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The economic value of supplier working relations with automotive original equipment manufacturers

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THE ECONOMIC VALUE OF SUPPLIER WORKING RELATIONS WITH AUTOMOTIVE ORIGINAL EQUIPMENT MANUFACTURERS

By

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Dedication

I would be remiss not to mention the greatest contributor to this effort, my wife, Krista. The support she gave me during the process and the patience she demonstrated were the reasons this was possible. Without her encouragement and constancy, I doubt I would have been able to complete this study. After countless evenings and weekends spent in quiet contemplation, I would like to dedicate my work to her.

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Abstract

Do the different approaches automotive Original Equipment Manufacturers (OEMs) take to working relations with their suppliers affect economic variables that impact bottom line results? This study is focused on exploring this question through four hypotheses:

1. Cooperative-trusting relationships lead to reduced costs of sourced materials and overhead.
2. Cooperative-trusting relationships lead to increased levels of innovation with a lower investment in research and development.
3. Cooperative-trusting relationships lead to improved product quality.
4. Cooperative-trusting relationships lead to better resource management of inventory.

Statistical Analysis Software (SAS) was used to perform regression analyses on panel series data. All four hypotheses were proven to a statistical significance of at least 0.10. These results provide the empirical data necessary to substantiate the anecdotal evidence that cooperative-trusting supplier relationships provide economic value. The working relationships automotive OEMs have with their suppliers affect economic variables that impact bottom line results and competitive advantage.

Table of Contents

List of Figures

Chapter 1: Introduction and Background

Introduction

Do the different approaches automotive Original Equipment Manufacturers (OEMs) take to working relations with their suppliers affect economic variables that impact bottom line results? There are substantial differences between the supplier relations approaches taken by the different Automotive OEMs. There is a range of supplier relations approaches with extremes on both the adversarial and *cooperative-trusting* sides. Adversarial approaches are typically characterized by a lack of trust, communication, cooperation, equality, or some combination of these (Dyer 2000; Stallkamp 2005a). Conversely, cooperative-trusting approaches generally have open and transparent lines of communication and close collaboration; are predictable, consistent, and fair; and involve relevant parties working jointly as a single team with shared responsibility and accountability (Winter 2004; Stallkamp 2005a).

There are widely divergent views as to whether cooperative-trusting OEM-supplier relations are worth the effort to develop and maintain versus more adversarial approaches. Academic literature and the trade press substantiate the efficacy of cooperative efforts, as there are many published articles pronouncing the benefits of cooperative relations in the working environment. Some of the benefits of a cooperative approach include cost savings for all parties, less complex and costly procurement negotiations and administration, shorter product development cycle times with greater innovation, increased flexibility, enhanced quality, and even next-generational competitive advantage (Clark 1989; Noordeweir, John et al. 1990; Helper and Sako 1995; Dyer 1997; Dyer and Chu 1997; Sheth and Sharma 1997;

Hacker 1999; Pecaut and Gordon 1999; Vonderembse 2002; Liker and Choi 2004; Segil 2004; Stallkamp 2005a).

Despite the abundance of anecdotal evidence and some related studies, many manufacturers are not convinced, and they argue that more adversarial approaches yield greater benefits with far less effort. Such skepticism is well founded. In fact, there is a lack of both economic metrics and empirical evidence to substantiate the assertion that cooperative-trusting OEM-supplier relationships leads to bottom-line economic results worth the investment (Liker and Choi 2004). Despite the anecdotal advantages, an empirical analysis of supplier working relations is necessary to demonstrate the economic implications and substantiate the benefits. The purpose of this study is to provide the quantitative analysis of the value of cooperative-trusting relations for automotive OEMs.

Problem Statement

Due to the scarcity of statistically significant data linking OEM-supplier relations to hard economic benefits, firms cannot select a relationship approach based upon the potential returns. This situation can lead to firms selecting suboptimal supplier relation approaches due to the lack of knowledge. The effects of supplier relation approaches and the implications for a firm's competitive advantage likewise cannot be fully appreciated without an empirical study on the effects of supplier working relations with OEMs.

Without measuring the economic value of supplier relations, firms are unable to accurately justify an appropriate supplier relation approach. Until supplier relation approaches can be compared with relevant and related metrics, an economically driven argument cannot be made for employing cooperative and trusting supplier relation efforts.

The significance of this argument is exacerbated by the growing importance of suppliers in OEM competitiveness.

Market trends have transformed the automotive industry from vertically integrated hierarchies to integrated networks of suppliers providing larger and more complex production components and services. Supplier relation strategies have likewise evolved, but measurements of the potential benefits of the approaches are not available. In many cases, OEM approaches to supplier relations have not evolved to match the market's shift. The dissemination of increasingly larger responsibilities to suppliers has created a need for OEMs to work *with* their suppliers to improve overall productivity, effectiveness, and efficiency through cooperation (Dyer 2000).

In fact, many scholars now argue that competition in industry has changed from company versus company to supply chain versus supply chain (Fine 1998; Dyer 2000; Rice and Hoppe 2001; Vonderembse 2002; Zhang, Dong et al. 2003; Liker and Choi 2004; Ndede-Amadi 2004). Indeed, suppliers typically provide goods and services that account for 50 to 70 percent of an OEM's total expenses to produce an end product (Dyer 2000; Tangri 2004). Supplier management has become more important due to this trend (Kim and Michell 1999) and has spurred considerable research into improving supply chain management. Despite the emphasis on supply chain management, most of the research has been focused on analytical approaches, while the area requiring the most work is in managing supplier relationships (Handfield 2004b).

Rather than analyzing individual characteristics such as trust or communication between suppliers and OEMs independently, a more accurate and realistic approach is to analyze the full range of supplier working relations. The range of trusting cooperative

relations as measured by Planning Perspectives Inc. Working Relations Index (WRI) (Henke 1990; Liker 2004; Liker and Choi 2004; Flynn 2005; Stallkamp 2005a) includes five components focusing on Relationships, Hindrance, Communication, Help, and Profit Opportunity, each of which are composed of variables that help to quantify the OEM-supplier working relation.

The WRI measures the quality of the overall OEM-supplier working relations, ranging from adversarial to cooperative and trusting. Using the WRI as a proxy for the quality of OEM-supplier working relations, an analysis of the effect of supplier working relations can measure the impact of the various supplier relation approaches of the automotive OEMs. The relative WRI scores for 2000-2004 are displayed in Fig. 1.

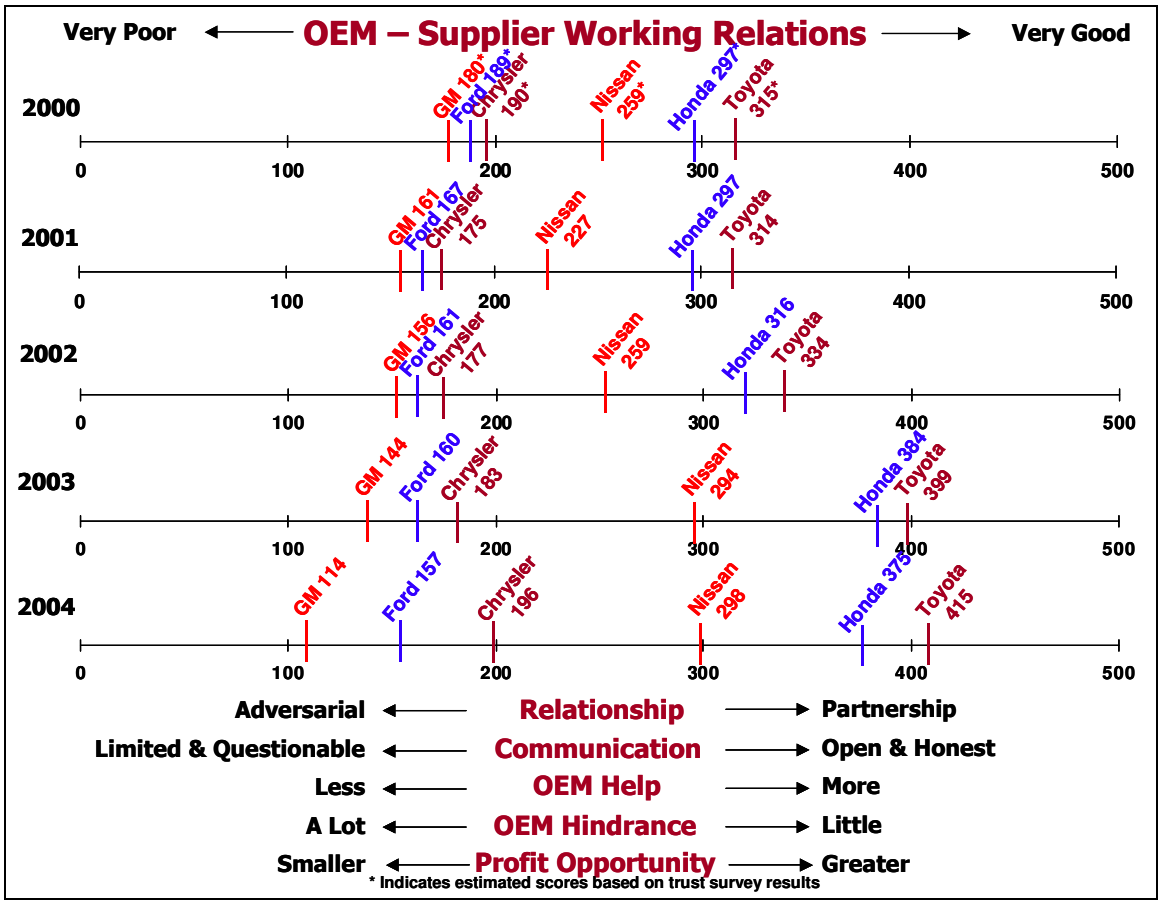


Fig. 1. WRI results representing years 2000-2004, courtesy of Planning Perspectives Inc.

Hypotheses

The benefits expected from a cooperative-trusting approach to supplier working relations are in the areas of cost, product development and innovation, quality, and flexibility in resource utilization. To explore these expected benefits, this study is focused on four main hypotheses. The hypotheses are

1. Cooperative-trusting relationships align trading partners in a system cost reduction approach, which leads to reduced costs of direct sourced materials and lower overhead costs managing suppliers.

2. Cooperative-trusting relationships leverage supplier relationships and investments, which leads to increased levels of innovation with a lower overall investment in research and development.
3. Cooperative-trusting relationships foster collaboration and an emphasis on end product quality, which leads to improved product quality.
4. Cooperative-trusting relationships enhance coordination between trading parties, which leads to better resource management of inventory.

This study recognizes that the approach OEMs take to their trading partners affects more than just these hypothesized areas. However, it is outside the scope of this study to address the less quantitative effects of relationships.

Purpose of the Study

The objective of this study is to provide a quantitative assessment of the economic value of cooperative-trusting OEM-supplier relations in the automotive industry. In achieving the objective, the study will meet the following goals:

- Determine the relationship of economic variables with characteristics of cooperative-trusting OEM-supplier relations;
- Develop metrics that relate economic benefits to specific OEM-supplier relationship characteristics;
- Describe the potential mechanisms by which OEM-supplier relations create economic value; and
- Determine the degree to which economic benefits are gained or lost as the characteristics of cooperative-trusting OEM-supplier relationships change.

Justification and Significance

In meeting this purpose, the study will provide multiple significant benefits for both industry and government, including the following:

- Understanding of the implications of manufacturer relations approaches on related economic variables when working with suppliers;
- Justification for resource allocation to create and maintain cooperative and trusting OEM-supplier relations; and
- Direction for improving specific areas of OEM-supplier relations and supply chain management activities to maximize the opportunity for economic gain under conditions of cooperative-trusting OEM-supplier relations.

The theoretical framework for this thesis is based on the economic value of assets, in which the relationship approach an OEM selects is considered an asset. The basic theory of assets indicates that a rational economic actor (the OEM) would be willing to pay/spend anything up to the discounted present value of the stream of net benefits that it would generate. In the case of this thesis, the benefits are derived in the four hypotheses. With more cooperative-trusting relations, OEMs will benefit with lower costs, higher innovation with lower investments, better quality, and enhanced inventory/resource management.

When considering which approach to *buy*, OEMs would consider the relative cost to benefit ratios of the various approaches. OEMs can assess the relative benefits of approaches by starting at a completely adversarial approach and incrementally evaluating the marginal benefit gained as the approach becomes more cooperative-trusting. The present value of each approach must be evaluated as well. Since the expected benefits of cooperative-trusting

relationships include both short and long term benefits, the present value needs to be estimated with a discount rate and risk premium (since the future benefits of relationships are probabilistic, not guaranteed). As a rational economic actor, an OEM would select the mixed approach that provides the maximum value over the estimated lifetime of the relationship.

This study builds on the theory of assets by providing a model for evaluating the relative benefits of cooperative-trusting relationships between OEMs and suppliers. OEMs can assess their current approach and the marginal benefits possible with alternative approaches with an estimate of the value gained through cooperative-trusting relations.

Chapter 2: Review of Related Literature

There is a distinct division between the supplier relations approaches taken by domestic US automotive OEMs and Japanese Foreign Domestic OEMs (the North American Japanese automotive OEMs Toyota, Honda, and Nissan). Numerous studies have addressed the disparities between Domestic and Japanese automotive OEM approaches to relationships, but few attempt to empirically demonstrate the benefits of cooperative and trusting OEM-supplier working relations (Dyer and Chu 1997). According to some, long-term, closely linked relationships have performance advantages for automakers and their suppliers in both the United States and Japan (Helper 1991; Helper and Sako 1995). Indeed, experts agree that corporations should build close-knit networks of suppliers that work together to provide value to both parties (Vonderembse 2002; Liker and Choi 2004).

Domestic US automotive OEMs (General Motors, Ford, and DaimlerChrysler) have historically maintained adversarial relations with their suppliers, with few exceptions, since the early 1900s (Asanuma 1989; Helper and Hochfelder 1995; Mudambi and Helper 1998; Liker and Choi 2004; Flynn 2005). The short-term benefits of adversarial practices have immediate and quantifiable results, which fuel their continued application. Long-term costs are rarely a concern to Domestic OEMs because stockholders and management emphasize current performance. For example, domestic automakers are about four times more concerned with cost than quality, while Foreign Domestic OEMs are more balanced (Webster 2003). Even though domestic firms have made attempts to build better superficial supplier interactions, it has been largely unsuccessful, particularly in creating the

fundamental elements of the relationships (Helper 1989; Helper and Sako 1995; Liker and Choi 2004).

Indeed, a 1991 study of supplier relations with domestic and Foreign Domestic OEMs indicated that suppliers are more than twice as likely to expect domestic OEMs to behave opportunistically if given the chance, and other studies echo this notion (Dyer, Cho et al. 1996; Dyer 1996a; Kim and Michell 1999). Even the General Motors vice president for Worldwide Purchasing, Production Control & Logistics, Bo Andersson, stated at the 2004 Auto-Tech conference that the relationship between GM and its suppliers is "occasionally dysfunctional" (Murphy 2004).

