Transportation price benchmarking: implications for firm performance

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Abstract

Purpose – The purpose of this paper is to understand how transportation price benchmarking impacts firm performance.

Design/methodology/approach – In this study, firm transportation costs and other financial variables are examined with regression analysis. This study extends empirical research on benchmarking by using current data, taking a longitudinal approach, using additional research methods, and by taking a contingency theory approach to examine firm performance contingent on the relative size of benchmarking information.

Findings – Firms can reduce prices paid for transportation (thereby improving firm performance) by participating in benchmarking consortiums, and the amount of price reduction is contingent on the size of firm transportation spending relative to that of the benchmarked firms. Furthermore, the contingent relationship is concave, which indicates that participation in benchmarking consortiums can be optimized.

Research limitations/implications – Despite the wide range of companies in this sample and the longitudinal approach of this research, this study examined benchmarking performance in just one marketplace (truckload transportation).

Practical implications – The findings help managers to lower transportation costs and optimize the benefits that can be obtained from benchmarking.

Originality/value – Transportation prices paid by firms are difficult to obtain because firms are not required to isolate and disclose this information on financial statements. Therefore, the transparency of transportation pricing data in this study which include a wide cross-section of firms provides a unique examination of actual transportation prices and how they can be used for benchmarking.

Keywords Logistics, Supply chain, Benchmarking, Transport operations, Trust, Cost reduction, Information exchange, Logistics management

Paper type Research paper

Introduction

Firms often compare their internal operations, processes, and data with other firms for the purpose of improving their performance – a process called benchmarking. Research demonstrates that sharing information can improve logistics performance (Zhou and Benton, 2007; Huang *et al.*, 2003; Lambert *et al.*, 1998). However, firms have difficulty finding benchmarks that are similar and appropriate to their own operation (Tongzon, 1995), and when these benchmarks are attained, it requires much effort to maintain the relationships that are required for long-term benchmarking. (Hess and Francis, 2004). For many firms, the practice of benchmarking has advanced beyond a few isolated events of comparison to become partnerships marked by frequent, systematic, and ongoing comparisons. For these reasons, in many purchasing marketplaces, benchmarking consortiums have begun to organize and disseminate information about member firms, for member firms (Bowerman, *et al.*, 2002). Thus benchmarking consortiums can provide large amounts of needed information easier than firms can acquire the information themselves. Yet, the consortiums require a two-way flow of information and managers

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know there can be downsides to sharing their own information with other firms. Giving up proprietary internal information does not come easily.

The literature says companies may withhold information, thereby maintaining information asymmetry, for several reasons including: to maintain competitive advantage, to maintain bargaining power, to manage their partnerships, to avoid being exploited, or to protect growth-stage products (Kembro *et al.*, 2014; Yigitbasioglu, 2010; Kim *et al.*, 2006; Narayanan and Raman, 2004). Asymmetrical sharing implies that firms have asymmetrical gains. Others studies show that strategic alliances can improve supply chains (Whipple and Frankel, 2000); but firms have to be willing to share information (Fawcett *et al.*, 2009) which can weaken one participant relative to others (Hamel *et al.*, 1989). Furthermore, firms look out for themselves, first, and network partners, second (Keebler and Plank, 2009; Narayanan and Raman, 2004). Therefore, little research attention has been given to some looming questions: What is the cost of sharing internal information for benchmarking purposes, and what is the optimum amount of internal information to relinquish in exchange for useful benchmarking information from other firms?

The purpose of this research is to explore these important questions and advance understanding of the performance of benchmarking by observing how benchmarking information can be used by supply chain partners to reduce transportation prices. To begin, this study replicates the research of Carr and Smeltzer (1999) by using: contemporary data, another research methodology, and by taking a longitudinal perspective. Their studies were important for purchasing and supply management by applying social comparisons theory – which was previously limited to the individual level – to the firm level. This research extends the social comparison lens used by Carr and Smeltzer (1999) by adding a contingency theory approach, theorizing that the relationship between benchmarking and firm performance is contingent on the size of benchmarking information relative to that of other firms, and that benefits from benchmarking can be optimized.

