Transparency of Information Acquisition in Supply Chains

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Abstract

In a supply chain serving a market with random demand, a downstream retailer faces uncertainty in the availability of demand information. He may conduct market research but may not acquire useful insight into customer preferences or potential demand. Or, he may possess a large amount of transaction data but fail to translate the data into information that would provide guidance to pricing or stocking level decisions. In other words, whether the retailer will be informed of the market demand, i.e., whether his information acquisition will be successful, can be uncertain. When his information acquisition has uncertain outcome, should the retailer keep the outcome a secret, or should he make it transparent to the upstream manufacturer by conveying to the latter whether or not he has successfully acquired useful market information? We find that, when facing a powerful manufacturer, such as one who can dominate the terms of trade by offering a quantity bundle contract menu, the retailer may become less disadvantaged, and gain more from his information (i.e., earn a higher information rent), by making his information acquisition process transparent to the manufacturer. This requires, of course, that the retailer is able to credibly convey to the manufacturer that his information acquisition has succeeded or has failed.
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1 Research problems

Firms in a supply chain make attempts to acquire information and modern data collection technologies have led to an explosion in both the scope and volume of customer and market data that are accessible to retailers. Much research work that focus on the value of information has assumed that information has been or can be obtained and that there is no uncertainty in the availability of information to the retailer, who either has no access to the information at all or always succeeds in obtaining the information. In reality, however, there may be uncertainty in the availability of information. For instance, a retailer who conducts market research may not acquire useful insight into customer preferences or potential demand. Or, he may possess a large amount of transaction data but fail to translate the data into information that would provide guidance to pricing or stocking level decisions. Therefore, whether a retailer will be informed of the market demand, i.e., whether his information acquisition will be successful, can be uncertain.

When his information acquisition has uncertain outcome, being a success or failure, should the retailer keep the outcome a secret, or should he make it transparent to the upstream firm by conveying to the latter credibly whether or not he has successfully acquired useful market information?

Casual observation seems to indicate that many firms tend to conceal not only the content of information but also the success or failure of information acquisition. For example, web-based survey becomes popular nowadays for many firms to acquire information from customers. Survey providers, such as SurveyMonkey, create a convenient system so that users (firms) only need focus on designing the survey, sending out email invitations, and analyzing the returned data. It seems to be a common practice for firms to keep from others all kinds of information, such as the number of returned survey forms, the taste of the customers, or the potential demand, even though the available information technology can easily make the outcome of information acquisition more transparent (e.g., by showing the number of customers who have completed the survey form).

In a supply chain setting, would a retailer have incentive to make his information acquisition transparent to the upstream manufacturer? To explore this question, we model a supply chain where the downstream retailer makes attempt to acquire demand information, with uncertain outcome — the acquisition may or may not yield useful information. We compare the two cases when the retailer’s information acquisition outcome is, and when it is not, observable to the manufacturer. We then analyze the impact of information acquisition transparency to individual firms in the supply chain.

2 Model assumptions and outline of analysis

Demand. We consider a supply chain that has one upstream manufacturer and one downstream retailer. The manufacturer has a constant marginal production cost and the retailer has a constant marginal operating cost. The inverse demand function is given by \( p = \tilde{A} - q \), where \( p \) is the market clearing price, \( q \) is the selling quantity from the retailer, and the intercept \( \tilde{A} \) represents random market
potential. We assume that the uncertain market potential $\tilde{A}$ follows a binary distribution, $\tilde{A} = A_H$ with probability $r$ and $\tilde{A} = A_L$ with probability $1 - r$.

**Information acquisition.** The retailer makes an attempt to acquire information about the market potential $\tilde{A}$, but his attempt may succeed or fail. To model this possibility, we assume that the retailer becomes informed of the realization of $\tilde{A}$ with a probability $t$. One can think of this probability $t$ as the retailer’s information acquisition capability: the larger is $t$, the more likely is it that the retailer will successfully obtain the demand information. There are two layers of uncertainty regarding information: (1) the attempt of acquisition may be successful or unsuccessful, and, if successful, (2) the observed realization of $\tilde{A}$ may be high or low (i.e., $A_H$ or $A_L$). The manufacturer does not know the realization of $\tilde{A}$. However, she may become acquainted with the success or failure of the retailer’s information acquisition attempt; at the very least, the retailer may himself choose to disclose the success or failure of his acquisition attempt (if doing so is to his advantage). In other words, the outcome of the retailer’s information acquisition can be observable or unobservable to the manufacturer.

