90%	30.70%	5.20%	43.90%	35.70%	8.2% *
% Shop workers trained in technical concepts	35.10%	35.30%	-0.20%	39.60%	37.40%	2.20%
Training $ per shop floor worker	$184	$306	-$122	$160	$206	-$46
% Shop workers in teams	16.70%	23.60%	-6.9% *	23.70%	18.30%	5.40%
# Keyboards/keypads per employee	0.22	0.26	-0.04 *	0.31	0.4	-0.09 *
% Employees using computers	43.40%	47.30%	-3.90%	61.90%	61.20%	0.70%

** Significant at higher than 99% level

* Significant at 90-99% level

Appendix 5. Regression Analysis, Union/Non-Union Wage Gap

(PBS Data)

For 1997-98 and 2002-03, we present three regressions, one each on avgwage, pbswage, and healthpct. Please see variable definitions below.

avgwage is a somewhat noisy measure of wages, from shop worker payroll divided by shop worker hours (but sometimes respondents define "shop workers" differently in the 2 sections of the questionnaire, so the average wage is prone to error)
pbswage is a better wage measure, a weighted average of hourly wages by worker type, but is only available for a subset of pbs participants
healthpct is percent of shop workers covered by employer-provided health insurance
localwage97 is average wage in plant's county, a measure of local job market conditions
el, lv, mb, mf, mpa, miscauto and other are industry sector dummy variables
lnemp is natural log of total employment, a measure of plant size
vafte is value-added per full-time equivalent
kfte is replacement value of machinery and equipment per full-time equivalent
trnshop is spending on training per shop worker
auto is percent sales to auto industry
eto is percent of sales that are one-of-a-kind, engineered to order
jobshop is percent of sales from "job shop" type orders that are short-term, non-repeating
comptr is percent of employees using computers as part of their jobs
uniondum is union dummy variable

1997-98: reg **avgwage** localwage el lv mb mf mp miscauto other lnemp vafte kfte trnshop auto eto jobshop comptr uniondum

```
      Source |       SS       df       MS              Number of obs =     641
-------------+------------------------------           F( 17,   623) =   23.04
       Model |  4853.25302    17  285.485472            Prob > F      =  0.0000
    Residual |  7719.66586   623   12.391117            R-squared     =  0.3860
-------------+------------------------------           Adj R-squared =  0.3693
       Total |  12572.9189   640  19.6451858            Root MSE      =  3.5201

------------------------------------------------------------------------------
     avgwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 localwage97 |   .0037964   .0012905     2.94   0.003     .0012622    .0063306
          el |   .2023155   .6416379     0.32   0.753     -1.05772    1.462351
          lv |   4.524433   .8085146     5.60   0.000     2.936689    6.112177
          mb |   1.467011   .6031893     2.43   0.015     .2824809    2.651542
          mf |   .4762639   .4549382     1.05   0.296    -.4171342    1.369662
         mpa |   1.698134   .4254819     3.99   0.000     .8625814    2.533686
    miscauto |   1.203913   .7399672     1.63   0.104    -.2492191    2.657045
       other |   1.429805   .6252973     2.29   0.023     .2018589     2.65775
       lnemp |    .008844   .1489369     0.06   0.953    -.2836351    .3013231
       vafte |   .0000444   5.30e-06     8.38   0.000      .000034    .0000548
        kfte |   .0000123   3.99e-06     3.09   0.002     4.49e-06    .0000202
     trnshop |   7.37e-06   .0000562     0.13   0.896    -.0001031    .0001178
        auto |  -.0083707   .0039244    -2.13   0.033    -.0160774    -.000664
         eto |   .0449852   .0077524     5.80   0.000     .0297612    .0602092
     jobshop |   .0194282   .0054209     3.58   0.000     .0087828    .0300735
      comptr |   .0078616   .0049679     1.58   0.114    -.0018942    .0176174
    uniondum |    .629031   .4118398     1.53   0.127    -.1797314    1.437793
       _cons |   3.915177   1.037494     3.77   0.000     1.877769    5.952585
------------------------------------------------------------------------------
```

1997-98: reg **pbswage** localwage el lv mb mf mp lnemp vafte kfte trnshop auto eto jobshop comptr uniondum

```
      Source |       SS       df       MS              Number of obs =     392
-------------+------------------------------           F( 15,   376) =   37.25
```

```
      Model |  2386.69218    15  159.112812           Prob > F      =  0.0000
   Residual |  1605.94292   376  4.27112478           R-squared     =  0.5978
-------------+------------------------------           Adj R-squared =  0.5817
      Total |   3992.6351   391   10.211343           Root MSE      =  2.0667

------------------------------------------------------------------------------
     pbswage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 localwage97 |   .0039601   .0009948     3.98   0.000     .0020041    .0059162
          el |  -1.189786   .5952168    -2.00   0.046    -2.360157   -.0194149
          lv |   4.839526   .6064341     7.98   0.000     3.647099    6.031953
          mb |   2.457658   .5236483     4.69   0.000     1.428011    3.487304
          mf |   1.675108   .3245324     5.16   0.000     1.036982    2.313234
         mpa |   2.764613   .3396412     8.14   0.000     2.096779    3.432448
       lnemp |   .4229427   .1172741     3.61   0.000     .1923475     .653538
       vafte |   .0000133   4.27e-06     3.12   0.002     4.91e-06    .0000217
        kfte |   .0000108   3.23e-06     3.33   0.001     4.40e-06    .0000171
     trnshop |    .000011   .0000334     0.33   0.742    -.0000547    .0000766
        auto |  -.0089612   .0027154    -3.30   0.001    -.0143005   -.0036219
         eto |   .0318657   .0061974     5.14   0.000     .0196798    .0440516
     jobshop |   .0171113   .0050386     3.40   0.001     .0072039    .0270186
      comptr |   .0099756   .0037233     2.68   0.008     .0026544    .0172968
    uniondum |   1.120302   .3064028     3.66   0.000     .5178243     1.72278
       _cons |   3.423263   .8266014     4.14   0.000     1.797922    5.048604
------------------------------------------------------------------------------
```

1997-98: reg **healthpct** localwage el lv mb mf mp lnemp vafte kfte trnshop auto eto jobshop comptr uniondum

```
      Source |       SS       df       MS              Number of obs =     388
-------------+------------------------------           F( 15,   372) =    4.00
       Model |  62191.4367    15  4146.09578           Prob > F      =  0.0000
    Residual |  385333.277   372  1035.84214           R-squared     =  0.1390
-------------+------------------------------           Adj R-squared =  0.1042
       Total |  447524.714   387  1156.39461           Root MSE      =  32.185

------------------------------------------------------------------------------
   healthpct |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 localwage97 |   .0442835   .0155892     2.84   0.005     .0136294    .0749376
          el |  -11.91163   7.184911    -1.66   0.098    -26.03976    2.216501
          lv |   19.28392   10.15198     1.90   0.058    -.6785465    39.24639
          mb |   19.44912   7.687259     2.53   0.012     4.333188    34.56505
          mf |   12.31861   5.036832     2.45   0.015      2.41438    22.22285
         mpa |   1.865348   4.737437     0.39   0.694    -7.450164    11.18086
       lnemp |   1.073375   1.786653     0.60   0.548     -2.43983    4.586579
       vafte |   7.74e-06   .0000643     0.12   0.904    -.0001187    .0001341
        kfte |   .0000996   .0000506     1.97   0.050     1.43e-07    .0001991
     trnshop |   .0002905   .0005203     0.56   0.577    -.0007326    .0013137
        auto |   .0918154   .0428071     2.14   0.033     .0076411    .1759898
         eto |  -.0443413    .108569    -0.41   0.683    -.2578272    .1691446
     jobshop |   .0199458   .0661016     0.30   0.763    -.1100339    .1499255
      comptr |  -.0003038    .055847    -0.01   0.996    -.1101191    .1095115
    uniondum |   7.763289   4.670564     1.66   0.097    -1.420729    16.94731
       _cons |   31.17476   12.12008     2.57   0.010     7.342308    55.00722
------------------------------------------------------------------------------
```

2002-03: reg **avgwage** localwage el ht lv mb mf mp miscauto other lnemp vafte kfte trnshop auto eto jobshop comptr uniondum

```
      Source |       SS       df       MS              Number of obs =     411
-------------+------------------------------           F( 18,   392) =   17.16
       Model |   5575.6146    18  309.756366            Prob > F      =  0.0000
    Residual |   7074.9427   392  18.0483232            R-squared     =  0.4407
-------------+------------------------------           Adj R-squared =  0.4151
       Total |  12650.5573   410  30.8550178            Root MSE      =  4.2483

------------------------------------------------------------------------------
     avgwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   localwage |   .0024138    .001659     1.45   0.146    -.0008478    .0056754
          el |  -1.269475   .9672014    -1.31   0.190    -3.171026    .6320758
          ht |   2.882477   3.082272     0.94   0.350    -3.177375    8.942329
          lv |   5.081243   1.173209     4.33   0.000     2.774675    7.387811
          mb |   7.354282   1.465304     5.02   0.000     4.473445    10.23512
          mf |   2.236672   .7104149     3.15   0.002     .8399724    3.633372
          mp |   2.130839   .7525881     2.83   0.005     .6512256    3.610453
    miscauto |   .4943924   1.053668     0.47   0.639    -1.577154    2.565939
       other |  -.5585948   1.277758    -0.44   0.662     -3.07071    1.953521
       lnemp |  -.0232937   .2420281    -0.10   0.923    -.4991291    .4525417
       vafte |   .0000401   7.28e-06     5.52   0.000     .0000258    .0000544
        kfte |   .0000118   4.05e-06     2.91   0.004     3.84e-06    .0000198
     trnshop |   .0003267   .0006845     0.48   0.633     -.001019    .0016723
        auto |  -.0221087   .0060805    -3.64   0.000    -.0340633   -.0101542
         eto |    .035671   .0129445     2.76   0.006     .0102217    .0611203
     jobshop |   .0271176   .0113569     2.39   0.017     .0047895    .0494457
      comptr |  -.0008372    .007709    -0.11   0.914    -.0159932    .0143189
    uniondum |    .183479   .7039101     0.26   0.794    -1.200432     1.56739
       _cons |   7.160844   1.820018     3.93   0.000     3.582626    10.73906
------------------------------------------------------------------------------
```

2002-03: reg **pbswage** localwage el lv mb mf mp lnemp vafte kfte trnshop auto eto jobshop comptr uniondum