Conversely, Japanese and Foreign Domestic OEMs (Japanese OEMs with major operations in North America, i.e., Toyota, Honda and Nissan) traditionally have more cooperative and trusting relationships with their suppliers (Mudambi and Helper 1998; Kim and Michell 1999; Dyer 2000). Specifically, survey results indicate that Japanese OEMs are better communicators, are more trustworthy, and are more concerned with the economic viability of suppliers than domestic OEMs (Liker and Choi 2004). Similarly, a 2003 J.D. Power and Associates study also found that suppliers believe that Japanese OEMs, particularly Toyota and Honda, are adept at promoting innovation while domestic OEMs were below average in their ability (Liker and Choi 2004). The dominance of the Japanese OEMs in the recent market likewise seems to indicate that supplier relations may have a role in their competitive advantage. In fact, a study has shown that cooperative and trusting OEM-supplier relations will support technology sharing from suppliers, greater supplier investments into new technology, and higher quality products with improved levels of service (Szczesny 2004).

Despite the qualitative research that has been done to date, both sides point to conventional wisdom that supports their approach. Adversarial proponents have the advantage of tangible, short-term results to assess the value of their approach. Cooperative-trusting advocates, however, have had to rely upon anecdotal evidence and possible indicators to support their decisions. The literature reviewed presents the arguments of both sides and serves as the foundation for this study.

Adversarial Relations

Adversarial approaches that organizations take with their suppliers are characterized by a lack of trust, dedicated assets, communication, cooperation, equality, or some combination of these (Dyer 2000; Stallkamp 2005a). Adversarial approaches typically look to minimize dependence on suppliers, maximize bargaining power, and avoid commitment (Kim and Michell 1999). Adversarial approaches typically result in adversarial relations that are distinguished by arms-length interaction including, but not limited to, rigidly defined product and process specifications, constricting legal contracts, little information sharing (including production schedules), lack of trust, multi-sourcing with the intent of creating intense competition, and short notice supplier changes for price advantages (Morris and Imrie 1992; Dyer 2000).

In many cases, adversarial relations are not explicitly chosen. Rather, organizations tend to be driven towards adversarial relations by market factors, competition, incentives, and basic business realities though there are exceptions (Flynn 2005). Typically, adversarial relations are driven by four major business factors: distrust, poor communication, limited planning, and constant vying for control (Stallkamp 2005a). These factors create friction

between organizations that lead to inefficiencies, which add costs to business operations, slow down responses to market changes, and create barriers to change and improvement.

Adversarial relations do not stop at direct suppliers. Indeed, adversarial practices that are imposed upon OEM first tier suppliers are used against their second tier suppliers as well (the first tier suppliers' suppliers) (Kobe 2001, March). First tier suppliers tend to argue that adversarial relations with their suppliers are adopted to meet the demands of their customers (Flynn 2005). Typically these costs are just transferred to lower tier suppliers, sometimes causing them to go out of business, and are not removed from the system (Segil 2004; Hanley and De Koker 2005).

These adversarial approaches are not just theoretical; they are demonstrated by several automotive OEMs, particularly the Domestic OEMs. Supplier surveys indicate that domestic US automakers are often seen as *abrasive* in their price reduction efforts, not as collaborative with product development matters, and less willing to share savings from cost reduction efforts compared to more cooperative Japanese and Foreign Domestic OEMs. The typical adversarial approach for automotive OEMs to reduce costs is to increase competition to motivate existing suppliers to incrementally improve, force suppliers to reduce slack in their operations, and to switch business to cheaper suppliers if available (Helper 1997). Ford and General Motors have both used these adversarial approaches to compel suppliers' price reductions (Asanuma 1989).

As a result, suppliers indicate that they continue to provide more cooperative and trusting automakers with higher quality parts, new technology, and cost-cutting strategies, which may be contributing to the competitive advantage of Foreign Domestic OEMs (Webster 2003). Indeed, suppliers' willingness to share new technology with OEMs is

impacted by the OEMs' policies and approaches with suppliers. For example, a new policy issued by Ford in January 2004, similar to a GM policy, states that with new contracts, suppliers must allow the OEM to share auto-parts technologies with other firms in the Ford group (WallStreetJournal 2004, August 24). With intellectual property rights so explicitly endangered, suppliers may certainly be less willing to share their newest products with this customer.

The value of adversarial relations. Adversarial relations, while slighting future returns, do offer some immediate benefits. Adversarial OEMs have used market dependencies to demand price reductions from suppliers, leveraging the oligopsonistic market (market with multiple suppliers and a limited number of customers that tends to give more power to the customers) that existed since the 1920s, in which few buyers were available for multiple suppliers to sell their products to (For example, only one OEM has a need for Explorer power trains). Suppliers competed viciously for OEM business and were willing to actually take losses to maintain their business.

While some price reductions could be expected with scale economies and learning curves, most adversarial OEM price reductions did not follow such models but were instead arbitrary. OEMs have been known to demand immediate 5% price decreases from all supplied parts or to pay suppliers only 95% of their invoices and mark them paid in full. For example, General Motors used intense supplier competition and price reduction demands in the early 1990s to generate a very tangible savings of around $4 billion (Kim and Michell 1999). The immediate returns are obvious, but the long-term costs are hidden.

In addition to immediate benefits, some OEMs assert that the cost of maintaining adversarial relations is relatively low compared to trusting cooperative relations (Stallkamp

2005b). This is half true since little to no effort is required to support minimal communication and mistrust, which is a savings compared to communication-rich cooperative relations. However, the cost avoided by maintaining minimal relations is not entirely saved because of the large amount of effort expended reacting to problems that arise because of poor communication. The costs of redesigning parts through Engineering Change Notices (ECNs), late shipments, incorrect quantities, and poorly coordinated product development are rather substantial and likely cost more than the savings from reduced relationship maintenance.

However, the way OEMs have leveraged suppliers to force cost reductions may be changing. The market dependencies have shifted with the growth of Foreign Domestic OEMs, and suppliers have begun to exercise their options by pursuing business with more cooperative customers (Parker 2003). Indeed, there is a trend that bilateral OEM-supplier power is shifting more to suppliers, creating a more balanced environment in which suppliers are not forced to accept OEM mandates (Flynn 2005). As one supplier executive puts it "We're not a charity, we're a business. And we understand [OEM] issues, but [the OEMs] have to understand [the suppliers']. We have to be profitable or we can't put capital in this business." This attitude is becoming more common as suppliers are now able to pick and choose their customers for their limited capacity.

The costs of adversarial relations. Adversarial relations are short-term oriented to increase competition and enable OEMs to switch suppliers to a supplier with lower piece prices (Flynn 2005). However, switching suppliers is expensive and risky and can endanger supplier investments in R&D and tooling (Sherefkin 2003). Another cost associated with changing suppliers through adversarial actions is the replacement costs of finding and

training new suppliers, particularly in instances where suppliers are highly customized to specific, complex business such as automotive parts (Segil 2004). There can be additional costs to changing sources that aren't easily tracked, including unknowns such as quality and the cost of poor quality, component overall fit into end product, warranty costs, problem resolution timeliness, flexibility, and engineering support to name a few.

Adversarial relations are exacerbated and sustained by short-term transaction-oriented attitudes. In these cases, immediate price reductions are rewarded internally, while long-term investments are typically viewed as unfavorable versus more immediate returns. Short-term oriented approaches may come from the way OEMs measure their objectives. Procurement areas are measured by how much they spend and how much they are able to reduce their piece part prices.

The immediate gains from adversarial actions are often made by sacrificing future costs in the way of warranties, product development, tooling, and capital equipment with suppliers (Stallkamp 2005a). Many of these costs are not only incurred by the OEMs, but suppliers too are negatively impacted by short-term approaches. Indeed, many automotive suppliers have gone out of business due to a lack of profitability, partly caused by OEM price reduction mandates (Fig. 2).

2000	2001	2002	2003	2004	2005
•Key Plastics •Cambridge Industries	•Talon Automotive •Mexican Industries •A.G. Simpson •Hayes Lemmerz •Federal Mogul	•Valeo •Harvard Industries •Aetna Industries •Exide Technologies •DCT •GenTek	•Insilco •Venture Industries •Atchinson Casting •Precision Tool & Die	•Veltri Metal •Citation •Intermet •Amcast Industrial •Oxford Automotive	•Tower Automotive •EaglePicher •Meridian •Collins & Aikman •Delphi

Fig. 2. Timeline of North American supplier bankruptcies.

The effect of the short-term orientation is to create an environment in which suppliers have no opportunity to recover their investments because their contracts are subject to cancellation with little recourse. For example, General Motors instated a contracting clause that gives suppliers 30 days to match a rival's lowest price, or else GM can terminate their business with no liability. If this approach continues into the long run, automakers could experience a decrease in vehicle quality as they lose their innovative and high-quality suppliers and are left with less experienced suppliers that only offer lower piece prices (Parker 2003).

Suppliers play a major role providing goods and services that help create an organization's competitive advantage. However, if suppliers are focusing their efforts strictly on reducing piece price, their decisions may negatively impact other areas of business performance such as quality or innovation (Vonderembse 2002). Similarly, suppliers treated with adversarial relations are unwilling to invest in customer specific technologies and equipment because adversarial OEMs typically reserve the right to transfer production to the

lowest cost supplier on short notice (Appleby and Twigg 1988; Morris and Imrie 1992; Helper 1997).

Adversarial relations are marked by poor communication and a lack of coordination, which typically lead to late and unplanned engineering changes. These late and unplanned engineering changes can impact not only suppliers' costs but also, to a greater extent, the costs of the OEM. Indeed, these changes lead to costs for slowed production and excess work and rework for expediting logistics and material handling (Pecaut and Gordon 1999). A lack of trust can exacerbate information-sharing problems, as suppliers are generally unwilling to share important information if they do not trust the OEM to work cooperatively with them (Dyer and Chu 1997).

The use of arbitrary price reduction demands is a prevalent and destructive form of adversarial relationships. In the automotive industry, uncooperative OEMs typically prefer to generate quick savings by demanding that suppliers reduce the price of their products by a specified amount (Sherefkin 2003). These price cuts are rarely directed towards reducing actual supplier costs or system costs; rather, they reduce supplier margins. The system costs remain, and they will reappear deeper in the supply chain and eventually work their way back up to the OEM. The price reductions demanded by domestic OEMs have historically been used to help control their own costs (Parker 2003). In addition to demanding larger price reductions, domestic OEMs typically leave it up to their suppliers to absorb the reductions, whereas Foreign Domestics generally assist in their suppliers' improvement efforts (Cleveland 2004).

The practice of arbitrarily reducing prices not only eats into supplier margins, sometimes making products unprofitable, but it also rewards suppliers that are not the most

trustworthy. For example, suppliers that give their best price to OEMs are punished for doing so when they are required to further reduce prices, making the business unprofitable. To remain viable, these suppliers look for ways to make up for the lost revenue. However, suppliers that inflate prices are able to absorb cost reductions without impacting their bottom line. This creates the cycle of suppliers inflating prices, and OEMs demanding price reductions, with the more dependent side on the short end.

It has even been reported that suppliers providing a component to domestic OEMs costs the supplier eight (8) percent more on average than supplying a similar part for Toyota or Honda. Some potential causes of these higher costs include higher administrative costs from extra meetings, more paperwork, and unnecessary negotiations and haggling (AutomotiveNews 2005). Particularly, the impact to transaction costs can be decomposed into four costs of transacting: Search Costs, Monitoring Costs, Contracting Costs, and Enforcement Costs (Dyer and Chu 1997). Lorenz also indicates that transaction costs are directly linked to the possibility that partners will behave opportunistically (Lorenz 1988). Indeed, suppliers indicate that much of their time and money is wasted with writing exceptions to domestic OEM terms and conditions that are subject to change at any time (Kobe 2001, March). For example, historic contracts from domestic OEMs ranged from 24-30 pages, while Toyota and Honda have purchase agreements of essentially terms and conditions that are only 8-10 pages long.

Cooperative Relations

Cooperative and trusting relations are relationships that have open and transparent lines of communication and close collaboration, are predictable, consistent, fair, and involve relevant parties working jointly as a single team with shared responsibility and accountability

(Winter 2004; Stallkamp 2005a). Trusting and cooperative relationships are not *soft*, *cozy*, or *touchy-feely* relationships in which partners are allowed to take advantage of each other. Instead, trusting and cooperative relationships are typically more demanding and more disciplined than adversarial relationships. The objective of fostering cooperative and trusting relations with suppliers is to create a cohesive supply chain where all partners understand how their participation contributes to the end goal (Vonderembse 2002).

One hypothesis is that cooperative relationships will have strong elements of trust to offset vulnerability and dependability, while adversarial relationships will be lacking trust due to the reliance on formal regulations (Mudambi and Helper 1998). Trust between OEMs and suppliers is the foundation of effective cooperative relations (Poirier 1999). Indeed, all relationship-building activities are founded on trust, and supply partnerships are held together by trust (Fawcett and Williams 2001).

Many equate the Toyota and Honda approaches to supplier relations as exemplary of cooperative and trusting relations, and even traditional North American suppliers prefer to do business with them over domestic OEMs (Winter 2004). Indeed, Japanese automaker performance is attributed in part to their long-term relationships with suppliers, high levels of information exchange, joint problem solving, and "governance by trust" (Dertouzos, Lester et al. 1989; Smitka 1991; Cleveland 2004). An analysis of the partnering model employed by Honda and Toyota revealed that although different actions are taken, there is a common foundation underpinning the relationships. The underlying steps to the Japanese approach to cooperative and trusting supplier relationships are (Liker and Choi 2004)

- "Understand how the supplier works;
- Transform competition into opportunity;

- Supervise suppliers;
- Develop supplier capabilities;
- Share relevant information intensively; and
- Improve operations together." (107-108)

The Japanese procurement approach is generally based on long-term *strategic* partnerships rather than the short-term contracting, which has been typical of the U.S. automotive industry (Smitka 1990). A study (Wasti and Liker 1997) found that the average length of the relationship between suppliers and buyers in the Japanese automotive component industry was 22 years. Even though the long-term relationships reduce leverage with suppliers, Japanese OEMs are able to achieve greater efficiency through their consistent relations (Helper 1990). The OEMs maintained competition between 2-4 suppliers, but provided each with enough business to maintain their economic viability (Sheth and Sharma 1997). Generally, these relations are more likely to avoid making demands that would negatively impact supplier economic viability (Flynn 2005). This approach is taken to make sure that suppliers are profitable enough to invest in future technologies and improve performance while maintaining an environment with motivation to innovate (Kobe 2001, March; AutomotiveNews 2005).

Despite the Japanese reputation for superior supplier relations, domestic OEMs have also been able to develop strong cooperative and trusting relations with suppliers. Perhaps the paramount example of effective domestic relations was demonstrated by Chrysler during their Supplier Cost Reduction Effort (SCORE), in which the characteristics of a collaborative relation were in place with suppliers (Kobe 2001, March). Between 1991 when first introduced and 1998, Chrysler leveraged supplier suggestions to reduce costs by $5 billion

just through SCORE alone. However, one of the surprising advantages was that suppliers were able to improve their profit margins and devote more of their internal funds to advancing Chrysler-specific products and processes that further increased enterprise efficiency (Dyer 1996b). Indeed, any savings generated by suppliers were split in half between the OEM and suppliers, so there was a definite incentive for suppliers to find these opportunities. Suppliers were trusted to share their savings equitably, and that trust spoke volumes to suppliers that were typically accustomed to being audited by OEMs, an adversarial and untrusting approach (Stallkamp 2005b).

