

PB2001106325



# Cars, Capacity, and Competition in the 21st Century

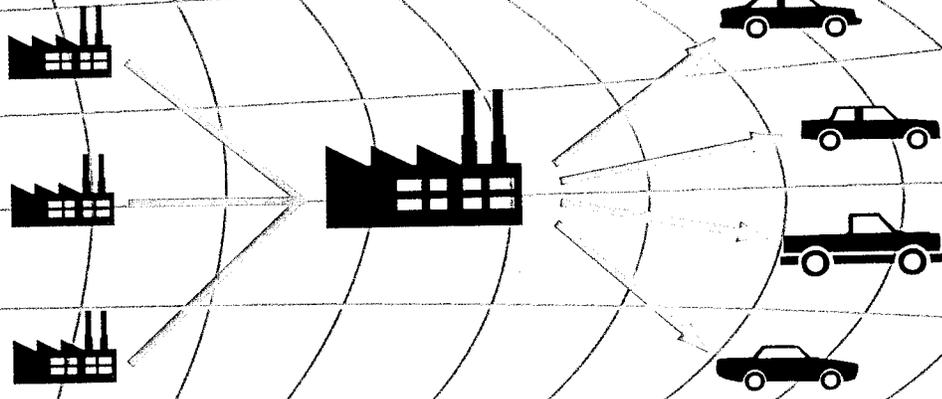
Final Report  
December, 2000

BOSON



**TENNECO**  
Automotive

TRW



OSAT

Michael S. Flynn  
Sean P. McAlinden

Kim Hill

Kara F. Alkire

Morgan H. Edwards

University of Michigan Transportation Research Institute  
Office for the Study of Automotive Transportation  
[www.osat.umich.edu](http://www.osat.umich.edu)

REPRODUCED BY: **NTIS**  
U.S. Department of Commerce  
National Technical Information Service  
Springfield, Virginia 22161

NTTS

# **Cars, Capacity, and Competition in the 21<sup>st</sup> Century**

Michael S. Flynn  
Sean P. McAlinden<sup>1</sup>  
Kim Hill<sup>2</sup>  
Kara F. Alkire  
Morgan H. Edwards

Office for the Study of Transportation  
University of Michigan Transportation Research Institute  
Ann Arbor, MI

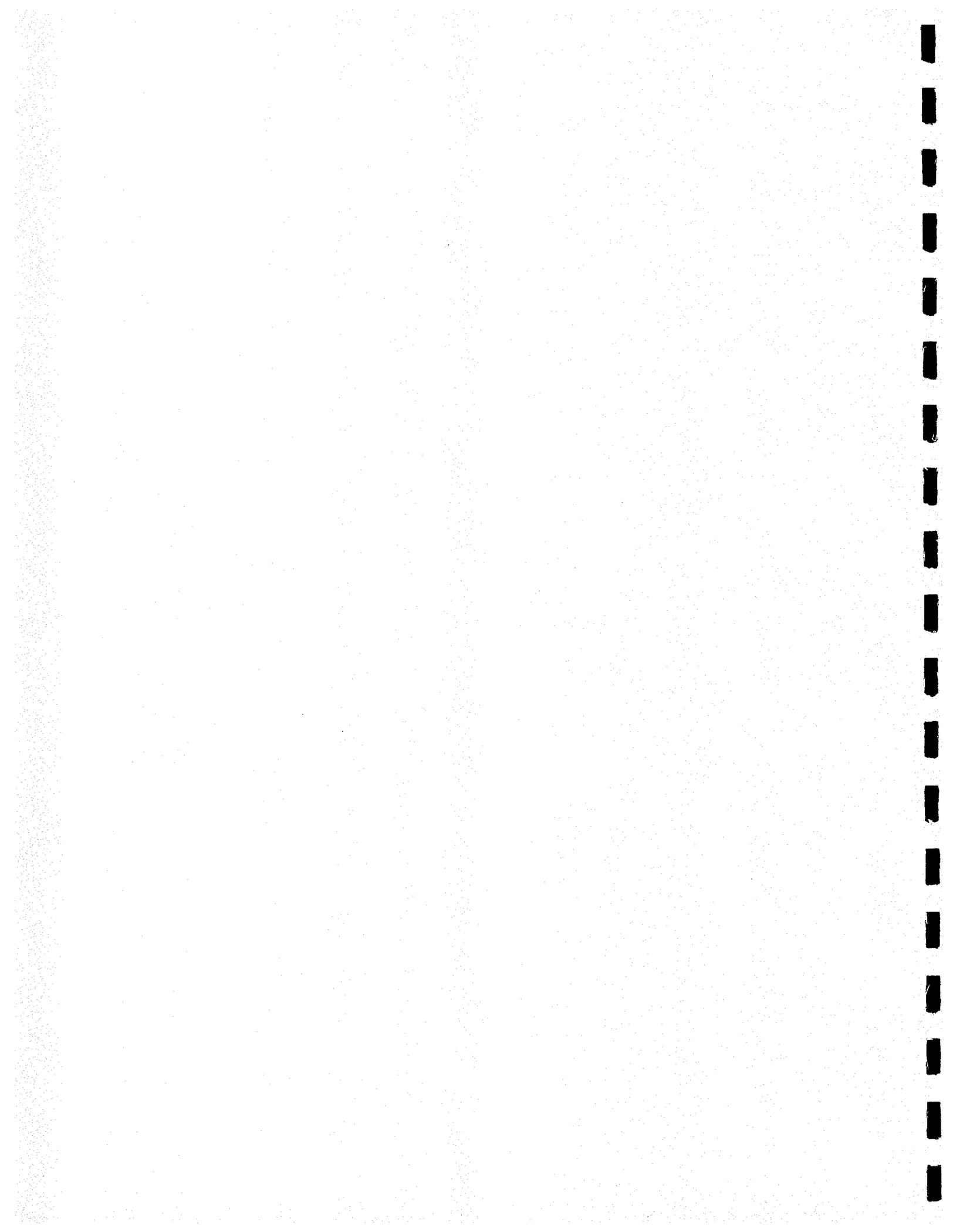
**December, 2000**

**University of Michigan Transportation Research Institute  
Office for the Study of Automotive Transportation  
UMTRI 99-43**

---

<sup>1</sup> Currently at the Center for Automotive Research, ERIM, Ann Arbor, MI.

<sup>2</sup> Currently at CFI Group, Ann Arbor, MI.



# TABLE OF CONTENTS

Acknowledgements	i
Executive Summary	1
Introduction	2
Globalization	2
Analytic Models	5
Results	9
Conclusion	26
Implications	27
Appendix 1	29
Appendix 2	30
Appendix 3	34



### **Acknowledgements**

OSAT has undertaken a review and examination of some of the key sourcing and production issues raised by the industry's rapid globalization, seeking to identify and quantify some initial parameters of these challenges. This effort was prompted by a presentation at our 1997 Management Briefing Seminar by Peter Hellman, the president of TRW Automotive. Robert Bosch and Tenneco joined TRW in sponsoring the project, providing financial and substantive support for our efforts. We gratefully acknowledge the unflagging, cheerful, and valuable advice and help of Messrs. Mark Davison (Bosch); Philip Dur and Richard Harris (Tenneco); and John Keogh (TRW).

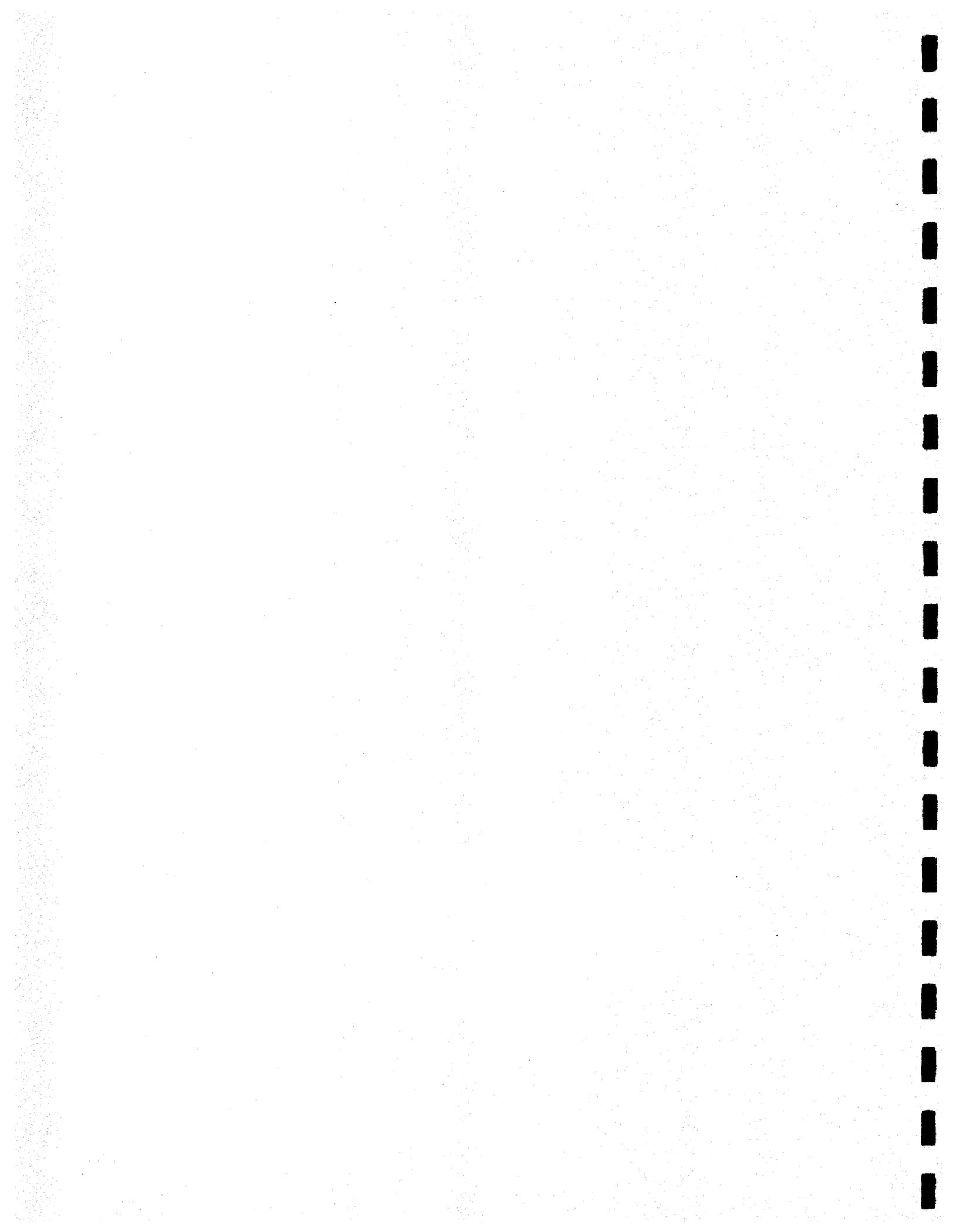
W. Van Bussmann of DaimlerChrysler, John Cope of Honda, Ronald Knox of General Motors, and Guido Scampa of Volkswagen all served on the project's Advisory Board. They provided thoughtful, well-considered reviews and discussion, and willingly gave us more time and support than we had initially expected.

Of course, the authors accept full responsibility for any remaining errors of fact, analysis, or interpretation.

**PROTECTED UNDER INTERNATIONAL COPYRIGHT  
ALL RIGHTS RESERVED  
NATIONAL TECHNICAL INFORMATION SERVICE  
U.S. DEPARTMENT OF COMMERCE**

Reproduced from  
best available copy.





## **Cars, Capacity, and Competition in the 21<sup>st</sup> Century**

### **Executive Summary**

The end of the 20<sup>th</sup> century finds the automotive industry undergoing massive expansion as its markets and production bases become truly global. Globalization raises significant risks for, and important strategic challenges to, companies throughout the entire industry value chain. The vehicle manufacturers drive much of the industry's globalization effort, as they target markets to pursue and develop strategies for providing vehicles through imports and local production. Local vehicle production strategies require decisions to import some parts and components and to source others locally, a strategy that often entails asking offshore suppliers to establish local facilities.

Globalization challenges are particularly complex for automotive suppliers because their processes and economic situations often differ from the vehicle assemblers, as well as from one supplier to another. Suppliers' volume requirements cover a wide range, and are frequently higher than the scale for effective assembly activity. Moreover, suppliers find production sites differentially attractive because their ratios of capital and labor costs can vary widely.

This report reviews the effects of differing constraints on sourcing/production decisions for a simulated car in a model world. Our car consists of three components, and competes in a world of seven countries. The components cover a wide range of capital investment, scale requirements, transportation costs, and tariff levels. The countries represent different size markets, growth potential, and access to regional markets.

We modeled the comparative costs of building a new plant in each of six countries relative to two different base cases: the United States and Poland. Our modeling scenarios examine the effects of market growth, regional access, and plant scale. We examine these scenarios at the level of the individual component in each country, all three components within each country, and all three components across the seven-country world. Finally, we model the costs of building and supplying within the United States and Poland relative to the costs of building and supplying within the other seven countries.

