

**"VERTICAL RELATIONSHIPS & THE ROLE OF
INFORMATION TECHNOLOGY: AN EMPIRICAL
STUDY OF US & JAPANESE SUPPLIER
RELATIONSHIPS IN THE AUTO INDUSTRY"**

by

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Vertical Relationships and the Role of Information Technology:

An Empirical Study of US and Japanese Supplier Relationships in the Auto Industry

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**Vertical Relationships and the Role of Information Technology:
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Auto Industry**

ABSTRACT

This paper explores the specific influence of information technology (IT) in the broader framework of other factors predicting the degree of quasi-integration between two independent firms that are vertically-related in a value delivery system. We test the relative influence of three sets of constructs proposed by transaction cost economics, political economy and information systems literature. Specifically, we analyze data pertaining to 447 supplier relationships in the automobile industry in the US and Japan and find that three general constructs affect the level of quasi-integration: (1) the market within which a relationship operates, (2) the characteristics of the relationship itself and the relative power of the supplier, but also (3) inter-organizational uses of information technology. However, the significance and the direction of the effects of these independent variables on the depend variable differ across the two countries. In particular, we develop implications from the differences in IT use across the two countries and propose a distinction between a US "electronic market" strategy to supply management and a Japanese "IT-mediated quasi-integration" strategy.

Introduction

Managers and researchers around the world agree that business competition, and hence management practices, are undergoing profound transformations. Among others, we are in the midst of experiencing three converging trends: (1) vertical disintegration and the emergence of new types of cooperative relationships; (2) a greater use of information technology (IT) applications to enable and support coordination across organizational boundaries, (3) and a general internationalization of most industries and businesses.

Many large firms, especially in the manufacturing sector, are streamlining their operations, typically moving away from traditional vertical integration toward more external contracting of key activities. They are at the same time shifting toward a supply system with fewer direct suppliers and transforming relationships from traditional arm's length relations to new inter-organizational arrangements based upon a cooperative logic (Powell, 1987; Jarillo, 1988; Thorelli, 1986). These take the form of complex networks of cooperative relationships or quasi-integration, also described as "value-adding partnerships" (Johnston and Lawrence, 1988), or "alliances" (Heide and John, 1990; Anderson and Narus, 1990).

New information and telecommunication technology applications, such as EDI (electronic data interchange) or VANs (Value Added Networks), can support coordination across organizational boundaries, and as such have emerged as one of the factors leading to more IT-mediated relationships (Venkatraman, 1991; Malone, Yates and Benjamin, 1987; Bakos and Brynjolfsson, 1992). This phenomenon of inter-organizational relationships that explicitly leverage information technology capabilities has been variously described as: 'value-adding partnerships' (Johnston and Lawrence, 1988), 'inter-organizational systems' (Barrett and Konsynski, 1982; Cash and Konsynski, 1985), 'information partnerships' (Konsynski and MacFarlan, 1990) and 'electronic integration' (Venkatraman and Kambil, 1991) within a broader continuum of electronic markets and electronic hierarchies (Malone, Yates and Benjamin, 1987).

Hence, if we want to understand why manufacturers are moving toward less vertical integration and greater quasi-integration with their suppliers we need a broader research perspective than the ones adopted in different research streams. One first stream, within the vertical integration and transaction cost analysis literature focuses on the comparative efficiency of alternate governance structures to access intermediary products and operations (Williamson, 1985, chapter 1). On the other hand, the relational contracting literature in marketing channels approaches

relationships from a behavioral theory and political economy perspective, where the concern includes the socio-political aspects of the relationship (Heide and John, 1990; Anderson and Narus, 1990).

The information systems research community has conceptually recognized the potential for information technology to transform the nature of inter-organizational coordination (Malone, Yates and Benjamin, 1987), though no empirical study has yet systematically examined the extent of use of IT across organizational boundaries in one industrial sector (with the exception of Zaheer and Venkatraman, 1990), nor has any study compared the influence of IT factors with more traditional economic and behavioral factors. Also, in spite of the importance of business internationalization and the ubiquitous use of information technology in developed economies, no empirical study has yet systematically examined the influence of different factors, including information technology, on the level of quasi-integration.

In this paper, we thus propose to examine the factors, in particular information technology, that influence the trend towards more quasi-integration with suppliers in the specific context of the auto industry. Quasi-integration is operationalized as the percentage of the total volume outsourced for a component that is purchased from a given supplier. The greater the part of volume that is procured from one supplier over other competitors, tighter is the business relationship and greater the quasi-integration. Specifically, we are interested in answering the question: is more quasi-integration associated with more use of EDI applications, and do 'information technology use' variables have additional explanatory power when compared with more traditional predictors derived from the economic (e.g., asset specificity) and behavioral perspectives (i.e., power and influence). The theory building of this paper relies on (1) previous theoretical perspectives that suggest environmental and relational characteristics of a business relationship as critical factors affecting vertical quasi-integration between two firms and on (2) recent descriptions of the use of IT, especially EDI (electronic data interchange), as a set of tools enabling greater coordination across organizational boundaries.