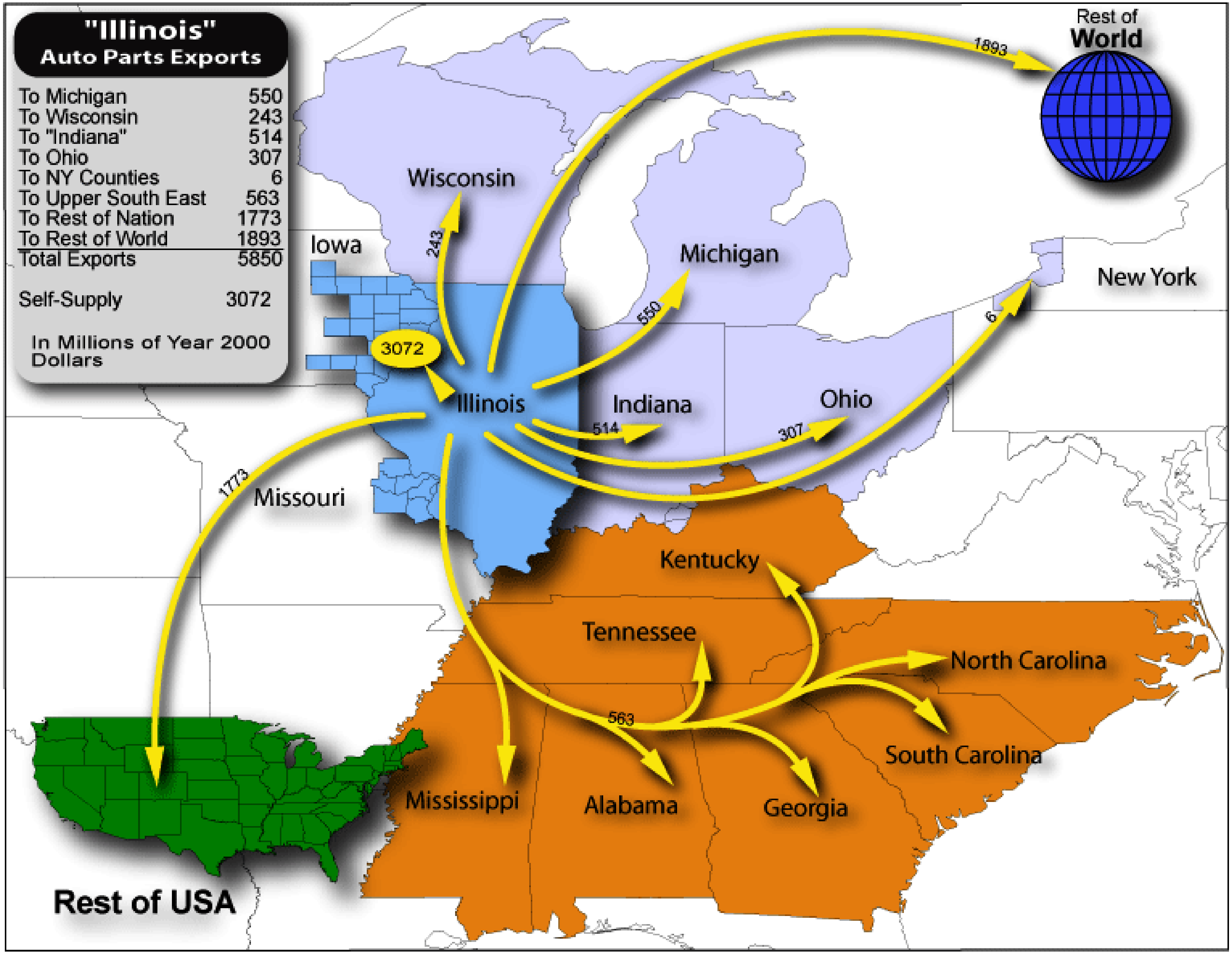
```
      Source |       SS       df       MS              Number of obs =     330
-------------+------------------------------           F( 15,   314) =   35.77
       Model |  2578.11483    15  171.874322            Prob > F      =  0.0000
    Residual |   1508.8015   314  4.80510031            R-squared     =  0.6308
-------------+------------------------------           Adj R-squared =  0.6132
       Total |  4086.91632   329  12.4222381            Root MSE      =  2.1921

------------------------------------------------------------------------------
     pbswage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   localwage |   .0036503   .0009668     3.78   0.000      .001748    .0055525
          el |  -1.039802   .5612848    -1.85   0.065    -2.144157    .0645523
          lv |   4.567391   .6926966     6.59   0.000     3.204477    5.930304
          mb |   4.590207   .8169844     5.62   0.000     2.982751    6.197663
          mf |   2.008461   .3849057     5.22   0.000      1.25114    2.765781
          mp |   3.024152   .4217387     7.17   0.000     2.194361    3.853943
       lnemp |  -.0610748   .1457591    -0.42   0.675    -.3478628    .2257131
       vafte |    .000019   4.16e-06     4.57   0.000     .0000108    .0000272
        kfte |  6.74e-06   2.42e-06     2.79   0.006     1.98e-06    .0000115
     trnshop |   .0004081   .0003387     1.20   0.229    -.0002583    .0010745
        auto |  -.0024896   .0034028    -0.73   0.465    -.0091847    .0042055
         eto |   .0253775   .0075147     3.38   0.001      .010592     .040163
     jobshop |   .0188913   .0069807     2.71   0.007     .0051565    .0326261
      comptr |   .0078626   .0044821     1.75   0.080    -.0009563    .0166814
    uniondum |   .0482343   .3988563     0.12   0.904    -.7365345    .8330031
       _cons |   6.750515   1.014206     6.66   0.000     4.755017    8.746014
------------------------------------------------------------------------------
```

2002-03: reg **healthpct** localwage el lv mb mf mp lnemp vafte kfte trnshop auto eto jobshop comptr uniondum

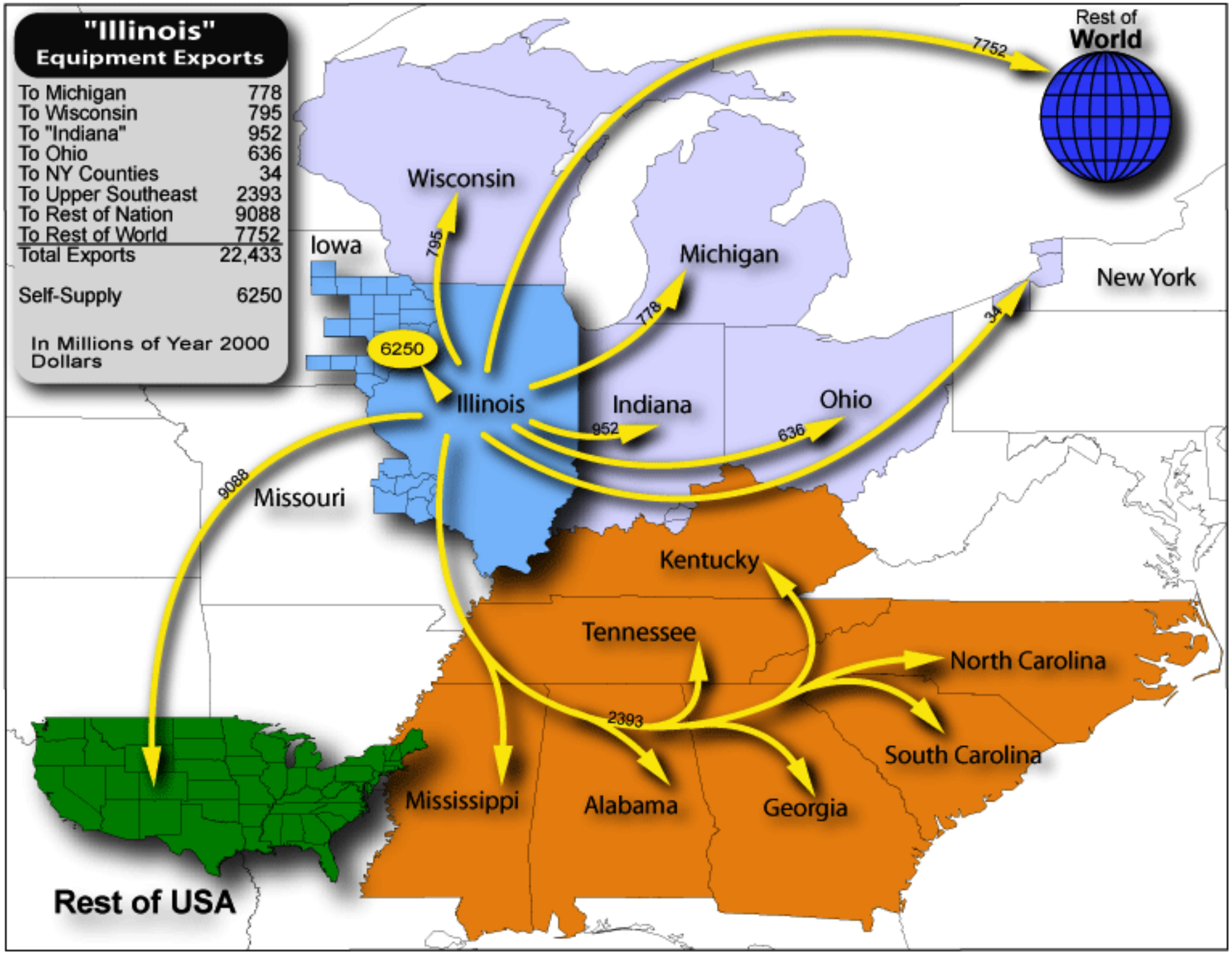
```
      Source |       SS       df       MS              Number of obs =     408
-------------+------------------------------           F( 15,   392) =    4.96
       Model |  76480.3644    15  5098.69096           Prob > F      =  0.0000
    Residual |  402803.013   392  1027.55871           R-squared     =  0.1596
-------------+------------------------------           Adj R-squared =  0.1274
       Total |  479283.377   407  1177.60044           Root MSE      =  32.056

------------------------------------------------------------------------------
  healthpct |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
  localwage |   .0021652   .0126689     0.17   0.864    -.0227422    .0270726
         el |   2.357204   6.838303     0.34   0.731    -11.08713    15.80154
         lv |   20.69938   8.378679     2.47   0.014     4.226611    37.17215
         mb |   8.971456   10.52882     0.85   0.395    -11.72857    29.67148
         mf |   19.90594   4.686329     4.25   0.000     10.69246    29.11943
         mp |   16.11308   4.989721     3.23   0.001     6.303115    25.92304
      lnemp |   .0371147   1.867133     0.02   0.984    -3.633732    3.707961
      vafte |   .0001454    .000055     2.64   0.009     .0000373    .0002535
       kfte |   .0000665   .0000285     2.33   0.020     .0000104    .0001225
    trnshop |  -.0055247   .0045065    -1.23   0.221    -.0143847    .0033352
       auto |   .0280108   .0438986     0.64   0.524    -.0582953    .1143169
        eto |   .0522906   .1004212     0.52   0.603    -.1451409    .2497221
    jobshop |    .071061   .0841051     0.84   0.399    -.0942925    .2364144
     comptr |   .0079748   .0585273     0.14   0.892    -.1070918    .1230415
   uniondum |   12.93593    5.29044     2.45   0.015      2.53474    23.33711
      _cons |    41.1567   13.50722     3.05   0.002     14.60105    67.71236
------------------------------------------------------------------------------
```

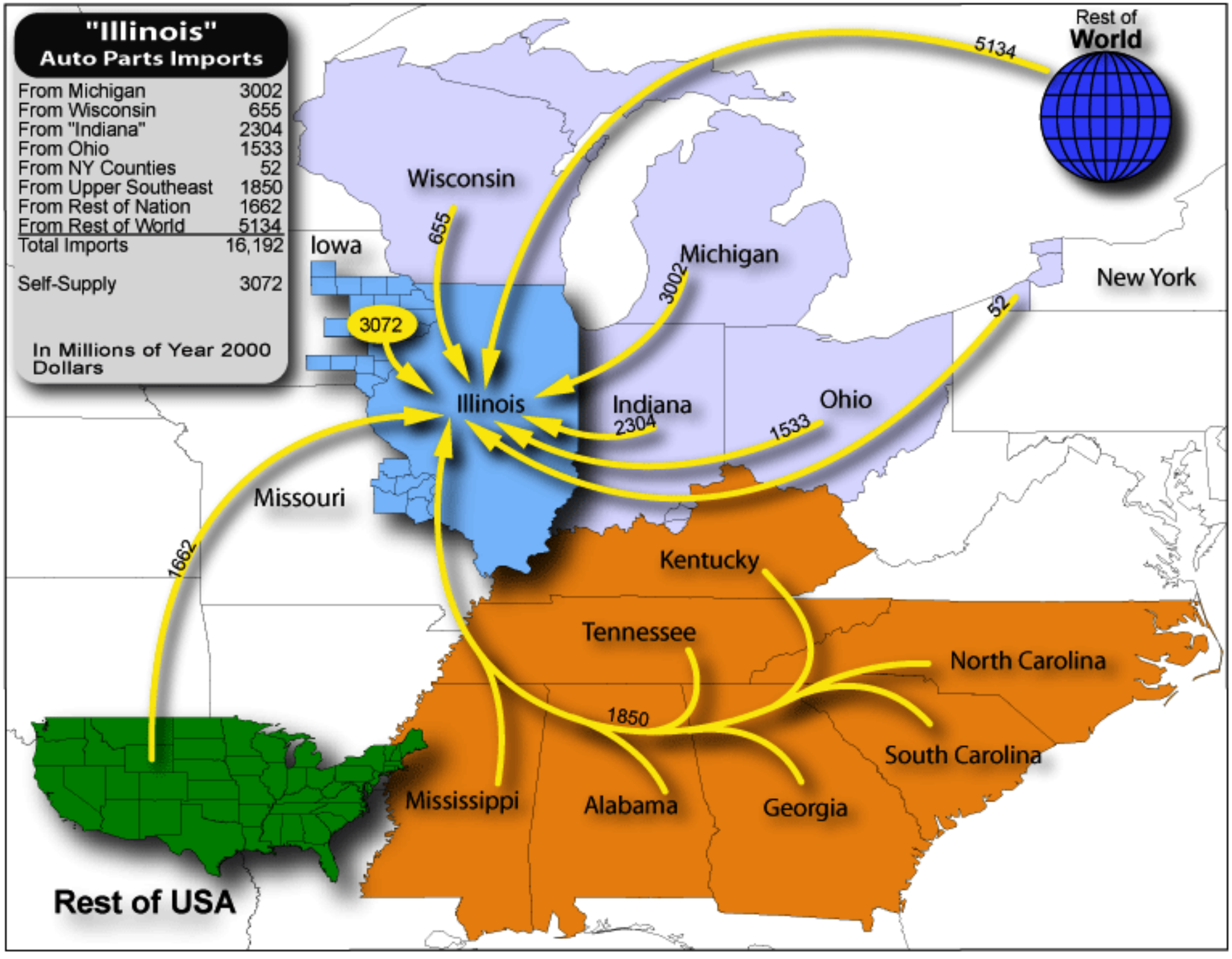
Appendix 6. Trade Model Results, Five Upper Great Lakes States