For suppliers, sourcing production from existing capacity in the United States is almost always less expensive than the local build option. However, the cost penalty associated with the build option varies substantially, both across components and across countries. Moreover, the size of the penalty is quite sensitive to the volumes available to the local plant. Additionally, supplier distance is important for transportation costs, as well as reliable just-in-time delivery requirements. A "build-everything-everywhere" strategy imposes a significant cost penalty relative to a strategy that relies upon component- and country-specific sourcing/local production optima. Finally, the costs of building and delivering locally vary, and a one-world price for supplier goods cannot be set at the minimum.

## **Introduction**

The North American industry today is substantially different from what it was just a few years ago, with the expanding operations of Japanese and German manufacturers, as well as suppliers from numerous nations, giving it a distinctly global cast. Moreover, the traditional industry is itself becoming more global, as long-established multinational companies strive to restructure themselves into better coordinated and truly global operations, while others take their first steps offshore toward a global future.

Prospects for growth within the more mature automotive economies are quite limited. Competition within the industry has also increased, as both the marketplace and production base for motor vehicles have become more crowded, and more companies compete for shares of a slow-growth business. For manufacturers, it is more difficult to differentiate products from those of other assemblers, to achieve traditional scale economies, and to capture high customer loyalty. For suppliers, it is more difficult to balance customer portfolios across specific markets, vehicle segments, and product opportunities. This situation requires both manufacturers and suppliers to look to new markets around the globe.

## **Globalization**

If established markets are slow-growth, becoming more crowded, and increasingly competitive, both manufacturers and suppliers will turn elsewhere, seeking the higher levels of production that permit them to capture scale economies and profit opportunities. And, indeed, that is exactly what has developed over the past decade, as manufacturers and their suppliers enter and expand across a range of more recently targeted, higher-growth automotive markets.

These fresher markets typically have a relatively low density of motor vehicles and a large population base; economies and personal income levels experiencing rapid growth; and a developing automotive infrastructure, including retail distribution and service support networks, roadway systems, and, often, some vehicle and parts production. Expanding into these markets offers not only the potential of capturing share in a growing market, but it also provides some insurance against the fluctuations of established markets, and permits balancing activities across regions. A critical question for companies is whether to participate through imports, minimal manufacturing or assembly, or full-scale production.

The combined resources required to support expansion efforts globally and to improve competitive performance in traditional markets are daunting, and, for most companies, demand record investment levels. For some companies, major decisions are becoming a common experience, as country after country becomes a target for automotive expansion, and resources must be deployed carefully and for maximum effectiveness.

The continuing importance of scale economies in the automotive industry is suggested by the efforts of manufacturers to impose some level of design and production commonality

across their global products. Manufacturers are developing common, shared platforms (the chassis and underbody components) that can be economically adapted to meet variations in customer requirements and preferences. They also seek to increase sharing of components and subsystems throughout the vehicle, as well as across different models. Suppliers pursue scale economies as well, including efforts to persuade their different assembler customers to purchase identical components in those areas that are invisible to the customer.

An automotive manufacturer's ideal world would see common user requirements permitting the design and development of one vehicle, and the world's economic and policy environment supporting one assembly plant for worldwide distribution and consumption. However, the automotive market, the general economy, and policy dynamics will almost certainly prevent the development of this one-car, one-plant world.

The automotive industry is an attractive source of economic development and job generation, and many governments are determined to ensure that their nations share and participate in the benefits from producing as well as from using motor vehicles. Nations use a variety of trade policies, rules, and regulations to capture automotive assembly plants and, in rarer instances, supplier plants as well. Conversely, tariffs, quotas, administrative actions, and required levels of domestic content are used to set numerical ceilings on the number of imported vehicles permitted to enter a country. This often make it necessary to use locally produced supplier parts, components, and even subsystems, without regard to their price and quality. Various financial incentives, investment credits, and exemptions from taxes and other requirements effectively subsidize and encourage local capital investment.

These government actions often distort the economic efficiency of the manufacturers' worldwide network of assembly plants, preventing them from siting plants where such plants would optimize the physical location and logistical requirements for supporting supplier factories and markets. Sometimes, primarily through domestic content restrictions, countries effectively require the siting of supplier plants in addition to assembly plants. And sometimes the manufacturers themselves require supporting supplier plants to locate where they site assembly plants. One of the problems that face suppliers is the substantially smaller level of resources they have for global investment compared with the manufacturers. Additionally, government grants that can subsidize investments and offset cost penalties are almost always granted to assemblers, and rarely to suppliers, even when the supplier's presence is an important share of the assembler's value to the host country.

Once the fundamentals suggest an emerging market is at or near a take-off point—a decision often made with surprising unanimity among the manufacturers—assemblers begin to enter. Whether their strategy is “first-in” or a “fast-follower,” suppliers that follow their customers to these markets are likely to be dependent on the success of those customers. But customer success may still yield production volumes insufficient to justify the suppliers' own investments and business risks. In some cases, even if the

supplier were to capture one hundred percent of the market, this would still not represent enough demand to offset the investment cost.

A manufacturer's insistence that suppliers accompany it to new production sites appears to result from three concerns. First, manufacturers are trying to develop a truly worldwide supply base, at least among key suppliers, and prefer that such suppliers serve them wherever they have built assembly plants. Second, all the global manufacturers have now adopted major elements of just-in-time production, a manufacturing philosophy that calls for manufacturing efficiency and quality supported by low levels of inventory, emphasizing the importance of supplier proximity. Third, manufacturers are concerned about possible supply line interruption as those lines multiply, complicate, and lengthen. Of course, proximate supplier plants often simply move these risks to a different point in the supply and logistics system, as supplier-to-supplier logistics problems can ripple up through the supply chain.

There is a fundamental and important question facing the industry as it globalizes and responds to the demands of markets and national production bases around the world: What is the most cost-effective way to supply the components demanded by the growing number of assembly plants worldwide? Given the rapid rate of industry expansion and the high investment it demands, this is a critical question. Moreover, this question must be answered at a system level, covering the entire automotive production chain, lest the optimum for one company or operation prove to be suboptimal for the entire system.

There are four basic reasons why this challenge of cost-effective globalization is so critical, and why the way the industry and its participants respond to it will have profound effects on the automotive future:

- First, the cost of producing and delivering a motor vehicle, relative to the average household income, is a critical determinant of the rate of expansion of the new and emerging markets. If costs exceed an optimal minimum, then market growth will slow, unless manufacturers choose to temporarily surrender profits or absorb losses until their operations become cost-efficient in that market.

- Second, developing duplicate industry production operations across numerous markets in a region risks seriously exceeding optimal worldwide capacity, resulting in a number of adverse capacity consequences. New, excess plants will run at less-than-optimal, efficient capacity, raising their own unit costs and, thus, the cost of vehicles. Moreover, they will almost surely prevent already-established plants from gaining production volumes, thus decreasing the efficiency of those already existing plants.

- Third, the business needs and operational situations of suppliers differ substantially from the manufacturers' assembly operations, and they also differ widely from one supplier to another. In particular, the composition of supplier production-related costs for capital equipment, materials, labor, and

transportation varies, and that means an attractive production site for a manufacturer or a particular supplier may be unattractive to another supplier. Thus, one decision model or rule for all supplier companies would be suboptimal.

- Fourth, the costs and risks of investments required for products in various markets vary widely. If these differences are ignored, companies may be put at serious risk, and the cumulative consequences of suboptimal system decisions across different markets are potentially extremely damaging to the entire supply chain. Consequently, it would also be suboptimal to use one decision model or rule for all markets.

### **Analytic Models**

In order to evaluate the supplier build or import decision, we consider a sample of components, markets, and possible plant sites that provide a range of comparative estimates. We analyze the costs associated with producing and supplying three different components, based on size, weight, and complexity, in seven countries representing the main regions of the world. We extrapolate these to evaluate the range of build and sourcing options available for supplying this “car” throughout its “world.” The three components are fuel injectors, steering systems, and exhaust systems. (See Appendix 1) We chose these components because they vary widely in terms of required plant investment, labor content, tariff treatment, and transportation costs, providing a nice range of industry requirements. Our comparative estimates capture most of the cost factors and other considerations for supplying components, and we are confident the results hold reasonably well for many components supplied in most countries worldwide.

We modeled three factors for these components, one reflecting capacity and two reflecting demand dimensions. First, we modeled two levels of plant scale or volume. Since most countries in the real world, and indeed many in our model world, have markets that would be oversupplied by the establishment of a full-scale production plant, we determined whether a reduced-scale plant would be a feasible alternative. Such a smaller scale plant might represent the more realistic possible alternative when determining whether to build or import. Second, we examined the effects of local market growth, projecting market sizes for 2002 based on growth through 1997. In most instances these projections are for quite aggressive growth. Third, we have also examined how optimal build/sourcing mixes would change if that seven-country world actually contained three regional trade associations, providing access to a larger potential market for some regional plants.

We collected sales, production, import, and export data for 38 selected countries spanning six continents for our analysis of country, regional, and global trends. These countries include developed and developing economies, and vehicle markets of varying sizes. From this set of 38 countries we selected seven countries to serve as a model automotive world for the evaluation of the build/sourcing decisions throughout the report.

These countries are Argentina, Germany, India, Mexico, the Philippines, Poland, and the United States. (See Appendix 2)

This model world has representatives from each major manufacturing region—North America, South America, Western Europe, Eastern Europe, Southeast Asia, and Asia. Four of these countries also represent major regional trade associations—the North American Free Trade Association (NAFTA), the Common Market of the South or Mercado Comun del Sur (MERCOSUR), the European Union (EU), and the Association of Southeast Asian Nations (ASEAN).

The seven countries do not represent our projection of today's—or tomorrow's—"hot" markets in automotive manufacturing and sales. Rather, the selection represents an attempt to identify countries where market interest is developing or automotive manufacturing investments are occurring, as well as a few markets where interest and investment have been more stable or predictable.

Two separate sets of analyses are undertaken. One set of analyses uses an existing U.S. plant as a base comparison, and the other set uses an existing Polish plant as the comparative base. This allows us to examine how our findings would be altered by the inclusion of a very large market in the model world.

The model world includes both established and emerging economies, and the vehicle sales of its constituent countries are displayed in figure 1 below. The United States and Germany, the largest and third-largest markets in the world, are excluded from figure 1 because their size compresses and obscures the data from the other five countries.

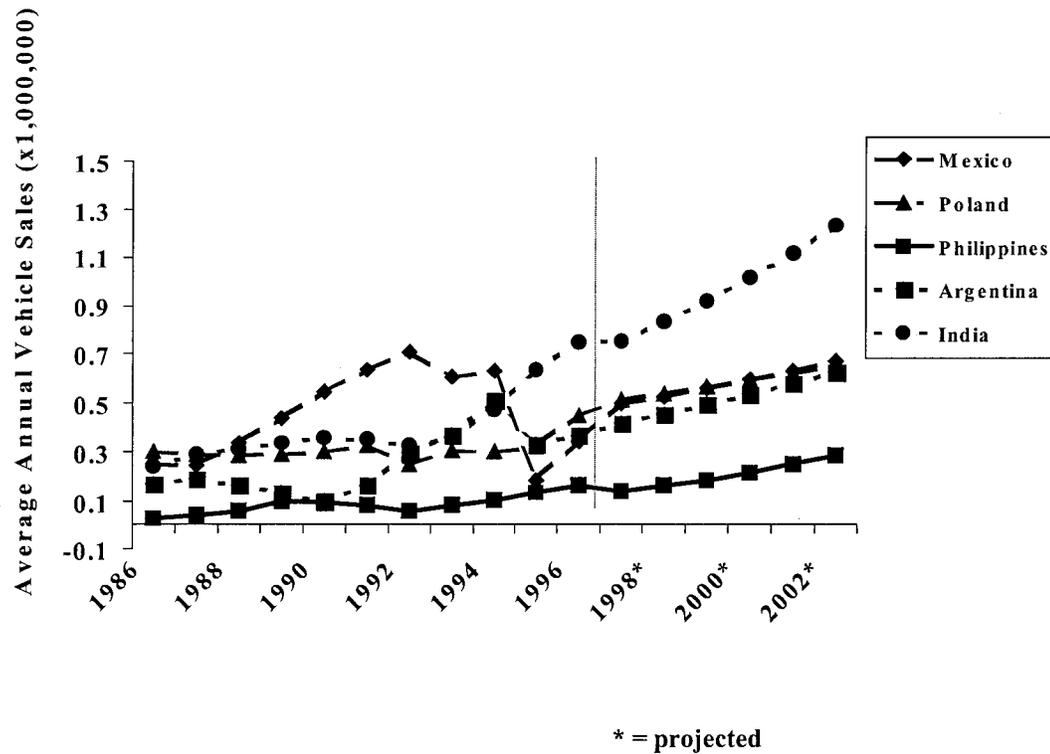


Figure 1: Model World Total Vehicle Sales

The limits of our modeling work are clear: Its foundations are restricted to a three-component car and a seven-country world, and are therefore of uncertain generality. After all, it is an open question how closely these results apply across other materials, parts, components, or systems, or in other markets. Nor do our models permit the complex considerations characteristic of true system-based decisions. Finally, they do not reveal a new, one-strategy solution that fits all situations. Nevertheless, these model analyses do possess some unusual strengths.