The use of benchmarking as a management tool continues to grow in importance (Acquaye *et al.*, 2014; Gunasekaran, 2002). As benchmarking consortiums become a more frequently used tool by purchasing managers, firms, and academic researchers need to know the value that can come from benchmarking relationships and the extent to which firms should work collaboratively or at arm's length (Cox, 2001). Therefore, this contemporary replication of Carr and Smeltzer (1999) is beneficial for several reasons. First, the replication reinforces the rigor of previous research because replications with different data, across different timeframes, and using different methods increase the robustness of the findings (Goldsby and Autry, 2011). Second, this research expands upon social comparisons theory by using tenets of contingency theory, suggesting that the expected results of benchmarking are contingent on internal and external conditions (Wheeler, 1991). Perhaps this is the reason that Carr and Smeltzer (1999) were not able to find significant differences between firm sizes, when in actuality, benchmarking is contingent on other factors such as the relative size of the benchmarking information. Third, our expanded theoretical viewpoint has implications for practitioners. Namely, that there is a cost of sharing information with benchmarking consortiums, and this cost can be quantified, thereby providing better understanding which can be used to improve logistics management.

Background

Benchmarking consortiums

Benchmarking is a strategic skillset (Eltantawy, 2005) that is commonplace (Cox, 2001) and generally driven by the promise of improved competitive positioning

and productivity (Rogers *et al.*, 1995) because it can be used to determine the association between logistics and financial performance (Toyli *et al.*, 2008). As a method to organize benchmarking efforts by firms, consortiums have formed to provide benchmarking information in various marketplaces and they have a profound effect on firm performance (Smith *et al.*, 1991). Specifically, the information provided by transportation benchmarking consortiums can be used by firms to monitor the rates, volumes, and shipping lanes that other firms are securing for their freight transportation. It has been shown that firms are increasingly likely to connect with other firms into networks to exchange operational information, because this level of access and capability can improve firm performance (Whymark, 1998). Similarly, Vickery *et al.* (2003) show that integrating information technologies across supply chain partners can impact SC integration, customer service, and ultimately financial performance.

Benchmarking literature

Searching the literature with the term "benchmarking" uncovers a vast amount of research, but after closer examination much of it can be disregarded for the purpose of this study. For example, there are studies that use benchmarking to collect data for studying topics unrelated to benchmarking (e.g. Blumberg, 1994), there are studies that use benchmarking as a methodology to study topics unrelated to benchmarking, such as process efficiency (e.g. Jalalvand *et al.*, 2011; Min and Jong Joo, 2006), and there are studies that benchmark companies according to a particular dimension for comparison (e.g. Toyli *et al.*, 2008; Cavinato, 2005). Caplice (2007) overviews the truckload transportation market and discusses the procurement of services in the context of electronic marketplaces, illustrating how they are used; but does not provide empirical information. Daugherty *et al.* (1994) empirically find a relationship between logistics benchmarking and firm size, internal performance, supplier performance, and technology adoption by using 217 surveys of manufacturers. Despite these few studies, a search of transportation and benchmarking literature reveals little empirical research on how benchmarking information can be used to improve the performance of organizations; and therefore, this research is timely and relevant.

A theoretical perspective of benchmarking

The most common lens for understanding how individuals use information to compare, evaluate, and adapt their own behaviors to a comparison group is social comparisons theory (Carr and Smeltzer, 1999). Social comparisons theory says that individuals look for knowledge about themselves by comparing themselves to others (Wheeler, 1991). Carr and Smeltzer (1999) theorize that this can be generalized from individuals to the organizational level, and furthermore has relevance for benchmarking purchasing behavior in firms. Specifically, social comparisons theory posits that by using benchmarking a firm can compare its processes to other organizations and this generates value (Carr and Smeltzer, 1999).

To begin, this study replicates the hypotheses of Carr and Smeltzer (1999) on the relationship between benchmarking and firm performance. These hypotheses formally stated are:

H1. A positive relationship exists between benchmarking and firm performance.

H2. Firm size has an impact on the relationship between benchmarking and firm performance.

Firm managers readily find value in benchmarking information, but to receive information from other firms they usually must provide some internal information in exchange. Some exceptions include large retailers that can demand information in exchange for having products on their shelves (Hofer *et al.*, 2012), and key suppliers or patent holders of highly demanded items who are positioned to require more information from supply chain partners (Ulaga and Eggert, 2006) in exchange for the privilege of selling their products. However, most firms do not fit these criteria and a level of trust is required to share internal information (Kwon and Suh, 2005). Specifically, when firms agree to participate in a transportation benchmarking consortium they share more than pricing information, they also expose insights into their distribution network and market volumes. For example, even though firm names are hidden, when there are spikes in transportation services into and out of a region (transportation lane) that is known to be occupied by a certain company, their competitors can use this as reconnaissance information.

