Markets for Product Modification Information

Ganesh Iyer & David Soberman*

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*The authors contributed equally to this research and names are listed in alphabetical order. Ganesh Iyer is an Assistant Professor at the John M. Olin School of Business, Washington University in St. Louis and David Soberman is an Assistant Professor at INSEAD, France. We thank Andy Mitchell, Ambar Rao, Brian Ratchford, the Area Editor and two anonymous reviewers for their comments. We are also grateful to seminar participants at Northwestern University and the ESSEC/INSEAD/HEC joint Marketing Seminar (1998) and to Alan Levine and Iris Jacobson of ICOM for their support of this research.

E-mail: iyer@mail.olin.wustl.edu; david.soberman@insead.fr
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Abstract

An important product strategy for firms in mature markets is value-adding modifications to existing products. Marketing Information that reveals consumers’ preferences, buying habits and lifestyle is critical for the identification of such product modifications. We consider two types of value-adding modifications that are often facilitated by marketing information: "retention" type modifications that increase the attractiveness of a product to a firm’s loyal customers and “conquesting” type modifications that allow a firm to increase the appeal of its product to a competitor’s loyal customers. The paper examines two aspects of the markets for product modification information: i) the manner in which retention and conquesting modifications affect competition between downstream firms and ii) the optimal selling and pricing policies for a vendor who markets product modification information. We consider several aspects of the vendor’s contracting problem including how a vendor should package and target the information to the downstream firms and whether the vendor should limit the type of information that is sold? We also examine when a vendor can gain by offering exclusivity to a firm?

We address these issues in a model consisting of an information vendor facing two downstream firms who sell differentiated products. The model analyses how information contracting is affected by differentiation in the downstream market and the quality of the information (in terms of how impactful the resulting modifications are). We analyse two possible scenarios. In the first, the information facilitates modifications that increase the appeal of products to the loyal customers of only one of the two downstream firms (i.e., one-sided information). In the second scenario, the information facilitates modifications that are attractive to the loyal consumers of both the firms (i.e., two-sided information).

The effect of modifications on downstream competition depends on whether they are of the retention or of the conquering type. A retention-type modification increases the “effective” differentiation between the firms and softens the price competition between firms. Conquering modifications, however, have benefits as well as associated costs. A conquering modification of low impact reduces the “effective” differentiation between competing products and leads to increased price competition. However, when conquering modifications are of sufficiently high impact they also have the benefit of helping a firm to capture the customers of the competitor.

The vendor’s strategy for one-sided information always involves selling to one firm. When information identifies high impact modifications, it is sold to the firm for which the identified modifications are conquering. In contrast, when the modifications have low impact, the optimal
strategy is to sell the information to the firm for whom the modifications are the retention-type. With two-sided information, the equilibrium strategy is for the vendor to sell the complete packet of information (information on both retention and conquisting modifications) to both downstream firms. However, in equilibrium, both the firms only implement retention-type modifications. The information on conquisting modifications is “passive” in the sense that it is never used by downstream firms. Yet the vendor makes strictly greater profit by including it in the packet. This obtains because the price charged for information depends critically on the situation an individual firm encounters by not buying the information. The presence of conquisting information in the packet puts a non-buyer in a worse situation and this underlines the “passive power of information”. The vendor gains by including the conquisting information even though it is never used in equilibrium.

Key Words: marketing of information, information packaging, exclusive contracts, retention modifications, conquisting modifications, product modifications and passive power of information.
1. Introduction

1.1 Background

Marketing Information sold by syndicated data vendors is one the fastest growing segments of market research in the 1990’s.\(^1\) Syndicated vendors are becoming sophisticated in providing information that helps marketing managers to formulate and modify product strategy. Vendors such as ICOM, Acxiom, Yankelovich, and NFO Worldwide, to mention a few, offer syndicated systems that track ongoing changes in consumer preferences, brand attitudes, buying habits, lifestyle and demographic trends. This information provides marketers with knowledge on how to add value to their product offerings. Table 1 provides details of syndicated information systems offered by 9 of the top 50 market research organizations in the U.S that help clients in designing or modifying their products.

\[\text{(Table 1)}\]

This type of information is particularly important because close to 90% of new product activity involves modifications to existing products rather than completely new products. These modifications include changes to product features, line extensions and changes in positioning or packaging.\(^2\) Syndicated database systems of the type shown in Table 1 have some critical advantages in this context. First, they help clients to continuously monitor changes in consumer and market trends (with associated implications for their products). Second, the increasing technological sophistication of syndicated databases enables firms to add value in a highly targeted fashion. The following example illustrates how information can help modify and add value to a product:

\[\text{ICOM is one of North America’s fastest growing syndicated providers of database marketing information. The company has developed a relational database that incorporates household level information on demographics, activities, preferences and brand consumption in a number of product categories. Some of the most aggressive users of ICOM’s data are pharmaceutical companies that compete in OTC categories such as pain relievers. Motrin (Johnson & Johnson) and Advil (American Home Products or AHP) are ibuprofen based products that compete in the OTC pain relief market. Both these brands have the same active ingredient (i.e., ibuprofen). However, analysis of ICOM’s database revealed that Advil’s usage}\]

\(^1\) The top 50 U.S. market research firms grew at 9% and reported world-wide revenues of $5.96 billion in 1998 (see “Business Report on the Marketing Research Industry,” Marketing News, June 7, 1999).
was relatively high among headache sufferers. In contrast, Motrin usage was higher among sufferers of backache and menstrual cramps. In March of 1999 using ICOM’s database, J & J developed a booklet and a marketing program specifically targeted at the consumers in the database who were identified as frequent sufferers of backaches and menstrual cramps. The booklet was designed to "educate" consumers about the efficacy of Motrin for this type of pain relief. Clearly, J & J is using this particular initiative to build Motrin’s appeal with its more loyal users.

Marketing information available from the ICOM database enabled J&J to add value to Motrin by providing valuable information/knowledge that was relevant to its loyal users. This is labeled as a retention-type modification. However, J&J could also have used the information to increase the appeal of the product among consumers who are loyal to Advil by highlighting its efficacy for headaches. We call this a conquisting type modification.

This paper examines the role of information that points to retention or conquisting modifications and the issues faced by vendors in selling this type of information. It establishes how retention and conquisting modifications affect competition between downstream firms and then analyses the optimal marketing policies for a vendor of such information. The research is motivated by questions such as: Should the vendor sell this information exclusively or broadly within a category? Should the vendor’s strategy differ depending upon whether the information helps a firm to target its own as opposed to its competitor's customers? Should the vendor sell complete information packets or should she limit the type of information that a buyer will receive? (for e.g., information on own versus competing customers)

1.1 **Product Modification Information: Taxonomy and Characteristics**

Information vendors such as ICOM provide product modification information to client firms in a broad range of markets. While the essential function of this information is to facilitate value additions to the product, the manner in which the information works differs widely from one case to the other. Table 2 provides a taxonomy of the different types of product modification information.

(Table 2)

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2 *Gorman’s New Product News* reported that 89% of the 6125 new products accepted by grocery stores in the first five months of 1991 were line extensions.

3 The paper focuses on the role of value adding modifications in mature markets such as packaged goods, beer, OTC medicines where firms primarily compete for market share. Consequently, the role of product modifications is to retain one’s loyal customers or to attract the existing customers of a competitor.
The first type is information that facilitates modifications to the physical features or attributes of the product. The reformulation of Breathsavers with a chlorophyll dot was a modification to a physical feature of the product. Such a modification makes the product more attractive to consumers who are currently loyal to Clorets (i.e., a conquering modification). However, marketing information can also facilitate product modifications in the broader context of the overall product offering. Thus syndicated information can add value through identifying a suitable packaging strategy. For example, the Yankelovich Monitor can identify the consumers in its database who represent the "sporty trendsetter" lifestyle segment. This segment has an interest in socializing and consuming beer in licensed establishments but likes to consume beer in smaller amounts than the standard 12 oz bottle. For Coors Light, already the preferred beer in this segment, using this information to increase the distribution of the "7 oz pony bottle" would make the brand more attractive to its loyal users. The third type of product modification information follows from Levitt’s (1969) concept of the augmented product. The examples in Table 2 show how syndicated data can help manufacturers to "augment" valuable services or information to the core product. The R.L. Polk information adds value by allowing the mall owner to augment the core product (in this case the mall) through a value-adding free-delivery service program. Similarly, J&J was able to use the ICOM database to augment the product by providing valuable information to consumers about the efficacy of Motrin for backaches.

In summary, syndicated information might not only have value for consumers in and of itself (as in the pain reliever example), but also because it might help develop a packaging change or indicate changes to the existing features of the product. In other words, information in this framework can be thought of as a resource or as knowledge that allows a firm to add value through any component of the product.

1.2 Framework and Results

We develop a model of an information vendor selling to two differentiated downstream firms. The model highlights the role of two factors: the degree of differentiation between the downstream firms and the impact of the information in terms of how valuable the resulting modifications are.

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4 Product modifications can be facilitated by resources other than marketing information. For example, "product design" firms such as the Development Agency and Dollery Rudman assist clients in the redesign of their products. Nevertheless, this paper is motivated by the syndicated information industry because marketing information is the most pervasive "resource" that is required to implement product changes. Even when a company hires a product design expert to effect a product change, information on consumer preferences is an essential prerequisite.
Consider the different situations that an information vendor can face. A vendor might have information that can facilitate modifications that are attractive to the loyal consumers of both firms. We define this as “two-sided” information. An example is the ICOM information that points to marketing activity that yields differential benefits to the users of both Motrin and Advil. An initiative to provide benefits to backache/menstrual cramp sufferers will be more valuable to Motrin users while an initiative to provide benefits to headache sufferers will be more valuable to Advil users. The vendor must decide whether to sell the information to both firms or to offer exclusivity. If the vendor decides to sell to both firms, she must also choose a “packaging” strategy. The vendor can sell complete information packets (that provide both firms with information that allows modifications for own as well as competitive customers) or limited information packets (for example, selling information that points to “retention” modifications only).

A second situation is one in which the vendor has information that identifies product changes that are attractive to consumers who are loyal to only one of the firms (we define this as “one-sided” information). In the Coors Light example, the sporty trend-setter segment is loyal to Coors Light. Thus the knowledge that they would like to consume beer in smaller amounts can be used to effect a pack-size modification that adds value differentially to consumers who are on the Coors Light side of the market. The decision that the vendor faces is whether to sell it to the firm (Coors Light) that currently serves these customers (in which case, the modifications would be retention-type), or to the firm that would like to acquire these customers (in which case, the modifications are conquesting-type), or to both.