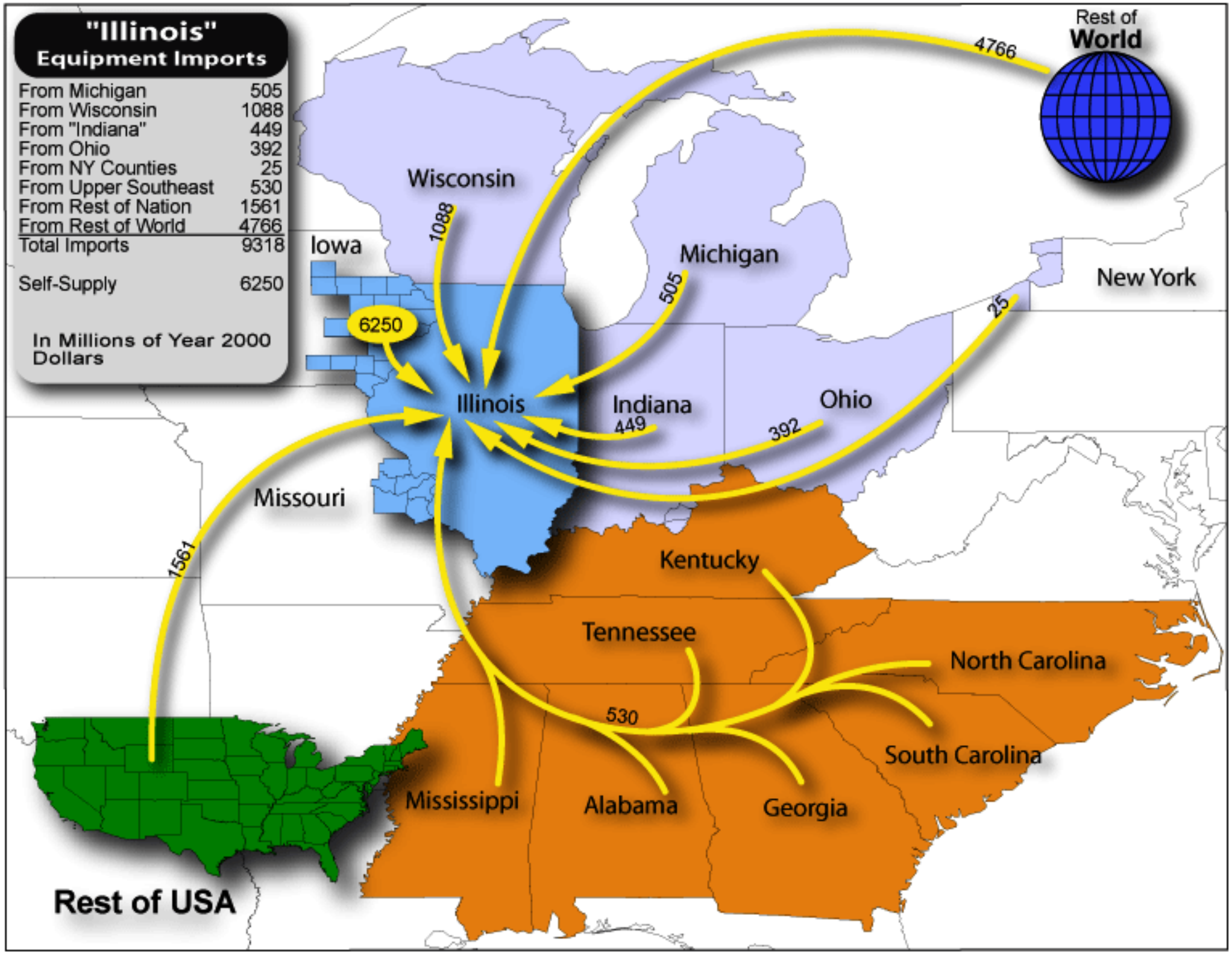
(Source: REMI runs)

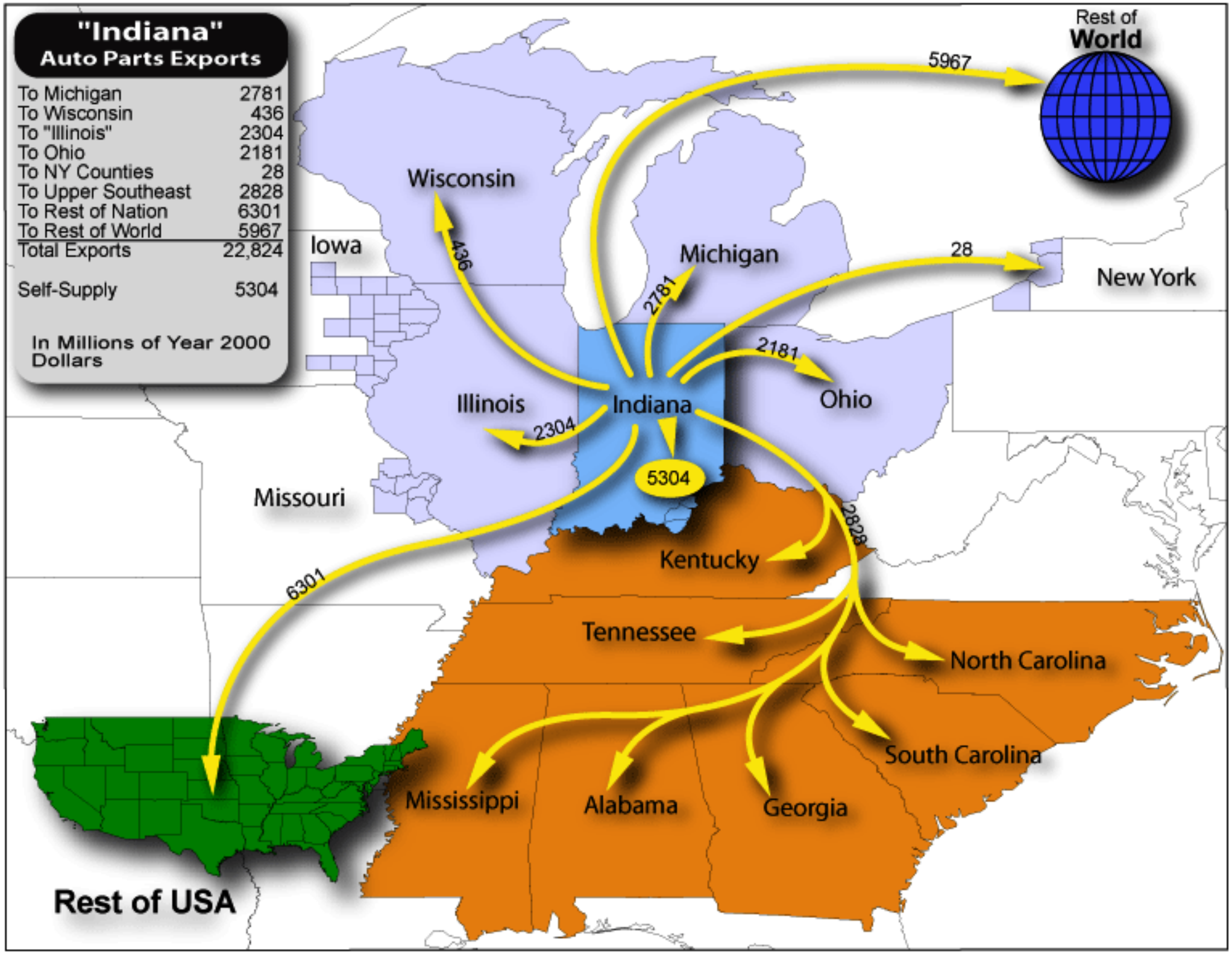


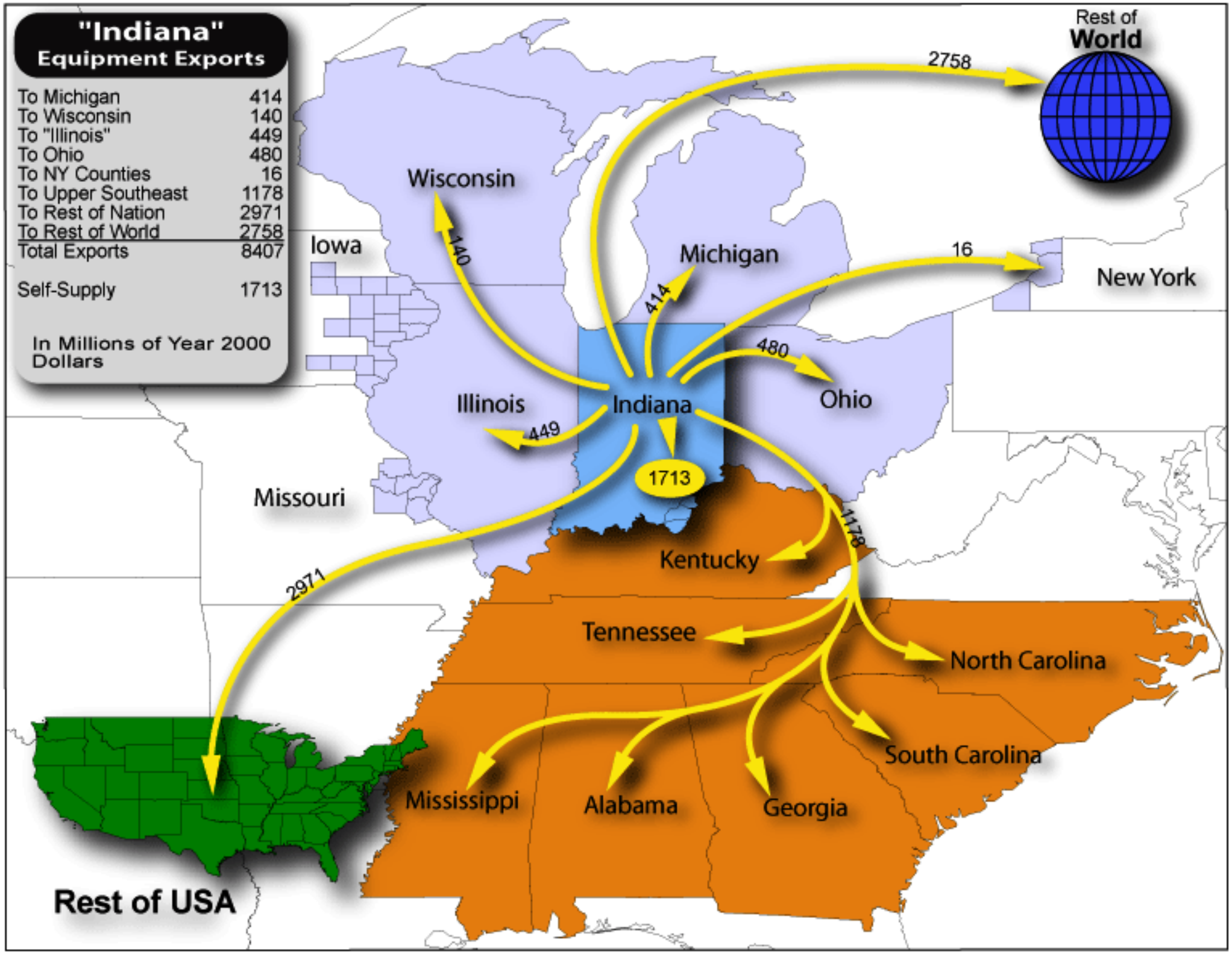
"Illinois"
Auto Parts Exports
To Michigan 550
To Wisconsin 243
To "Indiana" 514
To Ohio 307
To NY Counties 6
To Upper South East 563
To Rest of Nation 1773
To Rest of World 1893
Total Exports 5850
Self-Supply 3072
In Millions of Year 2000 Dollars
Rest of World
1893
Wisconsin
243
Iowa
Michigan
550
New York
6
3072
Illinois
Indiana
514
Ohio
307
1773
Missouri
Kentucky
Tennessee
North Carolina
563
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