The paper is divided into six sections. In the first section above, we review recent developments that justify the importance of studying relationships from an integrative perspective, including information technology. In the second section, we derive from transaction costs analysis supplemented by descriptive theories from organizational and information systems research some key factors conceptually related to inter-organizational quasi-integration. Specifically, we develop a set of five hypotheses that model the relationship between the dependent variable, quasi-

integration, and three constructs representing the independent variables, (i) the characteristics of the environment surrounding the relationship, (ii) the characteristics of the partnership including those of the supplier and (iii) the inter-organizational use of information technology. The third section describes the research design, operationalization of the constructs and sampling procedures that provided the empirical data set of 447 buyer-supplier relationships in the US and Japanese automobile industries that we used to test the hypotheses. The fourth section explains the analytical approach underlying the data analysis the results of which are described in section five. The final section discusses the findings, conclusions and implications of this study.

PREDICTORS OF VERTICAL RELATIONSHIPS IN THE AUTO INDUSTRY

The selection of the auto industry as the empirical setting was based on the following factors. Recent research studies (see especially, Cusumano and Takeishi, 1991; Nishiguchi, 1989; Helper, 1987; Lamming, 1989) have documented that supplier relationships have been undergoing major changes, "indicating far reaching transformations in the way automobile production and automobile companies themselves are organized" (Sabel, Kern and Herrigel, 1989). Traditionally, US automakers were characterized by a high degree of vertical integration having designed the car, manufactured nearly all the necessary core components and coordinated final production. The trend, however, is towards a car company becoming the *coordinator* of an increasingly intricate IT-mediated production network, typically purchasing more core components from outside, thus reducing its level of vertical integration and at the same time reducing its total number of suppliers. This new supply system based on cooperation, widely associated with Japanese companies (Asanuma, 1989; Dyer and Ouchi, 1993) and accepted as the major explanation to the global competitiveness of Japanese assemblers, has become the "best practice" to emulate (Womack, Jones and Roos, 1990). Thus, the necessity to include both US and Japanese manufacturers data into the study.

We wish to determine what factors are associated with a greater degree of quasi-integration between two independent business partners, i.e., an automobile assembler and its component supplier. Specifically, we identify and empirically test the relative importance of three sets of factors: (1) the environmental characteristics surrounding the relationship; (2) the characteristics of the relationship itself, which we analytically decompose into: (i) the characteristics of the relationship itself and (ii) the characteristics of the specific partner; and finally (3) the use of IT

applications to support inter-organizational coordination (see figure 1 for a display of the conceptual model). The first two factors are seen as sources of uncertainty while information technology is viewed as a mechanism used to increase the information processing capabilities of the relationship and help management better cope with uncertainty.

ENVIRONMENTAL CHARACTERISTICS:

Market Concentration and Market Heterogeneity

Market Density. Williamson (1975) explains that markets with a small number of competitors with opportunistic inclinations fail and suggests that the most efficient response is to internalize the transaction. Thus, a car assembler faced with a market for a component with plenty of capable competitors would rely on the market mechanism and spread its volume among a few capable competitors playing them one against the other. On the other hand, a market characterized by a high market density represents greater risk for the buyer and less motivation to depend on any single supplier for a large portion of the volume it needs for the final assembly of its vehicle.

Market Heterogeneity Similarly, a supplier which specializes primarily in the design and manufacture of components for the auto industry is more dependent on the business auto manufacturers are willing to give him. As a result a manager responsible for sourcing decisions at a car manufacturer perceives less uncertainty and risk when dealing with parts suppliers operating in a homogenous market dedicated to the automobile industry than when dealing with suppliers producing components for other manufacturing industries as well (i.e., suppliers operating in a heterogeneous market). Hence, the following hypothesis (see figure 1):

Hypothesis 1: The buyer has a greater degree of quasi-integration with those suppliers operating in markets characterized by lower market density and lower market heterogeneity.

PARTNERSHIP CHARACTERISTICS:

Asset Specificity and Partner Characteristics

The level of uncertainty and risk perceived by management on the buyer side is also affected by the nature of the relationship itself. In other words, within the same product and market segment relationships do differ across suppliers. As opposed to the exogenous sources of uncertainty driven by the external environment

of the relationship (e.g., market density and heterogeneity), this type of 'partnership' uncertainty is endogenous to the relationship. We distinguish two components to partnership uncertainty: (1) one is related to the characteristics of the relationship, in particular the extent to which each partner has made investments highly specific to the relationship and (2) the other is related to the characteristics of the supplier itself, in particular its relative power and influence within the relationship. It is important to note that these two sources of partnership uncertainty are consistent with the theoretical arguments in the resource-dependency stream of organization theory (Pfeffer and Salancik, 1978) and the transaction cost economics perspective (Williamson, 1985).