Given the vendor decisions, the downstream firms decide whether or not to buy the information and once they have purchased information, they decide which (if any) modifications to implement. They then compete by choosing market prices simultaneously.

We find that retention-type modifications unambiguously soften price competition between firms. These modifications make firms behave as if the level of differentiation between them has increased, enabling them to raise prices without the fear of losing existing customers. In fact, even if only one firm implements a retention modification, its strategic effect is to raise all the equilibrium prices in the market. Conquesting modifications, however, have costs as well as associated benefits. While a conquering initiative has a "business stealing” advantage of helping a firm attract the loyal customers of the competitor, it also has the disadvantage of evoking an aggressive pricing response from the competitor. This strategic response of the competitor makes the overall market behave as if the effective firm differentiation is reduced and this exacerbates price competition. When a conquering modification has low impact relative to the market
differentiation, the main effect is increased competition and lower profits for both firms. Only when a conquering modification has sufficiently high impact, does the business stealing advantage (i.e. gaining customers from the competitor) overshadow the disadvantage of increased competition. As a result unless a firm identifies a high impact conquering modification, it is generally desirable to focus on building value with core customers.

The equilibrium strategy for a vendor of two-sided information is to sell the complete packet of information to both downstream firms. Interestingly, this is the case even though both firms ultimately implement only retention modifications (they possess the information on conquering modifications but choose not to use it). In other words, the conquering-facilitating information is passive in the sense that the downstream firms do not use it. This points to a strategic aspect of information markets: it is possible for the vendor to make strictly greater profits by including conquering information in the packet even though this information will not be used in equilibrium by the downstream firms. The intuition for this stems from the fact that the price charged for the information depends not only upon the equilibrium profits of the downstream firms, but also on the situation faced by an individual firm were it not to buy the information packet. The availability of conquering information puts a potential non-buyer of information in a worse situation because of the threat that the buyer will implement the conquering modifications and more adversely affect the non-buyer. This threat allows the vendor to extract a higher price from both buyers by selling complete packets of information. This highlights the "passive power of information" and demonstrates that information can have value even when it is not used.

With one-sided information the equilibrium strategy is to sell the information to only one of the downstream firms. If the information is sold to both the firms, one of the firms will have the ability to implement a retention modification. But its competitor will be able to implement a counter-acting conquering modification. The “value” of one-sided information for a given firm depends entirely upon its competitor not using the information. Under some conditions this requires the vendor to offer a guarantee of exclusivity. When one-sided information has relatively low impact, the optimal vendor strategy is to sell the information to the firm that uses it to implement a retention modification. In contrast, with one-sided information of higher impact, the equilibrium strategy is for the vendor to sell to the firm for which the modifications are conquering. Interestingly, exclusivity guarantees are only necessary when one-sided information is sold to the firm for which the modifications are conquering.
1.4 Related Research

A large body of research on product modifications deals with the measurement of consumer utility for product attributes. An important methodology is conjoint analysis which measures consumer preferences for products as bundles of attributes (see Green and Srinivasan, 1990 and Green and Kreiger, 1989). We focus on the competitive effects of product modifications and the problem faced by vendors of information that facilitates these modifications.

A stream of research examines the selling of information in financial markets. In this research, the role of information is to help a trader to obtain a precise estimate of a noisy market statistic. Grossman and Stiglitz (1980) have argued that because information is costly, market prices do not perfectly reveal fully reveal the available information, since if it did, vendors of information would receive no compensation. Admati and Pfleiderer (1986, 1988 and 1990) examine the sale of financial information and demonstrate that externalities between buyers affect the value of information and how broadly a given packet of information should be sold. Our characterization of syndicated marketing information differs from the characterization of information used in financial markets. In contrast to providing a better estimate of a stochastic parameter, we model information as a resource or knowledge about consumer preferences that allows a firm to add-value to its product in a targeted fashion (i.e., targeted at a particular segment of consumers).

In the marketing literature, Sarvary and Parker (1997) examine the competition between two sellers of noisy information. They show that the relationship between the information products of the sellers can often lead to a seller being better off facing competition than if it were a monopolist. We focus on the problem facing a vendor of product modification information when there is competition between the downstream buyers of the information. We highlight the type of competitive externalities that are created by information that adds value to the ultimate consumer. Raju and Roy (1997) consider the value of information to firms that are of different sizes. Our paper deals with buyer firms with different valuations for the information, not because they are of different sizes (firms in our framework are ex-ante symmetric), but because information allows a manufacturer to differentially add value based upon customer loyalty.

5 A different type of product design problem is studied in Hauser and Shugan (1983) who develop a model to analyse the product repositioning decision of an incumbent in the face of entry. A complete review of product design models is provided in Lilien, Kotler and Moorthy (1992).

6 Two other papers that model information are Pasa and Shugan (1996) and Soberman (1997). Pasa and Shugan model expertise as a marketer’s ability to create and interpret information about demand and they are concerned with characterising the value of such information. Soberman models information about media habits of category users, which allows a firm to send messages to category users more efficiently.
The paper proceeds as follows. The following section presents the model. In section 3, we analyze how conquering and retention product modifications affect the downstream competition between the firms. This sets up the stage for the main analysis of the paper in section 4 where we discuss the vendor’s equilibrium selling strategies. In section 5, we discuss the managerial implications and an extension of the analysis and we conclude in section 6.

2. The Model

The model consists of an information vendor and two potential buyers of information who compete in a downstream product market. The game has two stages. The first stage is the selling of information by the vendor to the downstream firms. After the firms have decided whether or not to purchase the information, they decide whether or not to make modifications to their products. They then compete in the downstream product market by simultaneously setting prices. Finally, consumers decide to buy at the firm that gives them greater surplus. We begin by describing the downstream product market.

2.1 The Downstream Market Before Product Modifications

The potential buyers of information are two firms \((i = 1, 2)\) that compete in a downstream product market. The information, if purchased by the firms, provides them with the knowledge to make modifications to their existing products.

We use a linear spatial market in which the products of firms are differentiated with respect to a primary attribute. The market is of unitary length and consumers are uniformly distributed along the market with unit density. Each consumer buys at most one unit of the product. The two firms are located at each end of the market. A product located at the same location as a consumer corresponds to that consumer’s ideal product and consumers incur a disutility for consuming a product that is not at their ideal point. Let us first consider the consumer’s surplus before any product modification. For a consumer located at \(x\) (the distance from the left endpoint), the following quasi-linear surplus function represents the surplus delivered by the unmodified product of Firm 1 and 2 respectively:

\[
CS_1 = R - p_1 - xt \\
CS_2 = R - p_2 - (1 - x)t
\]  

The context for our paper is information vendors such as ICOM, R.L. Polk, Yankelovich or Maritz Marketing which have different data collection procedures and offer syndicated services that are not easily substitutable. This provides relevance to the single vendor analysis. Furthermore, the single vendor
Here $t$ is the travel cost parameter that represents the psychological preference cost (or the per-unit distance disutility) of the consumer for not consuming her ideal product.\(^8\) $R$ is the reservation value for the unmodified product and $p_1$, $p_2$ represents the price to consumers of the two products.

### 2.2 Product Modifications

Next, suppose that firms have information that enables them to perform value-adding modifications to their products. The surplus functions with the modifications will be:

\begin{align}
CS_1 &= R + v_1(x) - p_1 - xt \\
CS_2 &= R + v_2(x) - p_2 - (1 - x)t
\end{align}

The function $v_i(x)$ represents the added value that a consumer at $x$ will obtain from firm $i$'s modification. Note that this incremental benefit is a function of the consumer’s location or relative preference for the two products. If $v_i(x)$ is decreasing in $x$, then the modification provides the firm’s loyal consumers with a greater incremental benefit than the consumers who are less loyal. This is a characterization of a retention modification. In contrast, if $v_i(x)$ is increasing in $x$, then the modification provides the firm’s loyal consumers with less incremental benefit than consumers who are loyal to the competing firm’s product. This is a characterization of a conquering modification.\(^9\)

We use the functional form $v_1(x) = \beta (1 - x); v_2(x) = \beta x$ to represent the effect of retention modifications on the surplus functions for the products of Firms 1 and 2 respectively. Figure 1 shows the consumer surplus function for a retention modification implemented by Firm 1. Note that in this formulation, $\beta$ is the impact of the modification i.e. a greater $\beta$ implies that the modification is more valuable (to all consumers but differentially so). In the same vein, $v_i(x) = \beta x; v_2(x) = \beta (1 - x)$ represents the effect of conquering modifications for each firm. Figure 2 shows the consumer surplus function for a conquering modification implemented by Firm 1\(^10\).

\[(Figures\ 1\ and\ 2)\]

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\(^8\) While we assume linear travel costs, the main insights of the paper also hold for travel costs that are quadratic in distance.

\(^9\) The term “conquering” is from Colombo and Morrison (1989) who use it in the context of a brand-switching model.

\(^10\) These modifications introduce the idea that a product modification can endogenously create vertical differences in a market where consumers a priori are horizontally differentiated. In other words, after the modification is implemented, consumers at different points in the market will have different willingness to pay (as in Moorthy, 1988 or Shaked and Sutton, 1982).
2.3 The Interpretation of Information and Product Modification

Because the sloped line, $v_i(x)$, represents what information facilitates in this framework, it is important to understand the economic meaning of the slope and how it represents the impact of information. In the pain reliever example discussed earlier, we could think of Motrin being at one end and Advil being at the other of the linear market. The sloped function $v_i(x)$ represents the effect of a change to the product that is highly correlated with loyalty to one of the two products.

In the pain reliever context, it is possible for the brand manager of Motrin to use the information from the ICOM database (that loyalty to Advil is highly correlated with headache relief) to implement a program that underlines the advantages of Motrin for relief from headaches. This is a prototypical conquering-type modification as it will have a greater effect on loyal users of Advil than the loyal users of Motrin. In contrast, the information from the database can also be used to highlight the efficacy of Motrin for relief backaches/menstrual cramps. This is a retention-type modification.

The model assumes that the characteristics of the information are fixed before the information contracting begins. This is equivalent to the assumption that the information costs are "sunk" at the time of contracting. This assumption is consistent with the institutional reality of the syndicated data vending industry. In general, the tracking systems of large syndicated data vendors such as ICOM and R.L. Polk are not tied to the needs of any single client firm. ICOM for example, maintains a database of more than 20 million households and they conduct mailings twice per year to more than 10 million households (Smith, 1998). Occasionally ICOM adds tailored questions at the request of important clients such as P&G or J&J. But, in the main, the costs of surveying and maintaining the database are sunk costs.