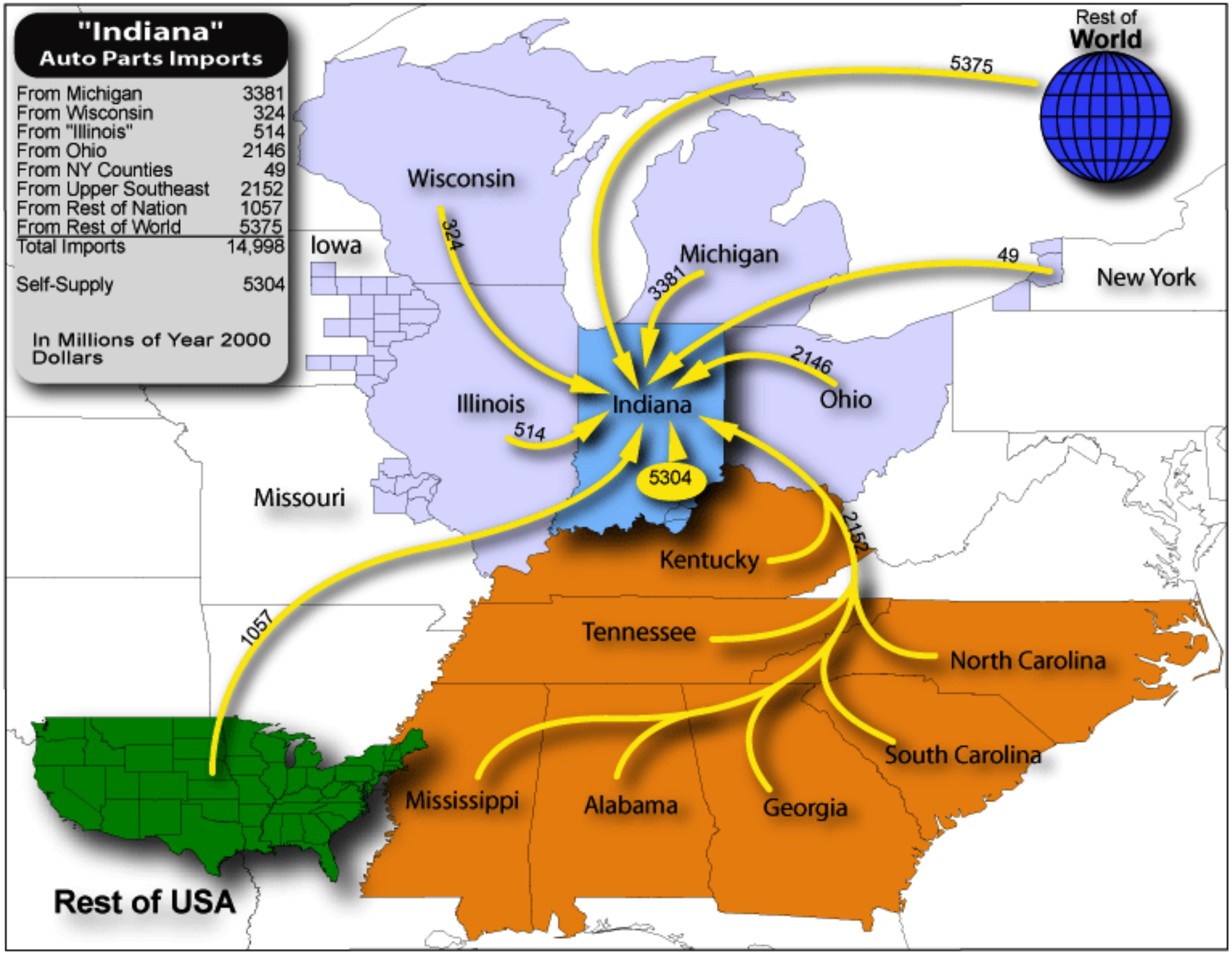

"Illinois"
Equipment Exports
To Michigan 778
To Wisconsin 795
To "Indiana" 952
To Ohio 636
To NY Counties 34
To Upper Southeast 2393
To Rest of Nation 9088
To Rest of World 7752
Total Exports 22,433
Self-Supply 6250
In Millions of Year 2000 Dollars
Rest of World
7752
Wisconsin
795
Iowa
Michigan
778
New York
34
6250
Illinois
Indiana
952
Ohio
636
9088
Missouri
Kentucky
Tennessee
North Carolina
2393
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

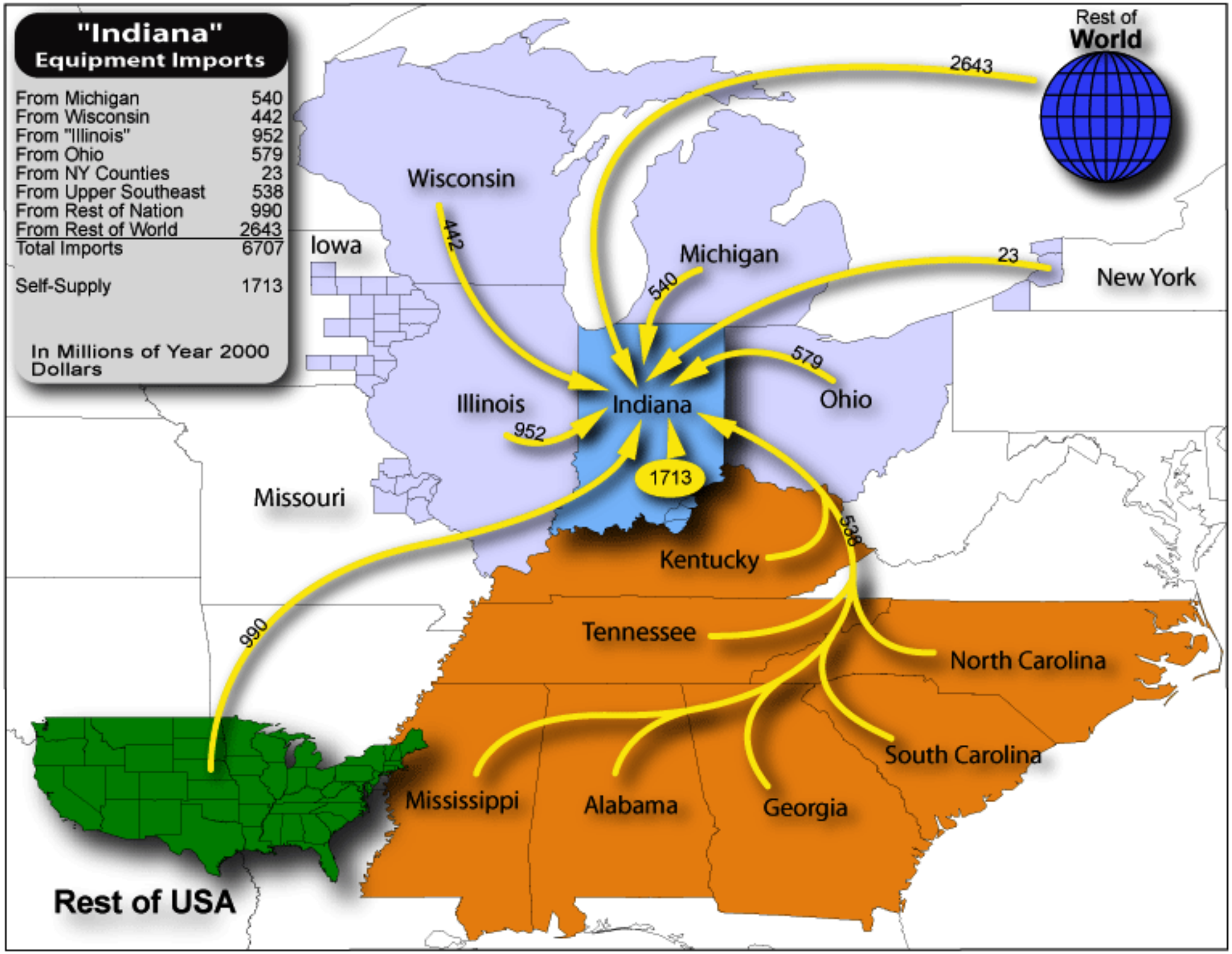

"Illinois"
Auto Parts Imports
From Michigan 3002
From Wisconsin 655
From "Indiana" 2304
From Ohio 1533
From NY Counties 52
From Upper Southeast 1850
From Rest of Nation 1662
From Rest of World 5134
Total Imports 16,192
Self-Supply 3072
In Millions of Year 2000 Dollars
Rest of World
5134
Wisconsin
655
Iowa
3072
Michigan
3002
New York
52
Illinois
Indiana
2304
Ohio
1533
Missouri
1662
Kentucky
Tennessee
North Carolina
1850
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

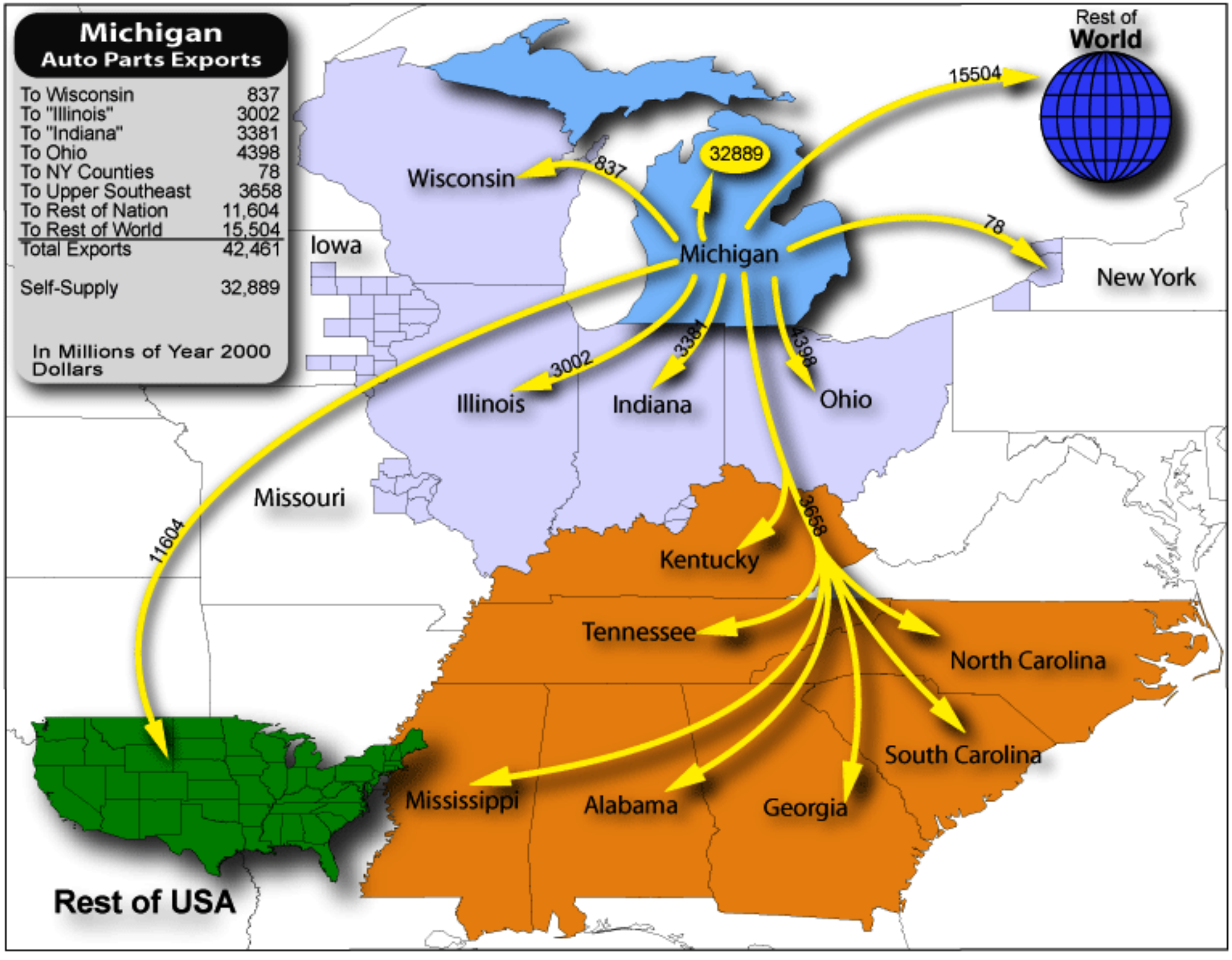

"Illinois"
Equipment Imports
From Michigan 505
From Wisconsin 1088
From "Indiana" 449
From Ohio 392
From NY Counties 25
From Upper Southeast 530
From Rest of Nation 1561
From Rest of World 4766
Total Imports 9318
Self-Supply 6250
In Millions of Year 2000 Dollars
Rest of World
4766
Wisconsin
1088
Iowa
6250
Michigan
505
New York
25
Illinois
Indiana
449
Ohio
392
Missouri
1561
Kentucky
Tennessee
530
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