Unlike traditional cost reduction programs, Chrysler engaged suppliers as peers and used their intimate knowledge of their parts to reduce costs equitably and fairly. The improvements realized by SCORE were not just immediate savings but were permanent and improved operations year after year. Another noticeable savings was that suppliers accepted increased responsibility for design, which reduced Chrysler costs for product development while increasing the rate of innovation. In 2000, Chrysler had the lowest percentage of sales dedicated to research and development for new products, while their time to market for new introductions improved (Stallkamp 2005a).

The value of cooperative relations. Cooperative and trusting supplier relations are reported by many to provide a competitive advantage by providing substantial economic value. Studies into components of trusting and cooperative supplier-buyer relationships indicate that trusting relationships reduce transaction costs and increase information sharing between parties (Dyer 1997). Additional findings suggest that not only are the benefits present, but they are substantial as well; in some cases transaction cost differences exceeded a magnitude of five times the cost (Dyer and Chu 1997). These findings tend to indicate that

trust in supplier working relations with their customers reduces the amount of time spent in unnecessary haggling and blame games, as well as other time-consuming activities that add no value to operations. Additionally, suppliers tend to invest more of their own resources and dedicate better employees to their better customers that reward supplier efforts (Flynn 2005). The longer-term relationships provided by cooperative and trusting relations enable suppliers to invest in their specific relationship with the OEM with more confidence (Morris and Imrie 1992).

Close collaboration is particularly critical during early new product development when concepts begin to take shape into designs. The early involvement of suppliers during product development has been demonstrated to provide a competitive advantage to Japanese automakers in introducing new products faster and with less effort than domestic OEMs (Clark 1989). For example, Japanese firms such as Toyota or Honda need only 12-18 months to design a new vehicle, where as domestic OEMs typically require 2-3 years (Liker and Choi 2004).

Chrysler has also leveraged supplier capabilities in product development to save costs while developing the Plymouth Prowler. The frame development work-sharing benefited both organizations; Chrysler saved five million dollars in research and development costs, and Alcoa gained additional business by showcasing their new technologies to other customers such as Audi (Stallkamp 2005b).

Indeed, the benefits of supplier relationships are valued so much by Japanese OEMs that neither Honda nor Toyota purchases very much from China for the wage savings, preferring instead the innovation capabilities of their long-term suppliers (Liker and Choi 2004). In fact, a study conducted by Vantage Partners shows that nearly 80 percent of

respondents to a survey said that strong working relationships with suppliers generated 25 percent or more quantitative value (Segil 2004).

Likewise, there are many benefits suppliers can realize from working with OEMs in collaborative and trusting working relations. Some potential benefits suppliers may realize include a guaranteed source of continued business, assistance in developing technology and tooling, purchasing leverage for high volume raw material purchases, managerial and technical assistance, and shared learning and improvement between the parties (Morris and Imrie 1992). Also, suppliers that perform more research and development for OEMs are typically rewarded with a greater portion of final production contracts than other suppliers previously, partially because of concerns for process control, integrated purchasing, and quality assurance (Rawlinson 1990).

The development of cooperative and trusting supplier relationships and commitment are demonstrated to be associated with one another, thus creating a mutually causal relationship (Dyer and Chu 1997; Mudambi and Helper 1998). This relation suggests that once cooperative-trusting supplier relations are created, they will be self-sustaining with potential multiplier effects. Further, it has been found that investments made to create and sustain cooperative and trusting relations simultaneously create economic value within the relationship (Dyer and Chu 1997). Indeed, a study by Pecaut and Gordon indicates that when supplier relationships are managed with demanding yet cooperative-trusting relations ("tough love"), there is generally an 8-10% one-time savings in total supply chain costs and a 3-5% savings each year beyond that (Pecaut and Gordon 1999). Given these associations between cooperative-trusting relationships' ability to self-sustain and provide economic value, firms

that develop cooperative-trusting relations with partners will reap continual economic benefits.

While many support the belief that cooperative and trusting supplier relations provide many benefits, the benefits are generally gained incrementally over time, often lagging implementation of cooperative efforts (Dyer 2000; Vonderembse 2002; Flynn 2005). The time lag can make it difficult to distinguish the benefits from supplier relations from other factors. These confounding factors make it difficult for OEMs and suppliers to discern whether their cooperative-trusting supplier relations are truly providing economic value.

The costs of cooperative relations. The approaches that typically foster cooperative-trusting supplier relations tend to require investments by both OEMs and suppliers to maintain. Particularly, investments to achieve the high levels of information flow necessary to support many of the cooperative and trusting relationship activities can be considerable. Additionally, OEMs and suppliers that invest in cooperative and trusting relations with their partners greatly increase the cost of switching and thus increase their dependence upon their selected partners (Helper and Levine 1992; Helper 1997; Kobe 2001, March). Both OEMs and suppliers are concerned that once they make investments in relationships, their partners may behave opportunistically to take advantage of their increased dependence. Indeed, the domestic OEMs have experiences in which suppliers have taken advantage of trusting relations to underperform or overcharge (Flynn 2005).

Suppliers are likewise concerned with potential costs of investing in cooperative-trusting relations. An element of trusting and cooperative supplier relations is for suppliers to share their cost structures more openly with their partners. In the short-term, this open sharing could reduce a supplier's profit margins while reducing system costs. However, in

the long-term, what was lost in piece price reduction and lower profit margins is made up in additional orders and a more competitive structure to garner more business with other buyers. In addition to increased business, suppliers and OEMs can reduce the amount of time trying to conceal information and creating false reasons for high costs or price reductions (Pecaut and Gordon 1999).

Relationship Approach Selection

Relationships with suppliers are not one-size-fits-all; relationships should be based upon the type of product supplied and the strategic fit of the supplier within the supply chain. It would be cost prohibitive and unnecessary to form close partnerships with all suppliers (Dyer 2000). Similarly, it would be inappropriate to treat strategic suppliers that are critical to competitive advantage as if they were commodity suppliers (Dyer, Cho et al. 1996; Vonderembse 2002). However, there are no cut and dry classifications for all suppliers. According to the Boston Consulting Group, approximately 50-70% of automotive product suppliers are neither strategic nor commodity suppliers to OEMs but are rather a middle group between the extremes (Pecaut and Gordon 1999).

The approach to supplier relationships can impact the costs present within a supply chain. An adversarial approach has an overreliance on attacking and removing variable costs (piece price) that ignores system level costs such as warranties, engineering costs, and research and development (Stallkamp 2005b). Cooperative and trusting supplier relations, however, tend to focus on technical advancements and system costs outside the variable cost of component prices (Helper 1990; Stallkamp 2005b).

In general, the relative benefits of cooperative-trusting relationships are dependent upon the type of industry and type of supplier. Four characteristics of suppliers that likely impact the benefits garnered are

1. The relative complexity of the system being created and the complexity of the components supplied,
2. The amount of engineering support required for the product supplied,
3. The quality requirements for the product, and the relative cost of poor quality, and
4. The necessary level for the reliability of supply for that component.

As these factors become more important to an OEM, the relative benefits of cooperative-trusting relationships increases. In essence, the technical interdependence with suppliers is a good indicator for the need for cooperation and trust. This is not to say that commodity suppliers are throwaway; their relationships still require some level of quality and reliability of supply.

Indeed, there can be too little and too much trust in relationships, where the potential benefits are not realized or the costs can outweigh the benefits and expose themselves too much (Hacker 1999). Extensive communication systems necessary to support cooperative relations can be costly to establish and maintain with multiple suppliers (Helper 1990). Additionally, the exchange of proprietary information can be extremely harmful to a firm's competitive advantage if inappropriately distributed by suppliers or OEMs.

Fluctuations in Relationship Approaches

Many procurement organizations tend to alternate between adversarial and cooperative relationships (Pecaut and Gordon 1999). Suppliers to domestic OEMs were typically managed with an adversarial approach to the point of the supplier going bankrupt, and only then would the OEM assist the supplier in turning a profit. According to the ex-president of the Chrysler group, Thomas Stallkamp, "The system was so screwed up, it was like going out and shooting people until they started bleeding to death, and then put them on intensive care and help them to get better." (Stallkamp 2005b)

Large firms have substantially reduced their number of suppliers, and in some cases suppliers become exclusive with a customer (Sheth and Sharma 1997). The exclusive relationship can increase supplier dependency with a high percentage of output going to a single buyer (Handfield 2004a). OEMs with a cooperative-trusting approach to supplier relationships may use increased dependency to integrate suppliers into new products and daily operations. However, in an adversarial OEM-supplier relationship, the dominant party (OEM) typically applies their economic leverage to dictate concessions without regard for the well-being and economic viability of the subordinate firm. This relation drives a short-term focus that emphasizes immediate gains while ignoring sustainable future growth (Stallkamp 2005a).

Domestic automakers have attempted to create the superficial practices of cooperative and trusting supplier relations; however, they have not successfully created the underlying relationship foundation that makes Japanese OEMs successful in their approach (Helper 1989; Helper and Sako 1995; Liker and Choi 2004). However, one true example of a domestic OEM pursuing a cooperative and trusting approach was the Chrysler's Extended

Enterprise approach, lauded as one of the most successful supplier involvement programs in the automotive industry (Stallkamp 2005a). Nominally similar though fundamentally different, Ford attempted a superficially cooperative approach to reducing supplier prices called Team Value Management, which focused on collaboration among purchasing, design, manufacturing, and suppliers. The objective of the Ford effort was to create more "open and transparent relationships with suppliers" (Parker 2003, 3), including supplier input on purchasing decisions. However, the effect of the Ford program did not noticeably impact supplier perceptions of cooperative spirit.

In contrast, the Japanese automotive industry developed the fundamentals of cooperative-trusting supplier relations over time through strategic alliances and cooperative supplier relations (Smitka 1990). This approach may have been chosen in part to gain the higher quality and lower cost of components associated with long-term supplier relationships versus internal production (Nishiguchi 1994). However, it is apparent that the Japanese Foreign Domestic OEMs took a long-term approach to developing the fundamentals of cooperative-trusting supplier relations. The long-term approach used seems to have garnered a more stable foundation to build closer and more efficient business practices with suppliers.

Chapter 3: Research Design and Methodology

This study builds on the work of Planning Perspectives Inc. (PPI). Over the past 12 years, PPI has tracked a variety of characteristics associated with cooperative-trusting supplier relations across more than 50 companies in four manufacturing sectors. PPI has quantified 17 of these characteristics into the Working Relation Index (WRI). The WRI provides a reliable, widely accepted metric for measuring manufacturer-supplier working relations (Liker 2004; Liker and Choi 2004; Flynn 2005; Stallkamp 2005a).

The WRI includes five components focusing on Relationships, Hindrance, Communication, Help, and Profit Opportunity. Communication indicates the extent to which OEM communication is open and honest; Help defines the amount of manufacturer help provided to suppliers in meeting buyer price and quality demands; Hindrance denotes the degree of manufacturer hindrance that impedes the suppliers' ability to do the best possible job in providing products to the manufacturer; and Profit Opportunity represents the supplier profit opportunity with each buyer.

The WRI characteristics, along with related manufacturer-supplier relationship data that PPI has collected, provide the foundation upon which the project is based. The PPI database is unique in both its breadth and depth of relationship-related measures and subsequently provides a strong foundation for determining the economic value of manufacturer-supplier relationships. This study consists of six basic steps. The general research steps follow.

1. Identify manufacturer-supplier behavioral characteristics that contribute to building cooperative-trusting working relations;

2. Identify the economic benefits that are or could be realized by the involved parties;
3. Identify metrics to quantify the behavioral characteristics and the economic benefits of a cooperative-trusting working relationship;
4. Collect and analyze market data on the economic metrics associated with a cooperative-trusting working relationship;
5. Cross-analyze economic metrics with cooperative-trusting relationship characteristics and attributes to determine correlations and importance; and
6. Report findings.

Dependent Variable Selection

The dependent variables are the measures used to evaluate the relative benefits of cooperative-trusting supplier relationships. These variables were selected as the most accurate metrics representative of the four hypotheses of this study. The metrics selected to support the hypotheses were

1. Cost of Goods Sold (COGS) – COGS represents all the costs that go into sourcing, producing, and selling the end product. COGS is an aggregate representation of costs that includes the costs of supplier interactions. Strategic sourcing and supplier relationship improvement initiatives are related with the Cost of Goods Sold, one of a manufacturer's highest bottom line costs (Vonderembse 2002; Tangri 2004). While COGS is an aggregate of total OEM costs, it is expected that the benefits of cooperative-trusting relationships will be large enough to discern from this

variable. This metric is the dependent variable for the first hypothesis: cooperative relations reduce costs.

2. Cadence – Cadence is the volume-weighted pace of launches of completely new and significantly redesigned vehicle models from an OEM. The Prudential Equity Group has measured cadence over a considerable time frame and has validated the applicability of this metric. Cadence is the best contiguous measure of OEM innovation that is readily accessible. This metric was selected to represent an OEM's relative rate of innovation. New products now account for a greater percentage of most companies' revenue due to the rapid change in end-customer demands. Shifting design responsibility from OEMs to suppliers improves the productivity of product design by leveraging the supplier expertise to reduce development time and lower overall costs (Vonderembse 2002; Liker and Choi 2004). This metric, along with research and development, supports the second hypothesis: cooperative relations increase innovation per dollar.
3. Research and Development (R&D) – R&D is the amount of capital an OEM invests in its own internal research programs to develop new products and innovations. This measure best represents the amount of effort an OEM spends on creating new products. This metric, along with cadence, supports the second hypothesis: cooperative relations increase innovation per dollar.

4. Quality Problem Index – The Quality Problem Index is an adaptation of the J. D. Powers and Associates (JDPA) Initial Quality Study (IQS). The IQS is a model-level study. It measures 135 attributes across nine categories, including ride/handling/braking, engine and transmission, and a broad range of quality problems symptoms reported by vehicle owners 90 days after ownership. JDPA is considered an authority in tracking automotive end vehicle quality, and their initial quality study most likely provides the most accurate measure of contiguous end product quality. End product quality is due in large part to the materials provided by suppliers and the overall fit of supplier parts into the end system. More cooperative-trusting OEM-supplier relationships have demonstrated improvements in product quality (Dyer 1997; Vonderembse 2002). This metric is the dependent variable for the third hypothesis: cooperative relations foster end product quality.
5. Inventory – Inventory is a measure of the total inventory an OEM carries. Studies have demonstrated that more cooperative-trusting OEM-supplier relationships garner performance improvements in resource utilization (Lieberman, Helper et al. 1998; Vonderembse 2002). This metric, along with inventory turns, supports the fourth hypothesis: cooperative relations improve material management.
6. Inventory Turns – Inventory turns is the fraction of a year that an average item remains in inventory. Low inventory turns is a sign of inefficiency, since inventory has no return on investment (i.e., cost of capital). This

metric is a measure of an OEM's material management efficiency and its ability to leverage supplier relationships to improve material usage. Studies substantiate that longer-term and information rich relationships indicative of cooperative-trusting relationships enjoy better inventory utilization rates (Lieberman, Helper et al. 1998). This metric, along with inventory, supports the fourth hypothesis: cooperative relations improve material management.