Next the model assumes that the information vendor has knowledge of the value of the information to the downstream buyers. This assumption captures the fact that firms such as ICOM have extensive knowledge of the research information needs of their clients and the particular industries that they serve. Vendors often organize their salesforce based on sectors such as pharmaceuticals (OTC), finance, automotive, packaged goods, insurance, and tobacco and have category specialists within each sector. ICOM specialists have quarterly "strategy meets" with their key clients to better tailor the surveys to the needs of the marketplace. Furthermore, client firms often require the services of ICOM to help them in judging the value of potential correlations and the likelihood of a proposed program being successful. This provides additional opportunities for learning about a client's business.
We now describe the first stage of the game that involves the selling and pricing of the information product.

2.4. Stage One: The Information Vendor Decisions

One-Sided Information

With one-sided information, the downstream firms are not symmetric. As in the Coors Light example, for the one firm (i.e., Coors), the information points to modifications that will increase value for its loyal customers (retention modifications) while for the other firm (i.e., Miller) the same information will facilitate a conquisting modification. The vendor has to decide on whether her strategy is to sell to only one firm or to sell to both firms. If the vendor opts to sell her information to just one firm, she must also decide which of the two firms she should sell to (the firm for whom the information is retention facilitating or the firm for whom it is conquisting facilitating). Furthermore, when a decision to sell to just one firm has been taken the vendor also has to decide whether or not a guarantee of exclusivity (i.e. a commitment by the vendor not to sell the information to the firm which has not purchased the information) is necessary. The game tree for the information selling stage with one-sided information is shown in Figure 3.

(Figure 3)

The timing of the game can be summarized as follows:

Step 1. The information vendor chooses the selling approach (exclusive or not).
Step 2. If the vendor chooses to sell exclusively, he decides whether to sell the information to facilitate retention or conquisting modifications.
Step 3. The information vendor sets prices for information conditional on the selling approach and target firm she has chosen.
Step 4. Firms make decisions on whether or not to purchase the information conditional on the terms and price offered by the information vendor.

Two-Sided Information

In contrast to one-sided information, two-sided information has the potential to facilitate modifications that add value to consumers who are on both sides of the loyalty spectrum. Thus the information that Motrin’s usage is highly correlated with sufferers of backache and menstrual cramp while the usage of Advil’s is correlated with headache relief can potentially be used by both firms to add value to either or both sides of the market. The greater complexity of two-sided
information means more selling options for the vendor. Only the strategy of selling to a single firm (exclusively) is simple because the vendor will always offer the complete set of information\textsuperscript{11}. When information is sold non-exclusively, the vendor must decide whether to sell complete information packets (i.e. both retention and conquisting information) or limited information packets (i.e. either retention or conquisting information but not both).\textsuperscript{12} The game tree for the first stage of the game with two-sided information is shown in Figure 4.

(Figure 4)

The timing is as follows:

\textit{Step 1.} The information vendor chooses selling approach (exclusive or not).

\textit{Step 2.} Assuming the vendor decides to sell non-exclusively, she must decide whether to sell the complete or limited packet of information.

\textit{Step 3.} The information vendor sets prices for information conditional on both the selling approach and packets he has decided to offer.

\textit{Step 4.} Firms make decisions on whether or not to purchase the information and then decide on the type of modifications to implement using the information.\textsuperscript{13}

If the information vendor chooses to sell to just one firm, the information will not be sold to the second firm if a first firm accepts the exclusive contract (an interesting issue that we explore is whether or not a guarantee of exclusivity by the vendor is a necessary element in the contract between the vendor and the downstream firm). If an exclusive offer is rejected, the vendor can then offer the information to the second firm (it is frequently the threat of being in the position of a firm without the information that makes the offer attractive). Exclusive contracts made between a vendor and a buyer are legally binding and have sanctity in a court of law.\textsuperscript{14}

In Figures 3 and 4, three dimensional outcome vectors describe the payoffs for the information vendor, Firm 1 and Firm 2 for each decision combination. These payoffs are

\textsuperscript{11} The vendor could offer a limited packet of information exclusively but this strategy is strictly dominated: the actions facilitated by a limited packet are a subset of the actions made possible with a complete packet.

\textsuperscript{12} It is possible for a vendor to sell a complete information packet to one firm and a limited packet to the other. This “asymmetric” packaging strategy, however, is strictly dominated by the strategy of selling “symmetric” information packets. Similarly, the strategy of selling only retention information to one firm and only conquisting information to the other is dominated.

\textsuperscript{13} Note that a firm is not under an obligation to implement modifications because it has purchased information. For example, a firm can buy both retention and conquisting information but use only one type.

\textsuperscript{14} In the U.S., exclusive contracts are subject to the rule of reason and in Canada the only anti-trust challenge to an exclusive contract is that it constitute an “abuse of dominant position.” See Continental TV Inc. v. GTE Sylvania Inc., U.S. 36 (1977) and Preston (1994) and the Director of Investigation and Research v. NutraSweet (1990), 32 C.P.R. (3d) 1 regarding the legality and enforceability of exclusivity contracts.
determined based on the modifications implemented by each firm and competition in the product/service market.

In Figure 3, the downstream profits are denoted by $\pi_y$, where $y = a, d, b, n$ denotes the circumstance of the firm in question (a denotes ‘advantage’ implying that the firm has an advantage due to the possessing the information when its competitor does not have the information, d denotes ‘disadvantage’, b denotes that both firms have the information and n denotes that neither firm has purchased the information) and $z = r, c$ relates to the type of modification that can be implemented by the information ($r$ and $c$ refer to the sale of retention and conquering information respectively).

In Figure 4, the subscript “rc” on the exclusive strategy profits implies that the packet contains information that facilitates both retention and conquering modifications. To simplify the presentation of the game tree under the non-exclusive selling of two-sided information, we show downstream profits as $\pi_a$, $\pi_d$, $\pi_b$ and $\pi_n$. The actual values of $\pi_a$, $\pi_d$ and $\pi_b$ depend on which type of information the vendor chooses to offer (complete, retention only or conquering only).

2.5 Stage Two: The Downstream Firm Decisions

The second stage of the game (which occurs after the information-selling phase) involves decisions by firms and consumers. In this stage the two downstream firms simultaneously choose prices contingent upon the outcome of the information-selling phase.

The demand faced by Firms 1 and 2 are $x$ and $(1-x)$ respectively, where $x$ is determined by the incentive compatibility constraint (or the value of $x$ where $CS_1 = CS_2$).\(^{15}\) The profit functions for the two firms net of any payments for information are:

$$\pi_1 = (p_1 - c)x$$

$$\pi_2 = (p_2 - c)(1 - x)$$

where $p_1$ and $p_2$ are the prices chosen by each firm and $c$ is the marginal cost for each unit of the product delivered. After the information market has closed, firms decide which (if any) modifications to make to their product. After the firms implement their modification strategies, they simultaneously choose market price to maximize profits.

Before examining the competition given product modification information, we will briefly discuss the base case of a market without information (i.e., no information is used by

\(^{15}\) We focus the analysis on the interesting case where there is competition between the two firms with unmodified products to begin with. This implies that $R > 3t/2 + c$.}
either firms). This means that the two firms compete with unmodified products that deliver consumer surplus as in (3) and (4). Simple computations yield equilibrium prices of $p_{1e} = p_{2e} = t + c$ and equilibrium profits of $\pi_{1e} = \pi_{2e} = t/2$. This case is the benchmark to understand the effect of product modifications on downstream competition.

### 3. Downstream Competition Given Product Modifications

It is important to first analyze the impact of the different types of modifications on downstream competition as this will help provide better insights into the selling strategies of the vendor that are analyzed section 4. In this section we ask the question: How would price competition between the firms evolve given that they are endowed with the ability to make certain types of modifications? Instead of presenting the analysis for all the possible scenarios of competition with product modifications, we concentrate on those that help in understanding the vendor’s choice of contracting strategies for one-sided and two-sided information in section 4. Accordingly, we examine three cases of downstream competition that pertain to when the firms have the information to facilitate a) retention modifications only b) conquering modifications only and c) both retention and conquering modifications. In addition, because we are interested in analyzing whether or not the vendor should offer exclusive contracts, we also examine each of these three scenarios for the case of only one firm having the information and for the case of both firms having it.

#### 3.1 Only Retention Modifications

Suppose only one firm (say Firm 1) has retention-type information and implements the modification, the incentive compatibility constraint is $\beta(1-x) - p_1 - tx = -p_2 - t(1-x)$. This leads to the demand functions for firms 1 and 2 respectively as $x_{ar} = x^* = (\beta + t - p_1 + p_2)/(\beta + 2t)$, while $x_{dr} = (1 - x_{ar})$. Solving for the equilibrium prices and profits we get,

$$p_{ar} = \frac{2\beta}{3} + t + c ; p_{dr} = \frac{\beta}{3} + t + c$$

$$\pi_{ar} = \frac{\left(t + \frac{2\beta}{3}\right)^2}{\beta + 2t} ; \pi_{dr} = \frac{\left(t + \frac{\beta}{3}\right)^2}{\beta + 2t}$$

(7)

Note that $\pi_{ar}$ is strictly greater than $t/2$, implying that a firm with the information to implement a retention modification will always choose to do so.
When both firms have retention-type information and implement the modifications, the demand functions of the two firms are given by the (incentive compatibility) condition 
\[ \beta(1-x) - p_1 - tx = \beta x - p_2 - t(1-x). \]
This yields Firm 1’s demand function as 
\[ x_{br} = x = \frac{\beta + t - p_1 + p_2}{2(\beta + t)}, \]
while firm 2’s demand function will be 
\[ x_{br} = (1-x). \]
The equilibrium prices and profits are 
\[ p_{br} = \beta + t + c, \quad \pi_{br} = \frac{t + \beta}{2}. \]
Note that \( \pi_{br} \) is strictly greater than \( t/2 \) and \( \pi_{br} \) implying that both firms will implement retention modifications if they have the ability to do so.

To summarize, the impact of the retention modification (reflected by the magnitude of \( \beta \)) affects the equilibrium prices and profits in the same manner as the differentiation parameter \( t \). In this sense, retention modifications act to increase the “effective” differentiation between firms and cause prices to rise. Interestingly, the strategic effect of a retention modification (in increasing equilibrium prices of the all the firms in the market) is evident even when only one firm implements the modification. The expression in (7) shows that prices of both firms go up unambiguously when only one firm implements a retention modification. The firm implementing the modification is able to protect its loyal consumers and increase its market share even though it charges a higher price. This induces the competing firm to respond by strategically raising its equilibrium price. Thus the firm implementing the modification confers a positive externality on its competitor thereby allowing it to charge higher prices. When both the firms implement retention modifications, this positive externality is even stronger. The competition between the firms is less intense and equilibrium prices (for both firms) are higher than when just one firm implements a retention modification.