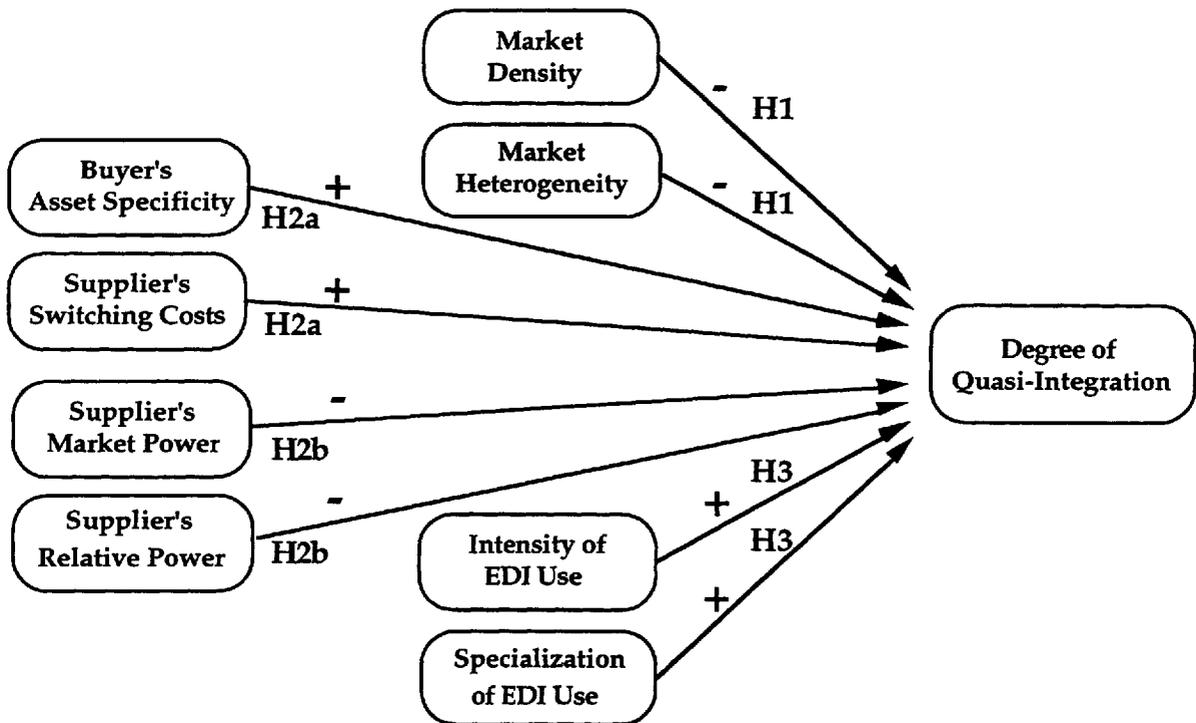
Asset Specificity. We define the supplier's asset specificity as the extent to which the investments made by the supplier are highly specific to the relationship with the buyer, i.e., investments considerably of less value outside this relationship through which the car company may hold the supplier hostage. The specificity of these investments makes it more costly and difficult for the supplier to switch to another assembler. Thus, an auto maker dealing with a supplier that faces high switching costs perceives less uncertainty about the future behavior of this supplier and may give them a greater piece of its business (i.e., increase the level of quasi-integration as operationalized in this paper). Though the consequence of high customer's asset specificity is similar, i.e., greater quasi-integration, the underlying logic is different. Indeed, the buyer needs to protect and amortize these specific investments and therefore do more business with this supplier. Hence, the hypothesis:

Hypothesis 2a: The assembler has a greater degree of quasi-integration with those suppliers engaged in a relationship where both parties have made investments highly specific to the relationship.

Supplier Power. Resource dependency theory (Pfeffer and Salancik, 1978) asserts that organizational survival depends on the acquisition of scarce and valued resources from the environment and suggests that firms seek to establish low cost, stable and efficient acquisition of these resources. Accordingly, auto assemblers strive to reduce their partnership uncertainty and select strategies that maximize their own inter-organizational power over suppliers. Hence, the hypothesis:

Hypothesis 2b: The assembler has a greater degree of quasi-integration with those suppliers with less power.

Figure 1: The Conceptual Model



USE OF INFORMATION TECHNOLOGY: Reduce Uncertainty

Greater levels of quasi-integration introduce more uncertainty into a buyer's decision-making because its activities are directly influenced by the supplier's role performance and it must concede some greater degree of organizational autonomy (Pfeffer and Salancik, 1978). This uncertainty, as proposed by Galbraith and other proponents of the information processing view of organizational design (Tushman and Nadler, 1978; Daft and Lengel, 1986), gives rise to information processing requirements that firms need to match with appropriate information processing capabilities for greater performance. Information systems researchers recognize that information technology can substantially contribute to increasing information processing capabilities within and across organizational boundaries (Malone, Yates and Benjamin, 1987). In particular, Venkatraman (1991) proposes 'electronic integration', i.e., the interconnection and integration of the business processes of two or more independent organizations through information technology applications, as an alternative business response to traditional vertical integration.

Electronic integration strategies may range from the mere electronic exchange of standardized documents between two business partners, to the integration and redefinition of fundamental management processes within and between the partners. American Airlines' SABRE systems, Baxter's ASAP system and GM's MAP program

are some of the more popular and vivid examples of systems in the US that support such an electronic integration strategy, while accounts of Japanese examples are gaining exposure (e.g., the inter-organizational systems developed by Seven-Eleven Japan, Kao, and Yamato). A key role for information technology is therefore to increase the information processing capabilities of a relationship, thereby making possible the implementation of quasi-integration strategies even for relationships operating in high uncertainty environments or embedded in a high uncertainty relational climate. For instance, the recent development of EDI (electronic data interchange) in the automobile sector makes it possible for an assembler to electronically coordinate with its supplier in most of the information and coordination intensive activities that span the life cycle of the relation (i.e., contract negotiation, component design, tool development, production control, delivery and even payment). Hence the hypothesis:

Hypothesis 3: The use of information technology will have a positive and significant relationship with the degree of quasi-integration.

ADDITIONAL EXPLANATORY ROLE OF INFORMATION TECHNOLOGY

Does information technology make any difference and does it have any explanatory power, especially when analyzed within a broader framework including environmental and partnership characteristics. Information systems researchers argue that IT as it reduces coordination costs does affect the comparative advantage of different coordination and governance mechanisms (Malone, Yates and Benjamin, 1987; Gurbaxani and Whang, 1991). This emerging body of work recognizes a critical role for information technology, and sees it as the next technological revolution which will change the way firms do business. In particular, in this study *we argue that information technology may provide a customer with the coordination capabilities traditionally associated with vertical integration without the cost of ownership*. Hence the hypothesis:

Hypothesis 4: Information technology variables will have a positive and significant additional explanatory power on the degree of quasi-integration.