Data Collection and Formatting

Data were collected from a variety of sources. The main sources of data were Standard and Poor's Compustat database; Planning Perspectives, Inc., Working Relations Index database; J. D. Powers and Associates database; Prudential Equity Group, LLC, database; and Economic Research Federal Reserve Bank of St. Louis.

All economic data including sales, cost of goods sold, inventory, inventory turns, and research and development investments were taken from the Standard and Poor's Compustat database. Once these data were extracted, nominal dollar values were converted into real dollars using the CPI methodology provided by the Research Department of the Minnesota House of Representatives (Dalton, Novak et al. 1998) (Fig. 3). CPI data were gathered from the St. Louis Federal Reserve website for Calendar Years 1998-2004.

Method	Example
1. Select the year that you want to use for the basis of the constant dollar (1989 dollars in the example).	1. CPI for 1989 = 124.0 (basis for constant dollar)
2. Divide the index for a given year by the index for the year chosen in step 1.	2. 1996 CPI = 156.9 156.9 / 124.0 = 1.26
3. Divide the current (or nominal) dollar amount for the given year by the result from step 2. This is the constant dollar amount.	3. 1996 dollars = $160 160 / 1.26 = $126.98 (in 1989 dollars) Something that cost $160 in 1992 dollars would cost $126.98 in 1989 dollars.

Fig. 3. CPI methodology for changing to real dollars.

J. D. Powers and Associates provided data from their Initial Quality Study that measures 135 attributes across nine categories, including ride/handling/braking, engine and transmission, and a broad range of quality problems symptoms reported by vehicle owners. The surveys were administered to purchasers and lessees of new model year vehicles 90 days after ownership. The index was generated for the 6 OEMs studied and is based on the relative quality of the OEMs in comparison to each other.

Planning Perspectives, Inc., provided data for the Working Relations Index (WRI). WRI data were provided for the 6 OEMs being studied: Ford, General Motors, DaimlerChrysler, Nissan, Toyota, and Honda. Data covered Calendar Years 2002-2005, and Trust data were provided for the years 2001-2005. At the direction of Planning Perspectives, Inc., estimates of 2001 WRI data were made using the available Trust and WRI data. Planning Perspectives, Inc., likewise advised that Calendar Year data represented the previous year's actions and should be used to represent the previous year. With this

information, the 2001-2005 WRI data were used to represent Calendar Years 2000-2004 relationships.

Prudential Equity Group, LLC, provided data from their Cadence report (Bruynesteyn 2005). Cadence is a calculated by dividing the total estimated production volume of new models and redesigned vehicles for a given year by the OEM's sales forecast. Cadence was used for Calendar Years 2000-2004 for the 6 OEMs studied: Ford, General Motors, DaimlerChrysler, Nissan, Toyota, and Honda.

Supplemental Interviews

To supplement the literature reviewed, interviews were conducted with representative academicians, industry experts, supplier executives, and OEM personnel. The interviews collected tacit knowledge that was not covered in publications.

Academicians within the field of automotive OEM-supplier interactions were interviewed to better understand the concepts and theories that surround the dynamics of relationships. Interviews were conducted with professors from five (5) major universities.

Industry experts who are well known and respected in the automotive industry were interviewed for their broad knowledge on the subject of OEM-supplier relationships and their evolution. Interviews were conducted with representatives of four (4) major automotive industry analysis organizations.

Supplier interviews were focused on the experiences with OEM relationship approaches and the relative responses and actions. Sales and purchasing executives from five (5) top tier-one suppliers were interviewed to collect their experiences with different OEMs relationships.

OEM interviews were conducted to gain an understanding of the approaches OEMs explicitly and implicitly take towards supplier relationships. Purchasing executives and agents were interviewed to determine what the strategies were for supplier relationships and what the day-to-day activities were that formed the overall relationship with suppliers. Interviews were conducted with representatives from three (3) major OEMs.

Data Analysis Methodology

Statistical Analysis Software (SAS) was used to perform all regression analysis of data. Regression analysis was the main methodology of data analysis, using the "Proc Reg" command in the SAS program. This is a unique data set since the Working Relations Index (WRI) and the Trust Index, calculated by Planning Perspectives Inc., exist only for the years 2001-2005. In order to estimate the relationships over time, given the limited time series, panel data were constructed using the five (5) available years of data for the six (6) OEMs studied, yielding a total of 30 observations for all analyses. While the number of observations was not ideal, it was limited in the amount of data available. However, pooling of the data presented enough observations and degrees of freedom to determine statistical significance.

Chapter 4: Presentation and Analysis of Data

Hypothesis 1: Cooperative Relations Reduce Costs

Cost of goods sold (COGS) is the measure of expenses a company incurs to manufacture and sell a product, including the price of raw materials and components as well as the cost of manufacturing a product. The largest component of COGS in the automotive industry, approximately 50 to 70 percent or more, comes from supplier-provided goods and services (Dyer 2000; Tangri 2004). The first hypothesis of this study is that more cooperative-trusting relationships, as measured by the WRI, have a lower cost of doing business with suppliers as measured by COGS. The hypothesis likewise indicates that as relationships become more cooperative and trusting, costs will decrease.

The estimates were as follows:

cogs = 6075.82 + 0.75 sales(-1)*** – 42.62 WRI* + 18501 df***
(1.00) (20.62) (-1.93) (9.21)

- 1553.42 dc + 811.56 dn + 7318.46 dt + 2334.98 dh
(-0.69) (0.12) (1.18) (0.30)

[Where: *** = statistically significant at 0.01
** = statistically significant at 0.05
* = statistically significant at 0.10]

Adjusted $R^2 = 0.996$

cogs = real cost of goods sold

sales(-1) = real annual sales lagged by 1 year

WRI = Working Relations Index measure of relationship

df = dummy variable for Ford specific effects

dc = dummy variable for Chrysler specific effects

dn = dummy variable for Nissan specific effects
dt = dummy variable for Toyota specific effects
dh = dummy variable for Honda specific effects

This model indicates that more cooperative and trusting relations do have lower reported COGS. This result implies that for each point of the WRI that an organization scores, their COGS are generally $42.6 million lower. This model confirms the hypothesis that OEMs with cooperative-trusting relations with suppliers have lower COGS.

The other significant results of this model are that real sales were positively related with COGS and the firm specific effect of a single OEM. These results are not surprising, as COGS is typically dependent on sales and is, in fact, roughly ¾ of sales costs, which is consistent with this model. The firm specific effect indicates that Ford Motor Company's COGS are generally higher than General Motors'. However, we can ignore these results since we are primarily interested in the results associated with the effects of the WRI score.

In addition to this model, a second model was used to explore the elasticity of the effect of relationships on COGS. To measure the elasticity, a double log model was used.

The estimates were as follows:

ln cogs = 3.27** + 0.48 ln cogs (-1)* – 0.24 ln WRI* – 0.08 d1**
(2.39) (1.86) (-1.93) (-2.49)

– 0.11 d2*** – 0.10 d3*** – 0.05 d4** + 0.02 df + 0.01 dc – 0.23 dn
(-4.89) (-4.06) (-2.28) (1.01) (-0.22) (-1.48)

+ 0.01 dt – 0.18 dh
(0.17) (-1.16)

Adjusted $R^2 = 0.987$

ln cogs = logarithm of the real cost of good sold

ln cogs(-1) = logarithm of the real cost of goods sold lagged by 1 year

ln WRI = logarithm of the Working Relations Index

d1 = dummy variable for the first calendar year, 2000

d2 = dummy variable for the second calendar year, 2001

d3 = dummy variable for the third calendar year, 2002

d4 = dummy variable for the fourth calendar year, 2003

The results of this model indicate that as relationships between OEMs and suppliers increase by 1 percent, their COGS will decrease by 0.24 percent. The other significant results are that COGS decreased for all OEMs each year from 2000-2004, which is consistent with the recent economic recessions and OEM efforts to reduce costs.

These models confirm the hypothesis that OEMs with more cooperative-trusting relationships with their suppliers will have a lower cost of doing business with their suppliers and thus a lower COGS. Further, OEMs that increase the cooperativeness and trustworthiness of their supplier relations reduce their COGS. These results support the assertions of Lorenz and Segil (Lorenz 1988; Segil 2004) that higher costs result when partners are expected to behave opportunistically, a characteristic of adversarial relations.

Pecaut and Gordon and an Automotive News article (Pecaut and Gordon 1999; AutomotiveNews 2005) were not far off the mark when they indicated that suppliers providing a component to OEMs with adversarial relations increased costs 3-8 percent more on average, compared to cooperative-trusting relations. In fact, according to this model using data from 2000-2004, the OEMs studied pay on average between 2-10 percent more in COGS annually than what they would if they attained the same level of WRI as their more cooperative competitors.

A graph of 5 years of COGS data can help to visualize the relative trends of COGS versus WRI for the OEMs studied. Figure 4 displays the trends of COGS as a ratio of sales for the 6 OEMs studied. Definite increasing trends are present for Ford and General Motors, while Chrysler, Nissan, and Honda have decreasing COGS ratios. This is consistent with the study findings, since Ford and GM have decreasing WRI scores, while Chrysler, Nissan, and Honda all have increasing WRI scores over this time period.

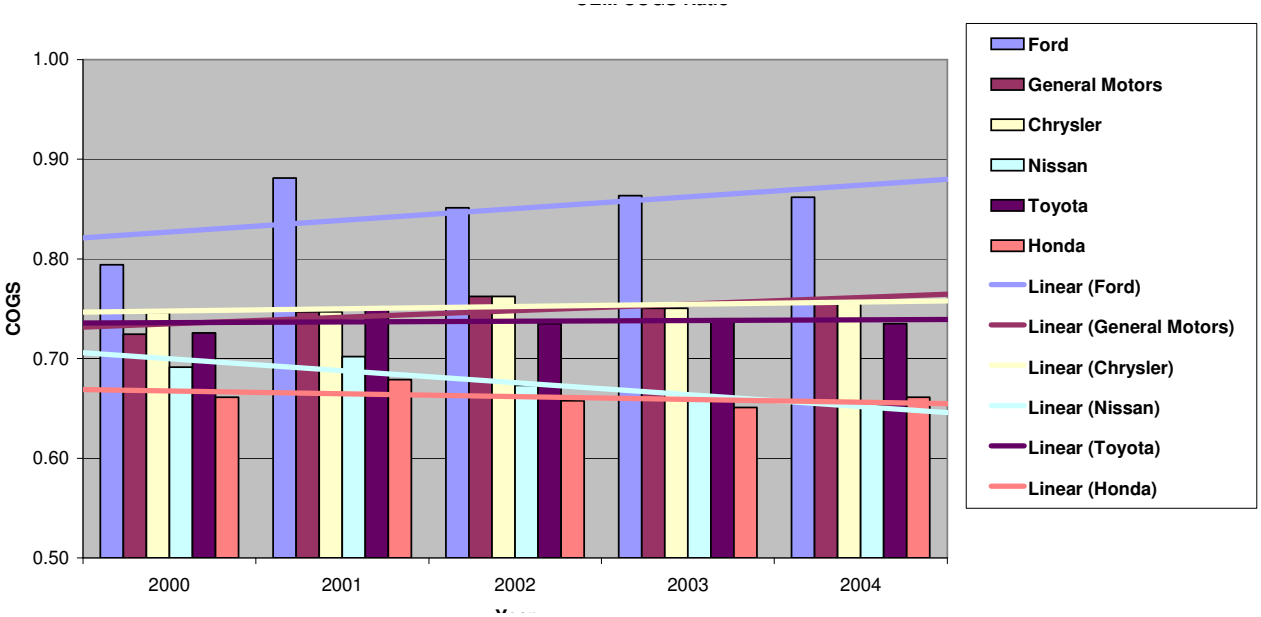


Fig. 4. OEM COGS trend from 2000-2004.

Contrasting the OEM WRI percentage (scores on a scale of 0 to 500) to their COGS ratios with sales, the negative relationship between WRI and COGS can easily be seen (Fig. 5). As WRI decreases, the COGS measure increases. Conversely, as WRI increases, COGS decreases.

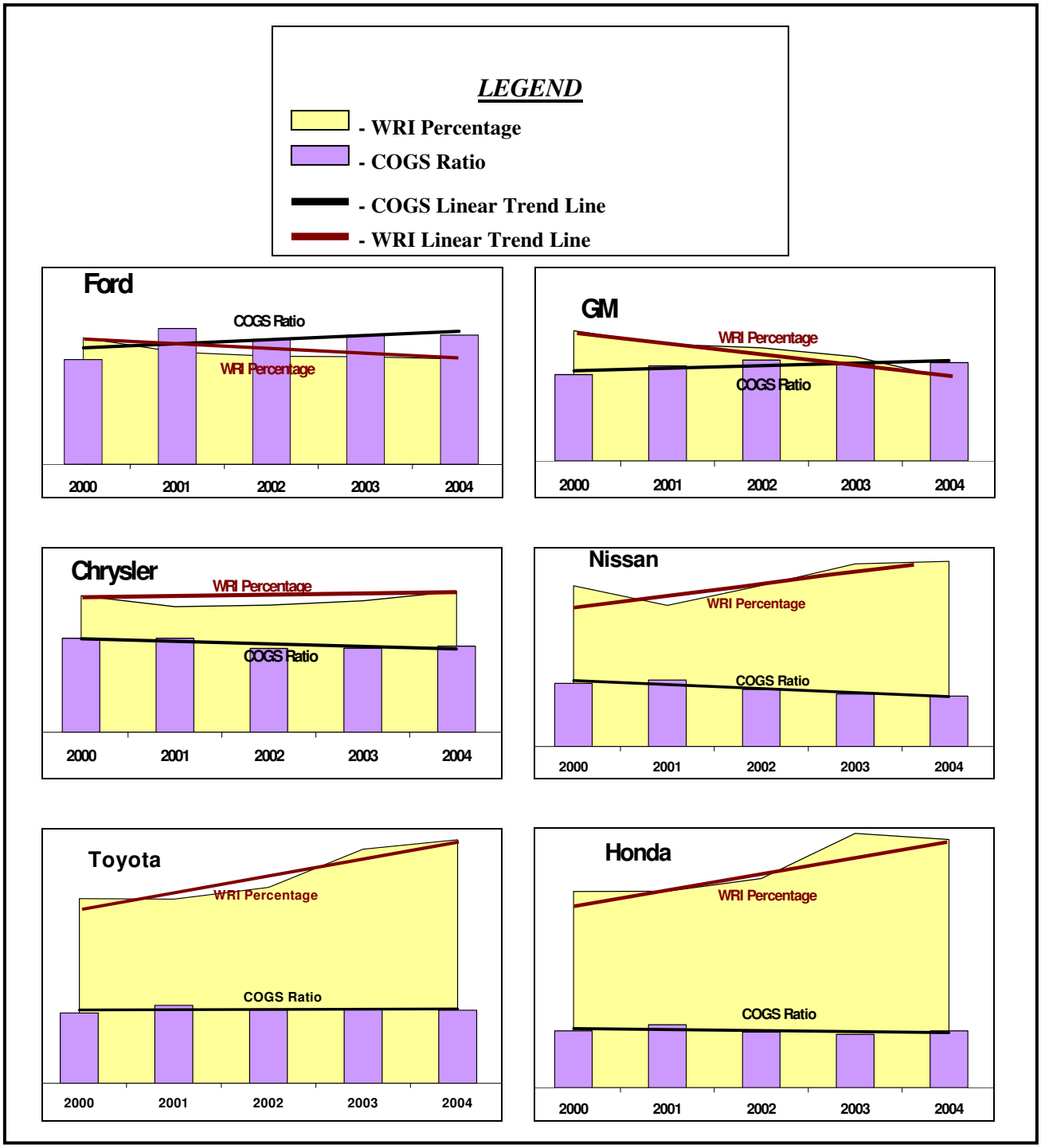


Fig. 5. Comparison of OEM WRI percentages and COGS ratios.