The success or failure of information acquisition can be viewed as the quality, or accuracy, of acquired information: successful acquisition means very accurate information, while unsuccessfully acquisition means very inaccurate information.

We assume that the outcome (success or failure) of information acquisition does not affect $\tilde{A}$, the market potential; i.e., market research by itself does not change the market demand.

**Supply contract.** We assume the manufacturer uses a menu of quantity bundle contracts, $\{(Q_i, T_i) : i \in I\}$, specifying an order quantity $Q_i$ and its corresponding payment $T_i$. This can be interpreted as a nonlinear pricing contract. Under asymmetric information as in our model, a menu of quantity bundle contracts is an optimal contracting form for the manufacturer. As an uninformed party in the supply chain, the manufacturer tries to elicit the retailer’s information through a properly designed quantity bundle contract menu. To the manufacturer, the retailer is of one of three types: failure ($F$), high ($H$), or low ($L$). A “failure” type retailer is one whose information acquisition has failed and who thus stays uninformed of the market potential. A “high” type retailer is one who has successfully acquired the demand information and found that the market potential is $A_H$. A “low” type retailer has successfully acquired the demand information and found that the market potential is $A_L$.

The sequence of events is as follows. First, the retailer observes the realization of the market potential $\tilde{A}$ with probability $t$, or learns nothing about $\tilde{A}$ with probability $1 - t$ (and this outcome may or may not be observed by the manufacturer). The manufacturer offers a quantity bundle contract menu. Then, based on the contract menu offered, retailer selects a pair, $(Q_i, T_i)$, and decides a selling quantity up to $Q_i$.

**Outline of analysis.**

**Observable acquisition.** If the retailer’s information acquisition outcome is observable to the manufacturer, then, when the retailer has failed to acquired demand information, the manufacturer offers a single contract $(Q_F, T_F)$ to the retailer; when the retailer has successfully acquired demand information, the manufacturer offers $\{(Q_H, T_H), (Q_L, T_L)\}$ to screen out the two types, “high” or “low”.

3
Unobservable acquisition. If the retailer’s information acquisition outcome is unobservable to the manufacturer, the manufacturer offers \{((Q_u^q, T_u^q), (Q_u^h, T_u^h), (Q_u^l, T_u^l))\} to screen out the three types, “failure”, “high” or “low”.

3 Major results

We show that, when \(t\) is relatively small and \(A_H/A_L\) is intermediate, the retailer’s ex ante profit under observable information acquisition is larger than that under unobservable information acquisition. That is, the retailer may benefit from having the manufacturer observe whether or not his information acquisition is successful.

The benefit to the retailer of the observability of his information acquisition has an important practical implication for the transparency of his information acquisition. Usually downstream firms like to keep their information acquisition activities to themselves and disclose neither their acquired information nor the quality (or accuracy) of that information, lest he loses his information advantage while the manufacturer benefits. It is true, as our model shows, that the manufacturer benefits from knowing the retailer’s information acquisition outcome, but the retailer should still seriously consider the option of making his information acquisition transparent because that may benefit him also. The factors that the retailer should consider include his own information acquisition capability and the market size. He should also consider the relative market power. When facing a very powerful manufacturer, such as one who can dominate the terms of trade by offering a quantity bundle contract menu, the retailer may become less disadvantageous, and gain more from his information (i.e., earn a higher information rent), by making his information acquisition process transparent to the manufacturer. This requires, of course, that the retailer is able to credibly convey to the manufacturer that his information acquisition has succeeded or has failed.

As an example of how this may be implemented, consider a retailer who uses an online survey system to collect customers’ feedback. He can design the system so as to let the manufacturer see the number of returns to the survey but not the content of the returns. The number of survey returns here can be seen as indicating the accuracy of information and closely related to the success of information acquisition: many returns tend to generate useful market information (successful information acquisition) and very few returns may generate virtually no useful information (unsuccessful information acquisition).

We have also studied the impact of greater information acquisition capability. Under unobservable information acquisition, the retailer has incentive to improve her acquisition capability when he is not so capable, but when he is already very capable, he becomes worse off by gaining greater acquisition capability even if doing so is at no cost to him. The manufacturer prefers a less capable retailer when the retailer is not capable and the market is not very dispersed, while she prefers a more capable retailer when the retailer is already very capable or the market is very dispersed. Under observable information acquisition, the manufacturer may also prefer a less capable retailer.