COMPARATIVE EFFECTS ACROSS COUNTRIES

Recent international studies of supplier relationships highlight the fundamental differences in supply management in the US and Japanese industries. Womack, Jones and Roos (1990), for instance, distinguish between the logic of mass

production still strongly prevalent within the US auto industry and the predominantly Japanese logic of lean production. In the purchasing area, Lamming (1989) argues for similar differences in supply management between US and Japanese automobile manufacturers. Consistent with these reported differences in US and Japanese production and supply management practices we suggest that the use of information technology will also accordingly differ across the two country settings. Hence the hypothesis:

Hypothesis 5: The relationship between the use of information technology and the degree of quasi-integration is different across the US and Japanese industries.

METHODS

Research Design

The data required for this study was collected from managers responsible for supplier relationships in automobile firms in the USA and Japan. Our field work proceeded as follows. First, we conducted a set of 17 interviews primarily in the Detroit and Tokyo areas with senior managers responsible for purchasing or engineering. These were complemented by visits to assembly plants, design and engineering facilities at both assemblers and suppliers. Both countries were included for these field studies to ensure that we were not reflecting a US-bias on the Japanese firms and vice versa. These interviews were focused at two boundary-spanning functions that were considered to be most critical for buyer-supplier relationships in the auto industry, i.e., purchasing and design. The interviews were exploratory in nature but focused on clarifying the following issues: (a) a preliminary corroboration of the applicability and appropriateness of the constructs and hypotheses developed to capture the antecedents and measures of vertical quasi-integration; (b) assessing the role and importance of information technology mechanisms, and partnership characteristics within the model as these were the two distinguishing dimensions of this study; and (c) ensuring that we have an adequate basis to sample the relationships covering the vast array of suppliers and components.

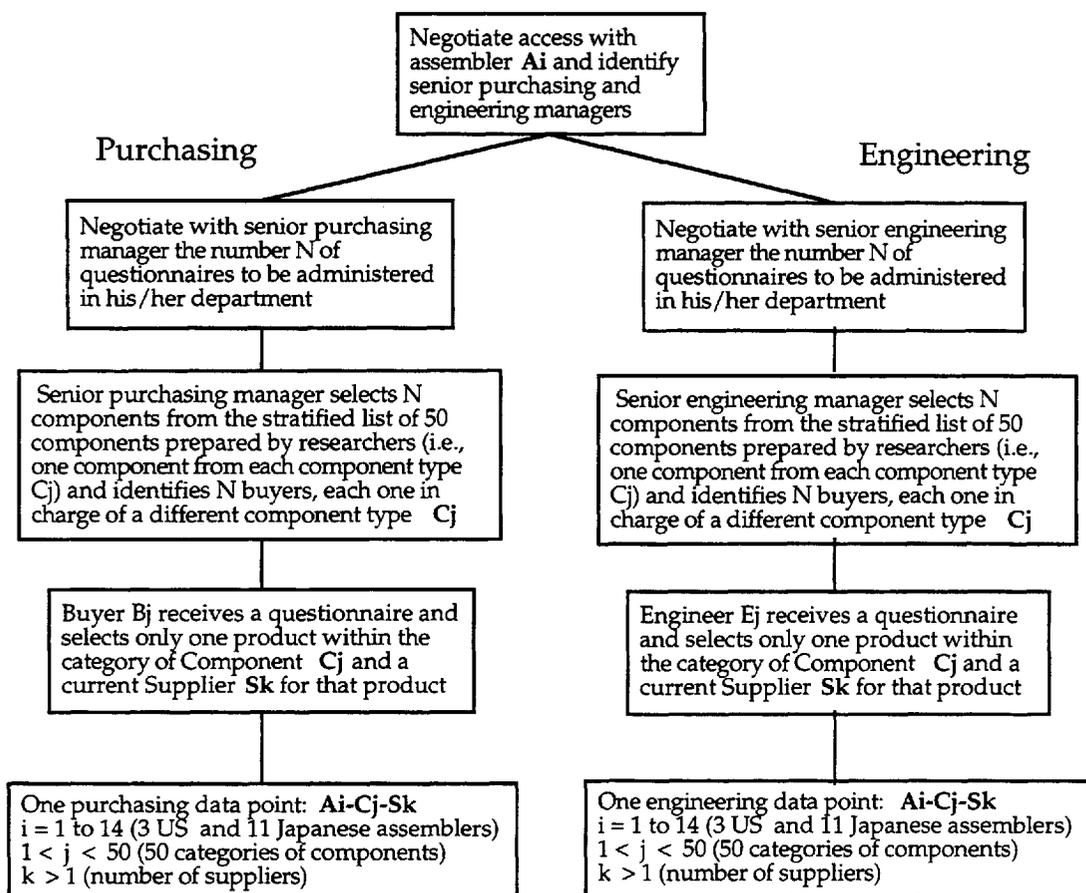
Subsequently, we developed a structured questionnaire to measure the variables -- both in English and Japanese for the two samples (an initial English version was first translated into a Japanese version by one of the authors itself independently translated back into English to check for and correct inconsistencies). Pre-tests of the instruments were conducted in 4 companies and 8 focus groups were

conducted with potential respondents (i.e., those purchasing agents and design engineers responsible for a given component account) to ensure that the target informants in both settings understood the wording consistent with the researchers' and that the Japanese version was a valid translation of the US version.