Hypothesis 2: Cooperative Relations Increase Innovation Per Dollar

Innovation is an important aspect of an automotive OEMs competitive advantage. Customers demand the latest and greatest at an affordable price. Fresher products brought to market faster are believed to lead to market strength, earnings, and share price. One measure used in the automotive industry to assess an OEM's relative innovation level is called Cadence (Bruynesteyn 2005). Cadence is a measure monitored by Michael Bruynesteyn at the Prudential Equity Group, LLC. Cadence is defined as the "volume-weighted pace of launches of completely new and significantly redesigned vehicle models." Simply put, it is a measure of the new models that typically "generate hype and excitement for an automaker, tend to sell well with minimal incentives, increase showroom traffic, and lead to increased sales of other models, as well as boost market share and ultimately affect profits and the share price." (Bruynesteyn 2005)

Achieving a high cadence, however, must be balanced with the level of investment an OEM places into research and development (R&D) programs. If the amount of money invested outweighs the benefits of high cadence, competitive advantage is lost. Striking this balance between investment and outcome is the topic of the second hypothesis. Cooperative-trusting OEMs are expected to have higher cadence and lower R&D because they tend to work with suppliers to bring their innovations into products faster, and suppliers tend to trust these OEMs with their intellectual property (Liker and Choi 2004; Szczesny 2004). To test this assertion, the second hypothesis is that cooperative-trusting OEMs as measured by the WRI have higher levels of innovation (as measured by cadence) and a relatively lower amount of resources invested into R&D.

The estimates were as follows:

cadence = 0.13417** – 0.34385 cadence(-1)** + 0.00044045 WRI*
(2.27) (-2.04) (1.92)

Adjusted $R^2 = 0.130$
cadence = index of OEM innovation and new product development
cadence(-1) = index of OEM innovation and new product development lagged 1 year

This model indicates that more cooperative and trusting relations do have higher cadence levels. This result implies that for each point of the WRI that an organization scores, their cadence is generally 0.00044045% higher. This model confirms the hypothesis that OEMs with cooperative-trusting relations with suppliers have higher cadence levels.

The other significant result is that cadence is negatively related to the previous year's cadence. This is consistent with the fact that high cadence levels place strains on resources, which can constrain near term investments for the following year's innovation improvements. However, this model is mainly concerned with the effect of the WRI measure, so the additional results can be ignored.

To further test this hypothesis, a model is necessary to measure the level of R&D investments an OEM makes. This model is used to see if cadence is impacted by R&D investment levels or by the OEM-supplier relationship approach used. To determine the marginal effect of relationships on R&D investment, a model was developed to investigate the elasticity of the effect of the WRI on R&D investments. To measure elasticity, the logarithms of the dependent variable and independent variables were modeled.

The estimates were as follows:

ln rd = 3.70090* + 0.28811 ln sales – 0.60614 ln WRI*** - 0.11636 d1***
(1.98) (0.85) (-3.94) (-3.11)

- 0.14405 d2*** - 0.12034 d3*** - 0.07231 d4** + 0.11711 df***
(-5.31) (-3.50) (-2.47) (4.42)

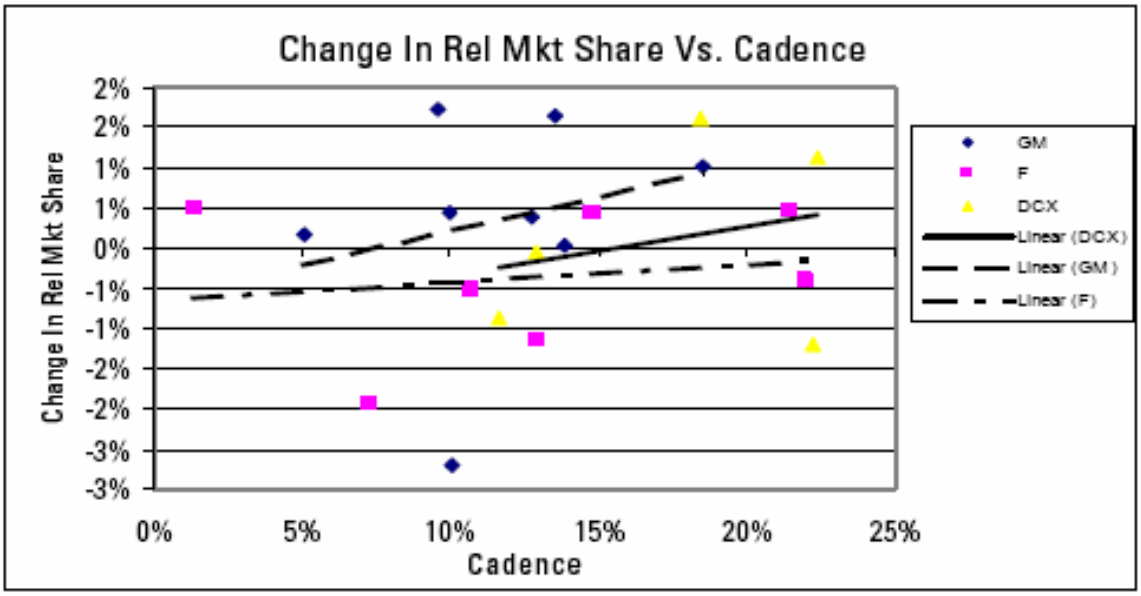
+ 0.09226 dc** - 0.11485 dn + 0.17783 dt* + 0.09076 dh
(2.71) (-0.63) (2.06) (0.52)

Adjusted $R^2 = 0.9658$
ln rd = logarithm of real research and development investments
ln sales = logarithm of real sales

The results of this model indicate that as WRI relationships between OEMs and suppliers increases by 1%, OEM R&D investments will decrease by 0.61%. Other significant results are annual effects and firm specific effects. Annual effects indicate that R&D investments decreased for all OEMs in each year from 2000-2004, which is consistent with the recent economic recessions and OEM efforts to reduce costs. Firm specific results echo the previous model's results that other OEMs annually invest relatively more than General Motors does. The effects of the WRI measure on R&D investment is of primary concern here, so the additional results can be ignored.

These results support the notion that close collaboration between OEMs and suppliers leads to faster introduction of new products with less effort (Clark 1989; Flynn 2005; Stallkamp 2005a). The combined results of this study's models demonstrate that OEMs with more cooperative-trusting supplier relations as measured by WRI do indeed have better cadence innovation with lower R&D investment costs. According to Prudential Equity

Group, firms are able to derive a competitive advantage from higher cadence as demonstrated by the figure below (Fig. 6). When high cadence levels are coupled with lower R&D investments, OEMs can achieve an even greater advantage in the market.



Sources: CSM Worldwide, Autodata, Wards, JD Power, Prudential Equity Group, LLC estimates.

Fig. 6. Effect of cadence on market share (courtesy of Prudential Equity Group, LLC).

Interpreting these results, adversarial OEMs with lower WRI scores have lower levels of innovation and relatively higher R&D investments. This indicates that adversarial OEMs do not successfully leverage supplier innovation and end up spending more on R&D without considerable innovation in return. This may be due to the lack of perceived trustworthiness by suppliers, or the inability of suppliers to invest in future technologies due to a lack of profitability with adversarial OEMs (Kobe 2001, March; Vonderembse 2002; AutomotiveNews 2005).

Hypothesis 3: Cooperative Relations Foster End Product Quality

End product quality is a measure taken from J. D. Powers and Associates' (JDPA) Initial Quality Study (IQS) that measures overall product quality 90 days after ownership. The higher the index number, the more problems encountered and thus the lower an OEM's end product quality relative to the other OEMs studied. End product quality is due in large part to the materials provided by suppliers and the overall fit of supplier parts into the end system. Cooperative-trusting relationships with suppliers should improve product quality due to improved communications, mutual concern, and a greater dedication to the end product (Dyer 1997; Vonderembse 2002; Webster 2003; Szczesny 2004; Stallkamp 2005b).

The third hypothesis of this study is that more cooperative-trusting relationships as measured by the WRI have a lower score on the JDPA quality problem index (i.e., higher quality). The hypothesis likewise indicates that as relationships become more cooperative and trusting, the quality problem index will decrease (i.e., quality will improve).

The estimates were as follows:

quality = 1.37*** - 0.0000018 profit(-1) – 0.0013 WRI*** - 0.11 d1**
(13.49) (-1.15) (-5.96) (-2.31)

- 0.09 d2* - 0.06 d3 - 0.03 d4
(-1.84) (-1.21) (-0.63)

Adjusted $R^2 = 0.5720$
quality = index for overall product quality
profit(-1) = real annual profit lagged one year

This model indicates that more cooperative and trusting relations do have better end product quality as measured by the JDPA IQS. This result implies that for each point of the

WRI that an organization scores, their quality problem index will improve by 0.0013. Considering that WRI scores can differ by hundreds of points, the impact on quality can be significant on OEM competitive advantage. This model confirms the hypothesis that OEMs with cooperative-trusting relations with suppliers have better end product quality.

The other significant results of this model are from annual effects. The annual effects indicate that in years 2000 and 2001, quality was better than other years by roughly 9-11 percent. These effects may be demonstrating the higher quality of components purchased in that timeframe versus the lower price components purchased from developing countries later in the 2000s. However, we can ignore these results since we are primarily interested in the results associated with the effects of the WRI score.

In addition to this model, a second model was used to explore the elasticity of the effect of relationships on quality. To measure the elasticity, the logarithms of the dependent variable and independent variables were taken.

The estimates were as follows:

ln quality = -0.27 + 0.13 ln sales* – 0.20 ln WRI* + 0.04 df**
(-0.55) (1.81) (-2.00) (2.56)

+ 0.04 dc** + 0.10 dn** – 0.03 dt + 0.06 dh
(2.27) (2.36) (-0.88) (1.28)

Adjusted $R^2 = 0.8519$

ln quality = logarithm of index for overall product quality

The results of this model indicate that as relationships between OEMs and suppliers increases by 1 percent, their quality problem index will decrease by 0.20 percent. The

elasticity demonstrates that as relationships improve, higher quality is fostered in the interactions of the OEM and suppliers. The result of cooperative efforts seems to bring the trading partners closer together and increase the emphasis on quality, similar to what studies have found for Japanese Foreign Domestic OEMs (Webster 2003).

The other significant results are for the logarithm of sales and firm specific effects. The positive relationship between the logarithms of sales and quality is likely because as the volume of sales increases, quality decreases to meet the increase in demand. The firm specific effects indicate that Ford, DaimlerChrysler, and Nissan all experience higher quality problem scores than GM during the study period. However, since the emphasis of the model was to determine the effects of the WRI on quality, we can ignore these additional results.

These models confirm the hypothesis that OEMs with more cooperative-trusting relationships with their suppliers will foster an environment of quality that will lead to higher quality end products. Further, OEMs that increase the cooperativeness and trustworthiness of their supplier relations will continue to improve their relative quality. These findings support the assertions of Dyer and Vonderembse (Dyer 1997; Vonderembse 2002).

Hypothesis 4: Cooperative Relations Improve Material Management

Total inventory and inventory turns are two measures of how effectively and efficiently an organization manages its resources. The more capital that is tied up in inventory means the less capital that is available for other actions, such as growth and innovation, not to mention the cost of capital. Organizations that are able to operate with lower inventories and higher inventory turns are better able to utilize capital and save costs. Long-term and information-rich relationships between suppliers and OEMs have

demonstrated performance improvements in inventory utilization (Lieberman, Helper et al. 1998). The fourth hypothesis of this study is that cooperative-trusting OEMs, as measured by the WRI, are able to more effectively manage their resources by leveraging their relationships with suppliers to reduce their own internal inventory levels and increase inventory turns.

The estimates were as follows:

inventory = 5235.29 + 0.18 sales(-1)** - 61.29 WRI*** - 3534.93 d1*
(0.39) (2.73) (-4.28) (-1.80)

- 5833.81 d2*** - 2913.75 d3 - 160.88 d4 – 13942 df*** - 955.91 dc
(-3.78) (-1.63) (0.12) (-9.01) (-0.46)

+ 8882.31 dn + 6792.01 dt + 13368 dh
(1.04) (1.32) (1.59)

Adjusted R^2 = 0.9530
inventory = real total inventory levels

This model indicates that OEMs with higher levels of WRI do have lower reported total inventory levels. This result implies that for each point of measured WRI that an organization scores, their inventory is generally $61.3 million lower. This effect seems to be a moderating effect versus lagged sales, which reduces the impact of larger sales volumes on inventory levels. This model confirms the hypothesis that OEMs with cooperative-trusting relationships with suppliers have lower inventory levels.

The other significant results of this model are associated with lagged sales, annual effects, and a single firm specific effect. The previous year's sales were positively related

with inventory, which is to be expected since resource planning typically uses historical sales data. Annual effects demonstrate decreases in inventory levels each year from 2000-2004, which is consistent with economic recession and Just-In-Time and lean practices focused on inventory reduction that OEMs applied during those years. The single significant firm specific effect is lower inventory levels for Ford Motor Company, possibly due to their extreme adoption of Just-In-Time inventory practices, slashing their inventory levels. However, the purpose of this model is to measure the effect of WRI on inventory levels, so the additional results can be disregarded.

Inventory turns is a measure of an organization's ability to cycle through their stock of materials, with higher turns generally associated with lower inventory levels. To evaluate the effect of OEM-supplier relationships on inventory turns, a model was created to measure the impact of the WRI on OEM inventory turns.