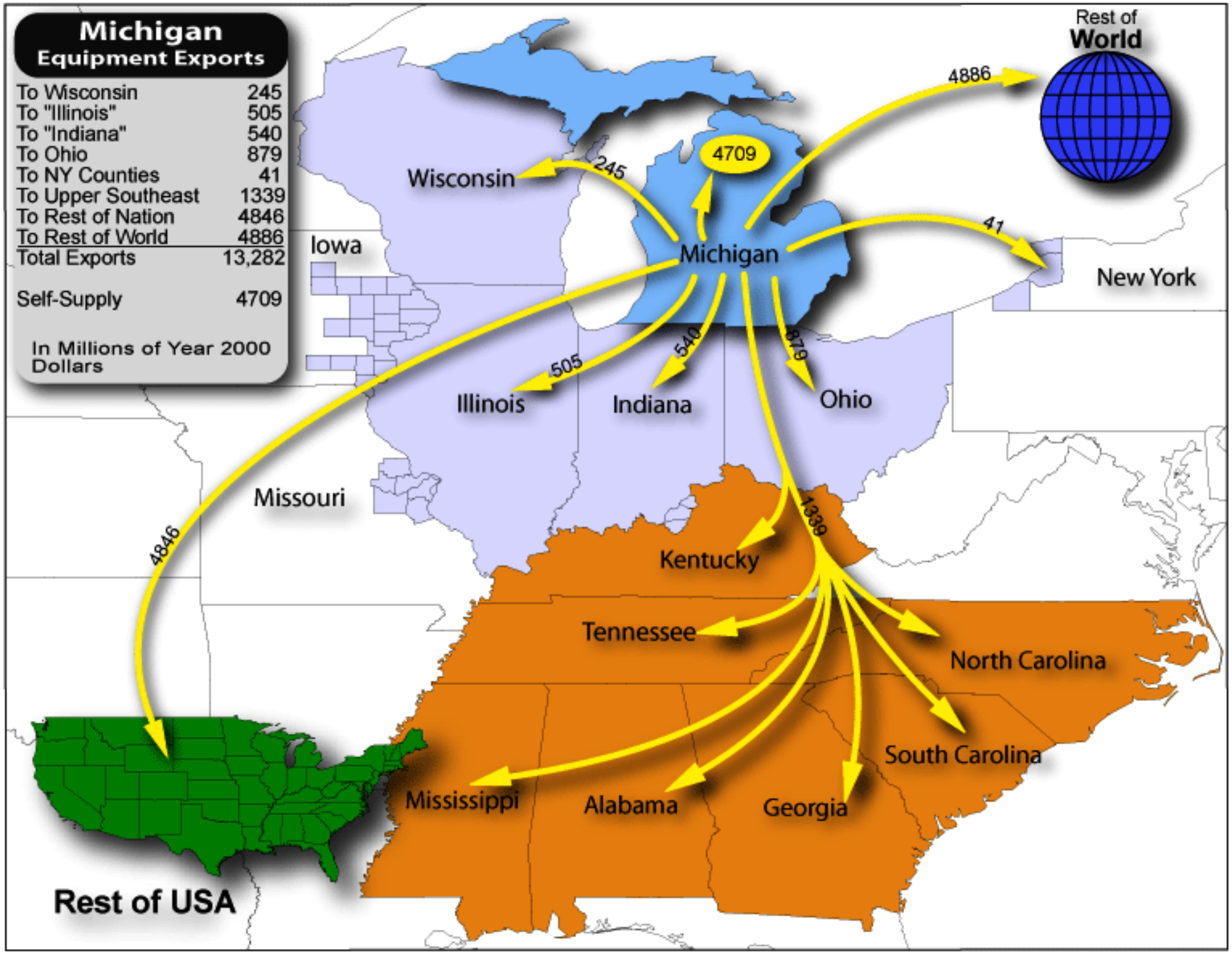

"Indiana"
Auto Parts Exports
To Michigan 2781
To Wisconsin 436
To "Illinois" 2304
To Ohio 2181
To NY Counties 28
To Upper Southeast 2828
To Rest of Nation 6301
To Rest of World 5967
Total Exports 22,824
Self-Supply 5304
In Millions of Year 2000 Dollars
Rest of World
5967
Wisconsin
436
Iowa
Michigan
2781
28
New York
2181
Ohio
Illinois
2304
Indiana
5304
Missouri
2828
Kentucky
6301
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

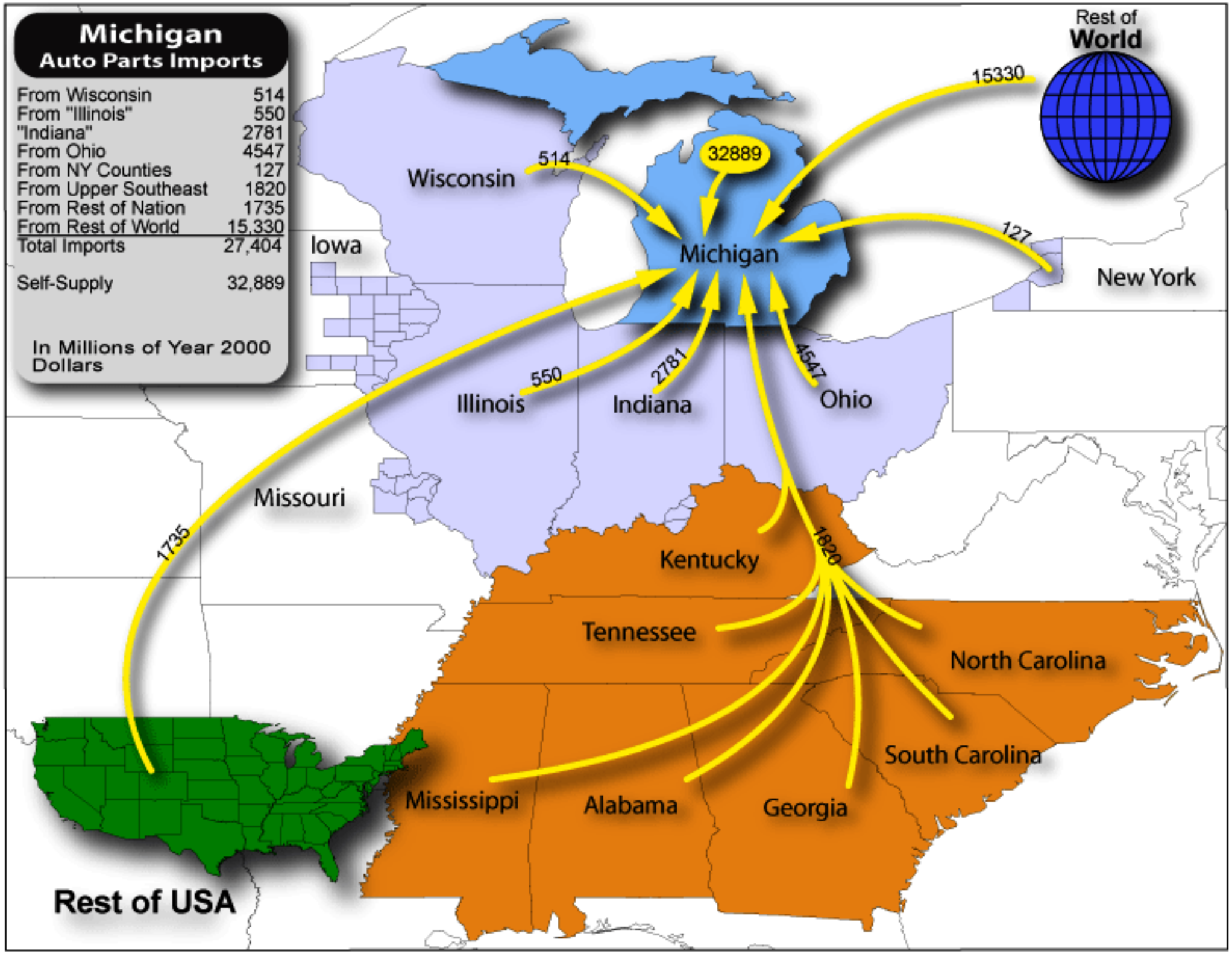

"Indiana"
Equipment Exports
To Michigan 414
To Wisconsin 140
To "Illinois" 449
To Ohio 480
To NY Counties 16
To Upper Southeast 1178
To Rest of Nation 2971
To Rest of World 2758
Total Exports 8407
Self-Supply 1713
In Millions of Year 2000 Dollars
Rest of World
2758
Wisconsin
140
Iowa
Michigan
414
16
New York
480
Ohio
Illinois
449
Indiana
1713
Missouri
1178
Kentucky
2971
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

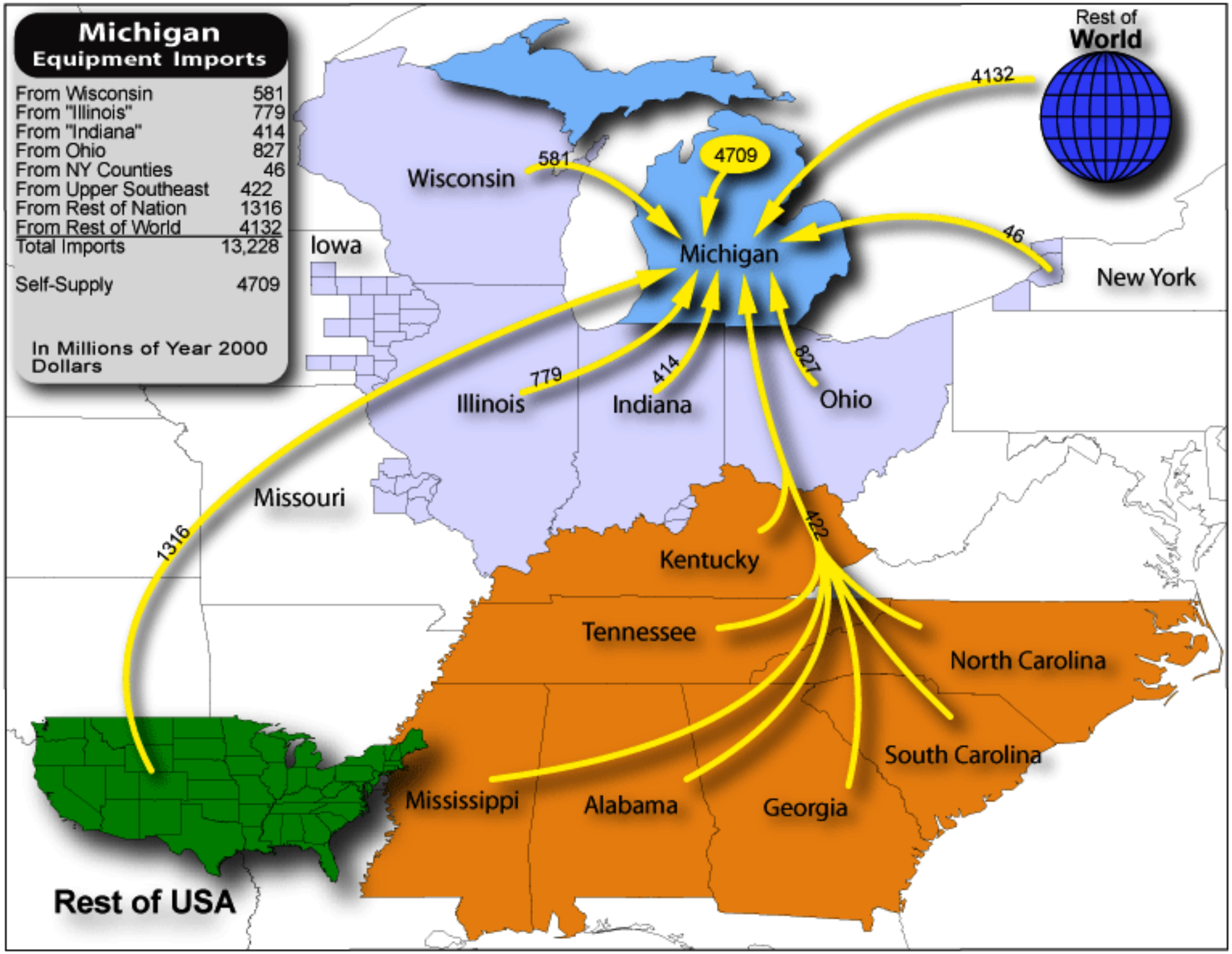

"Indiana"
Auto Parts Imports
From Michigan 3381
From Wisconsin 324
From "Illinois" 514
From Ohio 2146
From NY Counties 49
From Upper Southeast 2152
From Rest of Nation 1057
From Rest of World 5375
Total Imports 14,998
Self-Supply 5304
In Millions of Year 2000 Dollars
Rest of World
5375
Wisconsin
324
Iowa
Michigan
3381
49
New York
2146
Ohio
Illinois
514
Indiana
5304
Missouri
2152
Kentucky
1057
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