Sampling Procedures

Sampling followed the same process in all three US and all eleven Japanese auto companies (see figure 2). A purchasing and engineering senior manager at the central division or platform level were first asked to select a set of car components under their responsibility from the stratified list of 50 components prepared by the authors (i.e., to prevent from selection bias). Then for each of the selected components these senior managers helped identify the purchasing agent and/or engineer to whom we could send the questionnaire. The final decision about which specific supplier and which part number to choose was at the respondent's discretion (the respondent's name as well as the name of the supplier were not asked).

Figure 2: Sampling Procedures



In summary, each questionnaire represents a data point, that is a unique component-relationship-task triplet, where the controlled range of components included in the sampling contributes to variance in environmental characteristics, the variety of manufacturer-supplier relationships in both countries contributes to variance in partnership characteristics, and finally where the presence of two different boundary spanning functions dealing with different products and suppliers contributes to variance in task characteristics, hence the use of information technology. In sum, we tested the hypotheses proposed above with a sample of $n = 447$ independent buyer-supplier relationships (43% response rate; $n = 140$ in the US and $n = 307$ in Japan) across different auto manufacturers (i.e., all 3 US and 11 Japanese competitors), different supplier firms, and different vehicle components (e.g., standard fasteners, suspension systems, airbags).

Operationalization of the Variables

Following Venkatraman and Grant (1986), we paid particular attention to issues of operationalization and measurement in this study. Operationalization of the variables was achieved through two ways: (1) for those variables that have been previously employed in research settings, we adopted the measures as long as they satisfied acceptable measurement quality; and (2) for those variables that were unique to the hypotheses developed here, we developed operational measures; these were assessed for content validity through interviews and discussions with managers in Detroit and Tokyo. The detailed operationalization scheme for each construct is described in table 1 with examples of the specific indicators and the anchors used to calibrate them.

ANALYTIC APPROACH

To test the hypotheses developed above, we conducted multiple regression analyses on the data set for each country separately. As the primary objective of the paper is to test the comparative influence of several sets of predictors of vertical quasi-integration, we entered the independent variables into stepwise regressions in blocks. Each block groups together operationalizations of the same conceptual construct (e.g., market density and market heterogeneity operationalize the environmental characteristics theoretical construct). The influence of each individual construct, i.e., the collective influence of its operational measures is assessed by the significance of the change in R^2 when the corresponding block of variables is entered into the regression. For instance, the comparative explanatory power of information technology as a construct is assessed by the significance of the change in R^2 (sig. ΔR^2) when we enter the two variables, intensity of EDI use and specialization of EDI

use into the multiple regression. The equation representing the model developed in this study can be specified as follows:

$$\begin{aligned}
 \text{QI} = & b_0 + b_1 \text{ENVT1} + b_2 \text{ENVT2} + b_3 \text{CUS_AS} + b_4 \text{SUP_AS} \\
 & + b_5 \text{SUPW1} + b_6 \text{SUPW2} + b_7 \text{IT1} + b_8 \text{IT2}
 \end{aligned}$$

where:

QI	= level of quasi-integration, operationalized as the ratio of the total volume sourced from this supplier last year
ENVT1	= market density
ENVT2	= market heterogeneity
CUS_AS	= customer's asset specificity
SUP_AS	= supplier's asset specificity
SUPW1	= level of the supplier's power in its market segment
SUPW2	= level of the supplier's comparative power within the relationship
IT1	= intensity of IT use
IT2	= specialization of IT use

Table 1: Operationalization of the Constructs

Construct	Variables	Illustrative Questions and Scaling
<i>Dependent Variable</i>	quasi-integration (QI)	- Percentage of the total sourced volume this year that came from this supplier (0 to 100 %)
<i>Independent Variables</i>		
Environmental Characteristics	Market density (ENVT1)	- Domestic market share of the top 5 players combined for the component (5-point scale)
	Market heterogeneity (ENVT2)	- Extent to which the key competitors in this market segment also supply firms in other industrial sectors as opposed to specializing in the auto industry component supply business (7-point interval scale)
Characteristics of the Relationship	Customer asset specificity (CUS_AS)	- extent to which the assembler invested capital in this supplier - 5 point scale ranging from no capital participation; we own 1 to 10%; 11 to 50%; 51 to 99%; one of our divisions or subsidiaries
	Supplier asset specificity (SUP_AS)	- extent to which the assembler's business is economically significant to the supplier - measured using a 7-point interval scale ranging respectively from extremely non-significant to extremely significant
Characteristics of the partner	Market power (SUPW1)	- The supplier's domestic market share for the component (6-point scale)
	Relative power (SUPW2)	- Number of distinct products the supplier manufactures and delivers to the customer (5-point scale)
Use of Information Technology	Intensity of EDI use (IT1)	This indicator is the mean of 14 (for purchasing) and 9 (for engineering) dichotomous items measuring each whether a specific document is exchanged in electronic form with this supplier. For instance, in purchasing requests for quote, purchase orders, or shipping schedules can be exchanged in electronic form, while in engineering paper drawings, two-dimensional CAD or three dimensional surfaces can be exchanged electronically
	Specialization of EDI use (IT2)	This indicator measures whether data is exchanged in electronic form with this supplier in the engineering function (considered as a highly specialized use of EDI)

The sequence in which the eight independent variables were entered into the regression is consistent with the conceptual logic of the paper, i.e., explore the effect of the characteristics of the environment within which the relationship operates, then the characteristics of the partnership itself and finally the way information technology is used within the relationship. The first block of variables entered into the regression consisted therefore of market density and heterogeneity together (i.e., those variables pertaining to hypothesis 1), the second block included buyer's and supplier's asset specificity (i.e., hypothesis 2a), the third block included supplier's market power and relative power (i.e., hypothesis 2b), and finally the fourth block consisted of the intensity of EDI use and the specialization of EDI use (i.e., those variables pertaining to hypothesis 3).