This research adds a contingency focus to extend research on purchasing benchmarking. Contingency theory identifies there is no best decision for all circumstances. Instead, the best course of action (i.e. what, when, and how to benchmark) is contingent upon internal and external situations (Wheeler, 1991). Fawcett *et al.* (2008) demonstrate that this requires managers to recognize competitive changes in their environment and adapt accordingly if they are to improve performance. Contingency theory supports that firm managers can find the appropriate level and scope of sharing information by examining the supply chain context (Kembro *et al.*, 2014), and appropriate contingent responses by firms are enabled by better information sharing (Fawcett, *et al.*, 2008: Monczka *et al.*, 1998). Furthermore, if firms share information under unfavorable conditions, it can lead to excessive information sharing that causes performance problems, namely delayed or inappropriate decisions (Kembro *et al.*, 2014), leading good firms enter strategic partnerships with clear strategic objectives and a plan to limit transparency (Hamel *et al.*, 1989). Firms do not readily give competitive information away unless they stand to benefit more than the cost (Bowerman *et al.*, 2002). Because of these issues, there is a heightened focus on the value of information and not necessarily its cost alone (Essig and Arnold, 2001).

The positive relationship seen between transportation benchmarking and firm performance (as measured by lower transportation cost) may be contingent on the firm level of transportation spending relative to the total transportation spending by other participants in a benchmarking consortium. As the relative level of firm transportation spending rises, the firm is providing an increasing percentage of the benefits in the shared information pool. This means the firm could still benefit, but at a decreasing rate. Furthermore, at some point the marginal return from sharing information could become negative:

H3. The relationship between benchmarking and firm performance is contingent on the relative size of benchmarking. Specifically, transportation spend is convex in the ratio of firm transportation spend to the total transportation spend of its benchmarking partners.

Research methods

Sample

Empirical data for this study were obtained from a transportation benchmarking consortium, where member firms share rates paid for truckload transportation services

by lane in exchange for knowing the rates paid by other firms. The purpose of this and other benchmarking consortiums is to provide a controlled forum for sharing transportation purchasing information with the goal of reducing transportation rates for all member firms. There is a cost for firms to participate and acquire information from benchmarking consortiums beyond membership dues; specifically, a shipping firm has to be willing to contribute their own internal information. This requires a level of trust and willingness to collaborate by sharing information.

Empirical tests in this research rely on weekly panel data from 125 firms that participated in the transportation benchmarking consortium for varying lengths of time. This resulted in 236 weekly periods (four and a half years) of data with 16,768 firm-week observations to test *H1* and *H3*. Company revenue (used to measure firm size) was extracted from the Standard and Poor's Compustat database. GDP and fuel price were downloaded from the Economic Research database provided by the Federal Reserve Bank of St Louis. Since testing *H2* required publicly available information, testing *H2* was done with a reduced sample of 60 publically traded firms and 9,216 firm-week observations. Descriptive statistics and pairwise correlations are summarized in Table I. Pairwise correlations show minimally correlated independent variables. The independent variables with the highest correlations were *GDP* and *FUEL* (0.567). *BENCHSIZE* and *FIRMSIZE* are the next highest correlated variables (0.403), but they are used in different models.

Model variables and measurement

TS represents transportation spending and it is the dependent variable. It is calculated as the total amount of money that each firm spends on truckload transportation each week.

GDP is gross domestic product measured in millions of US dollars.

FUEL is an index for fuel cost. This is collected from the Federal Reserve of St Louis Economic Database (https://research.stlouisfed.org/fred2/).

TS(1) represents a one-period lag of the dependent variable, *TS*, which was added to the model to control for auto correlation.

TIME is a sequential variable that measures the week number. This allows testing the effects of time as companies participate longer in benchmarking. When testing contingency theory, research advises that the explanatory power of contingency theory can be improved by measuring the performance before and after information sharing initiatives are done (Kembro *et al.*, 2014). Furthermore, monitoring continuous return from purchasing benchmarking is also supported by social comparisons theory and social learning (Wheeler, 1991; Salancik and Pfeffer, 1978; Bandura, 1971). This variable is used to test *H1*.