3.2 Only Conquesting Modifications

Similar to retention modifications, we consider two cases: the first where only one firm possesses conquesting information and the second where both firms do.

Equilibrium when one firm has conquesting-type information

In contrast to retention modifications, the effect of conquesting modifications depends upon their impact. This is because conquesting modifications of sufficiently high impact can enable a firm to attract all the consumers from the competitor’s half of the market.

Let us first consider the case where the modifications are of sufficiently low impact that the competitor continues to operate. This happens in the model as long as \( \beta t = 1.5 \). The
incentive compatibility constraint is \( \beta x - p_1 - tx^* = -p_2 - t(1-x^*) \) which yields the demand functions for Firms 1 and 2 of \( x_{ac} = x^* = \frac{p_2 - p_1}{2t - \beta} \) and \( x_{dc} = (1 - x_{ac}) \). The equilibrium prices and profits are \( p_{ac} = t + c - \frac{\beta}{3} \), \( p_{dc} = t + c - \frac{2\beta}{3} \) and \( \pi_{ac} = (t - \frac{\beta}{3})^2 / (2t - \beta) \), \( \pi_{dc} = (t - \frac{2\beta}{3})^2 / (2t - \beta) \) respectively.

When \( \beta/t < 1.5 \), conquering modifications reduce the “effective” differentiation in the market and leads to increased competition. To see this, notice that consumer surplus (from Firm 1) can be rewritten as \( v - (t - \beta)x - p_1 \). The modification effectively reduces the consumer preference cost from \( t \) to \( (t - \beta) \) making it more attractive for consumers anywhere in the market (including consumers close to Firm 2) to purchase at Firm 1. Because Firm 1 now threatens customers close to Firm 2, the strategic response of Firm 2 is to reduce its price and protect its customers. Thus, by implementing a conquering modification, Firm 1 confers a negative externality on Firm 2 (Firm 2 sets lower prices and yet loses market share to Firm 1). In fact, when \( \beta/t < 1.5 \), conquering modifications also result in reduced profits for the implementing firm versus the base case because the benefit (in terms of increased demand) provided by the modification are more than negated by the fierce price competition. Consequently, even if a firm has the unilateral ability to implement a conquering modification, it will never do so when \( \beta/t < 1.5 \).

When \( \beta/t > 1.5 \), conquering modifications have another important effect. They allow the implementing firm (Firm 1) to attract all of the competitor’s customers and monopolize the market. The economic meaning of this is that the business stealing effect of the modification (i.e., the ability to attract the competitor’s customers) dominates its competition increasing effect. Nevertheless, in spite of Firm 2 being forced from the market, it continues to affect the pricing decisions of Firm 1 (because Firm 2 will re-enter the market when Firm 1’s price exceeds \( c+\beta-t \)). As a result, when \( \beta/t > 1.5 \), the equilibrium price for Firm 1 is \( p_{ac} = c + \beta - t \). Similar to the case when \( \beta/t < 1.5 \) the modification acts in a direction opposite to the existing differentiation (\( t \)). However, the equilibrium prices now increase in \( \beta \). Interestingly however (and contrary to what one would expect), \textit{prices actually decrease with higher differentiation}. Once a modification is powerful enough to allow Firm 1 to monopolize the market, greater differentiation is “bad” in the sense that it increases the cost of attracting the customers who are far away (i.e., lower prices have to be charged if distant consumers are to be attracted). Firm 1’s profit after implementing the
modification is $\pi_{ac} = \beta - t$ which is strictly greater than the base case profit. Therefore, a firm with the ability to implement conquisting modifications will always do so when $\beta t > 1.5$.

Equilibrium when both firms have conquisting-type information

When both firms implement conquisting modifications, the overall pattern of results is similar to above case when only one firm implements the modification. As before, equilibrium prices and profits ($t - \beta + c$ and $\frac{t - \beta}{2}$ respectively) are lower than the base case when the modification has relatively low impact (i.e., when $\beta t < 1$). The dominant strategy for a firm is not to implement the modification (independent of the competitor’s product strategy). Thus, the firms will choose to market unmodified products despite having the information to implement conquisting modifications.

However, for $\beta t > 1$, in equilibrium, a situation of market reversal occurs in which consumers close to Firm 1 buy at Firm 2 and those close to Firm 2 buy at Firm 1. Once again, the insights are similar to the case when only one firm has the ability to implement modifications. Here, conquisting modifications are powerful enough to allow each firm to attract the competitor’s customers. Consequently equilibrium prices and profits are increasing in $\beta$. Thus, when the modifications are of sufficiently high impact, it is possible that firms might actually implement the modifications despite their competition increasing character.  

In summary, this section illustrates the differences between the effects of retention and conquisting modifications. Retention modifications have the singular effect of increasing differentiation in the market and thereby causing prices to rise. In contrast, the effect of a conquisting modification depends on the impact of the modification relative to the level of market differentiation. Relatively low impact conquisting modifications lead to increased competition and lower profits for the firms. Consequently, firms will unilaterally choose to not implement these modifications even when they have knowledge to do so. However, higher impact conquisting modifications can give firms the compensating benefit of attracting the

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16 We find that when $\beta t \in [1, 1.5]$, each firm unilaterally prefers not to implement the modification regardless of whether its competitor implements the modification because the resulting price competition is too intense. However, when $\beta t \in [1.5, 2]$, the relative impact of the modification is large enough to give firms the incentive to implement the modification independent of the competitor’s strategy. The downstream firms find themselves in a quintessential Prisoners Dilemma because the decisions of both firms to implement the modifications lead to profits that are lower than the base case. Finally, when the relative impact of the modification is very large ($\beta t > 2$), both firms will implement modifications but the Prisoners Dilemma situation no longer exists. In this range, the conquisting modifications are powerful enough that $\pi_{bc}$ is greater than the base case profits.
customers of competition. This results in situations of market dominance (when only one firm can implement the modification) or market reversal (when both firms implement modifications). In these situations, the positive relationship between $\beta$ and profits can motivate firms to implement these modifications.

### 3.3 Both Retention and Conquesting Modifications

The analysis of sections 3.1 and 3.2 is restricted to situations where the firms have the ability to implement either retention or conquesting modifications (but not both). This allows us to fully understand the pure effects of retention or conquesting modifications. However, when two-sided information is available, it is possible for the downstream firms to implement both retention and conquesting modifications simultaneously. In this section, we derive the equilibrium strategies for firms which have the ability to implement both retention and conquesting modifications (denoted by the subscript ‘rc’). This analysis is important for understanding the contracting strategy for two-sided information.

Referring back to the pain reliever example, the analysis of this section pertains to a situation where the information possessed by each firm indicates not only Motrin's perceived superiority for backache and menstrual cramp relief, but also Advil's perceived superiority for headache relief. As before, we first consider the case where only one firm has the information.

**Only one firm has both retention and conquesting information**

A focal firm with both retention and conquesting information has the following options. It can implement only a retention modification, only a conquesting modification or it can implement both. From sections 3.1 and 3.2, we know the profits associated with the implementation of retention or conquesting modifications alone. Therefore, we need to analyze only the case of simultaneous implementation of retention and conquesting modification. When Firm 1 implements both types of modifications the incentive compatibility condition that determines the demands of the firms is $\beta - p_1 - tx^* = -p_2 - t(1-x^*)$. The Nash equilibrium of the downstream market is:

$$
p_1 = c + t + \frac{1}{3} \beta, \quad p_2 = c + t - \frac{1}{3} \beta; \quad \pi_{arc} = \frac{(\beta + 3t)^2}{18t}, \quad \pi_{arc} = \frac{(\beta - 3t)^2}{18t}
$$

(8)

We now compare $\pi_{ar}$, $\pi_{ac}$, and $\pi_{arc}$ to identify the equilibrium modification strategy for a firm that has the ability to implement both retention and conquesting modifications in Result 1. All proofs are in the appendix:
**Result 1:** A firm that has the unilateral ability to implement both retention and conquisting modifications:

a) Will choose to implement only a retention modification when \( \beta/t < \sqrt{3} \).

b) Will choose to implement both retention and conquisting modifications when \( \beta/t \in (\sqrt{3}, 3) \).

c) Will be indifferent between implementing a conquisting modification alone and implementing both retention and conquisting modifications when \( \beta/t > 3 \).

Result 1 leads to interesting generalizations about the strategies of the focal firm. When modifications have low impact (i.e. \( \beta/t < \sqrt{3} \)), retention modifications alone are the optimal strategy. In section 3.2, we saw that the main effect of low impact conquisting modifications was to reduce “effective differentiation” and create ruinous price competition. This effect exists even when the focal firm can implement retention modifications at the same time. Note that when a firm implements both retention and conquisting modifications simultaneously, it is equivalent to an overall quality improvement in the product for all consumers in the market.\(^{17}\) Thus, a further insight is that when the impact of the modifications are small, segment-specific improvements are more attractive than overall improvements.

When modifications are of intermediate impact (i.e. \( \beta/t \in (\sqrt{3}, 3) \)), the firm implements both retention and conquisting modifications. In this range, the business stealing advantage of conquisting modifications compensates for the increased price competition that it creates. Since the simultaneous implementation of retention and conquisting modifications is equivalent to an overall quality improvement, the result also suggests that when modifications are of intermediate impact, overall improvements are superior to segment specific (i.e. retention or conquisting) modifications. Finally, when modifications are of very high impact (i.e. \( \beta/t >3 \)), the primary driver is “business stealing.” As a result, conquisting modifications alone are as attractive as overall improvements.

As in the previous sections, the general pattern of results is that when the modifications have small impact relative to the level of differentiation, retention modifications tend to be more attractive. Only when modifications have sufficiently high impact in relation to the level of differentiation do conquisting modifications become attractive.

\(^{17}\) This obtains by summing the impacts of the modifications \( \beta x \) and \( \beta (1-x) \).
**Equilibrium when both firms have retention/conquesting information**

In this case again, each firm has three possible strategies in the normal form game: implement only retention modifications, implement only conquesting modifications or implement both types of modifications\(^{18}\). Table 3 below shows the best response mappings for each of these three potential strategies:

(Table 3)

**Result 2:** When both firms have the ability to implement retention and conquesting modifications, the unique Nash equilibrium is for both firms to implement retention modifications only.