Table 2 summarizes how the 5 hypotheses developed in this paper have been tested using the data collected in the US and Japan. Hypotheses 1 to 3 are supported if all coefficients b_i ($i = 1$ to 8) are statistically different from zero and if in addition coefficients b_1 and b_2 are negative, and b_3 to b_8 are positive. Hypothesis 4, as it pertains to the differential influence of information technology as a construct, it is supported if the change in R^2 due to intensity and specialization of EDI use variables is positive and significant. Finally, the differences across countries will be examined by comparing the signs of b_7 and b_8 across the two samples.

Table 2: Testing hypotheses 1 to 5

Hypothesis 1	b_1 and $b_2 < 0$ and statistically $\neq 0$
Hypothesis 2a	b_3 and $b_4 > 0$ and statistically $\neq 0$
Hypothesis 2b	b_5 and $b_6 > 0$ and statistically $\neq 0$
Hypothesis 3	b_7 and $b_8 > 0$ and statistically $\neq 0$
Hypothesis 4	change in R^2 due to IT > 0 and significant
Hypothesis 5	b_7 and b_8 different signs across the two country samples

RESULTS AND FINDINGS

Table 3 below summarizes the results from the multiple regressions conducted with the US sample ($n = 140$) and the Japanese sample ($n = 307$), while table 4 in appendix reports the detailed values for in particular R^2 , β coefficients and their significance levels. The R^2 values for both countries first indicate that the eight variables used in this study collectively constitute good predictors of quasi-integration in the two national settings (multiple $R = 0.35$; $R^2 = 0.12$; $F = 3.97$; $p <$

0.1 in the US, and multiple $R = 0.37$; $R^2 = 0.13$; $F = 1.69$; $p < 0.001$ in Japan). The highest significant correlation between the independent variables does not exceed 0.21 in absolute value, which reduces the concern for multicollinearity.

Table 3: Results for hypotheses 1 to 5

	Analytical Approach	Results	
		US	Japan
Hypothesis 1	$b_1, b_2 < 0$, statistically $\neq 0$	$b_1, b_2 < 0$, not significant	$b_1, b_2 < 0$, significant
Hypothesis 2a	$b_3, b_4 > 0$, statistically $\neq 0$	$b_3 < 0$, not significant $b_4 < 0$, not significant	$b_3 < 0$, significant $b_4 > 0$, not significant
Hypothesis 2b	$b_5, b_6 < 0$, statistically $\neq 0$	$b_5 < 0$, not significant $b_6 < 0$, significant	$b_5 < 0$, not significant $b_6 > 0$, significant
Hypothesis 3	$b_7, b_8 > 0$, statistically $\neq 0$	$b_7 < 0$, significant $b_8 < 0$, not significant	$b_7 < 0$, not significant $b_8 > 0$, significant
Hypothesis 4	change in R^2 due to IT > 0 and significant	ΔR^2 significant	ΔR^2 significant
Hypothesis 5	b_7, b_8 different signs across the two countries	$b_7 > 0$ $b_8 < 0$	$b_7 < 0$ $b_8 > 0$

Hypothesis 1: Environmental characteristics as a construct is a highly significant predictor of quasi-integration in the Japanese sample (multiple $R = 0.23$; $R^2 = 0.05$; F change = 5.96 and significant $p = 0.003$), but not in the US one (multiple $R = 0.10$; $R^2 = 0.01$; F change = 0.49 and not significant at 0.1). In both cases, though, the signs for b_1 and b_2 coefficients are negative in the direction hypothesized. Individually the variables operationalizing the construct are also significant only in the Japanese sample ($b_1 = -0.148$, $t = -2.25$ and t -significance = 0.025 for market heterogeneity, and $b_2 = -0.161$, $t = -1.97$ and t -significance = 0.05 for market concentration).

This result therefore indicates that Japanese auto companies maintain tight quasi-integration relationships in the high density markets, i.e., with fewer competitors as theoretical hypothesized on the basis of the small number assertion in transaction cost analysis. Japanese car manufacturers also develop quasi-integration strategies in highly homogeneous markets, i.e. in market segments when suppliers have specialized in serving the automobile industry.

Hypothesis 2a: In both countries, the characteristics of the relationship as a construct significantly contribute to R^2 change (multiple $R = 0.28$; $R^2 = 0.097$; F

change = 2.53 and significance $\Delta R^2 = 0.04$ in Japan; and multiple $R = 0.20$; $R^2 = 0.08$; F change = 1.91 and significance $\Delta R^2 = 0.114$ in the US).