The estimates were as follows:

inventory turns = -5.49 + 0.000029 sales + 0.028 WRI*** + 2.71 d1**
(-1.01) (1.13) (3.23) (2.50)

+ 2.84 d2** + 2.44 d3** + 0.95 d4 + 12.62 df*** + 0.55 dc + 2.53 dn
(2.36) (2.31) (1.15) (14.83) (0.57) (0.64)

+ 1.73 dt – 0.22 dh
(0.62) (-0.05)

Adjusted $R^2 = 0.9449$

inventory turns = number of inventory turns per year (number of times inventory cycled through)

This model indicates that higher OEM WRI scores do have higher reported inventory turn rates. This result implies that for each point of measured WRI that an organization scores, their inventory turn rate is generally 0.028 turns higher each year. Considering that WRI scores range in the hundreds, this can have a substantial impact on OEM inventory turn rates. This effect supports the results of the model for inventory levels. This model confirms the hypothesis that OEMs with trusting relationships with suppliers have higher inventory turn rates.

The model returned other significant results for annual effects and firm specific effects. Each year from 2000-2003 has an associated positive effect on overall inventory turn rate for all OEMs, ranging from 2.44 to 2.84 turns increases each year. These results coincide with industry efforts to reduce inventory levels and increase inventory turns. The single firm effect is for Ford Motor Company, and has a considerable positive effect that indicates Ford's turn rate is higher than average. This effect is consistent with Ford's aggressive implementation of Just-In-Time inventory policies and previous programs (i.e., Nirvana). However, the emphasis of this model is to determine the effects of WRI on inventory turns, so these extra results can be ignored.

These models confirm the hypothesis that OEMs with more cooperative-trusting relationships with their suppliers generally have lower inventory levels and higher inventory turns than adversarial OEMs. Inventory levels and turn rates may be better for cooperative-trusting OEMs because they are able to work with their suppliers better in coordinating the supply of parts, and suppliers are able to trust OEM forecasts and production schedules (Lieberman, Helper et al. 1998). The flow of information is critical to the usage of resources,

particularly when inventory levels are low as with the automotive industry's use of Just-In-Time practices. Also, cooperative-trusting OEMs have a greater reliability of supply from their suppliers, which reduces the amount of inventory insulation necessary to protect against disruption.

Contrasting the OEM WRI percentage (scores on a scale of 0 to 500) to their inventory ratios with sales, the negative relationship between WRI and inventory is apparent (Fig. 7). As WRI decreases, inventory levels increase. Conversely, as WRI increases, inventory levels decrease.

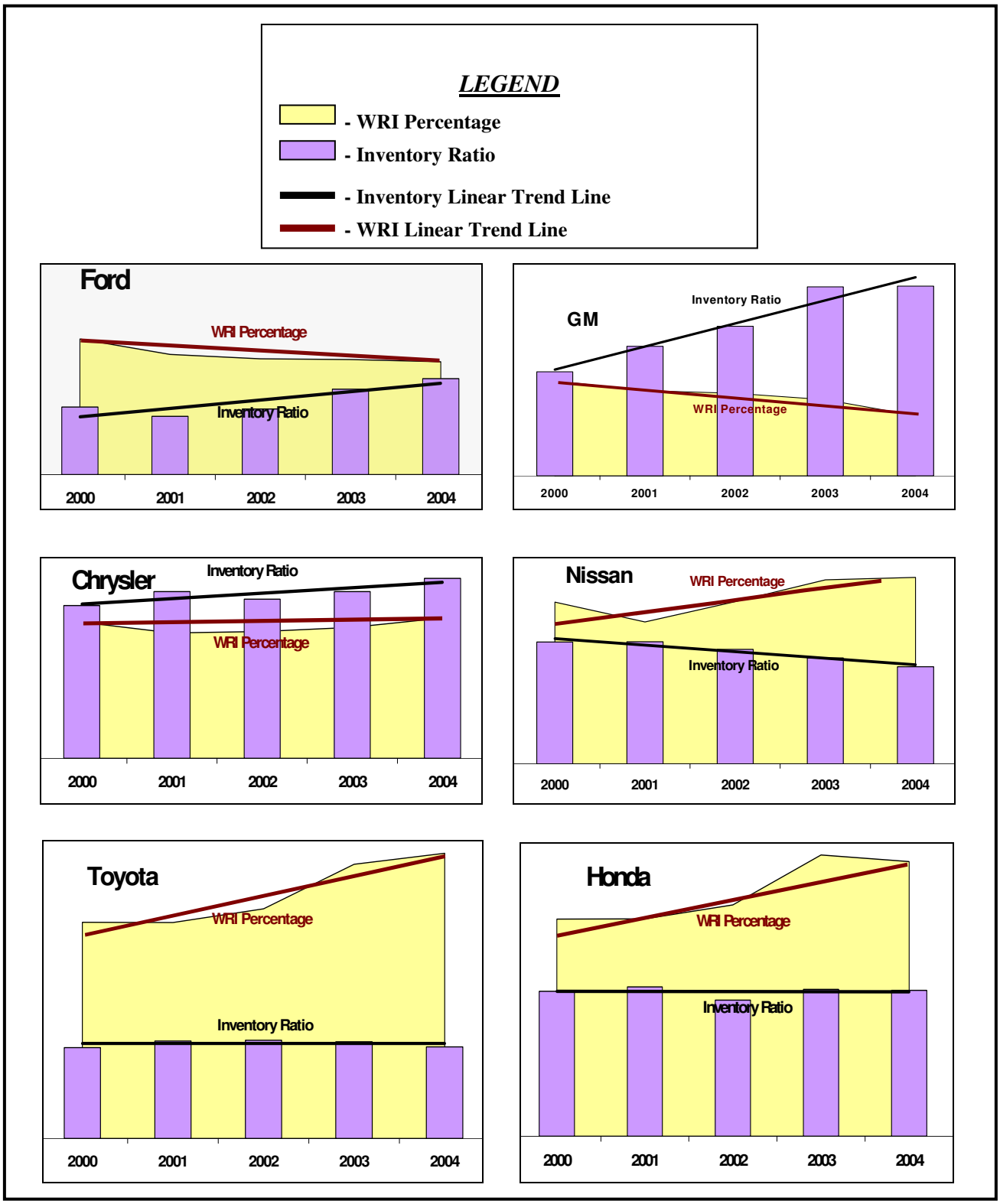


Fig. 7. Comparison of OEM inventory ratio and WRI percentage.

A graph of 5 years of inventory data can help to visualize the relative trends of inventory turn rates versus WRI for the OEMs studied. Fig. 8 displays the trends of inventory turn rates for the 6 OEMs studied. Definite decreasing trends are present for Ford and General Motors, and to a lesser degree Chrysler, while Nissan's turn rates are noticeably increasing and Toyota and Honda stay relatively stable. This is consistent with the study findings, since Ford and GM have decreasing WRI scores, while Chrysler's scores are marginally increasing, and Nissan's WRI scores dramatically increased in this time period. Toyota and Honda inventory turns likely remained stable, with a little improvement due to their long-term approach. Their relationships are already developed, and they seem to be in more of a maintenance phase. Since their relationship is in maintenance, improvements are likely not as dramatic, though they are still present. This suggests a logarithmic scale of improvement, where the higher scores are, the more they have to improve to see noticeable benefits.

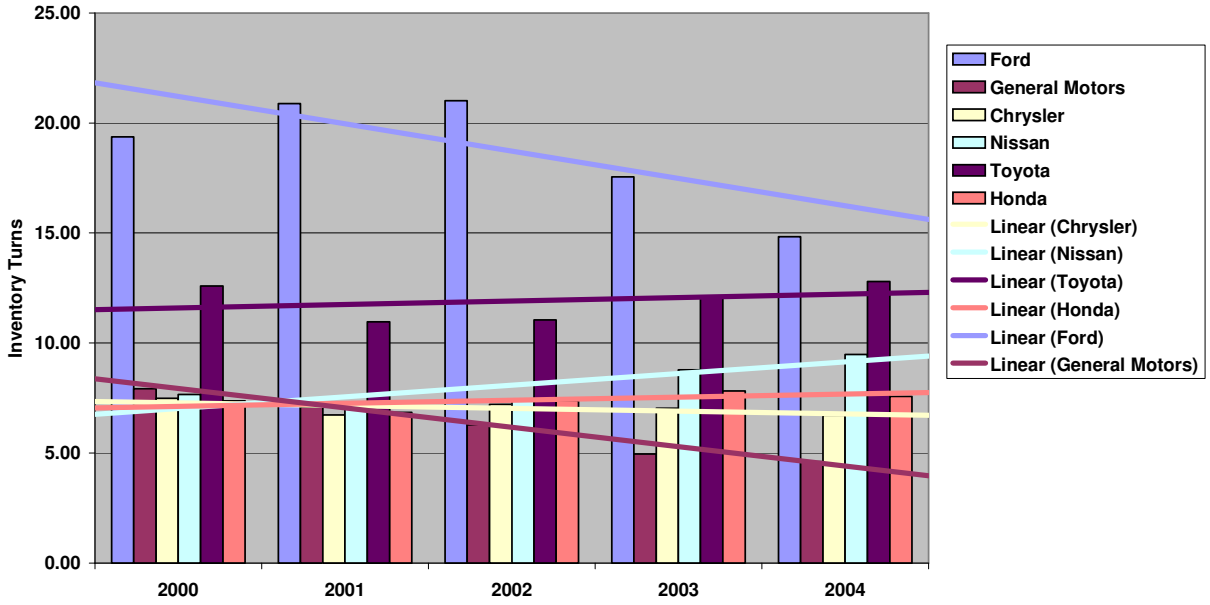


Fig. 8. OEM inventory turn rate trends from 2000-2004.

Inventory levels and inventory turn rates seem to be directly related to the level of working relationships between OEMs and suppliers. Adversarial OEMs tend to be less forthcoming with their forecasts, which results in higher inventory levels throughout the supply chain (e.g., the Pontiac Aztek). Cooperative-trusting OEMs generally work with suppliers and can achieve a leaner approach to inventory usage, leveraging supplier resources and efforts.

Chapter 5: Discussion

This study has determined the relationship of specified economic and performance related variables with characteristics of cooperative-trusting supplier OEM-supplier relationships. Metrics were developed to represent and relate the benefits of cooperative-trusting relationships to specific activities. The results of the analyses indicate that the anecdotal evidence in favor of cooperative-trusting relationships is substantiated. Each hypothesis was proven statistically significant. These results lay the foundation for the comparative analysis of relationship approaches for OEMs.

Despite the strong results of the analyses, there remains some discussion on why the benefits are achieved and how cooperative-trusting environments are created. This section will use the literature reviewed, interviews conducted, and data analyzed to discuss some possible explanations. Specifically, this section will postulate some of the mechanisms for how benefits are achieved, the barriers to fostering cooperative-trusting relations, and potential ways to overcome barriers. Finally, this section develops a game theory concept termed *Supplier's Dilemma*, which is constructed upon the prisoner's dilemma theory.

Mechanisms of Cooperative Supplier Relations

Cooperative-trusting relations are developed over time through a series of mechanisms ranging from major changes in corporate philosophy to the implementation of tactical tools. The characteristics of cooperative-trusting relations are sustained by mechanisms that support the overall approach, and the success of such an approach is affected by the combination of mechanisms in place. Some of the apparent mechanisms that were considered in this study are listed below.

Trust – Trust is a central component of cooperative-trusting supplier relationships. Developing a sense of trust and trustworthiness is necessary for both OEMs and suppliers. Developing trust appears to evolve over time with consistent, reliable, and equitable actions (Helper and Sako 1995). When trust between suppliers and OEMs develops, Maister, Green, et al. indicate that it is generally driven by four basic steps: Credibility – a common understanding on which to base the relationship; Reliability – dependability, consistency, and predictability; Intimacy – understanding each other's feelings, emotions, and dealing with each other in a genuinely caring perspective; and Lack of Self-Orientation – commitment to the concerns, needs, and behaviors of the other parties in the supply chain (Maister, Green et al. 2000). Despite the steps towards creating trust, it is apparent that it is something that develops slowly over time and is quickly lost with opportunistic actions.

Information Sharing – The flow of relevant information through regular communication is critical to developing and maintaining cooperative-trusting supplier relations. Effective communication of requirements with appropriate safeguards helps align partners' efforts to avoid duplication of effort and reduce system costs (Handfield 2004a). Information helps OEMs ensure that their component designs are compatible with suppliers' processes and equipment, thus improving system productivity and quality (Helper and Sako 1995).

Dedicated Assets – When the powerful partner (the OEM) has a short-term approach to relationships, supplier assets that are dedicated to that customer becomes a liability. However, a long-term OEM approach turns dedicated asset into a positive influence (Handfield 2004b). Suppliers that are able to invest in dedicated assets will be more productive and increase the system's efficiency. When suppliers are unable to invest in asset specificity, the overall system's productivity goes down.

Competition – Relationships can stifle themselves when partners do not maintain a competitive spirit (Anderson and Jap 2005). A detailed picture of suppliers' capabilities and cost structures maintains competitive tension that stimulates innovation and progress (Pecaut and Gordon 1999). It's been demonstrated that competitive tension helps partners to continuously improve and identify opportunities to reduce waste, improve processes and product design, and decrease costs (Strauss 1999). However, hyper-competition and the threat of bankruptcy turn competition into a liability that reduces the willingness of parties to invest in relationships. A balance of competition and consistency provides the benefits of rivalry and creates an environment conducive to optimizing the system. Elements of competition are also included in the *Contract Negotiations* mechanism.

Contract Negotiations – Frequently evaluating supplier contracts not only maintains competition with suppliers, but it also prevents a relationship from growing stale and complacent (Pecaut and Gordon 1999; Anderson and Jap 2005). However, a supplier should be in a position to believe that there is a high probability of continued business with an OEM for more than 3 years (Helper and Sako 1995). While renegotiating contracts enables buyers to switch suppliers if better opportunities arise, the essence of trusting and cooperative relations is to work with the current supplier to help them reach their goals with sufficient resources (Helper and Sako 1995). The penalties for not achieving these goals should not rest solely upon the supplier but should also be an incentive for the buyer to help. The long-term nature of cooperative-trusting contracts also reduces supplier uncertainty, which allows suppliers to make specific investments with their customers (Lorenz 1988; Vonderembse 2002). Through these activities, competition is maintained while the benefits of long-term relationships are gained.

Contract Maintenance – Partnerships reduce the contracting effort between manufacturers and suppliers and allow for more open exchanges of information (Vonderembse 2002). More flexible contracts allow relationships to grow, as opposed to writing constricting legal requirements that can stifle the development of partnerships and cooperation.

Product Design – Involving suppliers in product design enables OEMs to leverage supplier knowledge and enhance learning. These benefits create better solutions that can improve supply chain efficiency, improve quality, and increase performance before designs lock system costs into the product manufacturing (Vonderembse 2002). Indeed, once a product reaches final design, roughly eighty percent of the product costs are determined and more or less set for the life of the production (Tangri 2004). The system cost avoidance possible during product design requires the early collaboration of suppliers with collaborative trusting relations.

Barriers to Cooperative-trusting Relationships

If cooperative-trusting relationships were more beneficial than adversarial relationships (even anecdotally), why would OEMs choose to remain adversarial? Adversarial relationships, while typically not explicitly chosen (Flynn 2005), are the result of policies that are rigorously selected. Even though adversarial relationships are not chosen per se, several tier-1 supplier executives agree that "adversarial OEMs know about the problems, but they just don't care." However, OEMs have made strides to become more cooperative-trusting in their OEM-supplier approach. The difference between supplier perspective and OEM efforts suggests that there are barriers to the adoption of truly cooperative-trusting relations.