"Indiana"
Equipment Imports
From Michigan 540
From Wisconsin 442
From "Illinois" 952
From Ohio 579
From NY Counties 23
From Upper Southeast 538
From Rest of Nation 990
From Rest of World 2643
Total Imports 6707
Self-Supply 1713
In Millions of Year 2000 Dollars
Rest of World
2643
Wisconsin
442
Iowa
Michigan
540
23
New York
579
Ohio
Illinois
952
Indiana
1713
Missouri
538
Kentucky
990
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


Michigan
Auto Parts Exports
To Wisconsin 837
To "Illinois" 3002
To "Indiana" 3381
To Ohio 4398
To NY Counties 78
To Upper Southeast 3658
To Rest of Nation 11,604
To Rest of World 15,504
Total Exports 42,461
Self-Supply 32,889
In Millions of Year 2000 Dollars
Rest of World
15504
32889
837
Wisconsin
Iowa
Michigan
78
New York
3002
3384
4398
Illinois
Indiana
Ohio
Missouri
11604
3658
Kentucky
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


Michigan
Equipment Exports
To Wisconsin 245
To "Illinois" 505
To "Indiana" 540
To Ohio 879
To NY Counties 41
To Upper Southeast 1339
To Rest of Nation 4846
To Rest of World 4886
Total Exports 13,282
Self-Supply 4709
In Millions of Year 2000 Dollars
Rest of World
4886
4709
245
Wisconsin
Iowa
Michigan
41
New York
505
540
879
Illinois
Indiana
Ohio
Missouri
4846
1339
Kentucky
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

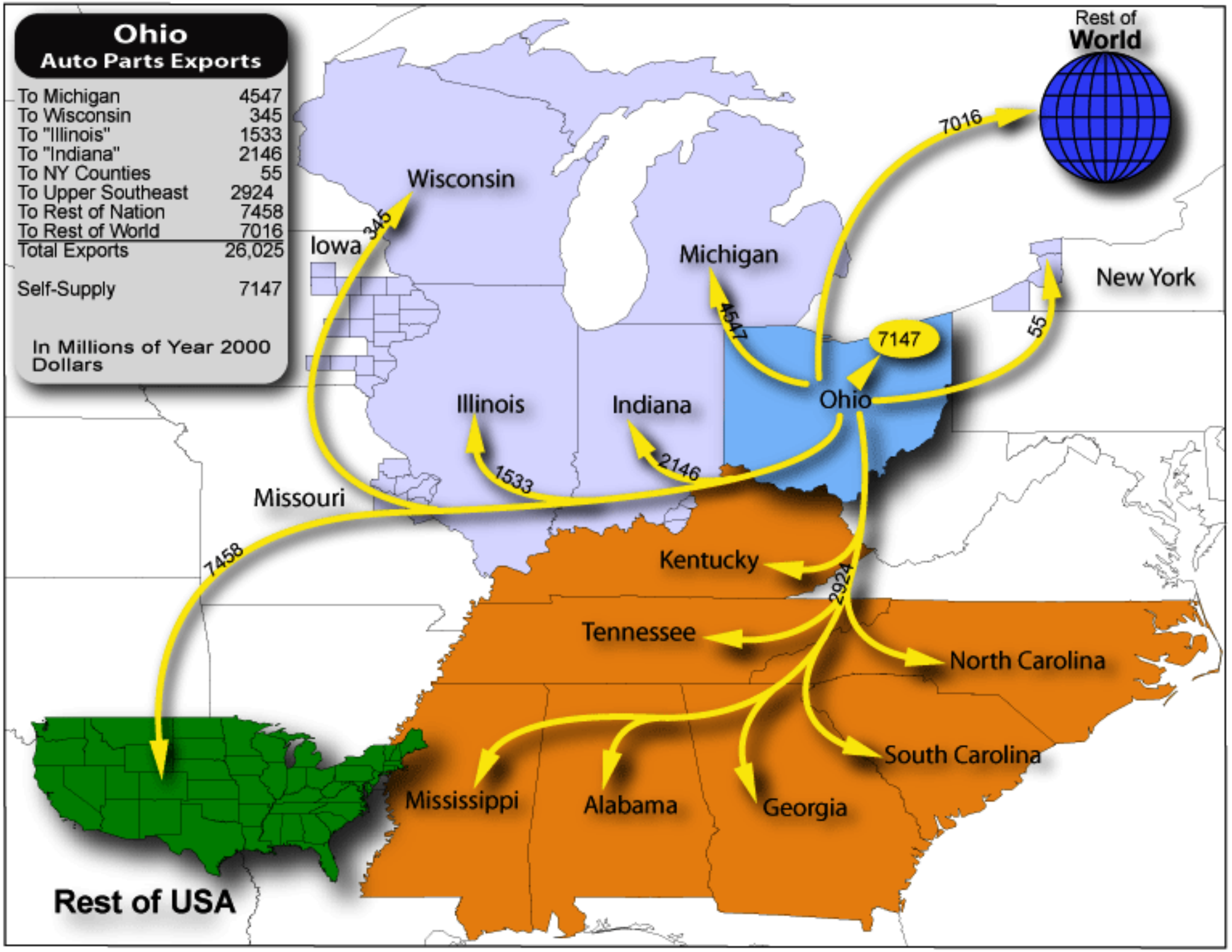

Michigan
Auto Parts Imports
From Wisconsin 514
From "Illinois" 550
"Indiana" 2781
From Ohio 4547
From NY Counties 127
From Upper Southeast 1820
From Rest of Nation 1735
From Rest of World 15,330
Total Imports 27,404
Self-Supply 32,889
In Millions of Year 2000 Dollars
Rest of World
15330
514
Wisconsin
32889
Michigan
127
New York
Iowa
550
Illinois
2781
Indiana
4547
Ohio
Missouri
1735
Kentucky
1820
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

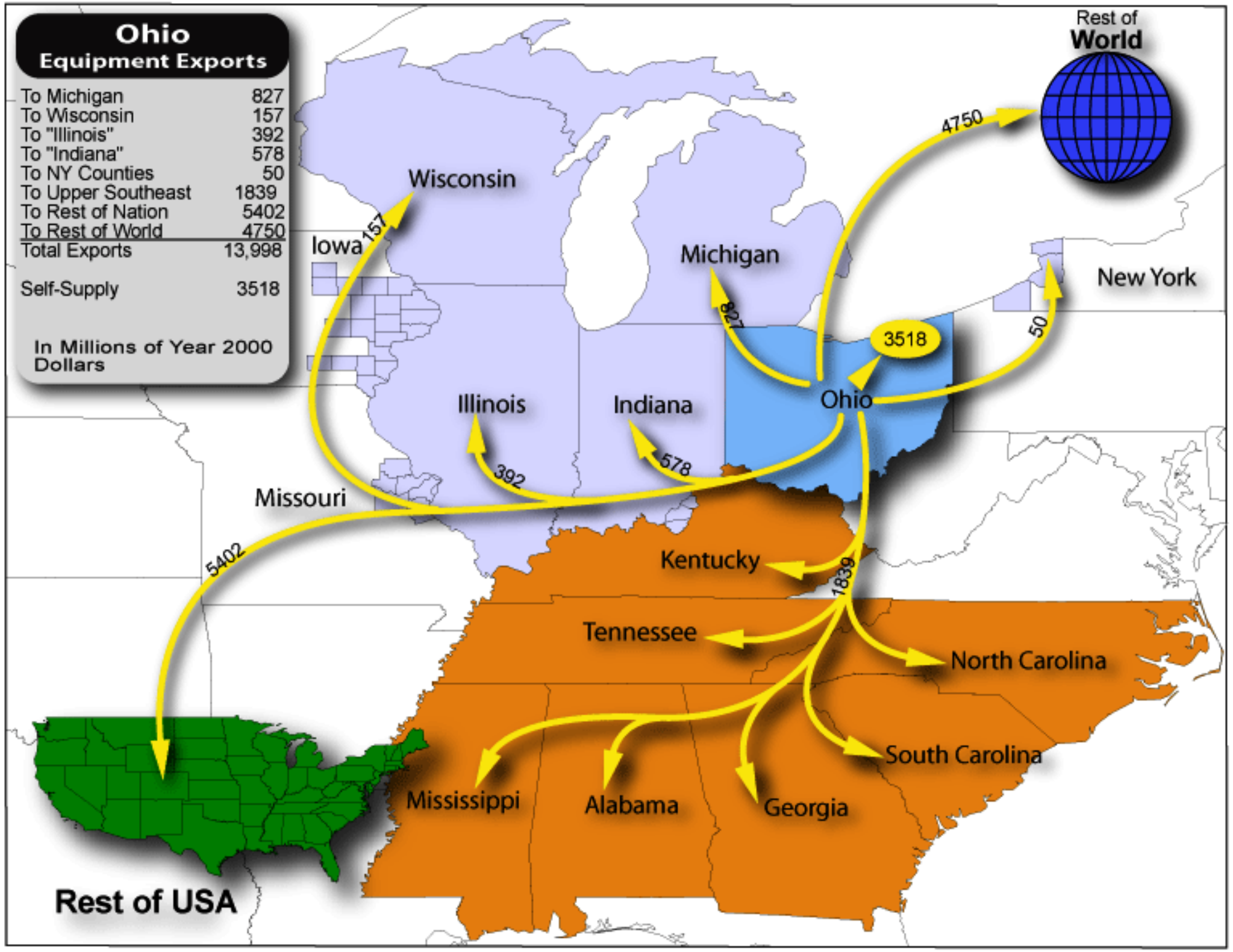

Michigan
Equipment Imports
From Wisconsin 581
From "Illinois" 779
From "Indiana" 414
From Ohio 827
From NY Counties 46
From Upper Southeast 422
From Rest of Nation 1316
From Rest of World 4132
Total Imports 13,228
Self-Supply 4709
In Millions of Year 2000 Dollars
Rest of World
4132
Wisconsin
581
4709
Michigan
46
New York
Iowa
Illinois
779
Indiana
414
Ohio
827
Missouri
1316
422
Kentucky
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