Examination of the individual variables used to operationalize the construct suggest that the assembler's asset specificity significantly affects the level of quasi-integration only in the Japanese sample. The sign for b_3 , however, is negative in opposition with hypothesis 2a ($b_3 = -0.12$, $t = -1.64$ and t -significance = 0.10). This result also goes counter to the belief held by many US managers interviewed during the fieldwork that cross-shareholding and therefore supplier group membership explains the exclusive and closed nature of supplier networks in Japan. What the data indicates, however, is that Japanese manufacturers may invest directly into some of their suppliers, but this does not necessarily constitute a guarantee the supplier will systematically get all the business, or even a major part of the volume for the component. Asanuma (1989) provides some insight into this unexpected finding and explains how in fact Japanese manufacturers keep in business a small group of two to three suppliers for a component who compete and cooperate within a limited market controlled by the assembler. For instance, manufacturer M who has heavily invested into its relationship with supplier S and owns part of its capital or equity, may for the life of the current car model give a greater percentage of the volume to another supplier who demonstrated greater design, engineering or manufacturing capabilities.

Supplier's asset specificity, on the other hand, is not a significant predictor of quasi-integration in both national settings. The difference in sign for b_4 coefficients, however, may provide some interesting insights. The negative coefficient in the US sample suggests that an American assembler may not necessarily do more business with those suppliers that depend on him. In contrast, Japanese auto makers would tend to do more business with suppliers that depend on them (SUP_AS is not significant in either country: $b_4 = -1.30$, $t = -1.27$ and t -significance = 0.20 in the US sample; and $b_4 = 0.07$, $t = 0.97$ and t -significance = 0.33 in the Japanese sample).

Hypothesis 2b: Rather than the "absolute" power of the supplier within its market segment, it is its relative power within the buyer-supplier relationship, measured as the range of products it manufactures and delivers to the customer, that significantly explains quasi-integration. The difference in signs for b_5 is revealing though. It is positive in Japan suggesting that Japanese auto makers do more business with bigger players and it is negative in the US sample suggesting that the big three tend to spread their volume for component across multiple competitors and avoid creating a dependence on top market players.

Coefficient b6 is significant in both countries but displays opposite signs. This indicates that while US assemblers develop quasi-integration strategies with suppliers providing them fewer distinct products, their Japanese counterparts engage in high volume relationships when the supplier has the design and manufacturing capabilities to provide a wide range of products. These are what we could call 'broad band' relationships.

Hypotheses 3 and 5: The signs and significance levels for coefficients b7 and b8 indicates that the two information technology variables behave differently across the two countries, suggesting therefore that information technology is related to quasi-integration, but may be used differently. Specifically, the intensity of EDI use is the significant variable in the US sample with a negative b7 coefficient, while the specialization of EDI use is the significant one in the Japanese sample with a positive sign.

A negative and significant b7 coefficient in the US contradicts hypothesis 3. It indicates that US assemblers do not necessarily exchange more information electronically with those suppliers they do a lot of business with ($b = -0.204$, $t = -1.94$ and t -significance = 0.05). To explain this result we need to refer to some of the fieldwork interviews where information systems managers at the big three described the recent creation of a consortium of US manufacturers, the Automotive Industry Action Group (AIAG) led by the auto industry, to develop industry-wide standards for the electronic exchange of data and documents across multiple functional areas. The objective is to build an information technology infrastructure for the standard and common use of EDI between all domestic manufacturers and all potential suppliers. Any manufacturer will then be able to coordinate electronically with any supplier and vice versa, eventually creating an "electronic market" for car components. Clearly US firms place great hopes in the possibility of coordinating with their suppliers via information technology. Some managers we interviewed view "...EDI as the *strategic* weapon that should allow them to get data from suppliers faster, with less errors and at a lesser cost..."

In contrast, the information technology variable that appears as significant in the Japanese sample is the extent of specialized use of EDI with a positive b8 coefficient ($b = 0.204$, $t = 2.75$ and t -significance = 0.01). In other words quasi-integration is not associated with more documents exchanged electronically across the board, but rather a more specialized use of EDI with the supplier in the engineering function. Analyses based on the data collected in this study and reported elsewhere (see Bensaou, 1992) further corroborate this notion that information technology is used differently in US and Japanese supplier relations. In

particular, the data shows that an important part of the electronic exchange of data between Japanese buyers and suppliers is operated through the exchange of tapes and disks via regular mail. Interestingly, in the same paper Bensaou reports t-test data that indicate that data and process integration between the two firms is much greater in the Japanese supplier relations (i.e., the variable consists of a Guttman scale: (i) is the data exchanged electronically used at all, (ii) is it re-entered manually, (iii) is it translated by special software or (iv) is it directly used by the partner's information systems without any human intervention; t-test across countries $t = 3.44$; $p < 0.001$ with a larger mean value in the Japanese sample).

A Japanese manager commented: "...we are not looking for a quick technological fix...it is more important for us to first make sure we have compatible assessment methods and technologies, a common language, and that our scheduling and production processes are well integrated...once this is accomplished a tool like the fax can be added to the process if people think we can gain in operational efficiency..." He insisted the main objective is to detect and correct problems as early as possible in the design process, integrate the production processes between the two companies, and at the same time ensure the perfect execution and coordination of these processes *within* each company first.

Hypothesis 4: The change in R^2 is significant in both samples, indicating that when compared to other traditional factors information technology as a construct does have a significant impact in explaining the level of quasi-integration (F change = 2.30 significant at 0.10 for the US sample and F change = 4.33 significant at $p < 0.01$ for the Japanese sample). This result suggests that not only in the US where the industry as a whole is creating an industry-wide platform to support an "electronic market" for components strategy, but also in Japan firms are making critical investments into information and telecommunication technologies to support coordination between buyers and suppliers. The strategy pursued by the Japanese auto manufacturers is in line with their supply system management approach and could be labelled an "electronic quasi-integration" strategy.