- First, our component cost estimates are for the general industry, not for any one company, but they do reflect input from important suppliers of each component. We are therefore confident that these estimates of industry costs have a solid basis in reality, and are neither artificial nor arbitrary.

- Second, estimates of operating costs in different countries are based on industry cost data that are unusually accurate, rich, and detailed. Our sponsoring companies provided us with extensive information from their experiences, data that permits us to explore numerous models and comparisons of different mixes of options for build/source in these markets.

- Third, the market scenarios that drive the production potentials in our model world are developed from extensive analysis of actual market and production data for 38 countries, spanning in most cases over 20 years.

- Fourth, we collected extensive information on the terms of trade and transportation costs for our three components and our 38-country sample. These permit us to incorporate these important factors into our build/source model comparisons in a much more realistic fashion than is generally the case. Tariffs across the components range from 0 percent in Mexico, to 21 percent in Argentina, while transportation costs range from just under 3 to just under 25 percent of production cost. (See Appendix 3)

- Fifth, our build/source model estimates include costs of maintaining an ample reserve for the sourcing case, inventory safety stocks that provide manufacturers assurance in a world of lengthened and less certain supply lines.<sup>1</sup>

- Sixth, we make generous assumptions about the potential of the investment in the alternative market. First, we assume that local plants will capture production equivalent to 50 percent of the available local market through a combination of local market share and production for export. Second, we assume continuing growth through 2002. These assumptions are quite lenient, making it more likely that a local plant can be justified. Hence, they are conservative in evaluating the relative attractiveness of the sourcing option, and biased, if at all, to the build option.

- Seventh, we focus on a series of comparisons between the base comparison cases, Poland and the United States, and other markets for reasons of space. However, since all these comparisons are to this common base, the interested reader may use them to compare directly any other two countries of interest.<sup>2</sup>

- Eighth, these analyses can be expanded to incorporate more components and more countries. This is useful for augmenting the analysis's coverage, as well as assessing the reliability and generality of our current results.

We believe that these models reflect accurate data for many *factors* that must usually be assumed. This decreased reliance on assumptions makes these analyses extremely useful and largely compensates for any shortcomings in scope, weaknesses that are, in any case, common to such modeling efforts.

---

<sup>1</sup>These safety stock costs are estimated for inventory sufficient to cover a surge in production two standard deviations above the expected level for a period of time that would permit adjusting production and delivering the higher required levels from the United States or Poland.

<sup>2</sup>The base case assumes existing capacity, and therefore does not include capital cost estimates. However, since capital costs are included in all other country estimates, and each is compared to the base as a common referent, bilateral comparisons of these countries can yield direct comparisons of their costs of local production. Of course, advantages reported in the figures will have to be converted to the appropriate percent of base costs. That is, an advantage of 25 percent is a cost level of 75 percent of the base cost level.

Generally, each case should be assessed individually and an optimal sourcing decision should be based on that assessment. For instance, this could mean that it is unwise for a supplier to build within a particular country, due to insufficient market size. If, however, the supplier were to supply the region, effectively increasing the market size, then the decision to build a new plant could become optimal.

## Results

The results of the modeling work are reported in a series of four numerical measures that summarize a number of relevant comparisons. *Measure One* compares the cost of providing components for local vehicle assembly from a capacity-available existing plant in the United States or Poland with the costs of building a local supply plant. This comparison expresses the cost of local sourcing as a percent above (local penalty) or below (local advantage) providing the component from the existing plant. This is the traditional comparison for evaluating the build/source decision.

*Measure Two* compares the total costs of building all three components in the local market with building or sourcing them on a component-specific, low-cost optimum. Measure two will either indicate a cost disadvantage, or be equal to zero, because the build everywhere (suboptimal) cost disadvantage will always be greater than or equal to the build/source (optimal) cost disadvantage.

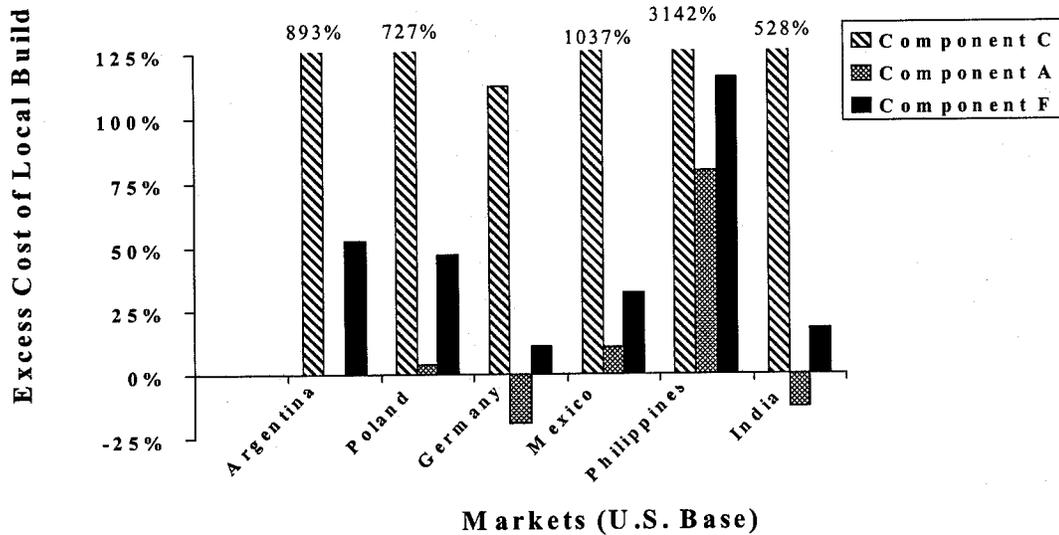
*Measure Three* sums the total cost penalties and advantages in building all three components across all seven countries in the model world. This measure effectively suggests the penalties associated with a build everywhere approach relative to each component supplier selecting its own optimal arrangements for each country.

*Measure Four* compares the cost of supplying the component for domestic assembly in two markets. It compares the lower cost build/source alternative for supplying the new market with the cost of building the component in an existing plant (U.S. or Polish) and sold in the same country. This comparison expresses the cost of providing the component in a new market as a percent above (local penalty) or below (local advantage) the cost of supplying the component within a country with an established plant.

We present our findings for two different base plants, one in Poland and one in the United States. When we use the U.S. plant as the comparison base, Poland is included as an alternative production site and market. Conversely, when the Polish plant is used as the base, the United States becomes one of the six alternative sites and markets.

Figure 2, displays the penalty/advantage of sourcing components from the U.S. plant to support each of the other six countries (including Poland) in the model world, compared with building these components in a full-scale plant in each country. A full-scale plant can be justified only in the case of Germany and India for component A, assuming there is available capacity in the United States for all three components. For component A,

local build in Argentina is virtually a tie with sourcing from the United States, with a relatively trivial direct penalty (well under 1 percent) for establishing a full-scale plant.



**Figure 2: Cost of Local Build versus U.S. Sourcing (1997 Full-Scale Plant, U.S. Base)**

Additionally, figure 2 illustrates three important points. First, sourcing from the United States is the best alternative in 16 of the 18 comparisons, with one comparison essentially a tie. Germany is the alternative closest to the U.S. cost level for each of the three components, and probably would be the next most attractive source in most two-country comparisons as well.<sup>3</sup> So the developed markets are more attractive sources than conventional wisdom might suggest. Second, the cost penalties associated with local production rather than sourcing from existing capacity are often quite large. Third, the relative costs of local production compared to U.S. sourcing vary greatly across these countries and components, highlighting the need for careful case-by-case evaluation of the build/source option.

<sup>3</sup> Making the direct comparisons discussed in the prior footnote does reveal, in a Poland base example, that Germany is the low cost production location for all three of these components. This primarily reflects the production scale its large market can support. If we subtract capital costs from these estimates—to reflect existing capacity—and if we add the necessary tariff and transportation costs, Germany might even be a lower-cost source than the United States for some of the other markets.

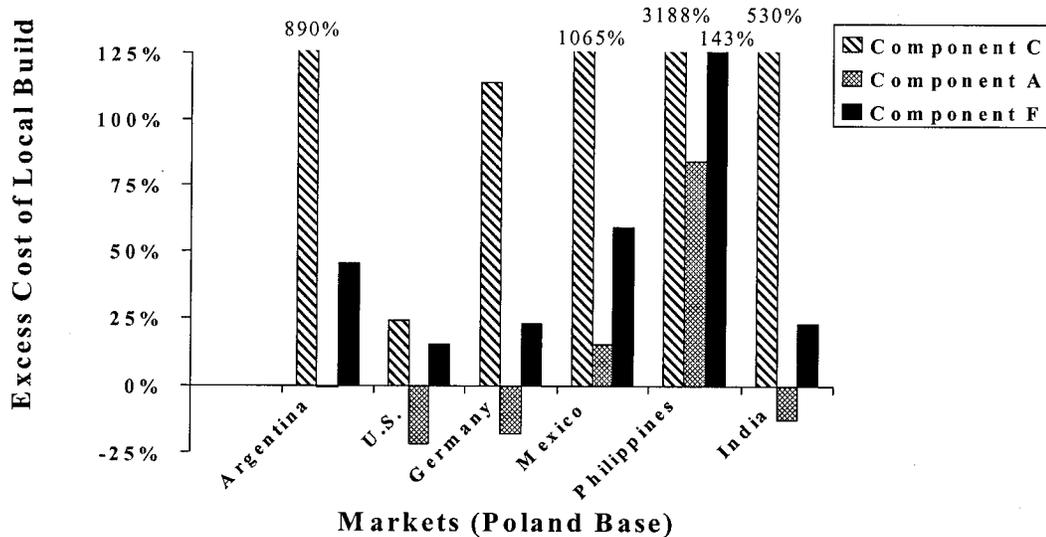


Figure 2A: Cost of Local Build versus Sourcing from Poland (1997 Full-Scale Plant, Polish Base)

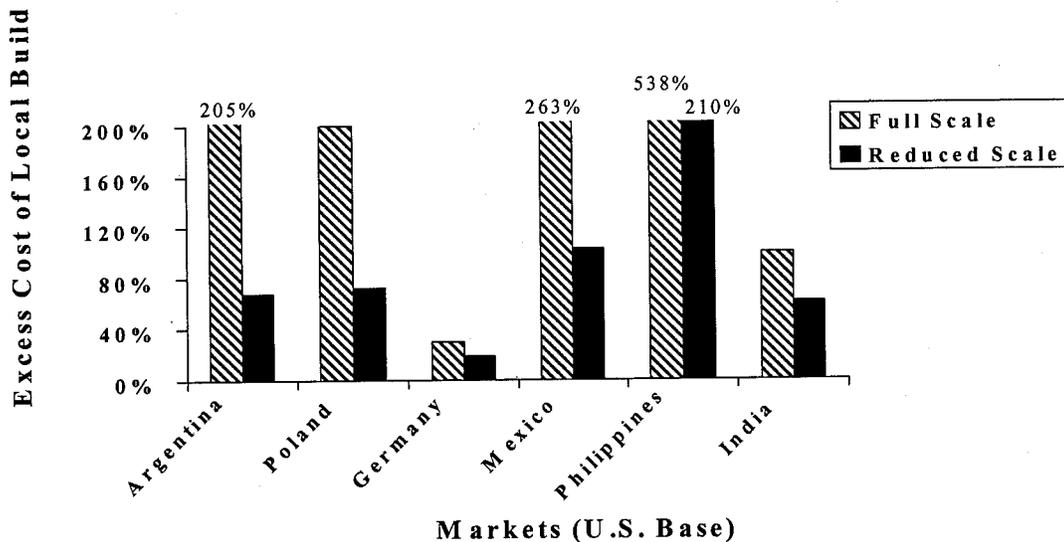
In figure 2A we use the existing Polish plant as the comparison base and substitute the United States for Poland as one of the alternative possible plant sites in our model world. Five markets experience cost differentials similar to those observed in figure 2. However, when we compare the U.S. cost penalty for building a new plant in figure 2A with the Polish penalty in figure 2, we find the U.S. penalties are much smaller. This is due to its vastly larger market. In fact, component A should be produced for the U.S. supplier market in a new U.S. facility rather than sourced from an existing plant in Poland. The cost penalty for building components C and F in Germany are somewhat higher compared with an existing Polish plant than when compared with a U.S. plant, reflecting Germany's proximity to Poland. This minimizes the transportation costs for sourcing from Poland, and thus raises the penalty for a new plant in Germany.

Our comparisons are influenced by two critical factors, the investment level and recovery period required for the new plant, and the production scale available to it. In fact, the differing comparisons against a Polish and a U.S. base described above highlight their importance, as they outweigh important differences between Poland and the United States in labor costs, transportation, and tariffs.