FIRMSIZE is a dummy variable that takes the value of 1 if firm revenue is greater than the mean. Thus, it identifies large and small firms which allows Model 2 to capture whether or not there is a difference between large and small firms. For a robustness

Variable	Min	Max	Mean	SD	*n*	Correlations			
GDP[a]	13,433	14,868	14,225	321	16,769	1.000			
FUEL	2.02	4.76	3.04	0.60	16,769	0.567	1.000		
FIRMSIZE (revenue)[a]	0.75	> 100,000	8,913	19,216	9,216	0.03	0.051	1.000	
BENCHSIZE	.00000143	0.12	0.011	0.012	16,769	−0.023	0.012	0.403	1.000

Note: [a]Millions of US dollars (annual)

Table I. Descriptive statistics and correlations

check this variable was also operationalized as firm revenue divided by total firm revenues, leading to the same result. This variable is used to test *H2*.

BENCHSIZE is used to represent the relative amount of benchmarking that is done by each firm relative to that of all firms. It is calculated by dividing the dollar amount of each firm's weekly transportation spend (TS) by the total transportation spend ($\sum TS$) of all members of the consortium ($TS/\sum TS$). This variable and its squared term are used to test *H3*.

Methodology

Regression analysis is used to test hypotheses following a four-step process. First, the control model was set, including independent variables *GDP*, *FUEL*, and $TS(1)$. Next, the *TIME* variable was added to test *H1*. Then, the *FIRMSIZE* variable was added to test *H2*. In the fourth model, the *BENCHSIZE* and $BENCHSIZE^2$ variables were added to test *H3*. To assess whether significant difference exists in the benchmarking-performance linkage, we employed ordinary least squares models to obtain the parameter estimates:

$$\text{(Control)}\, TS = \alpha_0 + \alpha_1 GDP + \alpha_2 FUEL + \alpha_3 TS(1) + \sum_{f=1}^{125} \alpha_f Firm_f + \varepsilon$$

$$\text{(Model 1)}\, TS = \alpha_0 + \alpha_1 GDP + \alpha_2 FUEL + \alpha_3 TS(1) + \alpha_4 TIME + \sum_{f=1}^{125} \alpha_f Firm_f + \varepsilon$$

$$\text{(Model 2)}\, TS = \alpha_0 + \alpha_1 GDP + \alpha_2 FUEL + \alpha_3 TS(1) + \alpha_4 TIME + \alpha_5 FIRMSIZE + \sum_{f=1}^{125} \alpha_f Firm_f + \varepsilon$$

$$\text{(Model 3)}\, TS = \alpha_0 + \alpha_1 GDP + \alpha_2 FUEL + \alpha_3 TS(1) + \alpha_4 TIME + \alpha_5 FIRMSIZE + \alpha_6 BENCHSIZE + \alpha_7 BENCHSIZE^2 + \sum_{f=1}^{125} \alpha_f Firm_f + \varepsilon$$

The Durbin-Watson statistic can be used to monitor serial correlation and it suggested there was high serial correlation in this panel data set (DW = 0.272). To control for this specification problem, a one-period lag of the dependent variable, TS, was applied in the model as an auto regressive term to capture the correlated effect of variables across subsequent periods. Auto regressive variables are common tools to control for serial correlation (Enders, 2010). The auto regressive term $TS(1)$ was significant in all models ($p < 0.01$) and the Durbin-Watson statistic became normal (DW = 1.996). Furthermore, a correlogram showed that the data became stationary after adding the auto regressive term.

A Hausman test demonstrated neither random nor fixed effects were correlated with the right-hand side variables ($\chi^2 = 0.282$). However, only a fixed effects specification is suitable for models that include an auto regressive variable that controls for serial correlation (Greene, 2003).

Results

Each of the models has high R^2 (> 0.96) and significant F-statistics ($p < 0.01$). The coefficient estimates for all control variables are significant, *GDP* ($p < 0.01$), *FUEL* ($p < 0.01$), and *TS*(1) ($p = 0.01$). The signs and values of these coefficients are in line with theory and expectations. The results from testing these models using the panel data set and the linear regression estimation method appear in Table II.