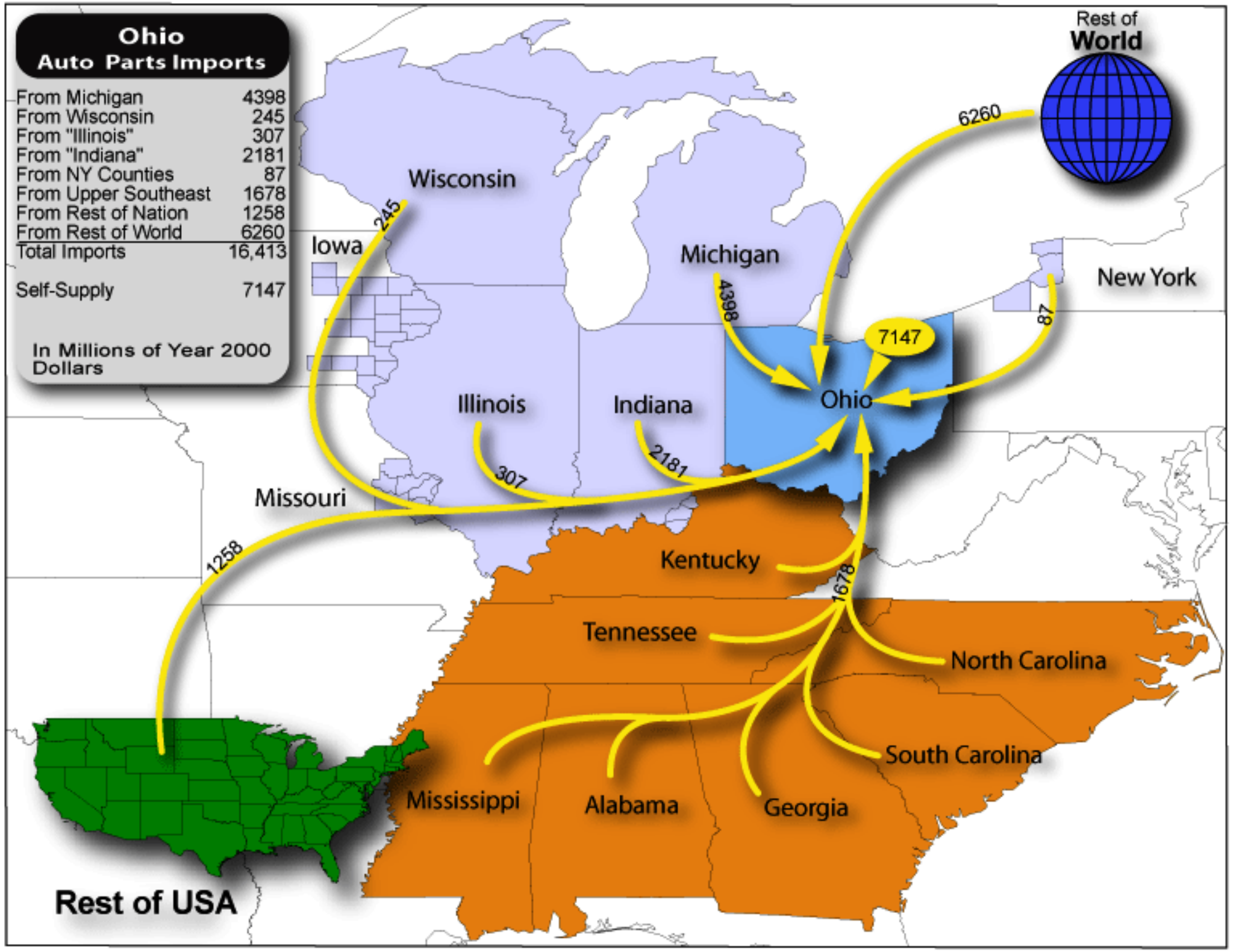
Ohio
Auto Parts Exports

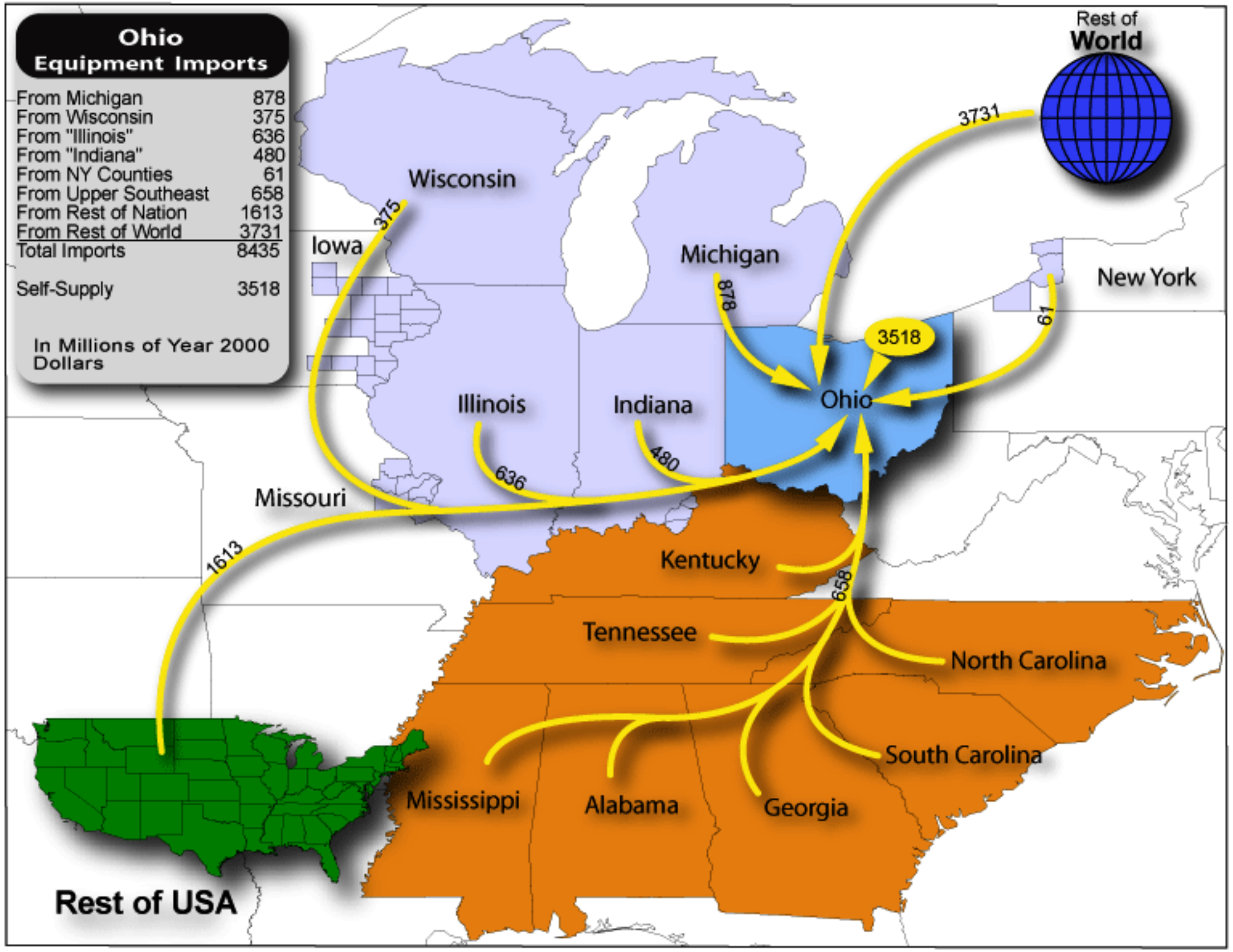
To Michigan	4547
To Wisconsin	345
To "Illinois"	1533
To "Indiana"	2146
To NY Counties	55
To Upper Southeast	2924
To Rest of Nation	7458
To Rest of World	7016
Total Exports	26,025
Self-Supply	7147