Is there an option of building a plant that requires lower investment, either because its capacity is reduced or its operations are structured differently, perhaps to take advantage

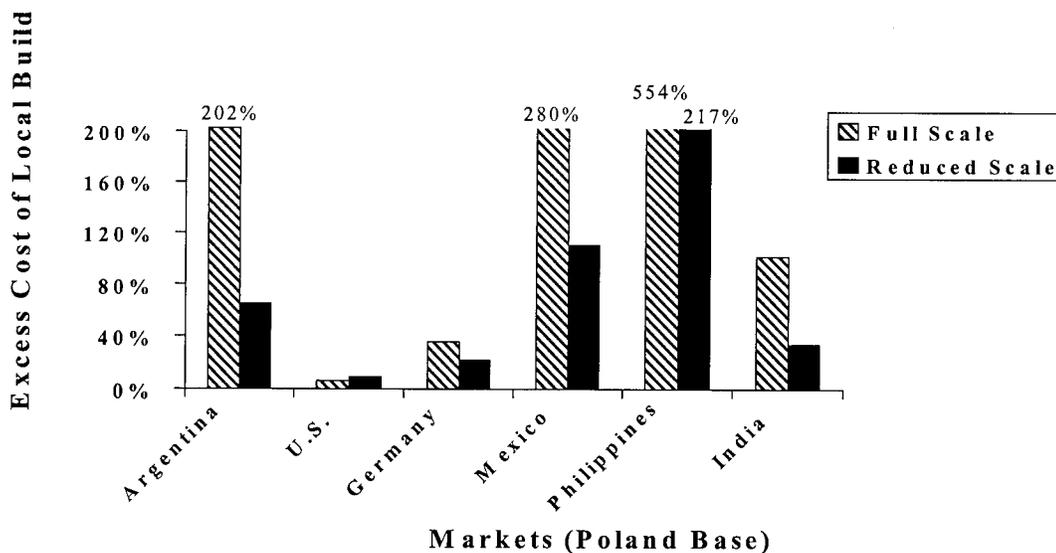
of lower labor costs in the emerging markets? To be sure, such process alterations may threaten quality and standardization achieved through the introduction of more capital-intensive, automated production; but they might lower costs. Moreover, in growing markets, today's plant volumes may well be lower than they would be in the future, and surely decisions on capacity should reflect this contingency.

Figure 3 presents the U.S. plant as the existing comparison base, while Poland is one of the alternative possible sites for a new plant. In figure 3A, the Polish plant is treated as the existing comparison base, while the United States is treated as one of the alternative possible sites for new plant investment. They display the differences in the comparison of costs for full- and reduced-scale plants, projected for a larger 2002 market. Here we average the three components, rather than showing each separately, in order to illustrate better the key summary point. Indeed, the combination of reduced-scale plants and larger production volumes can sharply lower the cost penalties associated with local production, but many of these penalties remain substantial.<sup>4</sup>



**Figure 3: Cost of Local Build versus U.S. Sourcing (2002 Full-Scale/Reduced Scale Plants, U.S. Base)**

<sup>4</sup> In the 18 component-by-country comparisons with the U.S. base, seven of the cases justify a local reduced-scale plant for 2002, on the basis of cost.



**Figure 3A: Cost of Local Build versus Sourcing from Poland (2002 Full-Scale/Reduced Scale Plants, Polish Base)**

Recall that the growth estimates for these countries are rather aggressive. Because of this, even full-scale new plants enjoy reduced penalties as production volumes grow over time, as shown in figures 4 and 4A. Figure 4 presents the U.S. plant as the existing comparison base, while Poland is one of the alternative possible sites for a new plant. In figure 4A, the Polish plant is treated as the existing comparison base, while the United States is treated as one of the alternative possible sites for new plant investment. Market growth alone justifies just two additional new plants above the 1997 level of two, already displayed in figure 2.

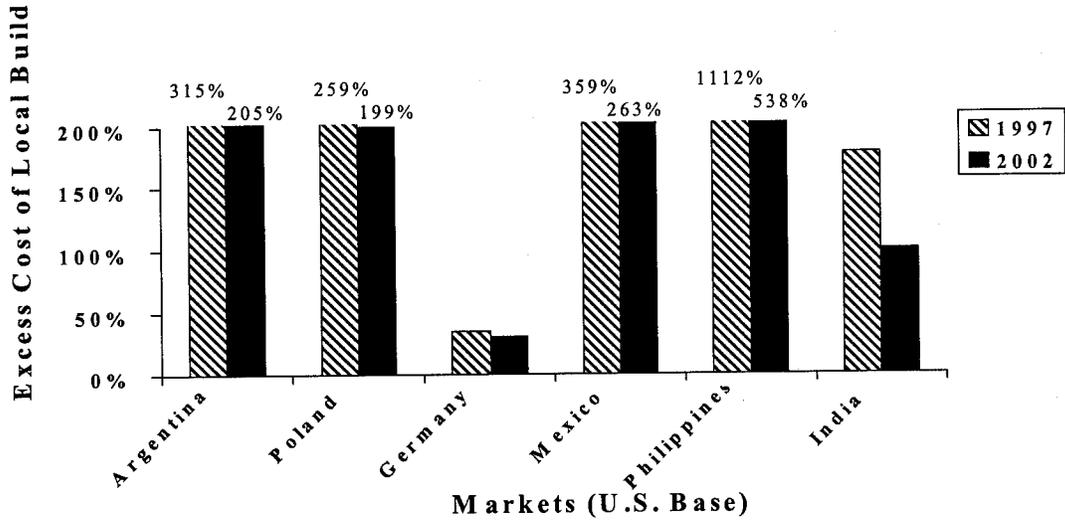


Figure 4: Cost of Local Build versus U.S. Sourcing (1997/2002 Full-Scale Plant, U.S. Base)

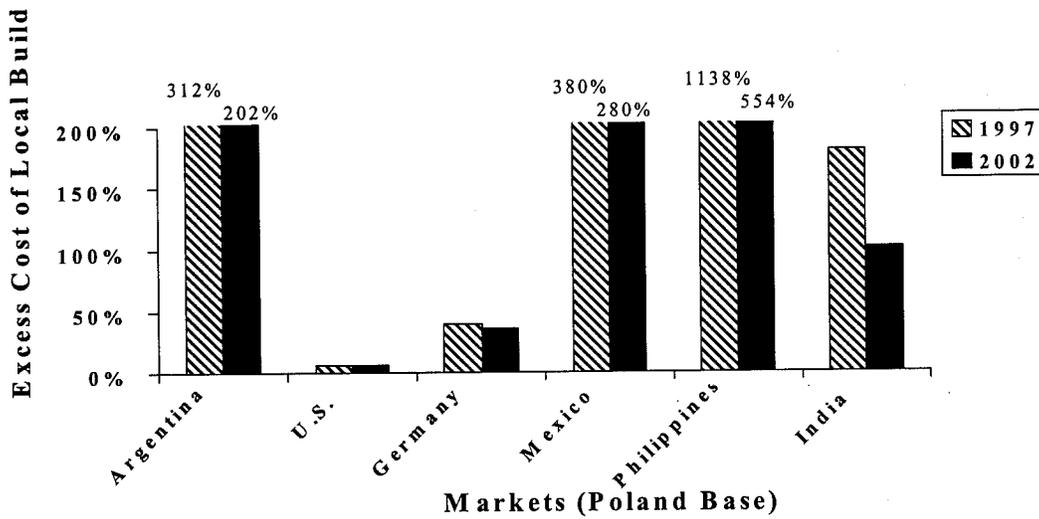
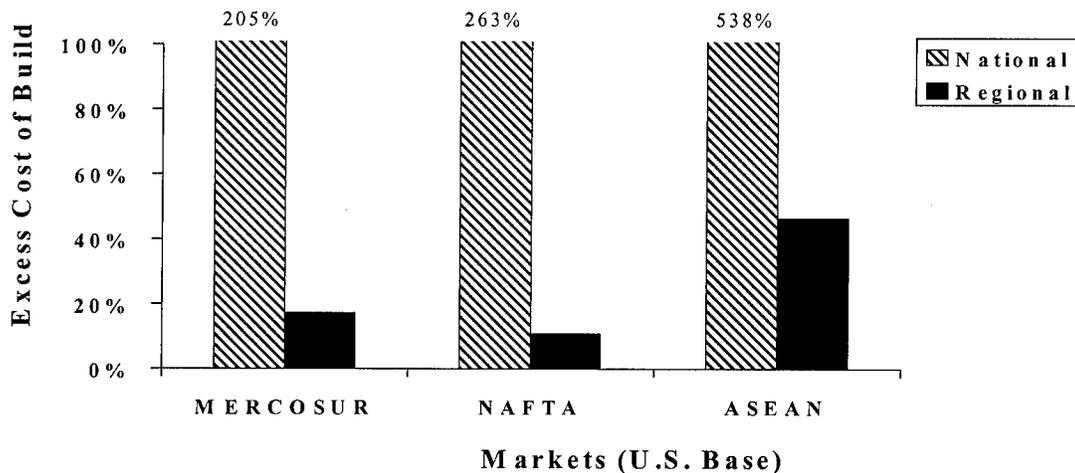


Figure 4A: Cost of Local Build versus Sourcing from Poland (1997/2002 Full-scale Plant, Polish Base)

Supplier and assembler markets can expand through mechanisms other than growth, and one of the most intriguing is the possibility of expanding or opening regional trade areas, such as ASEAN and NAFTA. Figure 5 presents the U.S. plant as the existing comparison base, while Poland is one of the alternative possible sites for a new plant. In figure 5A, the Polish plant is treated as the existing comparison base, while the United States is treated as one of the alternative possible sites for new plant investment. They display the consequences of access to larger regional markets for three of our sample developing industries, Argentina, Mexico, and the Philippines. These graphs compare the cost advantages and penalties of building the three components in already larger 2002 national markets, from figures 4 and 4A, with the penalties and advantages that each country experiences with access to the larger markets of its regional trade associations. The results are dramatic, as the penalties for local production are reduced by an order of magnitude. Still, the penalties remain substantial. To be sure, this model assumes that the plants can capture 50 percent of the available regional market, effectively requiring that most of the other countries in the region are not also establishing competing supplier plants.<sup>5</sup>



**Figure 5: Cost of Regional Build versus U.S. Sourcing (2002 Full-Scale Plant, U.S. Base)**

<sup>5</sup> This assumption may not be realistic. In particular, it is not likely that many Mexican supplier plants will capture 50 percent of the NAFTA region, if only because U.S.-based and Canadian-based suppliers are likely to compete strongly for these sales.

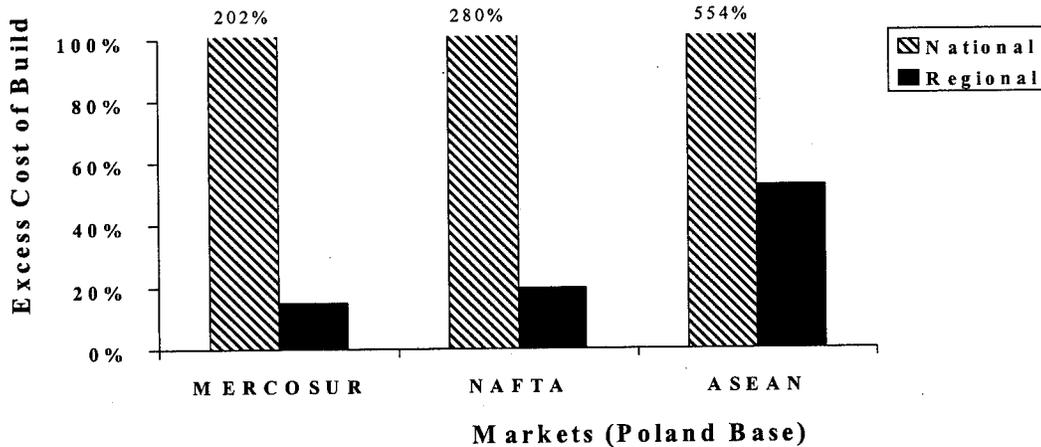


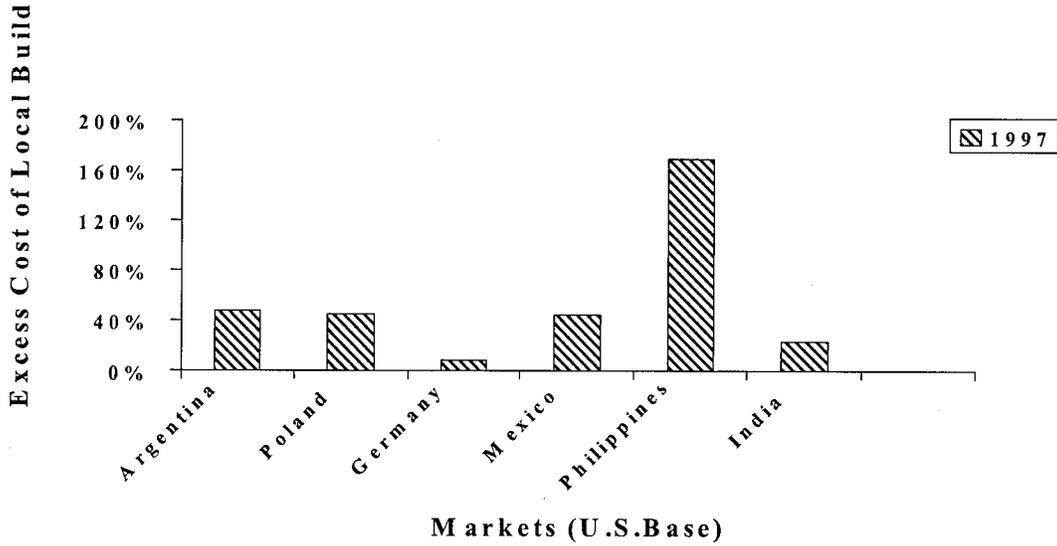
Figure 5A: Cost of Regional Build versus Sourcing from Poland (2002 Full-scale Plant, Polish Base)

The above models compare the build/source options for each component for each individual market, although we typically display the average of the three components. These models indicate that the potential cost penalties for the build versus the source option can be quite high, especially when plant scale grossly exceeds the market demand. We turn now to our second measure to compare the total costs of building all three components in the local market with building or sourcing them on a component-specific, low-cost optimum.