This result establishes an important aspect of competition given product modification information. Though both firms have the knowledge to implement conquesting modifications, neither firm makes use of it. One might think that a firm (say Firm 1) could improve its performance by implementing both retention and conquesting modifications in response to a competitor’s retention modifications. Firm 1’s equilibrium demand will increase. It can be shown that \(x^* = \frac{2\beta + 3t}{3\beta + 6t}\) which exceeds \(\frac{1}{2}\) (the market share of Firm 1 when it responds with retention modifications alone). But, the positive externality of Firm 2’s retention modification is eliminated by the competitive effect of Firm 1’s conquesting modification. Overall, the increase in price competition negates any benefit derived from higher demand. Consequently, a firm cannot improve its performance in this manner.

What is the economic intuition that explains why conquesting modifications are never implemented? Recall from section 3.2 that conquesting modifications have the disadvantage of intensifying the competition between firms. It is only when conquesting modifications are of sufficiently high impact that their business stealing benefits (in terms of attracting the competitor's customers) can counterbalance the cost of increased competition. However, when both firms can implement retention and conquesting modifications, the business stealing benefit no longer has any "bite." This is because a retention modification implemented by a firm will nullify any business stealing advantage that might exist for its competitor. Therefore when firms have both types of information, implementing the conquesting modification involves costs (of increased competition) but has no associated benefits. Each firm is better off unilaterally not implementing the conquesting modification regardless of the action of its competitor.

\(^{18}\) A fourth strategy of not implementing any modifications is strictly dominated under all conditions.
The result also suggests that if firms have the knowledge to make modifications to their products that are segment specific, a much greater percent of the modifications implemented in actual markets should be retention-type modifications. ICOM’s experience in selling syndicated information in consumer product categories is consistent with this suggestion. In the 8 large FCMG categories that ICOM operates in, 85% of the programs conducted by the vendor for its clients in 1998 focus on brand loyal users. Furthermore, there is also a suggestion that firms are unlikely to implement conquering modifications unless they are convinced that the competitor is passive and cannot respond with a retention product modification of its own. This underscores why exclusivity might be desirable to a firm that buys information with the intention of using it for conquering modifications.

4. The Selling of Product Modification Information

We now examine the main issue of the paper. We analyze the information vendor’s problem for two situations: in the first, she possesses one-sided information and in the second, she possesses two-sided information. In both situations, the vendor must decide whether to sell to just one or to both firms. Additionally in the case of two-sided information, she must also decide how to package the information.

4.1 Solving the Information Vendor’s Game

We begin by discussing how the equilibrium profits of the information vendor are determined. First, we determine the maximum price under which both firms will buy the information.\(^{19}\) We define this as the non-exclusive price for the information.

Selling Non-Exclusively to Both Firms

Note that the profit from selling the information non-exclusively requires that both firms buy. In Figures 1 and 2, the following inequalities must be satisfied to ensure that both firms buy

\[
\pi_a - P_b \geq \pi_n \quad \land \quad \pi_b - P_b \geq \pi_d
\]

\[\Rightarrow P_b \leq \pi_a - \pi_n \quad \land \quad P_b \leq \pi_b - \pi_d\]

Rewriting this:

\[P_b \leq \min(\pi_a - \pi_n, \pi_b - \pi_d)\]

\(^{19}\) Under US, Canadian and EC antitrust law, a syndicated data vendor is obliged to sell identical information to downstream firms that compete in the same market for the same customers at a uniform price. The vendors can charge different prices only if the information packets are different. An indication that price discrimination is not prevalent for the syndicated information discussed in this paper, is the fact that ICOM and most other firms publish standardized price lists.
The total revenue from the non-exclusive sale for the vendor is $2P_b$. If the information is of no value to a firm, the condition in (11) implies that the price will be zero.

**Selling Exclusively to One Firm**

When a vendor sells to only one firm, the downstream firm will realize $\pi_i$ in the pricing sub-game (see Figures 3 and 4). She must compare this to the profits that will be realised if she rejects the offer. In the case of two-sided information, a firm that refuses the information will make profit of $\pi_i$ in the price competition sub-game. This is because the vendor can sell the information to the second firm at a positive price if the first firm refuses it. Accordingly, $\pi_i$ represents the equilibrium profits of the firm that does not have the information when the other firm does. Thus, the first firm will pay any price up to $\pi_i - \pi_d$ for exclusive use of the information.

In the case of one-sided information the information has different value for the two firms (for one firm it is retention facilitating and for the other it is conquest facilitating). Thus, when an exclusive offer is rejected, the “rejection” profits can be determined by asking the following two questions: first, will the second firm be interested (at all) in buying in the information? Next, if the second firm does buy the information, what profits will the non-buyer of the information realise?

### 4.2 One-Sided Information

The following proposition establishes the optimal contracting strategy for one-sided information.

**Proposition 1:** One-sided information cannot be sold non-exclusively.

Suppose the vendor attempts to sell the information to both firms. If both firms have the information, the dominant strategy for the firm for which the modifications are retention-type is to implement the modifications regardless of the competitor’s strategy. The optimal strategy for the second firm (for which the modifications are conquering) is to make no modifications. This is because when both firms implement modifications their effects cancel each other. But if the second firm refrains from implementing the conquering modification, it actually benefits from the competition-reducing positive externality that is created by the retention modification. Thus the second firm has no use for the information and will be unwilling to buy it.

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20 As noted in section 3, there are situations in which conquest facilitating information is of no value because the modifications in question reduce the profit of the firm implementing them.
ICOM’s approach in the cat food category illustrates this result. In early 1999, the manufacturer of Friskies cat food learned through the ICOM database that loyalty to Friskies was highly correlated with concern for the cat’s welfare and interest in activities related to cat ownership. ICOM helped launch the Friskies Cat Club in the spring of 1999 that provides useful advice on cat ownership, information about cat shows and special offers. This initiative uses the (one-sided) correlation between loyalty to Friskies and the greater interest in cat ownership related activities. ICOM could have also sold its services to manufacturers of competing products such as 9 Lives or Eukanuba. But instead the vendor has decided on a sole long-term relationship with Nestle (the producer of Friskies) in the canned cat food category.

If the vendor sells one-sided information to only one firm, the natural question that follows is whether it should be sold as retention or as conquisting information. This is addressed in the next Proposition:

**Proposition 2:**

a. When \[ \frac{\beta}{t} < \frac{3\sqrt{73} + 9}{8} = 4.33 \], the equilibrium vendor strategy for one-sided information is to sell to the firm for whom the information facilitates retention modifications. A guarantee of exclusivity is never valuable when the information is sold to facilitate retention modifications.

b. When \[ \frac{\beta}{t} > \frac{3\sqrt{73} + 9}{8} \], the optimal strategy is to sell to the firm for whom the modifications facilitate conquisting modifications with a guarantee of exclusivity.

Recall that while retention modifications always reduce price competition, conquisting modifications of low impact increase price competition. Thus, when one-sided information is of low impact, an attractive price cannot be charged if the information is sold to the firm for whom it is conquisting. Consequently, the vendor sells the information as retention information. In contrast, information that allows impactful conquisting modifications can enable a firm to monopolise the market. A firm, therefore, is willing to pay for this information and this makes selling it to facilitate conquisting modifications attractive.

In the Friskies example, ICOM chose to sell the information to Friskies and not the manufacturer of 9 Lives. While useful, it is unlikely that the information about Friskies users is sufficiently impactful to allow a competitor like 9 Lives to switch all Friskies users to 9 Lives.
(and effectively eliminate Friskies from the market). As a result (and consistent with what actually happened), it is more likely that such information be sold as retention information.

A further issue is whether the vendor should provide a guarantee of exclusivity to a buyer of retention information. Retention modifications made by a firm have a positive externality on the competitor and this makes the guarantee of exclusivity worthless for one-sided information (i.e. a firm offered the information as retention-type will not pay extra for a guarantee of exclusivity). The reason for this is as follows: If the focal firm uses the one-sided information to implement the retention modification, its competitor does not have an incentive to implement a counteracting conquesting modification even if the information were available for free (since $\pi_{dr} > t/2$). This makes the guarantee of exclusivity unnecessary.

In contrast, to sell information as conquesting information, a guarantee of exclusivity is absolutely necessary because the maximum price charged for conquesting information depends on the competitor not having access to the information (otherwise the buyer's conquesting modification will be nullified).

### 4.3 Two-sided Information

With two-sided information, the vendor has three possible products he can offer for sale: retention packets, conquesting packets or complete packets containing both retention and conquesting information. The vendor also has an option of selling the complete packet of information exclusively to one firm (in principle, the vendor might sell restricted packets exclusively. But, as mentioned before, this is strictly dominated because the highest exclusive price obtains by putting an exclusive buyer in as strong a position as possible.) The equilibrium vendor profits for each option as a function of the modification impact are shown in Table 4.

(Table 4)

The following proposition identifies the equilibrium vendor strategies for two-sided information:

**Proposition 3:** The equilibrium strategy for a vendor selling two-sided information is as follows:

- **a.** When the information is of low impact ($\beta/t < \sqrt{3}$), the vendor is indifferent between selling the complete and the retention only information packets non-exclusively.
- **b.** When $\beta/t > \sqrt{3}$, the vendor will sell the complete information packets non-exclusively.

The proposition makes two points. First, the exclusive selling strategy is not attractive with two-sided information. Exclusivity puts the buying firm in a strong position and increases
the price this firm is willing to pay to the vendor, but it also has an associated disadvantage. Any gains that can be obtained by offering the buyer exclusivity are outweighed by the greater preference (travel) costs that are incurred by consumers who are far away from the buyer (this drives down market prices). The vendor is best served by keeping these costs low. A non-exclusive selling strategy ensures that consumers continue to patronise firms that are closer to them and thus creates a downstream situation in which market prices are higher. Ultimately, the vendor benefits from these higher prices by being able to charge the downstream competitors a high price for the information.

Discussions with ICOM suggest that in many categories with several major brands, the type of information that becomes available is consistent more often with idea of two-sided information than with that of one-sided information. This is because useful correlations are likely to be found with many major brands in a given category. Table 5 provides a sample of ICOM’s pricing policy in categories where useful correlations are possible with several brands in a category.