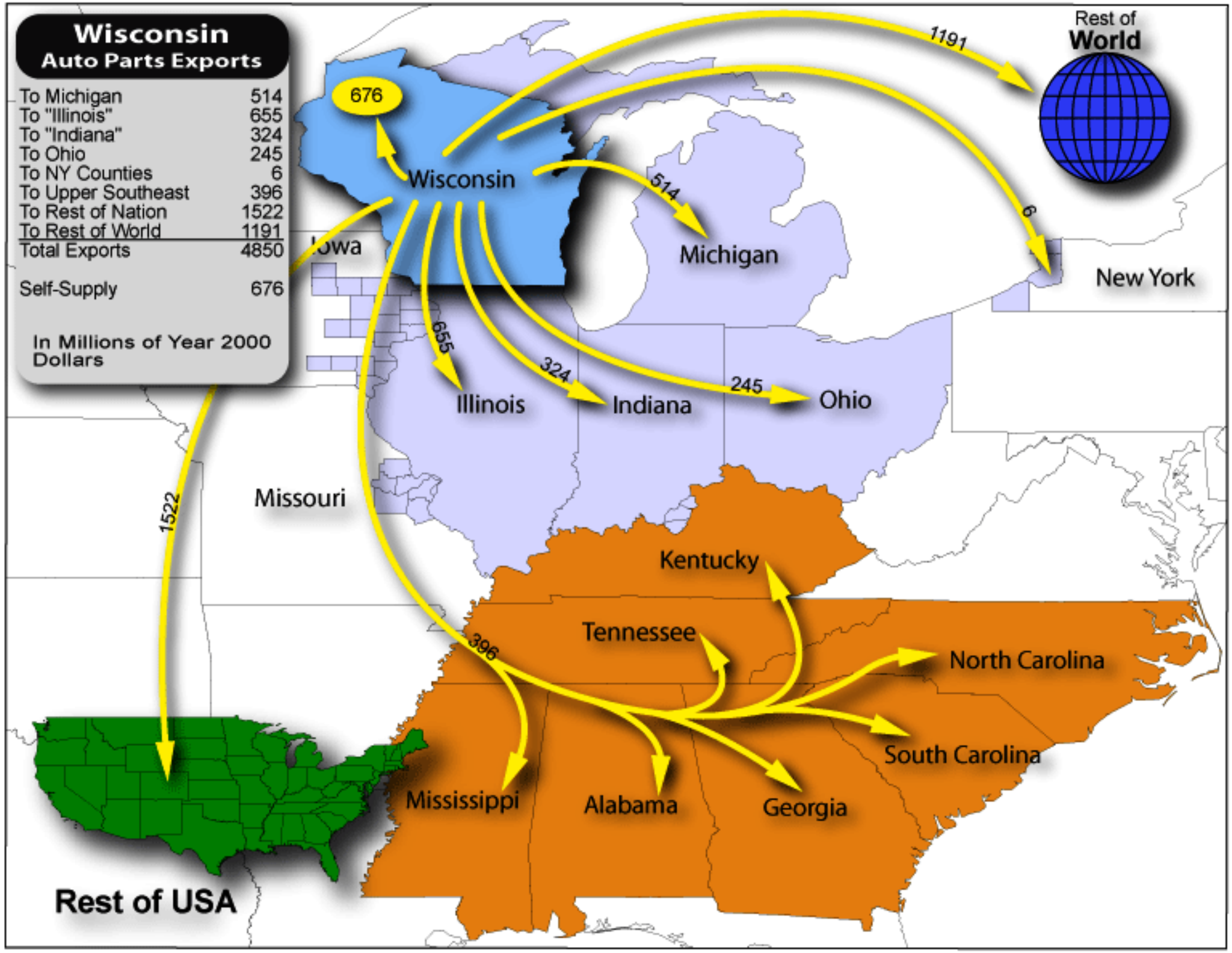
In Millions of Year 2000 Dollars

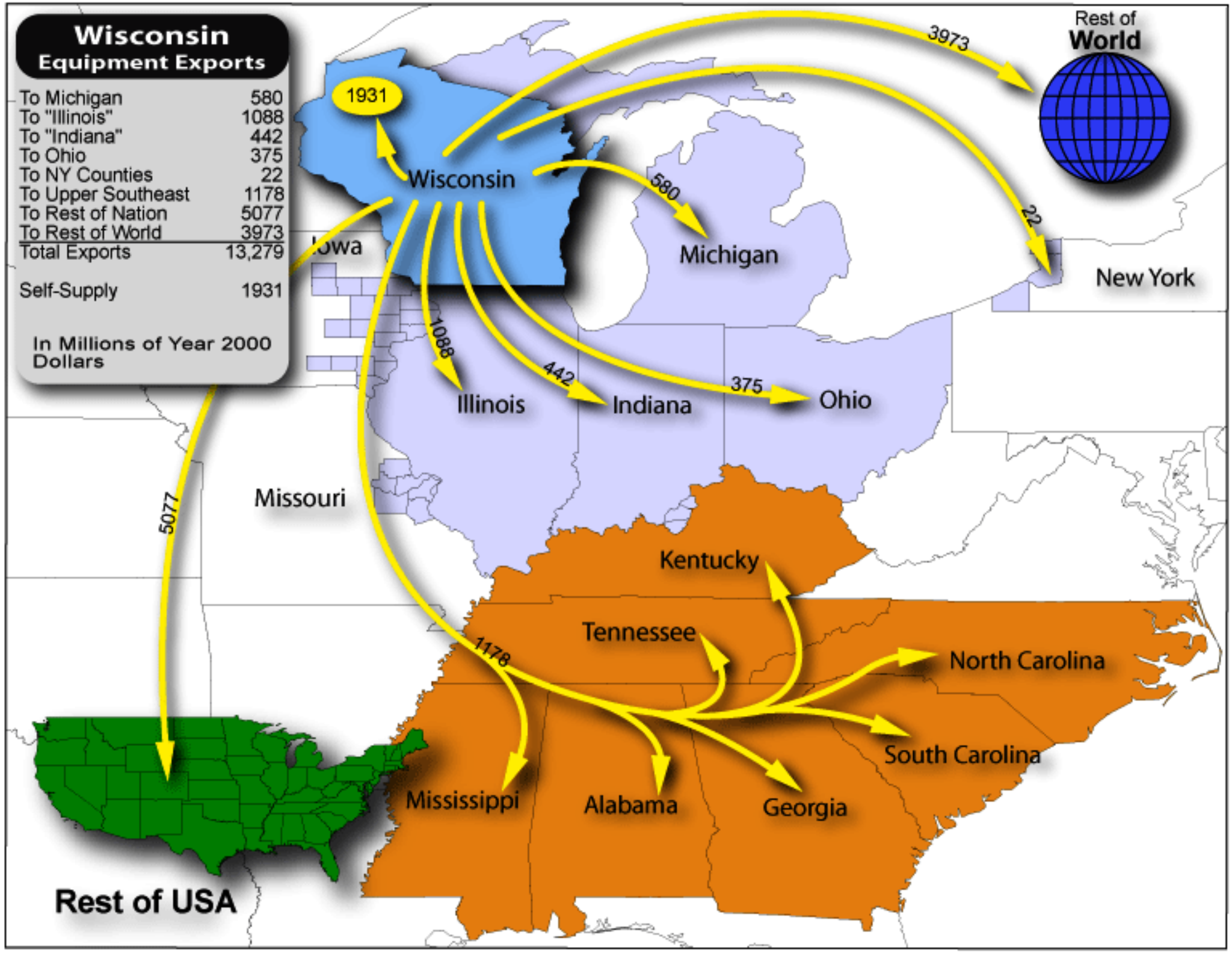


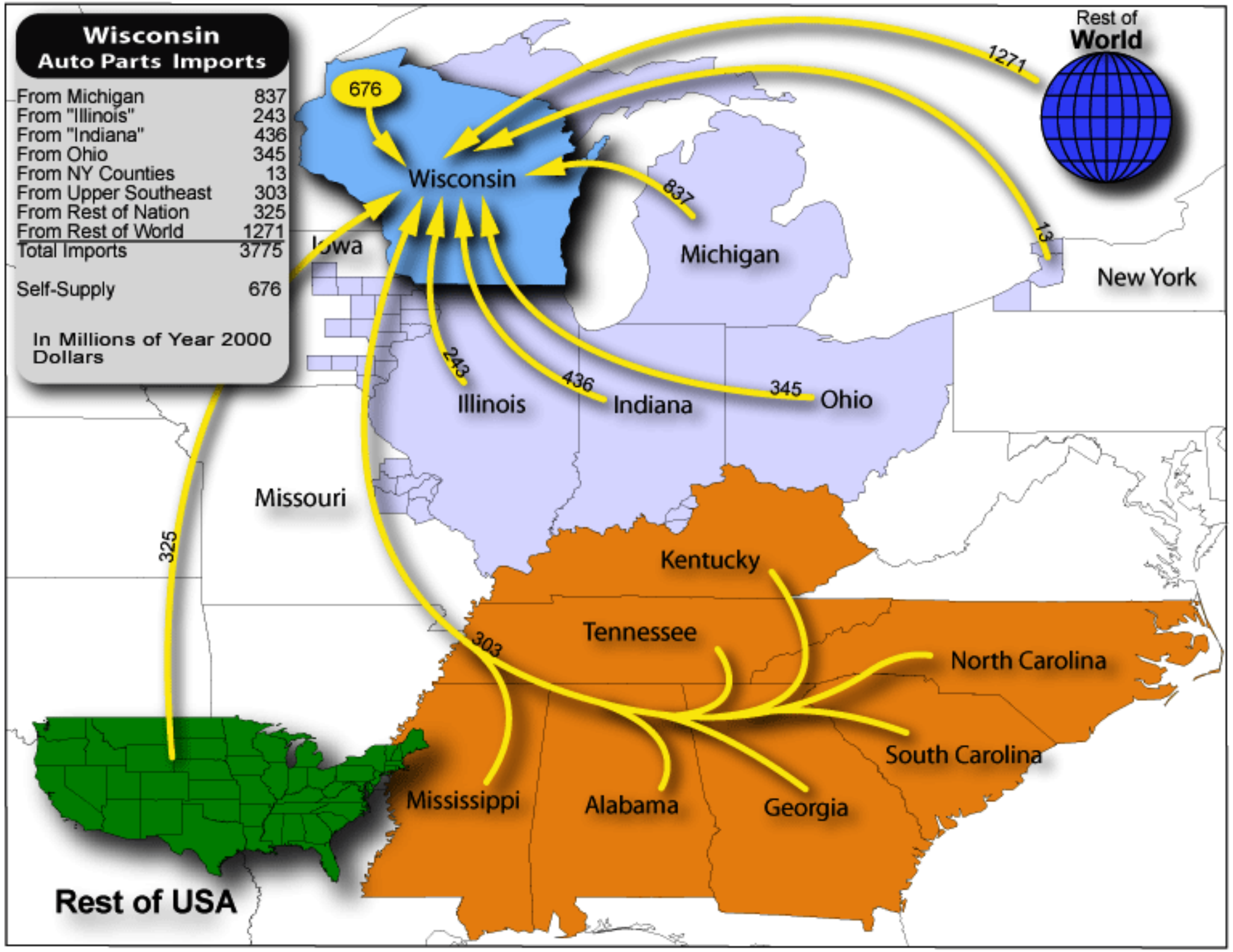

Ohio
Equipment Exports
To Michigan 827
To Wisconsin 157
To "Illinois" 392
To "Indiana" 578
To NY Counties 50
To Upper Southeast 1839
To Rest of Nation 5402
To Rest of World 4750
Total Exports 13,998
Self-Supply 3518
In Millions of Year 2000 Dollars
Rest of World
4750
Wisconsin
157
Iowa
Michigan
827
New York
50
3518
Ohio
Illinois
392
Indiana
578
Missouri
5402
Kentucky
1839
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA

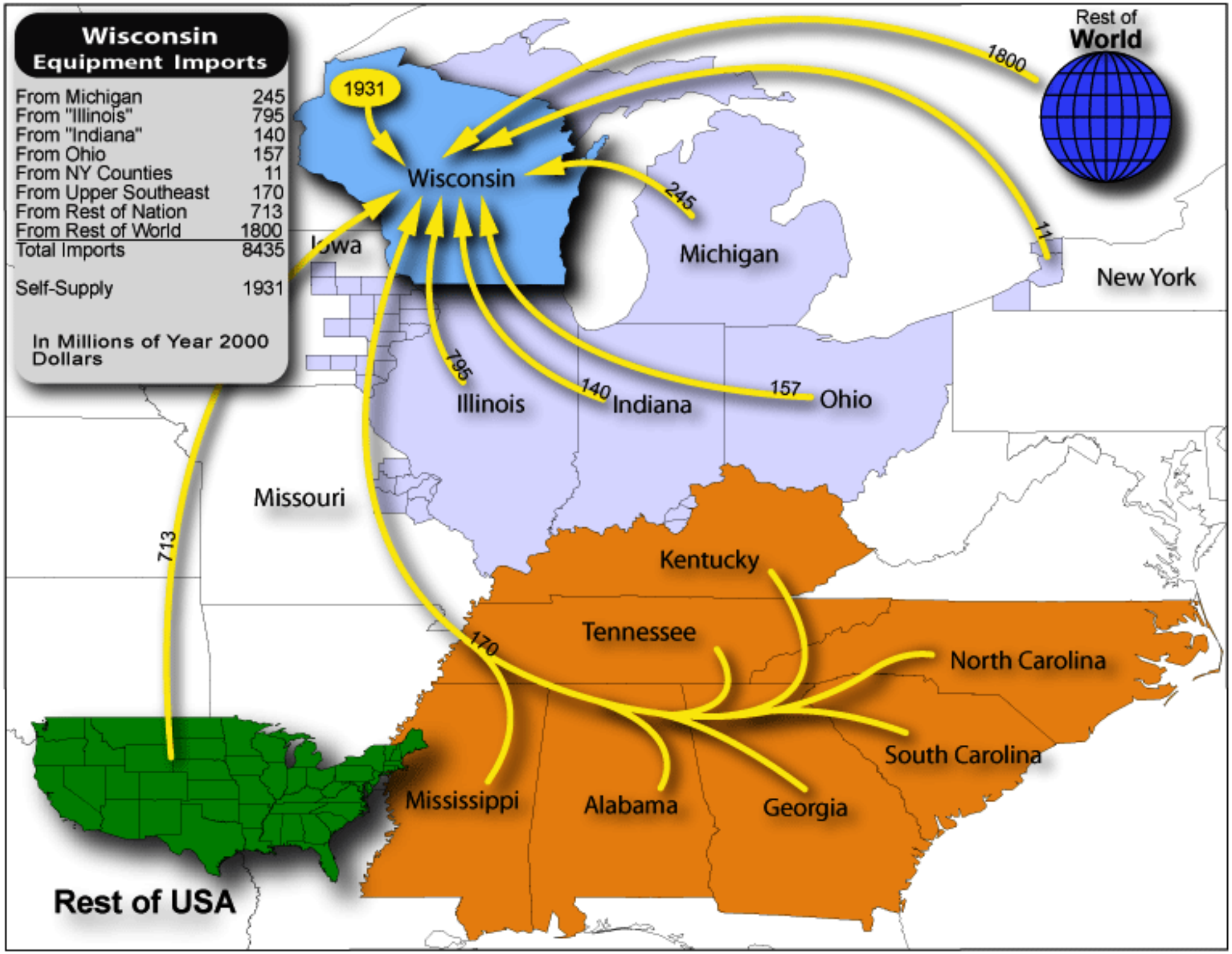

Ohio
Auto Parts Imports
From Michigan 4398
From Wisconsin 245
From "Illinois" 307
From "Indiana" 2181
From NY Counties 87
From Upper Southeast 1678
From Rest of Nation 1258
From Rest of World 6260
Total Imports 16,413
Self-Supply 7147
In Millions of Year 2000 Dollars
Rest of World
6260
Wisconsin
245
Iowa
Michigan
4398
New York
87
7147
Ohio
Illinois
307
Indiana
2181
Missouri
1258
Kentucky
1678
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


Ohio
Equipment Imports
From Michigan 878
From Wisconsin 375
From "Illinois" 636
From "Indiana" 480
From NY Counties 61
From Upper Southeast 658
From Rest of Nation 1613
From Rest of World 3731
Total Imports 8435
Self-Supply 3518
In Millions of Year 2000 Dollars
Rest of World
3731
Wisconsin
375
Iowa
Michigan
878
New York
61
3518
Ohio
Illinois
Indiana
480
636
Missouri
1613
Kentucky
658
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


Wisconsin
Auto Parts Exports
To Michigan 514
To "Illinois" 655
To "Indiana" 324
To Ohio 245
To NY Counties 6
To Upper Southeast 396
To Rest of Nation 1522
To Rest of World 1191
Total Exports 4850
Self-Supply 676
In Millions of Year 2000 Dollars
676
Wisconsin
1191
Rest of World
514
Michigan
6
New York
655
Illinois
324
Indiana
245
Ohio
Missouri
1522
Kentucky
Tennessee
396
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


Wisconsin
Equipment Exports
To Michigan 580
To "Illinois" 1088
To "Indiana" 442
To Ohio 375
To NY Counties 22
To Upper Southeast 1178
To Rest of Nation 5077
To Rest of World 3973
Total Exports 13,279
Self-Supply 1931
In Millions of Year 2000 Dollars
1931
Wisconsin
3973
Rest of World
580
Michigan
22
New York
1088
Illinois
442
Indiana
375
Ohio
Missouri
5077
Kentucky
Tennessee
1178
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


Wisconsin
Auto Parts Imports
From Michigan 837
From "Illinois" 243
From "Indiana" 436
From Ohio 345
From NY Counties 13
From Upper Southeast 303
From Rest of Nation 325
From Rest of World 1271
Total Imports 3775
Self-Supply 676
In Millions of Year 2000 Dollars
676
Wisconsin
Rest of World
1271
837
Michigan
13
New York
Iowa
243
Illinois
436
Indiana
345
Ohio
Missouri
325
Kentucky
303
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA


Wisconsin
Equipment Imports
From Michigan 245
From "Illinois" 795
From "Indiana" 140
From Ohio 157
From NY Counties 11
From Upper Southeast 170
From Rest of Nation 713
From Rest of World 1800
Total Imports 8435
Self-Supply 1931
In Millions of Year 2000 Dollars
Rest of World
1800
1931
Wisconsin
245
Michigan
11
New York
Iowa
795
Illinois
140
Indiana
157
Ohio
Missouri
713
Kentucky
Tennessee
170
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Rest of USA