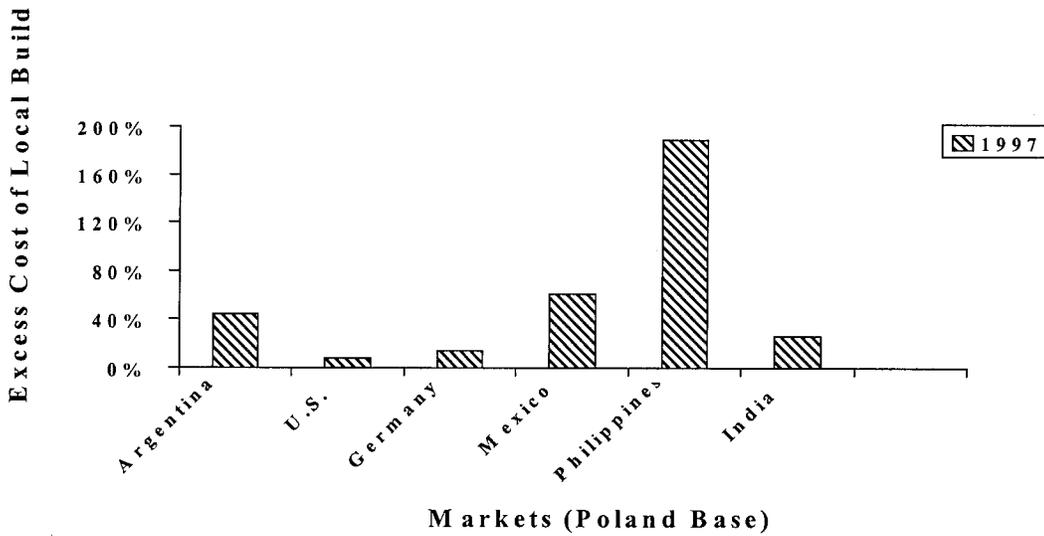
In this next group of models, we compare the total cost of our three-component vehicle built with combined optimal build/source mix with the costs of a completely local-build strategy. If sourcing from an existing plant is the optimal solution for any of the three components, then this measure will be positive, indicating the degree of penalty of a local-build strategy for each market. If building locally is the optimal solution for all three components, then this measure becomes zero.

Figure 6 includes the new Polish plant and the U.S. base plant, while figure 6A includes the U.S. alternative plant and the Polish base plant. They each display the costs of building all three components in a new local plant with the cost of supplying each by its own best alternative, be that sourcing from an existing plant or building locally. Establishing a full-scale plant for each of these three components in any of these countries, compared with sourcing from the United States or Poland, involves a cost

penalty at 1997 market levels. To be sure, it varies from less than 10 percent in Germany to well over 150 percent in the Philippines. But the penalty is important, even in the best of cases.

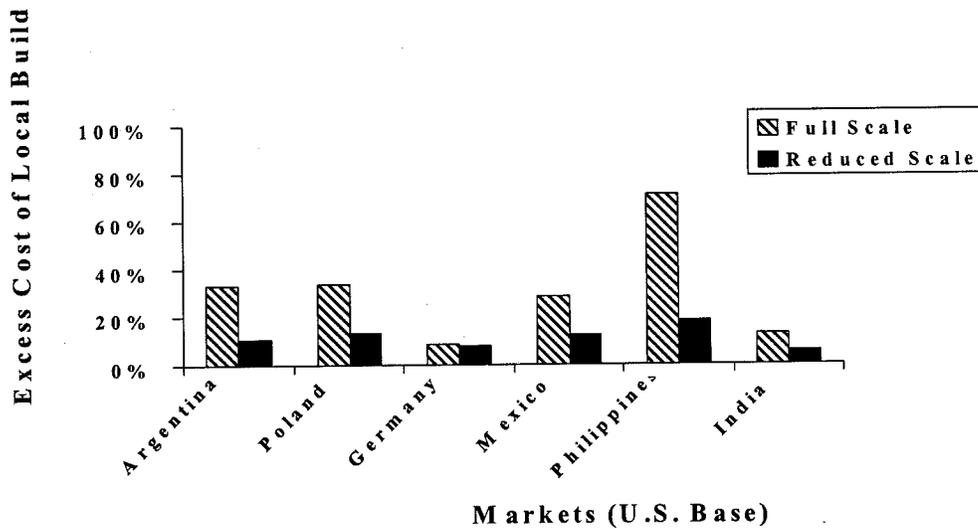


**Figure 6: Cost of Local Build All versus Optimum Mix (1997 Full Scale Plant, U.S. Base)**

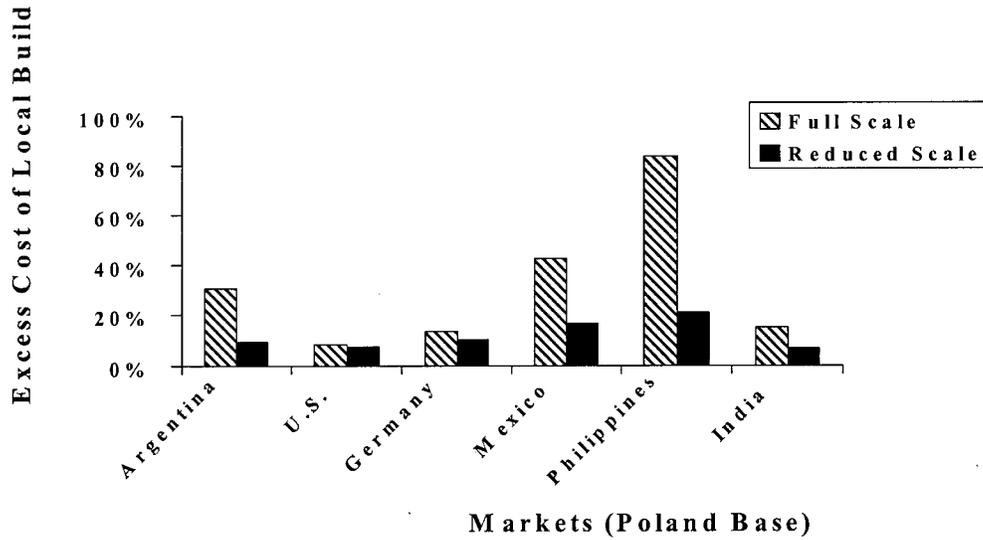


**Figure 6A: Cost of Local Build All versus Optimum Mix (1997 Full Scale Plant, Polish Base)**

Again, the option of building reduced-scale plants can reduce investment levels and thus, combined with some level of market growth, attenuate the cost penalty. These results for 2002 are displayed in figure 7, which includes the Polish alternative and a U.S. base plant and figure 7A, which includes the U.S. alternative new plant and the Polish base plant. Again, there is great variation across these countries, as the choice of a full- or reduced-scale plant matters little in Germany, where the full-scale plants are operating at a cost-efficient utilization rate, but matters greatly in the Philippines where full-scale plants will run well below their capacity. If the reduced scale option is still not an attractive one, at least it is less costly than requiring full-scale plants, although it might sometimes reduce product quality and undercut global standardization efforts. It may even be an attractive option, if, for example, local content requirements demand establishing some supplier activity.



**Figure 7: Cost of Local Build All versus Optimum Mix (2002 Full-Scale/Reduced-Scale Plants, U.S. Base)**



**Figure 7A: Cost of Local Build All versus Optimum Mix (2002 Full-Scale/Reduced-Scale Plants, Polish Base)**

Figure 8 includes the Polish alternative new plant and the U.S. base plant, while figure 8A includes the U.S. alternative and the Polish base plant. They indicate that market growth alone, even under optimistic scenarios, will not justify building full-scale plants for all three components in any of these markets. Additionally, local build strategies still impose heavy penalties, except in the case of Germany, where the penalties are lighter.

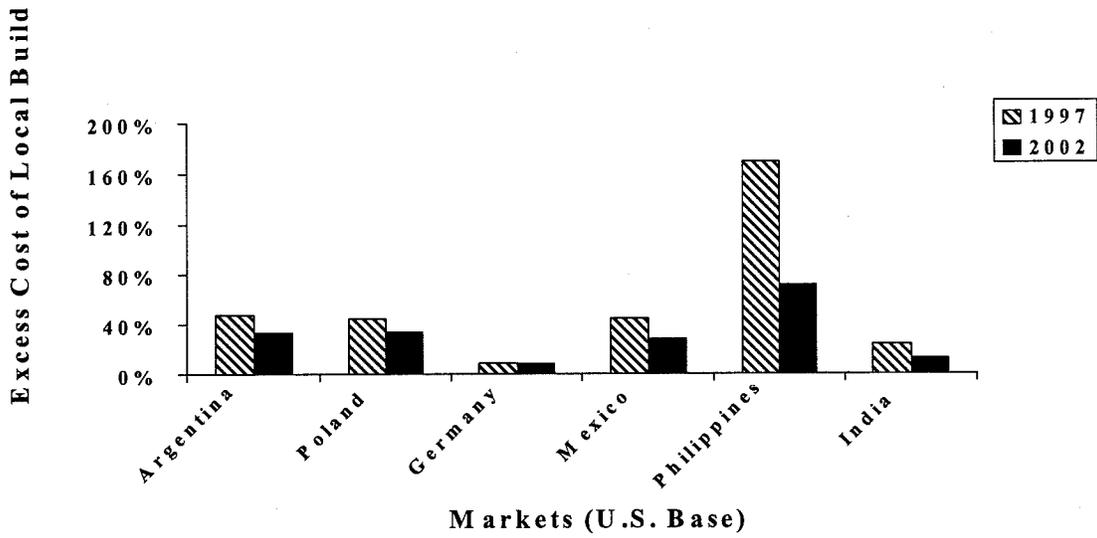


Figure 8: Cost of Local Build All versus Optimum Mix (1997/2002 Full-Scale Plant, U.S. Base)

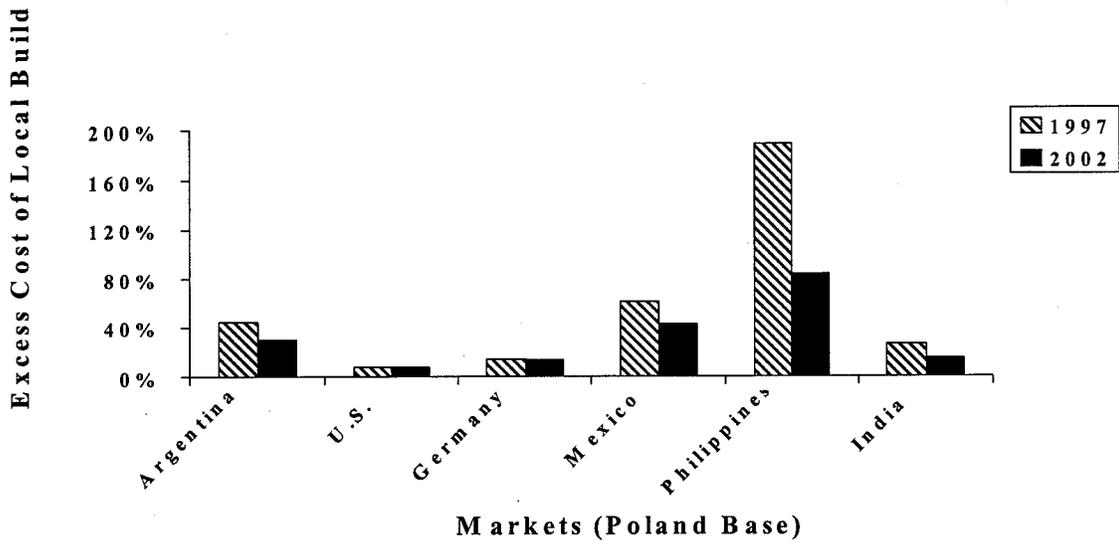
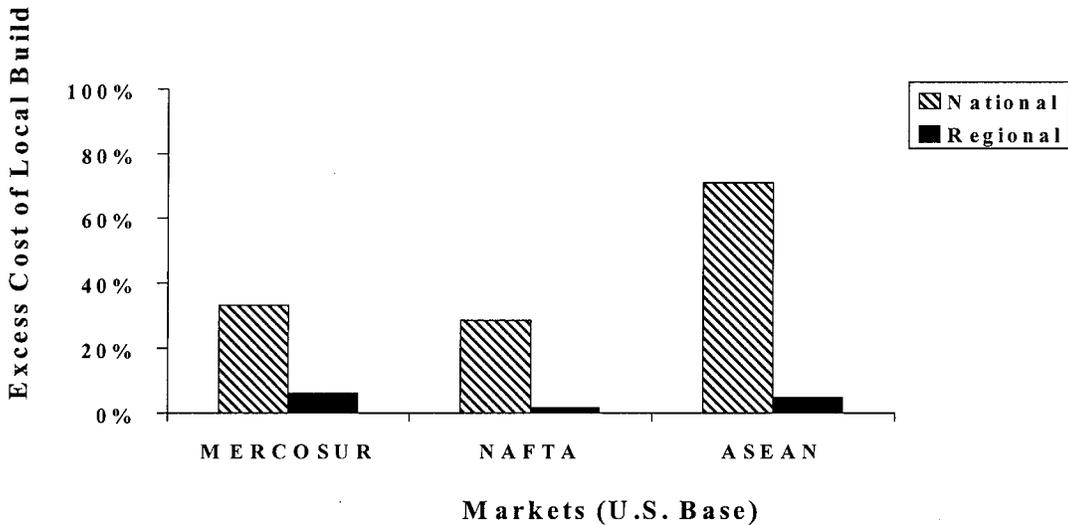