In the control model the independent variables that represent GDP and fuel prices were positive and significantly ($p < 0.01$) related to transportation spending meeting expectations. In Model 1, *TIME* is negative ($p < 0.05$) indicating that firms that participated in benchmarking decreased their transportation rates over time. Therefore, *H1* is supported, the same result found by Carr and Smeltzer (1999).

In Model 2, the dummy variable that identifies large firms (*FIRMSIZE*) is not significant, indicating there is not a differential impact between large and small firms on the benefit of purchasing benchmarking. Therefore, *H2* is rejected. This is similar to the conclusion made by Carr and Smeltzer (1999). They learn that both small and large firms have a significant impact, and they conclude that a difference was not found. For a second test of the *FIRMSIZE* variable it was operationalized as firm revenue divided by total revenue of all firms in the consortium. When calculated this alternative way *FIRMSIZE* was also not significant leading to the same result – *H2* is rejected.

In Model 3, the benchmarking variable (*BENCHSIZE*) and its squared term (*BENCHSIZE*^{2}) are statistically significant ($p = 0.01$). Since *BENCHSIZE*^{2} is significant; *H3* is supported. The results from this model suggest that the benchmarking information follows a non-linear relationship with *TS*, see Figure 1. Firms that provide a median amount of benchmarking information in a consortium attain more benefit that firms that provide the smallest or largest amount of benchmarking information. The non-linear relationship between relative benchmarking and firm performance is consistent with contingency theory and the premise that the ability of benchmarking to improve firm performance is contingent on the level of benchmarking involvement of the firm relative to other benchmarking participants.

	Variable	Control	Model 1	Model 2	Model 3
Control	*C*	−1,724,954*	−2,069,583**	−3,040,357*	−5,708,810***
	GDP	287***	330***	435***	308***
	FUEL	358,492***	355,233***	498,124***	323,799***
	TS(1)	0.8663***	0.8665***	0.8573***	0.7678***
H1	*TIME*		−1,800**	−4,328***	6,155***
H2	*FIRMSIZE*			−268,160 ns	
	BENCHSIZE				295,000,000***
H3	*BENCHSIZE*^{2}				−593,000,000***
R^2		0.97	0.97	0.97	0.98
F-stat		3,685***	3,657***	3,591***	6,773***
n[a]		16,643	16,643	9,133	16,643

Notes: [a]Some observations were lost when using the lagged term *TS*(1). *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table II. DV = firm transportation spend (*TS*)

Discussion

This research adds academic rigor to previous research by using new data, different methods, and by taking a longitudinal approach. Earlier studies find that benchmarking can improve firm performance – a conclusion derived from research using survey data (Daugherty *et al.*, 1994; Carr and Smeltzer, 1999). This study uses accounting data (US$) including both publically available data (i.e. inventory and sales) and proprietary data (i.e. prices paid for truckload transportation). The data used for this study cover a longer and more recent time period than previous research. The sample includes data from 236 weekly periods (four and a half years of accounting information) from 125 firms. It is interesting that, despite these differences in data and methodology, the research results from this research and previous studies are similar and reach the same statistical conclusions. Namely, that benchmarking is related to firm performance, and both small and large firms can benefit from benchmarking.

This study applies contingency theory to develop and test a new hypothesis in addition to reinforcing existing studies. Kembro *et al.* (2014) address the potential benefits of contingency theory applications to information sharing in supply chain management, specifically the fact that firms can determine the amount and type of information sharing appropriate for their firms by considering the supply chain context. Kembro *et al.* (2014) say, for example, that for each context, firms can decide which partners should get which information. Applying this contingency theoretical approach to benchmarking suggests that the appropriate amount and type of benchmarking likely depends on context (i.e. the specific firms involved, the marketplace, the product, the process, the managers, the strategy, etc.). Contingency theory suggests that even though firm size may not be a differentiator in attaining benefits from benchmarking, that the benchmark size (amount of benchmarking) relative to other firms may be important.