(Table 5)

Exclusivity is clearly valuable, as a firm must pay a premium of between $90K and $180K (depending on the size of the category) to obtain an guarantee from ICOM. Nevertheless, the data indicates that ICOM is generally better off when it deals with two or more firms in a category (instead of receiving the exclusivity premium plus the price from one firm, ICOM receives the indicated price from each of the firms that buy). As long as more than one downstream firm ultimately purchases information from ICOM's database, the vendor has a strong incentive to avoid granting exclusivity to a single firm. ICOM's CEO mentioned that there are instances of firms purchasing exclusivity for a period of time, but the vendor generally discourages exclusivity. As in our analysis, two or “multi-sided” information generates higher vendor profits when it is sold non-exclusively.

The second point pertains to the passive power of information. Recall, from Result 2 that firms implement only retention modifications even when they have the ability to implement both types of modifications. Yet Proposition 3 shows that the equilibrium strategy for the vendor is to sell both firms complete packets of two-sided information and not just the information that is ultimately used i.e. retention information. Clearly, the conquering information in these complete packets is “passive” in the sense that it is never used. Nevertheless, Proposition 3 demonstrates that this “passive” information has value. The reason is that the price charged for the information is not simply determined by the equilibrium profits made by the downstream firms. The price is also a function of the (off-equilibrium) situation encountered by a firm were it not to buy the
information. The inclusion of conquisting information in the packet puts a non-buyer in a worse situation (if only one firm buys, the buyer will implement both conquisting and retention-type modifications and put the non-buyer in a worse situation). This threat allows the vendor to strategically sell the complete packet and extract a higher price from both downstream firms. This highlights the “passive” power of information and shows that information can have value even when it is not used.

5. Managerial Implications and Extension

In this section, we examine the relevance of our analysis to observed markets. We discuss how the results are useful for providing guidance to marketing managers about the expected impact of alternative product strategies and to data vendors about the selling of product modification information. We also demonstrate the robustness of our results to non-linear value adding modifications.

5.1 Implications

A message of the paper is that retention modifications are more likely to be observed in real-world markets. Several authors in the descriptive literature have offered prescriptions that are consistent with this message. For example, Reichheld and Sasser (1990) and Reichheld (1996), have provided evidence from a range of industries which shows that the costs of retaining a firm’s loyal customers are much less than the cost of attracting new customers. Our analysis provides a strategic perspective on retention that goes hand-in-hand with the cost-based perspective in the descriptive literature. In the context of product modifications, we have shown that retention modifications have the potential to make one’s competitor behave less aggressively and thereby reduce the level of competition in the market. This highlights the importance for practitioners of considering the strategic benefits of modifications that build value for current loyal customers (i.e. retention modifications). Furthermore, our analysis suggests that conquisting modifications frequently intensify competition to the detriment of all downstream firms. To proceed with a conquisting modification, a manager must be convinced that the modification is highly impactful and that the competition will be unable to react to the modification.²¹

²¹ In the case of BreathSavers, research confirmed that the green dot of chlorophyll was a highly impactful modification for the brand. The subsequent market performance of BreathSavers justified this assessment. In 1985, BreathSavers share had been in decline for more than five years and its share of the hard rolled candy market was 5.7% versus Clorets’ share of 9.2%. Less than six months after the reformulation, BreathSavers share increased to over 10% and Clorets share had declined to under 8%.
The model also provides insight about the observed strategy of many syndicated data vendors. ICOM has a much higher incidence of sales of multiple brand information than "own" brand only information to downstream clients. Clearly the vendor can subdivide the information and actively promote the sale of restricted information packets (for example, own brand only information). However, managers at ICOM feel that once the "sunk" cost of collecting the information is incurred, selling complete packets of information to all the firms in the category is typically the strategy that has maximum revenue potential. This is consistent with the message of Proposition 3: that the sale of complete information packets to multiple firms (within a category) allows a vendor to leverage the passive power that results from including conqueting information in the package. A direct managerial prescription that follows from this observation is that the information vendor stands to gain from explicitly publicizing (through standard price-lists or through advertising) that complete information packets are available to all buyers.

5.2 Non-linear value adding modifications

The examples described in the paper indicate that the ability to conduct targeted modifications arise out the correlations that data vendors can identify between behavioural or personal difference variables and brand loyalty. To this point, we have captured this through a linear value-adding function. In this subsection, we examine the robustness of the insights (pertaining to the effects of retention and conqueting modifications on competition) to a non-linear specification of the value-adding functions. We present an analysis for a family of concave and convex value-adding functions in quadratic form.

(\textit{Table 6})

As in the linear function, $\beta$ captures the impact of the modifications. The new parameter $b$ determines the curvature of the function. These two parameters and the relationship between them describe the entire family of non-linear (quadratic) value-adding functions. Consider, for example, the retention modification function for Firm 1. When $b > -\beta$, the function is a decreasing concave function of $x$. But when $b < -\beta$, the function is a decreasing convex function of $x$. When $b = -\beta$, we recover the linear functional form. Figure 5 demonstrates the appearance of the retention function family for Firm 1.

(\textit{Figure 5})

Our interest here is in understanding whether the insights pertaining to the effects of retention and conqueting modifications on competition that were developed in sections 3.1 and 3.2 continue to hold when the value additions are non-linear. First, consider the symmetric
situation where both firms have the ability to implement the modifications. Interestingly, the derived demand functions for the non-linear system are identical to those generated by a linear system. For example, suppose both firms have the ability to implement retention modifications, then the derived demand will be:

\[-(\beta + b) x^3 + bx + \beta - tx - p_1 = -(\beta + b) + 2\beta x + bx - t(1 - x) - p_2 \]

(12)

Solving this gives firm 1’s demand to be

\[x_{1b} = \frac{\beta + t - p_1 + p_2}{2(\beta + t)}\]

which is exactly the same demand function reported in section 3.1 for the linear case. This is also true for conquering modifications assuming that both firms have the ability to implement the modifications. Thus, when both firms have the ability to implement modifications, the results and insights of the non-linear analysis are identical to the linear specification.

However, when only one firm has the ability to make modifications the analysis is not straightforward. Closed form expressions are difficult to obtain. Consequently, we simplify the parameter space to focus attention on a basic question: Does the non-linearity of the value adding function affect the insights of the paper when only one firm can make the modifications. We assume \(\beta = 1, t = 2, c = 0\) and simulate the equilibrium demand, pricing and profit for different values of \(b\) that capture a continuum from convex to concave non-linear value adding modifications. The results are summarized in Table 7.

(Table 7)

Consider the equilibrium prices and profits when Firm 1 has the ability to implement a retention modification. It can be seen that that prices rise unambiguously with the implementation of a retention modification. In addition, the profits for both the firms are higher than their equilibrium levels when firms compete with unmodified products. This shows that the positive externality of retention modifications identified in the linear case of section 3.1 continues to hold for non-linear value adding modifications. However, when Firm 1 implements a conquering modification, the equilibrium prices and profits are unambiguously lower than in the case of unmodified products. Thus the competition increasing aspect of conquering modifications holds even with a non-linear specification of the value adding function.

6. Summary and Future Research

Value-adding modifications to existing products are a common component of the marketing strategy of firms. This strategy is particularly critical in mature categories where firms compete for market share. This paper is motivated by the importance of "external" markets for
information that allow these modifications. Firms like ICOM, R.L. Polk, Acxiom and Donelley Marketing, to name a few, sell syndicated information that is used to facilitate product strategy. The paper examines how such information affects the competition between downstream firms and the optimal contracting approach for a vendor who sells it.

The equilibrium contracting strategy for one-sided information is to sell to one firm. The target firm and the contract for one-sided information depend on the impact of the modifications in relation to the level of differentiation. When the information has low impact, it will be sold to the firm for which it is retention-type. Only when the information facilitates very impactful modifications should it be sold as conquisting information. In contrast, two-sided information should always be sold to both firms as exemplified by ICOM’s policy with information in the pain reliever market.

The vendor’s selling strategy follows from the effects that retention and conquisting modifications have on downstream competition. Retention modifications have the same effect on competition as increases in product differentiation. Therefore, they reduce price competition. In contrast, conquisting modifications act in a direction opposite to the differentiation between the firms. Conquisting modifications of low impact have the effect of reducing the “effective” differentiation in the market thereby increase price competition. As a result, a market for conquisting information does not exist unless the modifications are sufficiently powerful.

One aspect that we do not explore in this paper is the cost of implementing the modifications themselves. We assume that modifications can be made costlessly and that a modified product is produced at the same marginal cost. An interesting extension would be to examine how the vendor’s ability to sell the information is affected by implementation costs. Another issue that we leave to future research is that of information acquisition. If an information vendor first decides whether or not to collect information, an important question is should he collect information on specific groups of customers or on the entire market. In sum, investigating markets for information is a fruitful area for future research.
References


# Table 1
Syndicated Information Systems used to Modify Product Strategy

<table>
<thead>
<tr>
<th>Company/Subsidiary</th>
<th>1998 Revenue (Mn.)</th>
<th>Description of Syndicated Information Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>The NPD Group Inc., Port Washington N.Y.</td>
<td>138.50</td>
<td>▪ Operates a HTI consumer panel consisting of 400,000 households and a monthly omnibus service Insta-vue. These services are use the NPD Powerview Concept Management system to track usage and attitudes and help clients optimize product management and concept development on an ongoing basis.</td>
</tr>
<tr>
<td>Market Facts Inc., Arlington Heights Ill.</td>
<td>136.50</td>
<td>Has a Consumer Mail Panel of 525,000 households in U.S. and Canada. This database is used in services such as ProductQuest and BrandVision that aid clients in product strategy and brand management.</td>
</tr>
<tr>
<td>Opinion Research Corp., International, Princeton N.J.</td>
<td>73.20</td>
<td>Offers several syndicated research services including Brand Perceptions and Customers-for-Life. These services help clients to monitor analyze brand loyalty antecedents and customer retention variables.</td>
</tr>
<tr>
<td>Roper Starch Worldwide Inc., Harrison, N.Y.</td>
<td>51.30</td>
<td>Roper Reports is a research tracking service on Americans' attitudes, opinions, values and lifestyles. It provides clients insights into the perception and impact of product attributes, features and benefits. Client support includes ongoing recommendations in the areas of product positioning and product development.</td>
</tr>
<tr>
<td>Burke Customer Satisfaction Associates (CSA)</td>
<td>52.40</td>
<td>Burke CSA's Secure Customer Index provides industry and &quot;best in class&quot; standards for assessing customer-driven processes to improve brand loyalty and customer retention.</td>
</tr>
<tr>
<td>Elrick &amp; Lavidge, Tucker, Ga.</td>
<td>32.70</td>
<td>E&amp;Ls' Database Research Center is syndicated and multi-client service. Using this E&amp;L conducts customer analysis including, Customer Acquisition (needs assessment, awareness and usage and lost prospect analysis), Customer Retention (lost customer analysis, vulnerability segmentation), Customer Value Analysis (competitive positioning and relative value scoring).</td>
</tr>
<tr>
<td>Yankelovich Partners Inc., Norwalk, Conn.</td>
<td>27.20</td>
<td>▪ In 1998, YPI acquired AIM a provider of customized database marketing systems that allows clients to optimize their acquisition, cross-selling and retention-marketing operations. ▪ Marketers use the Yankelovich Monitor syndicated database to identify the effect of consumer trends in the market-place on various marketing mix activities including product development, brand management, product positioning and targeting.</td>
</tr>
<tr>
<td>Data Development Corp., New York.</td>
<td>21.6</td>
<td>Provides customer loyalty and satisfaction tracking, positioning analysis and integrated analyses of product optimization and customer loyalty.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Modifications Through Product Features/Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category/Year</strong></td>
</tr>
<tr>
<td>Breathmints 1985</td>
</tr>
<tr>
<td>Specialty Publications 1999</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Modifications Through Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Family Restaurants 1997</strong></td>
</tr>
<tr>
<td>Light Beer 1991</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Modifications Through Services/Information Augmentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cat Food 1999</strong></td>
</tr>
<tr>
<td>Ibuprofen Pain Relievers 1999</td>
</tr>
<tr>
<td>Shopping Malls 1998</td>
</tr>
</tbody>
</table>