Figure 8A: Cost of Local Build All versus Optimum Mix (1997/2002 Full-Scale Plant, Polish Base)

Figure 9 presents the U.S. plant as the existing comparison base, while Poland is one of the alternative possible sites for a new plant. In figure 9A, the Polish plant is treated as the existing comparison base, while the United States is treated as one of the alternative possible sites for new plant investment. These figures show that if we combine national market growth with wider access to trade area markets, the penalties of a local build strategy diminish drastically. This is not surprising, because the local build strategy for each of the individual components becomes more viable and attractive. However, the remaining penalty is still not negligible, although just below 1.5 percent in the case of Mexico, a member of NAFTA. Similarly in figure 9A, the cost penalties of building a new plant for the Argentine market alone, compared with sourcing from an existing Polish plant, are much higher than they are for an Argentine plant serving the MERCOSUR market.



**Figure 9: Cost of Local Build All versus Optimum Mix (2002 Full-Scale Plant, U.S. Base)**

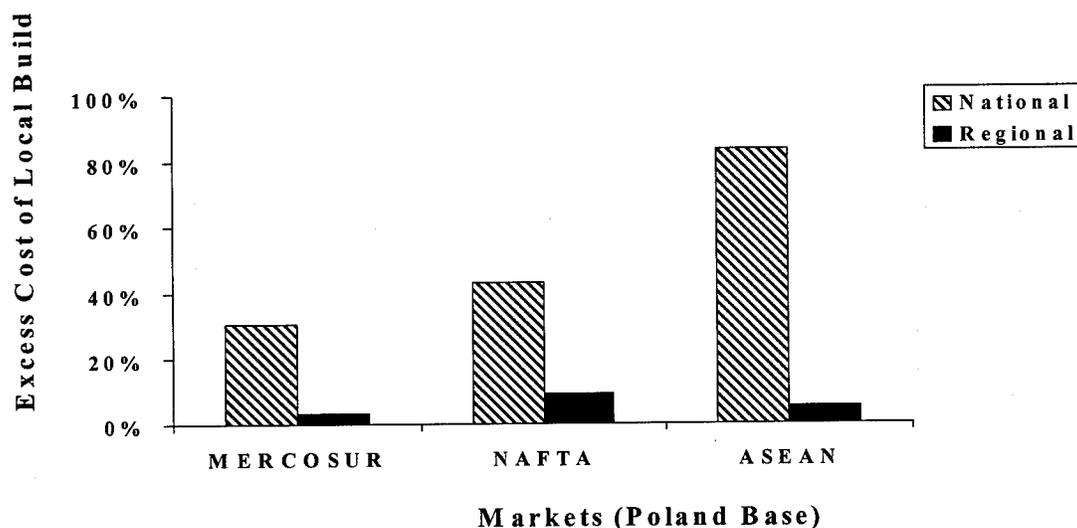


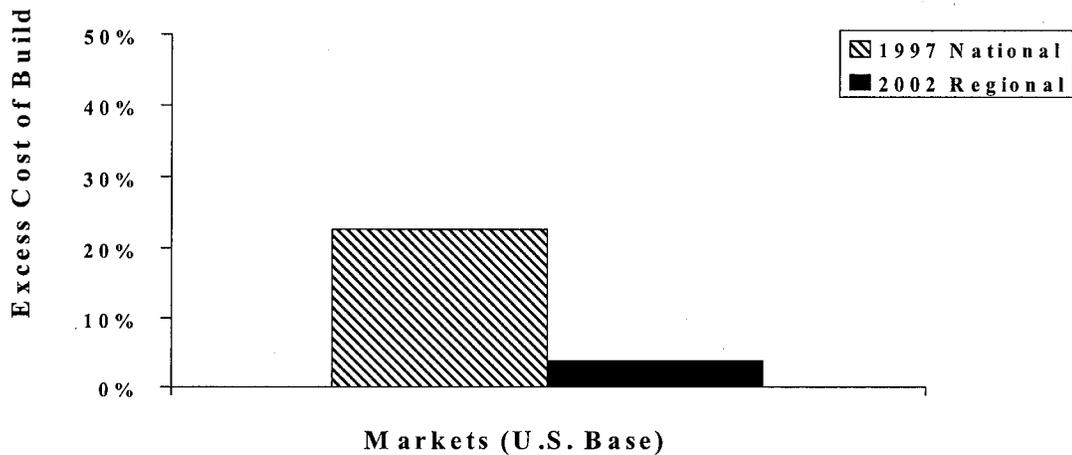
Figure 9A: Cost of Local Build All versus Optimum Mix (2002 Full-Scale Plant, Polish Base)

One variant of globalization calls for the automotive industry to establish a production base in numerous, if not all, national markets. The demands of governments rather than economics would drive such an outcome, as governments try to capture the economic benefits of automotive production. Our third measure sums up the total cost penalties and advantages in building all three components across all seven countries in the model world. This measure effectively suggests the penalties associated with a build-everywhere approach compared with each component supplier selecting its own optimal arrangements within each country.

The cross-hatched bar of figure 10, representing the scenario that includes the Polish alternative and the U.S. base plant, suggests that the penalty for a build-everything-everywhere strategy is substantial, costing in excess of 20 percent more than an optimal build/source strategy for full-scale plants in 1997. The solid bar shows the importance of market size, as national market growth and access to regional markets again sharply reduce the penalty of this strategy, to just under 4 percent.<sup>6</sup> The other scenarios are again

<sup>6</sup> Of course, there is a practical inconsistency in this model. Clearly, a build-everywhere strategy contains an important internal flaw: Building everywhere effectively limits the option of seeking scale economies through access to larger and larger regional markets, because these regions would be unlikely to develop in a world where every national market is tied to a local industry. Logically, build-everywhere strategies have limits. However, our model world reflects this, because we test a limited and realistic "everywhere."

intermediate. National market growth through 2002 cuts the penalty by somewhat less than 25 percent, while reduced investment lowers it by about half, still leaving a substantial penalty.



**Figure 10: Cost of Build All, Everywhere versus Optimum Mix (1997 National/2002 Regional Full-Scale Plants, U.S. Base)**

Figure 10A represents the U.S. alternative and the Polish base plant. The cross-hatched bar indicates that the cost penalty for building all components everywhere, is just over 10 percent at 1997 national market levels. However, the solid bar indicates that the cost penalty is reduced slightly, to just below 10 percent, with the growth available through 2002 and with wider regional market access for some new plants. This relatively narrow gap in cost penalties reflects the inclusion of the U.S. market in 10A, and its exclusion in figure 10. In the Polish base example, figure 10A, total national market size is 21 million units, increasing to a regional 38-million-unit market, not quite doubling the size of the market. However in the U.S. base example, the national markets total just 6 million units, increasing to a 38-million-unit regional market—a more than six-fold increase. These results point out that expanding from a national market strategy to a regional strategy can capture reductions in cost penalties, but other factors, such as base plant location, also affect the size of the penalties.

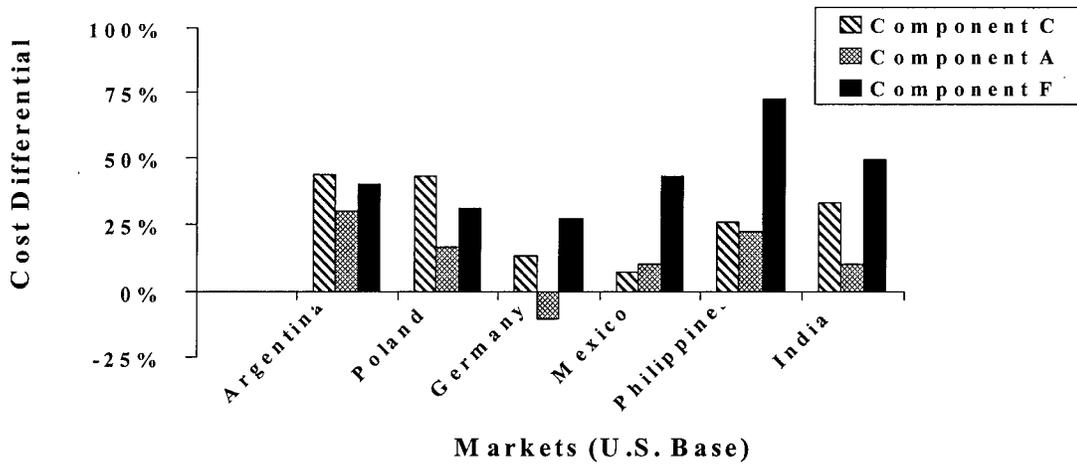


**Figure 10A: Cost of Build All, Everywhere versus Optimum Mix (1997 National/2002 Regional Full-Scale Plants, Polish Base)**

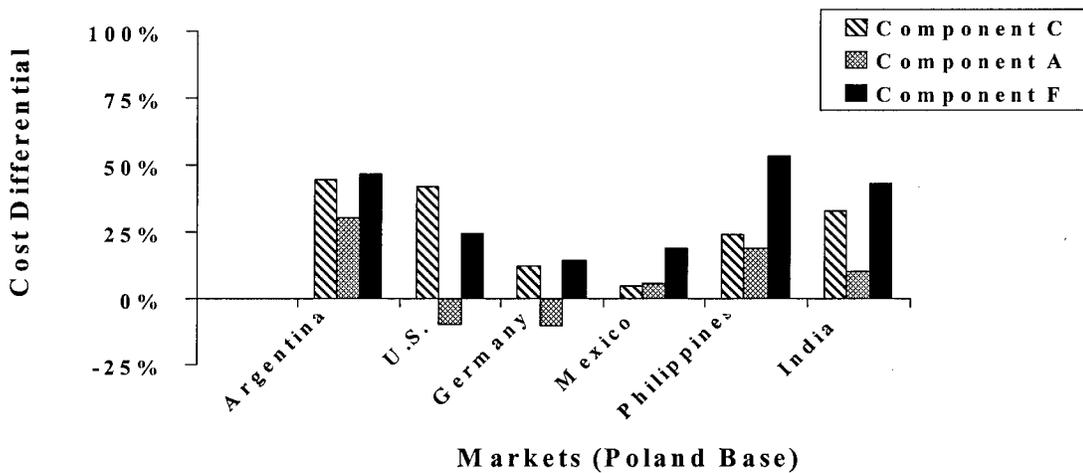
A separate, but important, question raised by globalization is whether or not a truly worldwide price is an attainable goal, or just an artificial demand imposed by the assemblers. Our final measure compares the cost of supplying the component in two markets. It compares the lower cost build/source alternative for supplying the new market with the cost of U.S. production for the U.S. market. This comparison expresses the cost of providing the component in a new market as a percentage above (local penalty) or below (local advantage) the cost of supplying the component in the United States from the established U.S. plant. Since such costs are rarely identical, it is important to keep decisions about pricing anchored in a local or global context rather than a one-country-fits-all approach.

Figure 11 displays cost penalties or advantages for alternative new plants compared with those of a U.S. plant, with each plant supplying its own market. Figure 11A displays the same comparisons against a Polish plant, with similar results. Note that in 17 of 18 cases the cost of building and delivering the product in the United States is lower than the cost of building and delivering the products in other markets. To be sure, this does not mean that the United States is the optimal source for all 17 component markets, since this estimate does not include tariff and transportation costs for delivering the product to other markets. When we look at the effects of investment levels, national market growth, and regional market access, we see the same patterns observed in our other measures. These

results suggest that a true global price must reflect some realistic average, since suppliers cannot deliver at the low price of any one market on a worldwide basis.



