INFORMATION LEAKAGE IN VERTICAL CONTRACTS

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1 Motivation

By “information leakage” we mean how information advertently or inadvertently reaches unintended recipients in a competitive environment. For example, information may be subsumed in the market price, and hence, conveyed from informed traders to uninformed traders unintentionally through the price discovery mechanism (Grossman and Stiglitz, 1980). Information leakage can also be deliberate or intentional. Clemons and Hitt (2001) analyze and discuss such misuse of information assets (they call it poaching) which is detrimental to the owner of these information assets. In this paper, we study the role of information leakage in a vertical contract and its effect on the incentives to acquire and share that information.

Information leakage requires information that can be leaked in the first place. In many realistic settings where information endowment is not determined by default, information acquisition necessarily precedes information leakage. Hence, apart from considering the impact of information leakage on the exchange or sharing of information, a more fundamental question to look at is the impact of information leakage on the incentives to acquire information. Casual intuition might suggest that information leakage discourages information sharing and thereby discourages information acquisition. Since information leakage permits information to reach players that were not intended by the information originator, it is reasonable to suppose that leakage reduces the value of information for the originator, discouraging information acquisition.

Academic models and real life cases have supported this line of reasoning. For instance, Li (2002) models information exchange between retailers and a supplier. Retailers can opt to share demand information with the supplier. However, since the wholesale price reveals information (leakage), there is no information sharing under the unique equilibrium in this setting. Grossman and Stiglitz (1980) find that because price conveys information from informed traders to uninformed traders, there is no pure strategy equilibrium with information acquisition as the outcome. Sometimes, the mere threat of information leakage can also play havoc. Salmon and Blasberg (1997) detail Liz Claiborne’s initiative in reducing product replenishment cycle times through quick-response. Liz Claiborne wanted retailers to share “Point-of-Sales” (POS) data for newly introduced fashion products so that uncertainty in demand could be resolved faster, minimizing both lost sales and inventory write-offs. However, they faced stiff resistance from the retailers who feared (intentional) leakage of valuable demand information to their competitors by Liz Claiborne.

The above arguments are over-simplified. In the context of information sharing, a key simplification that underlies the above argument is “truthful” information sharing. Once incentives to share infor-
information are explicitly considered, as we show in this paper, information leakage may actually induce information sharing. Further, information acquisition brings forth advantages like informed decision making in the face of uncertainty. Hence, even allowing for the fact that information leakage may have a negative externality on the information originator, it is not clear which effect will dominate: the positive impact of informed decision making or the (possibly) negative impact of information leakage.

2 Model Overview

We formalize the impact of information leakage on the incentives to acquire information by analyzing a supply chain consisting of one supplier and two manufacturers. One of the manufacturers takes a lead in developing and introducing a new product in the market. We call him the “incumbent”. The other manufacturer lags behind the incumbent in the product development process and follows him in the market with the same or perfectly substitutable product. We call him the “entrant”. The demand for the product is uncertain and the incumbent firm, if it so desires, can invest in obtaining market information on the uncertain demand. Both firms source a component from the (common) supplier. Now, if the incumbent acquires information, his order to the supplier is likely to convey demand information to the supplier. The supplier, if he so decides, can leak this order information of the incumbent to the entrant. Knowing this, the incumbent has to order strategically.

Notice that this structure, in it’s barest form, is akin to the Liz Claiborne example detailed above (leakage of demand information from a retailer through a supplier to a horizontally competing firm). The core issue in Liz Claiborne was whether to share demand information with the supplier under the threat of leakage. We actually go a step further and pose a more fundamental question, that of the incentives to acquire demand information in the first place (for example whether to do pre-launch trials of fashion apparels). Moreover, since we model intentional leakage, we explicitly consider the incentives of the supplier to leak information. A number of interesting questions arise, that we address in our analysis. Given the threat of leakage, under what conditions is information acquisition an equilibrium outcome? If information is acquired, is information shared in equilibrium? Under what conditions does the supplier leak information to the entrant? Can the incumbent prevent leakage? How should the supplier set the wholesale price? What is the effect of information leakage on supplier, incumbent and entrant profits, and on consumer surplus and welfare?

We assume that the demand curve is linear and downward-sloping, with an uncertain intercept. The sequence of events is as follows. The supplier announces the wholesale price, and the incumbent firm decides whether to acquire market information or not. The incumbent then places an order with the supplier. The supplier has the option of leaking this order information to the entrant (and the incumbent knows this). Then the entrant places an order with the supplier. The supplier delivers the ordered quantities, as requested, to the two firms. The incumbent enters the market first as a Stackel-
berg leader followed by the entrant as the Stackelberg follower. Prices and profits are determined a la Cournot. Note that the full game is a double Stackelberg game. The first is between the supplier and the incumbent (or the entrant) wherein the supplier announces the wholesale price and the second is between the incumbent and the entrant wherein they play a Stackelberg Cournot game.

When the incumbent does not invest in information acquisition, all parties have the same information endowment. However, the incumbent can alter his information endowment by investing in information acquisition. The latter case leads to an embedded signaling game. An informed incumbent signals the demand state through his order quantity to the supplier (and possibly to the entrant as well, if the supplier leaks). Hence, after the incumbent acquires information and places his order with the supplier, the following possible cases of information endowment may arise: (i) the supplier knows the demand, but the entrant does not (when the supplier does not leak the information), (ii) both the supplier and the entrant know the demand (when the supplier leaks the information) and (iii) neither the supplier nor the entrant know (when the incumbent successfully conceals his demand information). The first two cases arise when the incumbent truthfully reveals the demand state (leading to a separating equilibrium) and the last case arises when the incumbent masks the true demand state (leading to a pooling equilibrium).

3 Preliminary Results

Using the framework of a Perfect Bayesian equilibrium, we establish conditions under which the incumbent acquires information. We show that the incumbent acquires information whenever the demand is highly variable or the probability of low demand is sufficiently small. We formally show that the supplier always leaks (for all possible parameter values). It is worth emphasizing here that much of the literature has either ignored the incentives for leakage (as in Dye et al 2003) or have considered inadvertent leakage (Li, 2002). Hence, the incentives of the player who leaks have largely been ignored. Moreover, we show that if the incumbent acquires information, he always shares information with the supplier (and hence with the entrant). In other words, the incumbent always prefers the separating equilibrium. This result is in contrast with much of the literature (example, Li 2002) where the threat of leakage dissuades information sharing. We find that the supplier can strategically set the wholesale price to induce the incumbent to share information, leading to an equilibrium which is favorable to him. Also, counter-intuitively, a higher wholesale price favors information acquisition by the incumbent.

Further, we are in the process of investigating the impact of information leakage on the profitability of the three players and the supply chain as a whole. Moreover, we study the effect of exclusivity contracts between the incumbent and the supplier to prevent information leakage to the entrant.
References