*Modifications shown were considered by the focal company but not always implemented
### Table 3
Best Response Summary

<table>
<thead>
<tr>
<th>Competitor’s Action</th>
<th>$\beta/t &lt; 1.5$</th>
<th>$\beta/t &gt; 1.5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retention Modifications</td>
<td>Retention Modifications</td>
<td>Retention Modifications</td>
</tr>
<tr>
<td>Conquesting Modifications</td>
<td>Retention Modifications</td>
<td>Retention and Conquesting Modifications</td>
</tr>
<tr>
<td>Retention and Conquesting Modifications</td>
<td>Retention Modifications</td>
<td>Retention Modifications</td>
</tr>
</tbody>
</table>

### Table 4
Vendor Profit Summary

<table>
<thead>
<tr>
<th>Range of $\beta/t$</th>
<th>Retention Only</th>
<th>Conquesting Only</th>
<th>Complete Packets</th>
<th>Exclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1.5</td>
<td>Not feasible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5, $\sqrt{3}$</td>
<td>$\beta(\beta+15t)/9(\beta+2t)$</td>
<td>$2\beta-3t$</td>
<td>$\beta(\beta+6t)/9t$</td>
<td>$\beta/3$</td>
</tr>
<tr>
<td>$\sqrt{3}$, 2</td>
<td>$\beta-t$</td>
<td></td>
<td></td>
<td>$2\beta/3$</td>
</tr>
<tr>
<td>2, 3</td>
<td>$\beta-t$</td>
<td></td>
<td></td>
<td>$\beta-t$</td>
</tr>
<tr>
<td>3, 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5
Syndicated Data Vendor Pricing*

<table>
<thead>
<tr>
<th>Datasearch</th>
<th>USA (Database with 9 million households)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own Brand Users</td>
<td>150</td>
</tr>
<tr>
<td>Multiple Brand Users (category with less than 4 brands)</td>
<td>280</td>
</tr>
<tr>
<td>Multiple Brand Users (category with up to 8 brands)</td>
<td>450</td>
</tr>
<tr>
<td>Exclusivity Premium</td>
<td>90-180</td>
</tr>
</tbody>
</table>

*This information is provided courtesy of ICOM. Rates are in $’000’s per annum.
Table 6
Non-Linear Functional Forms for V(x)

<table>
<thead>
<tr>
<th>Information-type</th>
<th>Firm 1</th>
<th>Firm 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retention</td>
<td>( v_1(x) = -(\beta + b)x^2 + bx + \beta )</td>
<td>( v_2(x) = -(\beta + b)x^2 + 2\beta x + bx )</td>
</tr>
<tr>
<td>Conquesting</td>
<td>( v_1(x) = -(\beta + b)x^2 + 2\beta x + bx )</td>
<td>( v_2(x) = -(\beta + b)x^2 + bx + \beta )</td>
</tr>
</tbody>
</table>

Table 7
Results for Non-Linear Value Addition
(Downstream Competition where Firm 1 implements Modifications, \( \beta=1, t=2, c=0 \))

<table>
<thead>
<tr>
<th>Retention Modification (Convex Case) (decreasing ( b ) implies increasing curvature)</th>
<th>Retention Modification (Concave Case) (increasing ( b ) implies increasing curvature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( b )</td>
<td>( p_1 )</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>-1.1</td>
<td>2.66</td>
</tr>
<tr>
<td>-1.2</td>
<td>2.64</td>
</tr>
<tr>
<td>-1.3</td>
<td>2.63</td>
</tr>
<tr>
<td>-1.4</td>
<td>2.62</td>
</tr>
<tr>
<td>-1.5</td>
<td>2.61</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conquesting Modification (Convex Case) (decreasing ( b ) implies increasing curvature)</th>
<th>Conquesting Modification (Concave Case) (increasing ( b ) implies increasing curvature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( b )</td>
<td>( p_1 )</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>-1.1</td>
<td>1.65</td>
</tr>
<tr>
<td>-1.2</td>
<td>1.64</td>
</tr>
<tr>
<td>-1.3</td>
<td>1.63</td>
</tr>
<tr>
<td>-1.4</td>
<td>1.62</td>
</tr>
<tr>
<td>-1.5</td>
<td>1.60</td>
</tr>
</tbody>
</table>

* the equilibrium price and profit in this example with unmodified products is \( p_n=2 \) and \( \pi_n=1 \).
Figure 1
The Effect of a Retention Modification

available surplus
before transportation costs

β
The Effect of a Modification
based on Retention Facilitating
Information for Firm 1

Reservation Value "R"
for Unmodified Product

Firm 1
Linear Market of Unit Length
Firm 2

Figure 2
The Effect of a Conquering Modification

available surplus
before transportation costs

β
The Effect of a Modification
based on Conquest Facilitating
Information for Firm 1

Reservation Value "R"
for Unmodified Product

Firm 1
Linear Market of Unit Length
Firm 2
Figure 3

Stage 1: Game Tree for One-Sided Information

Assume the Indicated Modifications are Retention-Type for Firm 1 and Conquering-Type for Firm 2

Legend

<table>
<thead>
<tr>
<th>Firm 1 profit with information when Firm 2 does not</th>
<th>Firm profits when neither have information</th>
<th>( \pi_\pi )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm 1 profit without information when Firm 2 has it</td>
<td>Firm Profits when both have information</td>
<td>( \pi_\bar{\pi} )</td>
</tr>
<tr>
<td>Firm 2 profit with information when Firm 1 does not</td>
<td>Non-exclusive Price (chosen by information vendor)</td>
<td>( P_s )</td>
</tr>
<tr>
<td>Firm 2 profit without information when Firm 1 has it</td>
<td>Exclusive Price for Firm 1</td>
<td>( P_{\pi \pi} )</td>
</tr>
<tr>
<td></td>
<td>Exclusive Price for Firm 2</td>
<td>( P_{\bar{\pi} \bar{\pi}} )</td>
</tr>
</tbody>
</table>
Figure 4

Stage 1: Game Tree for Two-Sided Information

The game tree is identical for all three branches under non-exclusive selling.

Legend

Firm i profit with exclusive use of information $\pi_{sx}$  
Firm j profit when Firm i has information exclusively $\pi_{xe}$  
Firm profit under non-exclusive selling when it buys $\pi_{s}$  
Firm profit under non-exclusive selling when it does not buy $\pi_{x}$  
Non-exclusive Price (depends on packet) $P_x$  
Firm profits when neither have information $\pi_n$  
Exclusive Price for Firm 1 $P_x$
Figure 5
The Family of Non-Linear Retention Modifications for Firm 1
Appendix for “Markets for Product Modification Information”

Appendix A:

**Result 1:**
A firm that has the unilateral ability to implement both retention and conquisting modifications

d) Will implement retention modifications only when $\beta t < \sqrt{3}$,

e) Will implement both retention and conquisting modifications when $\beta t \in \{\sqrt{3}, 3\}$.

f) Will be indifferent between implementing conquisting modifications alone and implementing both retention and conquisting modifications when $\beta t > 3$.

**Proof**

Note that $\beta > 0$. Using the expressions in the paper, the downstream profits for a firm with the unilateral ability to implement both retention and/or conquisting modifications of magnitude $\beta$ can be computed to be:

<table>
<thead>
<tr>
<th>Range of $\beta t$</th>
<th>Retention only $\pi_{ar}$</th>
<th>Conquisting only $\pi_{ac}$</th>
<th>Both Retention and Conquisting $\pi_{arc}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1.5</td>
<td>$(t + \frac{2\beta}{3})^3$ $\beta + 2t$</td>
<td>$(t - \frac{\beta}{3})^3$ $\frac{2t - \beta}{2t}$</td>
<td>$(\beta + 3t)^3$ $\frac{18t}{18t}$</td>
</tr>
<tr>
<td>1.5-3</td>
<td>$(t + \frac{2\beta}{3})^3$ $\beta + 2t$</td>
<td>$\beta - t$</td>
<td>$(\beta + 3t)^3$ $\frac{18t}{18t}$</td>
</tr>
<tr>
<td>$&gt;3$</td>
<td>$(t + \frac{2\beta}{3})^3$ $\beta + 2t$</td>
<td>$\beta - t$</td>
<td>$\beta - t$</td>
</tr>
</tbody>
</table>

**Step 1:**

Consider the range of $\beta t \in \{0, 1.5\}$. Using the profit functions for this range $\pi_{ar} > \pi_{ac}$ (this is because $\pi_{ar} > \pi_{ac} \Rightarrow \beta < \frac{3\sqrt{10}}{5} \approx 1.90t$). Similarly in the same range, simple calculations show that $\pi_{ar} > \pi_{arc}$ when $\beta < \sqrt{3} t$, i.e. for the whole range $\beta \in \{0,1.5\}$. Thus, the optimal strategy in the range $\{0,1.5\}$ is retention modification only.
Step 2:

Simple calculations show that in the range of $\beta t \in [1.5, 3]$, $π_{arc} > π_{ac}$ when $\beta < 3t$ and $\beta > 9t$. For the range of $\beta t \in [1.5, 3]$. In addition, we know that $π_{ac} > π_{arc}$ when $\beta < \sqrt{3} t$. This implies that the optimal modification strategy is retention when $\beta t \in (1.5, \sqrt{3})$ and when $\beta t \in (\sqrt{3}, 3)$, the optimal strategy is for the firm to implement retention and conquesting modifications.