This research finds that benchmarking can improve firm performance, but that it is contingent on the participation level of firms relative to the total benchmarking information that is available. We find that firms can improve their performance, but at a decreasing rate as firms become more involved in benchmarking consortiums. This is intuitive when you consider that firms can increase performance as they become more involved, but when they provide an ever increasing amount of information relative to that contributed by other companies, at some point benefits will begin to decline. This means that purchasing and transportation managers can optimize their involvement in purchasing consortiums. *H3* examines this information and finds that benefits received from benchmarking are non-linear and are contingent on the relative size of the benchmark

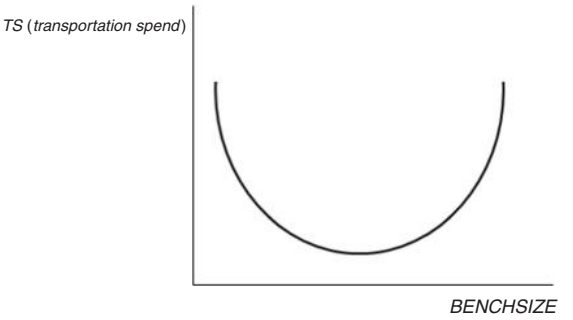

Figure 1.
Relative benchmarking size and transportation spend

information. This indicates that firms participating in a benchmarking consortium in relatively small or large amounts benefit less from benchmarking than average size firms in the consortium, as depicted by lower transportation spending in Figure 1.

It is also interesting to examine the implication of the duration of firm participation in benchmarking consortiums. Note that in model three, after the inclusion of the relative *BENCHSIZE* and $BENCHSIZE^2$ variables, the *TIME* variable is positive. This indicates that over time firms are benchmarking a larger absolute amount of transportation. This could imply that firms are satisfied with their results and increasing benchmarking participation.

Implications for managers

BENCHSIZE is the variable to measure the relative contribution of firms to the benchmarking consortium. As the level of benchmarking information (*BENCHSIZE*) goes up, transportation spending (*TS*) is reduced, but at a decreasing rate. This is important because firms need to know when using benchmarking consortiums is to their competitive advantage. As for the smallest firms, they cannot use as much of the purchasing information and therefore they receive less benefit. Larger firms can use more information from benchmarking consortiums to their advantage. However, as firms become very large, such that they are contributing a majority of the information in the benchmarking consortium, they receive less value from benchmarking because there is less information they do not already have. At some point, the escalating inadequacy of the information provided by the consortium reaches a level that no longer adds net benefit to large firms. Eventually, as this trend continues, the firms may have a negative performance impact because their contribution to the benchmarking consortium is large relative to the size of benchmarking benefits they receive.

Since benchmarking information that is appropriate and useful is difficult to attain and maintain, competing firms will regularly find and source services from the same consortium. Even though it is unlikely that firms will see each other's information (the source of the data is usually hidden), the firms will be using the same data as their competitors in pursuit of their goals. This makes it more important for purchasing managers to know how to optimize their participation level in benchmarking consortiums, or else their competitors might use the same benchmarking information more effectively.

Future research

Benchmarking continues to be an important research topic for purchasing managers and there are research areas for future analysis and development of theory and practice of purchasing benchmarking. First, additional research could replicate this study using data from other marketplaces where benchmarking is done. For example, this study focussed on the purchases of truckload services, and there may be differences between it and purchases of less-than-truckload services. Similarly, this research can tentatively be replicated in other purchasing marketplaces entirely outside of transportation. Second, there are likely behavioral benefits from benchmarking consortiums in addition to cost benefits, which could be elucidated for the purchasing community. For example, potentially the use of benchmarking consortiums could provide a standard method for processes that can make it easier for new purchasing managers to be successful (i.e. the learning curve is not as steep in regards to understanding the interdependencies and procedures in the transportation marketplace.)

Conclusion

This study strengthens academic and managerial understanding of benchmarking by replicating past hypotheses on benchmarking performance because an important part of synthesizing new knowledge is replicating prior studies with new theories, data sources, and methods (Goldsby and Autry, 2011; Carter, 2004). Then this research builds upon this base by applying a contingency theoretical approach to develop an additional hypothesis. This study concludes that performance can be improved by benchmarking and this is true for large and small firms. Also, the level of participation in benchmarking consortiums relative to that of other firms does impact the benefits received. Specifically, when firms provide a relatively small or large percentage of the total benchmarking information their performance (as measured by lower transportation cost) is not as strong as it would be otherwise. Furthermore, with this information, managers can optimize the benefits they receive from benchmarking.

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