Discussion and Conclusions

This study examined the factors related to the level of quasi-integration between a customer and its suppliers in the US and Japanese automobile markets. The conceptual model draws upon three research perspectives that have proposed different factors related to the nature of vertical relationships: (1) transaction costs analysis, (2) political economy and (3) information systems. The empirical study tested the relative explanatory power of these various factors, those representing characteristics of the market environment within which the relationship operates,

those representing the characteristics of the relationship itself, those of the supplier involved as well as the technological factors that affect the inter-organizational coordination capabilities of the relationship.

Contribution to theory: The empirical findings discussed above indicate that all these factors collectively affect the level of quasi-integration between the buyer and its supplier. An important result is the uncovered significance of two variables: the role of information technology and the relative power between the two partners in the relationship. In other words, this study supports predictions made by a transaction cost analysis (i.e., asset specificity as a significant predictor), but adds to our understanding the critical role of relational (i.e., supplier's relative power) and technological factors (i.e., EDI use).

In addition, we tested the influence of these factors across national settings. We found that in the US context the characteristics of the market within which a relationship operated do not have a significant impact, while characteristics intrinsic to the relationship and information technology do explain differences in quasi-integration. We also found that some of the hypotheses we derived from the research perspectives mentioned above did not necessarily apply to the Japanese context (i.e., we found an opposite sign for buyer's asset specificity, supplier's relative power). The results also suggest that information technology as a construct has a significant role in explaining quasi-integration, however, differences in the significance and sign of individual variables suggest that the role and impact of information technology differ across countries.

Contribution to methodology: This study represents the first attempt to systematically test for determinants of quasi-integration derived from multiple research perspectives that have independently shown the impact of their proposed explanatory variables. In addition, this is a first attempt to examine whether these theoretical assertions hold across countries. The study, indeed, tested the hypotheses with a sample of 447 distinct relationships where the sampling procedure (i.e., control over components, suppliers and tasks) was designed to have variance across the three independent variable constructs.

Contribution to practice: The findings suggest that in spite of the efforts reported by the trade press US manufacturers have not yet transformed their supplier relations. Indeed, our results are consistent with the general findings reported by Helper and Womack. We found for instance that US auto makers still spread their volume among multiple suppliers and avoid dependence over any big supplier. The approach towards information technology is also to "automate"

relationships and develop an industry-wide technological platform to allow coordination between any of the players in the industry. In contrast, the results from the Japanese sample are consistent with the long-term nurturing strategy of most Japanese manufacturers. Those suppliers who benefit from a tight quasi-integration relationship are dedicated to the auto industry, tend to provide a wide range of components to the buyer, operate in concentrated markets and have specialized proprietary electronic linkages with the buyer. Instead of an industry-wide standard Japanese manufacturers rather develop proprietary VANs linking the systems in their R&D labs, plants and offices to those of their suppliers, distributors and even banks.

Our finding that information technology is a significant determinant of governance, here quasi-integration, call for further research. In particular, this result implies that future exploration of vertical relationships within a delivery system should systematically include information technology as a key factor capable of influencing governance decisions at the same title as asset specificity or partner's relative power. In fact, the important investments in equipment made in the US manufacturing sector and the negotiations within and across multiple industries for common standards may suggest the emergence of new forms of IT-mediated "quasi-integration" where technology can provide the coordination capabilities without the cost of owning the supplier nor paying high search, control and coordination costs.

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Table 4: Results from multiple regression analysis

US Sample: n=140

Independent Variables	mult R	R ²	F	Sig F	ΔR ²	F change	Sig ΔR ²	β	t	Sig t
Environmental Characteristics ENVT1 = Market concentration ENVT2 = Market heterogeneity	.10	.01	.49	.61	.01	.49	.614	-.086 -.000	-.78 -.003	.43 .99
Characteristics of the Relationship CUS_AS = assembler's asset specificity SUP_AS = supplier's asset specificity SUPPW1 = supplier's power in its market SUPPW2 = supplier's comparative power	.28	.08	1.45	.20	.07	1.91	.114	-.148 -.130 -.06 -.154	-1.47 -1.27 -.58 -1.56	.14 .20 .56 .12
Information Technology IT1 = Intensity of IT use IT2 = Specialized use of IT	.35	.12	1.69	.11	.04	2.30	.105	-.204 -.014	-1.94 -.13	.05 .89

Japanese Sample: n=307

Independent Variables	mult R	R ²	F	Sig F	ΔR ²	F change	Sig ΔR ²	β	t	Sig t
Environmental Characteristics ENVT1 = Market concentration ENVT2 = Market heterogeneity	.23	.053	5.96	.003	.053	5.96	.003	-.161 -.148	-1.97 -2.25	.05 .025
Characteristics of the Relationship CUS_AS = assembler's asset specificity SUP_AS = supplier's asset specificity SUPPW1 = supplier's power in its market SUPPW2 = supplier's comparative power	.31	.097	3.73	.002	.044	2.53	.04	-.12 .07 .10 .17	-1.64 .97 1.20 2.61	.10 .33 .23 .01
Information Technology IT1 = Intensity of IT use IT2 = Specialized use of IT	.37	.133	3.97	.000	.036	4.33	.01	-.017 .204	-2.38 2.75	.81 .01