**Figure 11: Cost Comparison: Local Build/U.S. Build (1997 Full-Scale Plant, U.S. Base)**



**Figure 11A: Cost Comparison: Local Build/Polish Build (1997 Full-Scale Plant, Polish Base)**

## **Conclusions**

These model evaluations suggest a number of important considerations. First, we must stress again that each of these components and each of these local markets are quite different in important respects. While there are overall similarities, actual decisions must be made carefully, reflecting each individual component and market under consideration. One of the key factors in the build/source evaluation is the transportation cost associated with sourcing from existing capacity. Shipping the products from existing capacity elsewhere is a key differentiator among these components and makes a substantial difference in the potential cost penalties for building a suboptimal plant. For example, component A might reasonably be built in three of these national markets, and pays a severe cost penalty for local production in only one. Component F pays penalties that might be justifiable in two markets, while component C pays horrendous penalties in all national markets and clearly requires access to a regional market for it to have any chance of reasonable-cost local build.

Market proximity to the base plant, in combination with the shipping costs, also affects the build/source decision. For example, in our model world, the Polish plant is much closer to its nearest foreign market, Germany, than is the U.S. plant to its closest foreign market, Mexico. As the distance between base plant and market increases, shipping costs increase as well. In our model, the decision to build a new plant necessitates the recovery of all investment costs through sales of the manufactured product, oftentimes driving the new-plant unit cost well above the cost of importing the product. Thus, when deciding whether to build in a new market or source from existing capacity, low unit shipping costs could render a decision to build suboptimal.

Second, an important difference in the situation of manufacturers and suppliers is the likelihood of manufacturers receiving subsidies of some kind that help offset their investment costs. The source/build comparisons and calculations can change sharply when an important element, such as capital costs, is substantially reduced through such grants by a country that strongly desires the manufacturer's presence. This obviously changes the decision process for those manufacturers who receive these subsidies.

Third, building volumes is quite important to suppliers, since many have relatively capital-intense processes that require large production volumes for investment recovery. National market growth by itself will not have much effect on the size of the penalty; access to broader regional markets, combined with no additional national production bases in the region, may be critical for many local industries.

Fourth, developing reduced-scale plants can lower the cost penalty, but can involve some risks to uniform quality and global standardization. Reduced-scale plants probably make sense when they reflect smaller plants, fewer lines, and such, but probably make less sense if they require change in the fundamental production processes.

Fifth, the penalties associated with a strategy of building everything in a local market, and its extension to building everything everywhere, are far from trivial. In fact, for 2002, the countries range from an 8 percent penalty in Germany to a penalty over 70

percent in the Philippines (over 80 percent in the Philippines using the Polish base scenario). Penalties in three of the countries are about 30 percent higher than the costs of an optimal build/source mix strategy. This strategy imposes a penalty of over 22 percent in 1997, and this remains above 17 percent with strong market growth through 2002. When the Polish base example is used, the results, and implications, are similar. In two of the countries, the cost penalties are 30 percent or higher than the optimal build/source mix strategy. As with the U.S. base example, in no country are the cost penalties less than 8 percent.

Sixth, the results clearly imply adverse consequences for low capacity utilization. A major reason that plants in these countries experience high costs is that they are functioning at low capacity-utilization rates. One of the basic assumptions of our model is that new-plant investment will be recovered through product sales over the life of the plant. We find that building a plant in the United States incurs smaller per-unit cost penalties than does building a comparable plant in Poland. Due to the greater size of the U.S. market and the likelihood that the U.S. plant would run near full capacity, the average price per unit will be kept at a minimum. A plant in Poland, however, would be underutilized, driving up the average per-unit price. Moreover, new capacity pressures old capacity, and may reduce capacity utilization in existing plants. To be sure, assessing the indirect effects of new capacity in harming the efficiency of older plants elsewhere in the world requires careful assessment of capacity for each market and component. Nevertheless, for a variety of human and organizational reasons, it is not unheard of for companies to favor newer plants in product and volume allocation. Therefore, it is reasonable to be concerned that low levels of utilization in newer plants would lead to shifting of volumes to them from established plants elsewhere.

Seventh, extending these results of our three-component car in a seven-market world to an entire car in the real world paints a grim scenario indeed. These results suggest that the cost penalties associated with these local production strategies are sufficient to restrain market growth. Moreover, the cost discipline that overseas production can impose on existing plants may evaporate if the production cost is high because the local markets are too small to support efficient operations.

### **Implications**

There is little doubt that the industry must make more complex production siting and sourcing decisions as it globalizes. Strategies must respect and reflect the differences between component production and vehicle assembly, while also recognizing the great variation in the processes and economics of component production. The challenge is to minimize the total vehicle cost, and that is difficult when training and tradition call for optimizing at the level of the plant, company, or component, rather than the total system.

It is important that assemblers be cautious and not simply mimic each other's component sourcing/build strategies. The risk here is that such duplication will almost certainly put multiple suppliers at risk, because what constitutes healthy competition in larger markets becomes suicidal in smaller markets.

Successful companies will integrate the component- and country-specific advantages and disadvantages across their value chain into a cost-optimized vehicle. This certainly requires complex and adaptable strategies that can be tailored to the relevant situations and circumstances, rather than a unitary and rigid formula. For example, requiring a component A plant in the Philippines would be patently foolish in our model world, but could well happen if an assembler applies rather simple strategies of demanding proximate supply plants for reasons of supply security or meeting requirements for local content.

It may be that the industry should develop models of pooling and sharing the decisions, risks, and costs of investments required for a particular product in a specific market. Perhaps such pooling strategies might also apply to the incentives and subsidies that governments provide, but usually to the assemblers alone. On occasion, some suppliers are included in early stage discussions regarding tax credits, and expanding this practice to more suppliers and to more incentives would permit such sharing. It seems sensible to explore ways to share risks that might otherwise concentrate in one or a few companies, putting their contribution to the value chain at risk. The consequences of suboptimal system decisions are potentially too damaging to concentrate the risks in just one company.

Developing regional component-supply strategies should be a priority for both manufacturers and suppliers. Not all of the industry's decisions on plant siting are under its own control. However, even in the case of domestic content requirements, there can be an element of choice or selection as to what the exact mix of sourcing/building will be, as well as to what the exact distribution of component activity will be across nations and within regions. In these cases, the penalties should be minimized, and careful evaluation of which components will be sourced and which manufactured locally can at least restrict the cost penalties imposed by such requirements.

There are shared-risk strategies appropriate to these situations. For example, an OEM might ask its suppliers to distribute their individual local production commitments across a region so that each company builds one plant, and the regional market can provide scale economies. Properly planned, such a strategy could meet local content requirements, while taking into account the individual cost and risks to each supplier.

The selection of which suppliers should accompany an assembler to which markets must reflect more than their size, vehicle content level, and local preferences. Clearly, the cost penalties or advantages of local production compared with sourcing from established facilities should be among the factors considered, and a major one at that.

## **APPEDIX 1: PRODUCTION COST DATA**

### **Company Cost Data**

Our analysis of optimal sourcing began with a collection of industry-generalized micro data which, when input into our model, yields component-specific results, and becomes the base of our automobile cost analysis. General industry data for each type of component was requested from the sponsoring companies. A short survey, and subsequent follow-up survey, was the primary data-gathering instrument for variables such as fixed costs, variable costs, transportation costs, plant investment, plant life, and plant scale. This last input, plant scale, turns out to be an important consideration. Many countries in the world, and indeed most in our model, represent markets that would be oversupplied if a full-scale production plant went online. We consequently requested each sponsoring company to consider whether a reduced-scale plant would be built in a small market. Our research indicated that a smaller scale plant would more accurately represent the cost considerations of an actual build or import decision. All three companies were able to supply the necessary data to complete this reduced-scale scenario. Additionally, personal discussions with sponsor representatives are conducted to ascertain the accuracy of the input data for the model.

## APPENDIX 2: 38 COUNTRY DATA SET

### COUNTRY DATA

#### 38 Country Sample

We selected thirty-eight countries spanning six continents to comprise the data set including the use of economic models and country, regional, and global trends in this report. These countries include developed and developing economies, and various scale markets for vehicles. We collected sales, production, import, and export figures for these countries from 1978 to 1998 but, due to problems of availability of data in many of these markets, have employed 1986 through 1998 data in our models.

Data sources include industry publications, national trade associations, and domestic government sources for each of the countries. The three main industry publications relied upon in forming the data set include *Ward's Automotive Yearbook*, *Automotive News Market Data Book*, and *American Automobile Manufacturers Association's World Motor Vehicle Data*. Other industry sources include The Economist Intelligence Unit, and *Automotive International* and *Automotive News Europe*, both publications of Automotive News. Examples of contributing trade associations include the VDA (German Association of the Motor Industry), Society of Motor Manufacturers Trade (United Kingdom), ANFIA (Italian association of automotive manufacturers and tier-one suppliers), ABEIVA (Brazilian Association of Automotive Vehicles Import Companies), KAMA (Korean Automotive Manufacturers Association), and JETRO (Japanese External Trade Organization). Government sources include the National Trade Data Bank (the United States and Foreign Commercial Service) and embassies, consular offices, and bureaus of statistics, economics, trade, industry, and transportation. In addition, the three project sponsors were extremely helpful in the data collection process.

The annual sales and production figures represented in the models are typically an average of the three key industry publications, depending on availability. Whenever

possible, these figures have been compared and verified with data provided by official government sources. The annual import and export figures include contributions from the government sources and trade associations, as well as the industry publications.

## **COUNTRY SELECTION**

From the set of 38 countries we selected 7 countries to serve as cases throughout the models and report. The 7 cases include both developed and developing economies, as well as various market sizes within these categories. Four of the countries represent major trade regions, which were examined in the models to ascertain the effects of a larger market on costs.

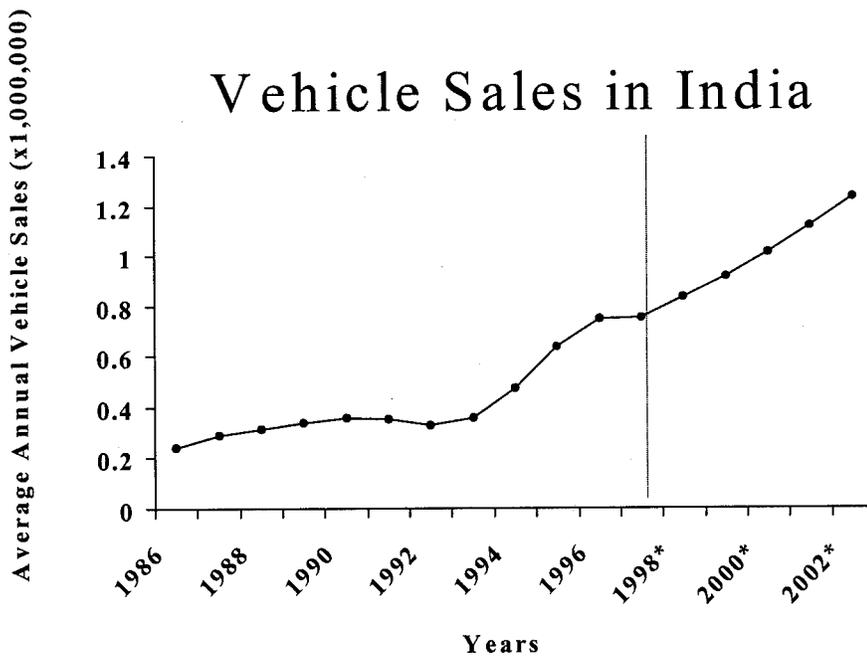
In the models, we have chosen to illustrate the results by country for the 7 countries, and then by trade agreement for the 4 trade regions. We believe that this better portrays the tendency of today's trade patterns to divide into inter- and intra-regional trade. Regional trade associations especially offer incentives for neighboring countries to engage in trade; such incentives often include lower tariffs, easing of non-tariff barriers, and the possibility of relationship building between nations. This is particularly true for manufacturing investments in developing economies. Developing economies tend to have higher tariff and non-tariff barriers than developed markets, yet may offer attractive incentives to produce and participate in their domestic markets. On the other hand, it is important to note that regional trade associations in general, including those represented in this report, have 3-, 5- or 10- year schedules to reduce tariffs and facilitate trade with nonmember countries. This leads us to believe that in the future, trade associations will become less important as their external trade barriers are gradually reduced due to continuing pressure from nonmember countries for freer trade. It is possible for the long-term trend toward diminishing tariffs, non-tariff barriers, and local content requirements to continue.