Two of the main barriers that are present in today's environment are based on the need for short-term results and the metrics used to track performance (both for suppliers and OEM buyers).

The need for tangible and immediate returns stems from stockholder expectations and prevents OEMs from "doing what's right for their future." A 5 percent decrease in price today is easy to see and touch, while cooperative relations that result in more innovative products in 3 years are harder to measure. The tendency of adversarial OEMs to shortchange the future for immediate returns is a barrier to building a cooperative-trusting relationship with suppliers. Suppliers tend to shy away from adversarial customers when possible. Suppliers cite an inability to get fair returns on their investments and technology as major barriers.

Also, adversarial actions are easier to resort to when there are financial problems, such as the ones the domestic automotive industry is facing today. The benefits of cooperative-trusting supplier relationships are also not guaranteed but are more associated with a probability. This shortsightedness leads suppliers to believe that adversarial OEMs are not as interested in removing system costs but are more interested in immediate price reductions.

The second barrier is the set of metrics used to measure buyer and supplier performance. OEM buyers are typically measured on piece price reductions, not on long-term relationships, innovation, or cost avoidance. By not tracking the *soft costs*, OEMs are directing their buyers to look only at immediate piece price reductions that fail to reduce system costs. These short-term objectives make it difficult for OEMs to really pursue positive relationships. Performance should be the backbone of OEM-supplier relationships,

but if performance is measured with short-term gains, cooperative relationships will be difficult to develop.

One analogy that Simon Nagata, vice president of purchasing for Toyota North America, used to describe the difference between adversarial and cooperative-trusting relationships is the difference between hunter/gatherers and modern farmers (Winter 2004). The analogy describes how some OEMs carefully nurture and cultivate their suppliers for sustained value, like a cooperative-trusting farmer. Conversely, some OEMs treat suppliers as if they were going to be hunted down and become lunch; those are the adversarial hunter/gatherers. Brett Smith from the Center for Automotive Research suggests that OEMs shift from the predatory practices of hunters (adversarial) to a cultivating approach (cooperative-trusting) for developing suppliers (Vashilash 2005).

Overcoming Barriers: Personal and Corporate Relations

Overcoming the barriers of adversarial relationships is a challenge that typically must be initiated by the OEMs. Once OEMs start toward cooperative-trusting relationships, suppliers must support the efforts to change the environment. To really signify the change, OEMs should lead with action and not just words. Building trust with key suppliers is a long-term proposition, and it is not going to happen overnight. Sourcing suppliers early in the life of a product is one action supplier executives mentioned would be a sign of cooperation, as long as the components weren't market tested thereafter. This action requires both parties' trust and commitment, which begins to build mutual trustworthiness.

One of the questions regarding development of cooperative-trusting supplier relationships deals with how they are created, that is, whether they are developed through

personal interactions or produced by a corporate culture. Supplier executives seem to agree that elements of both are necessary for truly successful relationships. An adversarial culture can be overridden by strong connections between people. Some suppliers had their most adversarial and most cooperative experiences with the same OEM. One supplier executive responded, "You're able to trust the person, even if you cannot trust the system." However, these personal relationships are more difficult to form if the corporate culture is adversarial in nature.

Corporate culture, however, seems to be a predecessor of cooperative-trusting relationships. Adversarial actions, such as rotating buyers through commodities and banning social interactions with suppliers (i.e., lunches, etc.), tend to restrict the ability to create personal relationships. Conversely, a culture of cooperation works to increase the individual relationship through interaction and teamwork. Establishing strong leadership that advocates cooperative-trusting approaches to OEM-supplier relationships seems to be essential to developing a cooperative approach. With strong leadership in place, the metrics used to measure performance can be changed to better support the development of cooperative-trusting relations.

According to Liker and Choi (Liker and Choi 2004), Toyota and Honda used similar foundational practices to develop their cooperative-trusting supplier relations. Their study identifies six activities central to both OEMs' approaches. These activities closely relate to the findings of other studies and the results of the interviews conducted for this study. The steps are as follows:

1. First, the OEMs need to work with suppliers to better understand how they work and what the barriers are between them.

2. Second, OEMs need to create opportunities for innovation and improvement, essentially an environment for continuous improvement. Typically cooperative-trusting firms carefully use controlled competition to balance rivalry with consistency.
3. Third, OEMs must be trustworthy and must trust suppliers but maintain some level of insight for verification. Performance is the foundation of this step, and careful attention should be paid to defining and measuring appropriate metrics.
4. Fourth, OEMs should use their own resources to help develop suppliers' technical capabilities. In the current market, it is supply chain versus supply chain; OEMs should invest in making the entire system more effective and efficient.
5. Fifth, communication with suppliers should be frequent and selective. Information overload can have the same negative effect as too little information. Communications should be made concisely for specific purposes.
6. Sixth, OEMs should cooperate with suppliers for continuous improvement.

Figure 9, an adaptation from Liker and Choi's publication (Liker and Choi 2004), illustrates the development of foundational practices and the hierarchy of supplier partnering.

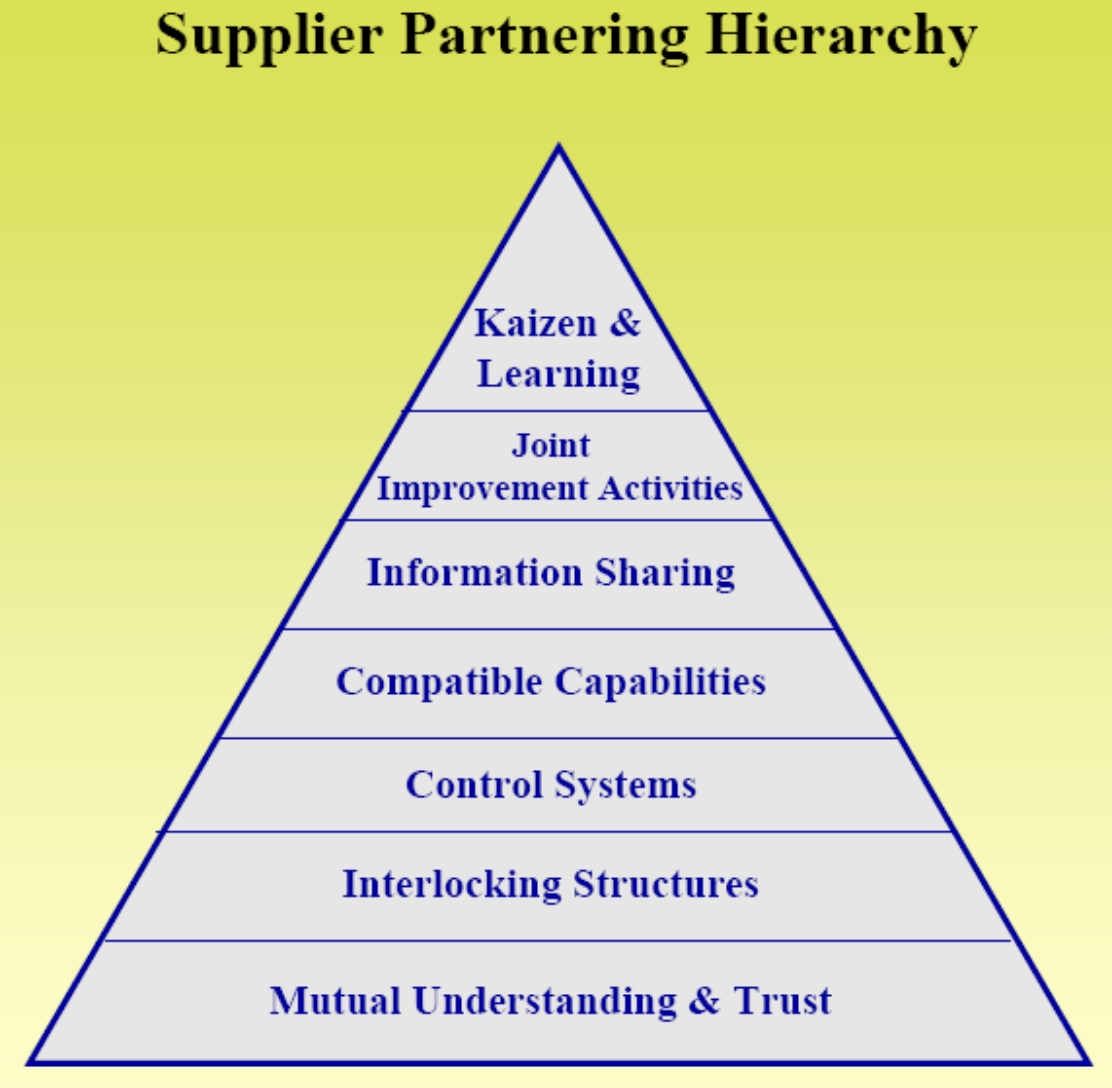


Fig. 9. Supplier partnering hierarchy courtesy of Jeff Liker (Liker and Choi 2004).

Supplier's Dilemma

The choice between adversarial and cooperative-trusting relations shares a game-theory structure closely related to the prisoner's dilemma. In the prisoner's dilemma, the two players in the game can choose between two approaches, either cooperative or adversarial. The idea is that each player gains when both cooperate, but if only one of them cooperates, the other one, who is adversarial, will gain more at the cost of the other. If both are adversarial, both lose (or gain very little) but not as much as is lost by the cooperator whose

cooperation is not returned. The whole game situation and its different outcomes can be summarized by a table (Table 1) in which hypothetical points are given as an example of how the differences in result might be quantified.

The interactions of the OEM-supplier relationship approaches appear to be very similar to those in the prisoner's dilemma. Adversarial OEM-supplier relationship approaches lead to a situation in which every inch gained by one organization is an inch given up by the other. The zero-sum game begins when suppliers are forced to arbitrarily reduce their prices for an OEM (or other adversarial actions). The natural response for suppliers is to respond by finding other ways to recoup their losses, such as charging higher prices for problem-solving services or future engineering changes (Stallkamp 2005b). In time, suppliers will expect to be forced to reduce costs and will find more creative ways to recapture their losses and remain profitable. This game is easily iterated down the tiers of suppliers as well. These interactions are something that could be termed the *Supplier's Dilemma*.

The zero-sum game played by OEMs and suppliers with adversarial relationship approaches has been occurring with domestic OEMs for some time. However, when OEMs and suppliers approach their relations with cooperative-trusting relations, both parties are better off in the end. A postulated table of outcomes is provided in Table 1.

Table 1

Supplier's Dilemma Table of Outcomes

Payoffs are (OEM, Supplier)		Supplier	
		Adversarial	Cooperative
OEM	Adversarial	(0,0)	(3,-3)
	Cooperative	(-3,3)	(2,2)

The game has been predominately played with an adversarial approach because of the optimization theory similar to that of the prisoner's dilemma. The problem is that if both decision-makers were purely rational, they would never cooperate. Indeed, rational decision making means that you make the decision that is best for you regardless of what the other actor chooses. The problem is that if both of the actors are rational, both will decide to be adversarial, and neither will gain anything.

However, applying the principle of sub-optimization, one reaches a different conclusion. With sub-optimization, one must consider the optimization of total system costs as opposed to the optimization each individual sub-system (i.e., looking at the supply chain versus OEM and suppliers). The concept is that optimizing the outcome for a subsystem in general will not optimize the outcome for the system as a whole. This principle is also known as the *tragedy of the commons*, in which shared resources are exhausted because of competition between the actors. In the case of automotive OEMs and suppliers, there is a limited amount of profit to be made. Each party wants to maximize its share, but the other actors are vying for the same share in order to maximize their own utility. Currently, few companies look at the system for optimization. Those that do (Toyota and Honda) are benefiting from their foresight.

Another way to look at the optimization of gains is to address the game as iterative. Year after year (sometimes sooner), the game is played again, and each party makes a decision to be cooperative or adversarial. In this scenario, a rational actor would cooperate as long as the other party cooperates and would switch to adversarial as soon as his/her partner does. The basic outcome of this approach is that cooperation is more beneficial in the

long run. Even with the discounted present value of future gains and a risk factor for the possibility of bankruptcy, both parties will typically gain more by cooperating. The *one-time win* of adversarial relations is made at the cost of future gains.

The supplier's dilemma succinctly demonstrates what the automotive industry has experienced without explicitly knowing the value of cooperating. One can quickly see the benefits of choosing cooperative approaches, but this type of action is *irrational* according to conventional wisdom. Despite the way the game has been played in the past, the opportunity to optimize for the system and achieve greater benefits for all is possible.

Chapter 6: Conclusions and Possible Further Research

This study has provided the empirical data necessary to substantiate the anecdotal evidence that cooperative-trusting supplier relations do provide real economic value. The working relationships automotive OEMs have with their suppliers do affect economic variables that impact bottom line results and competitive advantage. The four hypotheses of this study were validated:

1. Cooperative-trusting OEM-supplier relations significantly reduce overhead and material costs as measured by the Cost Of Goods Sold (COGS). The differences in what OEMs spend in COGS because of their relative relationship are on average between 2% and 10% of total COGS. Considering that this figure can be in the tens of billions, this is a substantial inefficiency.
2. Cooperative-trusting OEM-supplier relations concurrently increase the level of innovation and reduce OEM investments into research and development. OEMs have identified that innovation is vital to their competitive advantage. Ford has even stated that innovation is "the compass by which [Ford] sets its direction" (Ford 2005)(14). If the relationships OEMs have with suppliers affect innovation and innovation impacts competitive advantage, then relationships should be paramount to OEM survival.
3. Cooperative-trusting OEM-supplier relationships foster quality for individual components and overall end-product fit. Quality is a very important characteristic in the automotive industry. Consumers are more

knowledgeable and demanding, and their selection of products has increased. To remain competitive, OEMs not only need to have the latest designs, but they also must create products that will meet customer expectations in both cost and quality. The type of working relationship an OEM has with its suppliers substantially affects both of these product characteristics.

4. Cooperative-trusting OEM-supplier relations enhance material management practices, reducing total inventory levels and increasing inventory turns. The cost of capital in holding inventory for prolonged amounts of time is undeniable. With valuable assets tied up, OEMs are unable to invest in growth and development. Holding inventory also affects a company's balance sheet, which in turn has an immediate impact on market value. If OEMs are truly attempting to *lean out* their inventories and maintain high turn rates, they must consider the relative relationships they have with their suppliers.

These results provide the foundation necessary for OEMs to make informed decisions about the approach they take toward their working relations with suppliers. Adversarial actions and their relative benefits can be weighed against the cost of making such a decision. Likewise, OEMs can determine what the return on investment is likely to be for choosing cooperative-trusting supplier relations. With this information, justification can be made for resource allocation to create and maintain cooperative-trusting OEM-supplier relations if they are found to be rational.