## **Uncertainty and Variability of Global Markets**

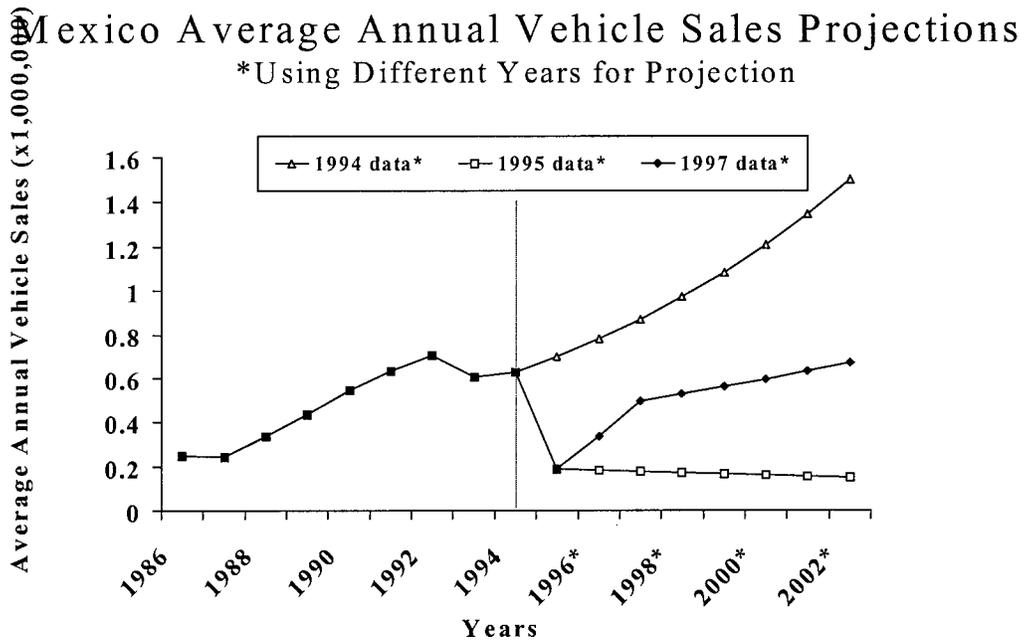
We used peak-to-trough and trough-to-peak analysis to measure the volatility in a country market or regional market in a specific time period. These calculations, for instance, identified a one-year 37 percent decline in vehicle sales in Thailand in 1996 to 1997 and an 89 percent average increase in vehicle sales over the 1986-1989 period in the Philippines. These calculations are of particular concern for developing markets that are more volatile, on average, from developed markets due to market size and rate of growth.

We also calculated compound growth rates using 12 years of data to measure the variability of these markets. The compound growth rates enable us to estimate the speed at which the markets are changing. For example, the growth rate over the 1986 to 1997 time period in Malaysia is a positive 16 percent compared to a negative 9.5 percent in France.

Employing the compound growth rates for each individual country, we are able to demonstrate one possible scenario for future markets by estimating the potential size of the markets for the next five years. These projections are linear and are based on data through 1997.



In order to illustrate the interaction between the variability of the market and the uncertainty of the projections even further, we have selected several base years for growth and subsequent projection calculations for a single market. For example, in figure A-1, we calculated three separate growth rates for Mexico using 1994, 1995, and 1997 data to illustrate how dramatically expectations can vary for a given market. The decrease in 1995 sales was due to the late 1994 crash of the Mexican peso.



**Figure A-1: Mexican Sales Projections Using Different Base Years**

These calculations demonstrate the difficulty in accurately projecting future market size. Nevertheless, the kinds of projections are necessary to determine the scope and scale of investment in a market, region, or the problems of global strategy.

## APPENDIX 3: TRADE ISSUES

### Tariffs and Other Duties

Tariffs information is drawn from a number of sources, most of which give fragmentary and incomplete rate data. The National Trade Data Bank (NTDB), maintained by the Department of Commerce and available on the World Wide Web, is organized by country. Data for most countries have been updated during the last twelve months, but in a few cases data were last updated in 1995. Under each country a subsection "Trade Regulations and Standards" (TR&S) contains a very general discussion of tariffs, with limited rate data. Rates are often expressed as averages across all products (including agricultural products) and are therefore of limited usefulness.

Within the NTDB for some countries, there is a section on "Automobiles and Automotive Parts" or "Automotive Spare Parts and Accessories." In these, a subsection on "Market Access" (MA) contains, in some cases, specific tariff rates for automotive parts, which is useful if the tariff rate is uniform across types of components.

The *Ward's/Pembertons World Auto Atlas and Directory, 1998* (W) contains general tariff rates for built-up (BU) and knocked-down (KD) vehicle imports for the major trading countries of the world. In a few cases, specific tariff rates are given for automotive component imports. Where component rates are not provided, KD rates are assumed to be applicable to component rates.

For Pacific-rim countries that are members of the Asia Pacific Economic Cooperation Agreement, up-to-date tariff rates by Harmonized System (HS) codes are provided in a Web-database at [www.apectariff.org](http://www.apectariff.org). From this database, it was possible to identify specific tariffs applicable to fuel injection systems, muffler and exhaust systems, and steering systems.

In addition to tariffs, information on other duties was also collected from the above sources. These other duties include value-added taxes, import quotas and licenses, trade balancing and foreign exchange requirements, local content requirements, restrictions of foreign investment and controls on profit repatriation, and export and foreign investment subsidies.

## **TERMS OF TRADE**

Historically, all nations have sought to manage external trade by erecting a variety of barriers to trade and investment with other nations, to protect special interests within their own economy, and to raise revenue for the general treasury. The principal protection and revenue source has been taxes applied to the value of imported goods (tariffs or duties, together with port taxes, customs processing fees, etc.). Occasionally, exports have also been taxed, largely to raise revenue. There also have been a variety of non-tariff barriers, including import quotas, trade-balancing requirements, foreign-exchange restrictions, local-content requirements, and restrictions on foreign investment and related dividend repatriation.

In addition to restricting trade, some nations have sought to stimulate trade by subsidizing foreign investment and exports, both largely because of their positive effects on job creation.

Whether we consider protection, subsidies, or both, these measures affect and distort investment and production decisions for automobile assemblers and parts manufacturers, because they alter the basic economic parameters of these decisions. They must be quantified to the extent possible and incorporated in the models being used in this study.

In recent years, the various negotiating rounds of the General Agreement on Tariffs and Trade (GATT) have tended to standardize the terms of trade, eliminate non-tariff barriers, lower the level of tariffs, and provide for enforcement mechanisms and remedies for

violations through the World Trade Organization (WTO). GATT has also attempted to reduce subsidies, but it is unclear how much progress has been made.

The growth of regional trade associations, such as the European Customs Union, the North American Free Trade Agreement (NAFTA), the Southern Common Market (MERCOSUR) Agreement in South America, and the nascent Asia Free Trade Agreement (AFTA) in Southeast Asia, operate within the framework of GATT. In most cases, regional trade areas are seen as complementary to GATT, resulting in faster progress in liberalizing trade than would be possible under GATT alone, although there may be exceptions. Regional associations tend to result in diminished tariffs within the trade areas, eventually reaching zero, for goods produced within the trade area with sufficient local content to qualify as "locally produced." They also provide for standardized external tariffs for goods that do not qualify or are produced wholly outside the trade area. These may erect temporary barriers to free trade between the trade area and the rest of the world.

Because each nation has its own terms of trade, some simple and some exceedingly complex, it is difficult to collect all the terms of trade in a simple table. We have attempted to capture the more uniform tariffs and other terms of trade for all the countries in this study at the end of this Appendix. Also at the end of this Appendix, we include a more detailed listing of terms of trade for the 7 countries that we focus on in building the mathematical models.

### **Tariffs**

Tariffs are applied as a percentage tax rate on the value of imported goods. Each country specifies how goods will be valued for this purpose. The most common valuation basis is called CIF (Cost, Insurance, and Freight), which means all the costs incurred in producing the goods and transporting them to the port of entry. Other valuation methods include FOB (Free on Board), which means all the costs of producing the goods and transporting them to the port of departure, including the cost of loading the vessel, but not

ocean freight and ocean insurance. Declared value, based on competitive analysis, is used by only a few nations.

### **Other Duties**

Many countries have in the past imposed special duties beyond the basic tariffs, sometimes to cover specific costs incurred in processing imports, but more often as additional hurdles to achieve various managed-economy objectives or to placate domestic interests. The automotive industry has been especially vulnerable to add-on duties reflecting national objectives to create an indigenous auto manufacturing and assembly industry and to restrict competition from import vehicles and components.

Under GATT, many of these special duties have been or are being abolished. As a signatory to GATT, a country agrees to consolidate all its tariffs into a single rate for each product, eliminate non-tariff barriers, and adopt uniform and transparent rules governing tariffs.

Nonetheless, some countries still maintain special port taxes. Of special interest in this study are the add-on duties in India. (See chart at the end of this appendix)

### **Value-Added Taxes and Their Effect on Tariffs**

Value-added taxes (VAT) are widely used outside the United States as the preferred form of sales or consumption taxes. In a VAT system, at each tier of the production chain, the tax is applied to the total value of the output of that tier and becomes part of the price of the product being sold to the next tier of production. At each tier (firm), a rebate is given for the value-added tax included in all the input material purchased by the firm. The net VAT paid to the government by that firm represents only the VAT rate applied to the difference between its selling price and its material costs (its "value added," which is the firm's labor and profit). At the point of final sale, the seller collects the entire VAT from the consumer.

In some VAT countries, a single VAT rate is applied to all products, although there may be certain products (such as food or drugs) that are exempt from VAT. Some countries, however, have different rates for different products.

Generally, VAT applies to all products, whatever their source, imported or domestic. Some special rules apply, however, to imports and exports. The exporting firm does not assess VAT on the exported product, but claims a rebate for all the VAT charged to it on its material purchases. It is often said this practice is how a VAT system stimulates exports. The importing firm, on the other hand, is liable for VAT on the total value of its imported purchases, including duties, other port taxes, and excise taxes and that drives up the taxable base of the import product.

In this study, the cost of domestically produced parts is compared with the cost of imported parts. VAT is equivalent on the base cost of the two parts, but an imported part carries the burden on the incremental VAT assessed on the duty, other port taxes, and excise taxes, if any. The equations in this study are adjusted for this effect.

### **Import Quotas and Licenses**

Import quotas are numerical limits imposed on the importation of products, usually without reference to country of origin. These are fairly common for built-up vehicle imports into less developed countries, but are relatively uncommon for components, except engines. Import quotas result generally from three motivations: a desire to reserve the national market for an infant local auto manufacturing and assembly industry; a belief that the national economy cannot afford the importation of goods viewed as luxuries (and the foreign exchange required to pay for them); and an intent to limit the environmental effects of large internal combustion engines.

### **Trade Balancing and Foreign Exchange Requirements**

Some countries require importers to balance their imports with exports of comparable value. The requirements stem from job-protection or -creation motivations and from the desire to control foreign exchange outflows. In some instances, the requirement will state explicitly that the import of built-up vehicles must be offset by the export of locally manufactured parts.

Mexico has historically had elaborate schemes of trade balancing and foreign exchange requirements, as well as import quotas and licenses, to protect its auto industry from U.S. domination. Under NAFTA, the requirements are continued, at diminishing levels, during a ten-year transition period (from 1994), for goods meeting the North American Rule of Origin tests, but by 2004 these requirements go to zero, for the most part. They remain indefinitely for imports from non-NAFTA countries and any products not meeting the Rule of Origin requirement.

### **Local Content Requirements**

Local content requirements may be imposed as an absolute requirement for imports or as a hurdle for qualifying for a preferential tariff rate.

In any complex product, local content is built up in the various stages of production in multiple supplier tiers. The rules for what counts as local content can be complex. In some cases, if a purchased component has more than 50% local content, the buyer of the component may count it as wholly locally produced when figuring the local content of the assembly that includes it. This is called "roll up." On the other hand, a component with less than 50% local content may count as nothing in the next tier's local content calculations. As a result, the final assembler or original equipment manufacturer (OEM) generally makes local content calculations in its sourcing decisions. The OEM then tells the suppliers how much imported content it will tolerate in components it is purchasing. Needless to say, the sharing of cost data, broken down between locally produced and imported parts, is a sensitive subject between buyers and sellers, and it is difficult for OEMs to collect precise data on local content.

The implication for this study is that it is not possible to include local content as a general factor in the model, even though in real-life cases, local content rules for a country may affect the cost trade-offs.

### **Restrictions of Foreign Investment and Controls on Profit Repatriation**

Some developing countries want to encourage foreign investment and some to discourage it, usually because their goal is to establish and protect locally owned manufacturing industry. In recent years, as globalization of the economy has proceeded, restrictions of foreign investment have diminished. The most common restrictions provide that foreign investors may not own controlling interest in the firms in which they invest; that is, they must have a local partner in their investment, and the local partner must maintain controlling equity. Controls on profit repatriation (dividend payments to foreign investors) usually stem from foreign exchange concerns and often limit foreign payouts to the amount of foreign exchange earned on export operations.

### **Export and Foreign Investment Subsidies**

Countries eager to establish manufacturing industries, increase indigenous employment, and earn foreign exchange sometimes provide various export subsidies. These can take the form of direct incentive payments on exported goods, rebate of taxes paid in the production chain, low interest loans for plant and equipment acquisition, government guarantees on borrowing, holidays from property taxes on new plant investments, and partial relief from income taxes.

In summary, the tariffs and duties discussion indicates that it is extremely difficult to account for all tariffs, duties, and any other added costs in the model, especially highly variable ones. We have made every attempt to use actual data or, where actual data was unavailable, reasonable estimates for the model.