The conclusions of this study should provide direction for further investigation into the elements of cooperative-trusting OEM-supplier relationships. With further research into this topic, there is the possibility of identifying specific practices that could maximize the opportunity for system-optimal economic gain. Some suggestions for future research include the following:

1. Evaluating the economic value of suppliers' working relationships with regard to supplier benefits. This topic would provide the motivation for suppliers to make investments into supporting cooperative-trusting relationships, if that decision were rational. For this option, it may be best to study suppliers by the products they provide, as different commodities may experience different relative benefits.
2. Identifying and developing the hierarchy of cooperative-trusting relationships at a greater level of granularity. Basic elements are anecdotally known, but the marginal utility gained by each mechanism is still unknown. Establishing the connections between mechanisms and their marginal benefits can help OEMs and suppliers plan their investments in a manner that will optimize the outcomes.
3. Applying the models within this study to other industries. Conceivably, cooperative-trusting relationship approaches can benefit a variety of industries, particularly more complex system integrations. Some industries to look at for further application include the aerospace and defense, shipbuilding, and industrial equipment industries.

4. Developing a model for selecting appropriate relationship approaches for suppliers. As indicated in this study, relationships are not one-size-fits-all. A model for selecting relationships based on supplier characteristics may provide OEMs a simplified approach to selecting the best mechanisms to apply with given suppliers. Considering that OEMs can interact with thousands of suppliers, a model could make the prospect of relationship management more feasible.

Consider the possibilities of adopting a new approach to the way business is conducted. Relationships are no longer intangible assets; this study provides the empirical evidence that determines their value. Archaic adversarial practices do not have to be the norm just because they are the only option with defined return on investment. Decisions can be made on the basis of a comparison of alternatives rather than the taking of the only option available. It is hoped that organizations will use this new knowledge to improve their operations and create new levels of efficiency throughout their supply chains.

References

Anderson, E. and S. D. Jap (2005). "The Dark Side of Close Relationships." Sloan Management Review **46**(3): 74-82.

Appleby, C. and D. Twigg (1988). "CAD diffusion in the west Middlands automotive components industry." Center for Industrial Studies. Wolverhampton, UK, Wolverhampton Polytechnic.

Asanuma, B. (1989). "Manufacturer-Supplier Relationships in Japan and the Concept of Relation-Specific Skill." Journal of Japanese and the International Economies **3**(1): 1-30.

AutomotiveNews. (2005, 1/3/2005). "Bashing Suppliers Damages Big 3's Market Position." Automotive News. Retrieved January 27, 2005, from http://www.autonews.com/apps/pbcs.dll/article?AID=/20050103/SUB/501030728&SearchID=73232374019748.

Bruynesteyn, M. (2005). Cadence Mid-2005 Update OEM Product Pipeline. New York, NY, Prudential Equity Group, LLC.

Clark, K. B. (1989). "Project Scope and Project Performance: The Effect of Parts Strategy and Supplier Involvement on Product Development." Management Science **35**(10): 1247-1263.

Cleveland, J. (2004). "Successfully Selling to the New Domestics." Automotive Design & Production **116**(8): 16-17.

Dalton, P., K. Novak, et al. (1998, February 1998). "Using Price Indexes." Retrieved June, 12, 2005, from http://www.house.leg.state.mn.us/hrd/pubs/indexes.pdf.

Dertouzos, M. L., R. K. Lester, et al. (1989). Made in America: Regaining the Productive Edge. Cambridge, MA, MIT Press.

Dyer, J. H. (1996a). "Does Governance Matter? Keiretsu Alliances and Asset Specificity as Sources of Japanese Competitive Advantage." Organization Science **7**(6): 649-666.

Dyer, J. H. (1996b). "How Chrysler Created an American Kieretsu." Harvard Business Review **74**(4): 42-56.

Dyer, J. H. (1997). "Effective Interfirm Collaboration: How Firms Minimize Transaction Costs and Maximize Transaction Value." Strategic Management Journal **18:7**: 535-556.

Dyer, J. H. (2000). Collaborative Advantage: Winning Through Extended Enterprise Supplier Networks. Oxford, UK, Oxford University Press.

Dyer, J. H., D. S. Cho, et al. (1996). "Strategic Supplier Segmentation: The Next 'Best Practice' in Supply Chain Management." International Motor Vehicles Program. Retrieved September 12, 2005, from http://imvp.mit.edu/papers/98/185a.pdf.

Dyer, J. H. and W. Chu (1997). The Economic Value of Trust in Supplier-Buyer Relations. International Motor Vehicles Program Working Papers – Supplier Performance and Relations. Philadelphia, PA, Wharton School, University of Pennsylvania.

Fawcett, S. E. P. and A. J. P. Williams (2001). "Supply Chain Trust and Commitment: Practical Perspectives for Long Term Success." Provo, UT, Brigham Young University.

Fine, C. H. (1998). Clockspeed: Winning Industry Control in the Age of Temporary Advantage. New York, NY, Perseus Books Publishing.

Flynn, M. S. (2005). "Barriers to Healthy OEM-Supplier Relationships". OSAT. Ann Arbor, MI, University of Michigan Transportation Research Institute.

Ford, B. (2005). "Bill Ford Remarks on Innovation." Retrieved September 25, 2005, from http://media.ford.com/article_display.cfm?article_id=21631.

Hacker, S. K. (1999). "Building Trust in Key Customer-Supplier Relationships." Retrieved September 25, 2005, from http://www.tpcuniversity.com/pdf/trust_cust_supplier.pdf.

Handfield, R. (2004a). "Can You Trust Big Customers?" Reports from the Supply Chain Resource Center Director. Retrieved September 25, 2005, from http://scrc.ncsu.edu/public/DIRECTOR/dir011404.html.

Handfield, R. (2004b). "Trust, Power, Dependence, and Economics: Can Supply Chain Management Research Borrow Paradigms?" International Journal of Integrated Supply Management **1**(1): 3-32.

Hanley, M. and N. De Koker. (2005). "A Look Under the Hood: A Financial Study by the Original Equipment Suppliers Association CFO Council and the Earnst & Young Global Automotive Center." Retrieved September 25, 2005, from http://www.ey.com/global/content.nsf/US/Industrial_Products_-_Automotive_-_Issues_-_Supplier_Financial_Best_Practices.

Helper, S. (1989). Changing Buyer-Supplier Relationships in the United States: Results of Survey Research. Cambridge, MA, International Motor Vehicles Program International Policy Forum.

Helper, S. (1990). "Comparative Supplier Relations in the U.S. and Japanese Auto Industries: An Exit/Voice Approach." Business and Economic History **19**: 153-162.

Helper, S. (1991). "How much has really changed between U.S. automakers and their suppliers?" Sloan Management Review **32** (Summer): 15-28.

Helper, S. R. (1997, May). "Complementarity and Cost Reduction: Evidence from the Auto Supply Industry." Retrieved September 25, 2005, from http://www.nber.org/papers/w6033.pdf.

Helper, S. R. and D. Hochfelder. (1995). "'Japanese-Style' Relationships in the Early Years of the US Auto Industry." Retrieved September 25, 2005, from http://hdl.handle.net/1721.1/1640.

Helper, S. R. and D. I. Levine (1992). "Supplier/Customer Participation and Worker Participation: Is there a Linkage?" Industrial Relations Research Association **153**: 12-25.

Helper, S. R. and M. Sako (1995). "Supplier Relations in Japan and the United States: Are They Converging?" Sloan Management Review **36**(3): 76-84.

Henke, J. W. J. (1990). "Working Relations Index." Retrieved April 27, 2005, from http://ppi1.com/whatwedo/relations_index.asp?image=what.

Kim, J.-B. and P. Michell (1999). "Relationship Marketing in Japan: The Buyer-Supplier Relationships of Four Automakers." Journal of Business & Industrial Marketing **14**(2): 118-129.

Kobe, G. (2001, March). "Supplier Squeeze – Relationship Between Automakers and Original Equipment Manufacturers – Industry Overview." Automotive Industries(March 2001): 11-13.

Lieberman, M., S. Helper, et al. (1998). The Empirical Determinants of Inventory Levels in High-Volume Manufacturing. Philadelphia, PA, International Motor Vehicles Program, Massachusetts Institute of Technology.

Liker, J. K. (2004). The Toyota Way: 14 Management Principles From The World's Greatest Manufacturer. New York, NY, McGraw-Hill.

Liker, J. K. and T. Y. Choi (2004). "Building Deep Supplier Relationships." Harvard Business Review **82**(12): 104-113.

Lorenz, E. H. (1988). "Neither Friends Nor Strangers: Informal Networks of Subcontracting in French Industry." Trust: Making and Breaking Cooperative Relations. Oxford, UK, University of Oxford**:** 194-210.

Maister, D. H., C. H. Green, et al. (2000). The Trusted Advisor. New York, NY, Simon & Schuster.

Morris, J. and R. Imrie (1992). Transforming Buyer-Supplier Relations: Japanese-Style Industrial Practices in a Western Context. London, Macmillan Academic and Professional LTD.

Mudambi, R. and S. Helper (1998). "The 'Close but Adversarial' Model of Supplier Relations in the U.S. Auto Industry." Strategic Management Journal **19**: 775-792.

Murphy, T. (2004). "United They Stand: Big 3 likeminded on quality, minority sourcing." Ward's Auto World **40**(10): 26-27.

Ndede-Amadi, A. A. (2004). "What strategic alignment, process redesign, enterprise resource planning, and e-commerce have in common: enterprise-wide computing." Business Process Management Journal **10**(2): 184-199.

Nishiguchi, T. (1994). Strategic Industrial Sourcing: The Japanese Advantage. Oxford, UK, Oxford University Press.

Noordeweir, T., G. John, et al. (1990). "Performance Outcomes of Purchasing Arrangements in Industrial Buyer-Vendor Relationships." Journal of Marketing **54**(4): 80-92.

Parker, J. (2003). Suppliers grow weary of raw deals: Some reject orders from U.S. carmakers. Detroit Free Press. Detroit. **October 30:** E–3.

Pecaut, D. and P. Gordon. (1999). "Tough-Love Procurement." Boston Consulting Group Retrieved September 25, 2005, from http://www.bettermanagement.com/library/library.aspx?pagetype=1&libraryid=6915.

Poirier, C. C. (1999). Advanced Supply Chain Management: How to Build a Sustained Competitive Advantage. San Francisco, CA, Berrett-Koehler Publishers.

Rawlinson, M. (1990). Subcontracting from Motor Vehicle Related Firms to Small Engineering Firms in the Coventry Economy, PhD diss., Coventry Polytechnic.

Rice, J. B. J. and R. M. Hoppe (2001). "Supply Chain Versus Supply Chain: The Hype & The Reality." Supply Chain Management Review **September/October**: 46-54.

Segil, L. (2004). "Turning Supply Relationships into Valuable Partnerships." Supply & Demand Chain Executive. Retrieved September 25, 2005, from http://www.sdcexec.com/article_arch.asp?article_id=6694.

Sherefkin, R. (2003). "GM: Be the cheapest, or be gone; Suppliers dislike GM's 30-day escape clause." Automotive News. **November:** 59-61.

Sheth, J. N. and A. Sharma. (1997). "Supplier Relationships: A Strategic Initiative." Industrial Marketing Management. Retrieved September 25, 2005, from http://www.jagsheth.com/docs/Supplier%20Relationships%20-%20A%20Strategic%20Initiative.pdf.

Smitka, M. J. (1990). "The Invisible Handshake: The Development of the Japanese Automotive Parts Industry." Business and Economic History **19**: 163-171.

Smitka, M. J. (1991). Competitive Ties: Subcontracting in the Japanese Automobile Industry." New York, NY, Columbia University Press.

Stallkamp, T. T. (2005a). SCORE! A Better Way to Do Business. Upper Saddle River, NJ, Wharton School Publishing.

Stallkamp, T. T. (2005b). Personal Interview. M. Milas. Bloomfield Hills, Michigan.

Strauss, K. (1999). "Panelists agree: Trust is the key to buyer-supplier relationships." Nation's Restaurant News **33**(24): 94.

Szczesny, J. (2004, August 22, 2004). "Survey: Poor Relationship." The News-Herald, Heritage Newspaper. Retrieved September 25, 2005, from http://www.thenewsherald.com/stories/082204/aut_20040822013.shtml.

Tangri, R. (2004). "Turning Suppliers into Partners: Total Cost Management Through Strategic Sourcing." Supply & Demand Chain Executive. Retrieved September 25, 2005, from http://www.sdcexec.com/article_arch.asp?article_id=6938.

Vashilash, G. S. (2005). "General Motors: The Road Ahead." Automotive Design & Production. Retrieved September 25, 2005, from http://www.autofieldguide.com/articles/010501.html.

Vonderembse, M. A. (2002). Building Supplier Relationships that Enhance Manufacturing Performance. London, UK, Spiro Press.

WallStreetJournal (2004, August 24). "Automotive Brief – Ford Motor Co.: Most Suppliers Decide to Stay, Despite Clause in New Pacts." Wall Street Journal. New York, NY**:** 1.

Wasti, S. N. and J. K. Liker (1997). "Risky business or competitive power? Supplier involvement in Japanese product design." Journal of Product Innovation Management **14**(5): 337-355.

Webster, S. A. (2003). "Honda, Nissan, Toyota rated tops by suppliers." The Detroit News. Retrieved September 25, 2005, from Http://www.detnews.com/2003/autosinsider/0305/16/b01-163341.htm.

Winter, D. (2004). "Transplant Supplier Relations." Ward's Auto World **40**(9): 5-6.

Zhang, D., J. Dong, et al. (2003). "A Supply Chain Network Economy: Modeling and Qualitative Analysis." Innovations in Financial and Economic Networks. Retrieved September 25, 2005, from http://supernet.som.umass.edu/articles/dingsite.pdf.

Appendix: Variable Names and Descriptions

Variable Name	Source	Description
WRI	PPI Inc.	Working Relations Index measure of supplier relationships
ln WRI	PPI Inc.	Logarithm of Working Relations Index
sales	Compustat	Real annual sales
sales(-1)	Compustat	Real annual sales lagged by one year
ln sales	Compustat	Logarithm of real annual sales
cogs	Compustat	Real cost of goods sold
cogs(-1)	Compustat	Real cost of goods sold lagged by one year
ln cogs	Compustat	Logarithm of cost of goods sold
ln cogs(-1)	Compustat	Logarithm of cost of goods sold lagged by one year
cadence	Prudential Equity Group	Index of OEM innovation and new product development
cadence(-1)	Prudential Equity Group	Index of OEM innovation and new product development lagged by one year
ln rd	Compustat	Logarithm of real research and development investments
inventory	Compustat	Real total inventory levels
inventory turns	Compustat	Number of inventory turns per year (number of times inventory cycled through)
quality	JD Powers	index for overall product quality problems
ln quality	JD Powers	logarithm of index for overall product quality problems
profit(-1)	Compustat	real annual profit lagged one year

d1		Dummy variable for the first calendar year, 2000
d2		Dummy variable for the second calendar year, 2001
d3		Dummy variable for the third calendar year, 2002
d4		Dummy variable for the fourth calendar year, 2003
df		Dummy variable for Ford specific effects
dc		Dummy variable for Chrysler specific effects
dn		Dummy variable for Nissan specific effects
dt		Dummy variable for Toyota specific effects
dh		Dummy variable for Honda specific effects