Step 3:

Consider the range $\beta t > 3$. Using the profit functions for this range $π_{arc} = π_{ac} > π_{ar}$ when $\beta > \frac{3t(1 + \sqrt{61})}{5} = 2.64t$. Since this is always true in the specified range, a firm will be indifferent between conquesting alone or both retention and conquesting together when $\beta t > 3t$. Q.E.D.

Result 2:

When both firms have the ability to implement retention and conquesting modifications, the unique Nash equilibrium is for both firms to implement retention modifications only.

Proof

First, it is important to recognize that the strategy combinations $(r,c)$, $(c,r)$ and $(rc, rc)$ involve situations where the modifications undertaken by firms neutralize each other. This means that the incentive compatibility constraint that governs demand for the firms is the same as in the base case. As a result, the profits are the same as in the base case $π_1 = π_2 = t/2$ discussed at the end of section 2.5. The algebraic expressions for the profits of other strategy combinations are found in sections 3.1 and 3.2 of the paper. Table 3 can be constructed easily using these expressions and comparing the focal firm’s profit for each potential response to a given strategy by the competitor.

To generate Table 4, the process is to identify the expression to the right of each range (in the first column) that is greatest. Aside from the middle column, the maximum is always found in the second column (i.e. retention only). In the middle column, when $\beta t > 1.5$, $π_{ac} > \frac{t}{2}$ (the profit associated with a retention response to conquesting modification by the competitor) since $\beta t > \frac{t}{2}$ for all $\beta t > 1.5t$. By eliminating dominated strategies (e.g. the conquesting only strategy) and identifying fixed points in each zone: $\beta t < 1.5$ and $\beta t > 1.5$, it is straightforward to show that the only equilibrium is for both firms to implement retention modifications (independent of $\beta t$). Q.E.D.
Proposition 1:
One-sided information cannot be sold non-exclusively.

Proof

Step 1:
For information to be sold non-exclusively, both firms must be willing to pay a price greater than zero to obtain the information. If the firm for whom the information identifies retention modifications purchases the information, it is a dominant strategy for that firm to implement the modification because \( \pi_{ar} > \pi_{br} > \pi_n \). In other words, the firm for whom the information identifies retention modifications is strictly better off by implementing the modification regardless of whether the competitor implements conquering modifications or not.

Step 2:
We now determine the best response for the firm for whom the information identifies conquering modifications, given that his competitor will always implement the modifications in question. Note that this involves a comparison of \( \pi_n \), the profit when both firms implement modifications (and the modification neutralize each other) and \( \pi_{ar} \). Note \( \frac{\left(t + \frac{\beta}{3}\right)^3}{\beta + 2t} > \frac{t}{2} \) for all \( \beta t > 0 \).

As a result, the firm will not implement the modifications even if it has the capability to do so. Consequently, the firm for whom the information identifies conquering modifications will not pay a positive price for the information. Q.E.D.

Proposition 2:

a. When \( \frac{\beta}{t} < \frac{3\sqrt{73} + 9}{8} \), the equilibrium vendor strategy for one-sided information is to sell to the firm for whom the information facilitates retention modifications. A guarantee of exclusivity is never valuable when the information is sold to facilitate retention modifications.

b. When \( \frac{\beta}{t} > \frac{3\sqrt{73} + 9}{8} \), the optimal strategy is to sell to the firm for whom the modifications facilitate conquering modifications with a guarantee of exclusivity.

Step 1:
Determine the zones in which both firms have positive value for the information versus the base case i.e. \( \pi_n = \frac{t}{2} \). For the firm for whom the information indicates retention modifications, it is easy to show...
that $\pi_{ar} > \frac{t}{2}$ for all $\beta$. For the firm for whom the information indicates conquering modifications, we need to compare $\pi_{ac}$ to $\frac{t}{2}$. As shown in section 4.2, $\pi_{ac} > \frac{t}{2}$ only for $\beta t > 1.5$. In other words, a firm rejecting information for retention purposes knows it will face an unmodified product from the competitor for all $\beta t < 1.5$. In contrast, a firm rejecting information for conquering purposes will always face a modified product from the competitor (since the vendor will be able to sell the information ex-post to the other firm). This establishes the expected profit for a firm in either situation on refusing the information.

**Step 2**

Calculate the difference between expected profits (by purchasing the information) and the base case described in Step 1 for all ranges of $\beta/t$. This is the maximum price that the vendor can charge each of the two firms for the information. These calculations are outlined in the following table.

<table>
<thead>
<tr>
<th>Range of $\beta/t$</th>
<th>Vendor Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sell as Retention Information</td>
</tr>
<tr>
<td></td>
<td>$P_r = \pi_{buy} - \pi_{reject}$</td>
</tr>
<tr>
<td>0, 1.5</td>
<td>$\frac{(t + \frac{2\beta}{3})^2}{\beta + 2t} - \frac{t}{2}$</td>
</tr>
<tr>
<td>$&gt;1.5$</td>
<td>$\frac{(t + \frac{2\beta}{3})^2}{\beta + 2t} - 0$</td>
</tr>
</tbody>
</table>

From this table note that

i. The upper right cell is negative for all values of $\beta$. Therefore selling to the conquering firm is impossible.

ii. The lower right cell is negative for all values of $\beta/t \in \left(0, \frac{3t(\sqrt{97} - 1)}{16}\right)$. Thus, for all values of $\beta/t \in \left(0, \frac{3t(\sqrt{97} - 1)}{16}\right)$, the profits from selling the information as retention information is higher than selling it as conquering information since as conquering information it cannot be sold for a positive price.
iii. Comparing the profits associated with the two strategies in the zone where both yield positive prices involves comparing the algebraic expression in the lower left cell to the expression in the lower right cell. For \( \frac{\beta}{t} > \frac{3\sqrt{73} + 9}{8} \), the right cell is larger.

Summarizing this step, the vendor will maximize profit by selling the information as retention information when \( \frac{\beta}{t} < \frac{3\sqrt{73} + 9}{8} \) and by selling the information as conquesting information when \( \frac{\beta}{t} > \frac{3\sqrt{73} + 9}{8} \).

**Step 3**

We now determine if guarantees of exclusivity must be provided to the buyers of information to legitimize the prices outlined in Step 2. This question can be answered by determining whether or not the information has positive value for the competitor given that the focal firm has purchased it. If not, then opportunism on the part of the vendor is not a problem for the first buyer. If however, the information does have positive value for the competitor, the vendor could act opportunistically and sell it to the competitor. Accordingly, in this situation, a guarantee of exclusivity would be required to justify the prices determined in Step 2. The analysis of this question is provided in the following table:

<table>
<thead>
<tr>
<th>Range of ( \frac{\beta}{t} )</th>
<th>Optimal Strategy (Step 2)</th>
<th>Difference (Profit for Competitor without the information versus with it)</th>
<th>Positive Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 0, \frac{3\sqrt{73} + 9}{8} )</td>
<td>Retention selling</td>
<td>( \frac{t}{2} - \frac{(t + \frac{\beta}{3})^2}{\beta + 2t} )</td>
<td>( \emptyset )</td>
</tr>
<tr>
<td>( \frac{3\sqrt{73} + 9}{8} )</td>
<td>Conquesting selling</td>
<td>( \frac{t}{2} \cdot 0 )</td>
<td>The entire range</td>
</tr>
</tbody>
</table>

This table shows that when selling the information as retention information, there is no value to a guarantee of exclusivity since the competitor's profits are strictly reduced by implementing conquesting modifications given that the focal firm implements the retention modifications in question. Conversely, when trying to sell the information as conquesting information, a guarantee of exclusivity is always needed. Q.E.D.
Proof of Proposition 3:
The equilibrium strategy for a vendor selling two-sided information is as follows:

a. When the information is of low impact ($\beta/t < \sqrt{3}$), the vendor is indifferent between selling complete packets or retention only information packets non-exclusively.

b. When $\beta/t > \sqrt{3}$, the vendor will sell the complete information packets non-exclusively.

As per equations 9, 10 and 11, two expressions, $\pi_a - \pi_n$ and $\pi_b - \pi_d$ must be evaluated for each possible strategy involving non-exclusive selling. For exclusive selling, we restrict our examination to the selling of complete information packets. Any profit level possible with the exclusive selling of a restricted information packet is also possible with a complete information packet.

Exclusive Selling of a Complete Information Packet
As discussed in the main text, we need to evaluate the expression $\pi_{arc} - \pi_{drc}$ for the entire range of $\beta/t$. Based on Result 1, we know that retention modification will be implemented for all $\beta/t < \sqrt{3}$, both retention and conquesting for $\beta/t \in \{\sqrt{3}, 3\}$ and either retention and conquesting or conquesting alone when $\beta/t > 3$. This allows us to construct the following table.

<table>
<thead>
<tr>
<th>Range of $\beta/t$</th>
<th>$\pi_{arc}$</th>
<th>$\pi_{drc}$</th>
<th>$\Pi_X = \pi_{arc} - \pi_{drc}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0, \sqrt{3}$</td>
<td>$\left( t + \frac{2\beta}{3} \right)^2$</td>
<td>$\left( t + \frac{\beta}{3} \right)^2$</td>
<td>$\frac{\beta}{3}$</td>
</tr>
<tr>
<td>$\sqrt{3}, 3$</td>
<td>$\frac{(\beta + 3t)^2}{18t}$</td>
<td>$\frac{(\beta - 3t)^2}{18t}$</td>
<td>$\frac{2\beta}{3}$</td>
</tr>
<tr>
<td>$&gt;3$</td>
<td>$\beta - t$</td>
<td>0</td>
<td>$\beta - t$</td>
</tr>
</tbody>
</table>

Non-exclusive Selling of Conquisting Information Packets
When both firms purchase conquisting information, it follows that they implement conquesting modifications (otherwise they could have been equally well off not purchasing the information at all). As per the discussion in the text when $\beta > t$, the firms effectively swap customers i.e. $x = (p_1 - p_2 + t \cdot \beta)/2(t - \beta)$ and $1 - x = (p_2 - p_1 + t \cdot \beta)/2(t - \beta)$. In contrast to the usual problem, the objective functions for each firm are $\pi_{1c} = (p_1 - c)(1-x)$ and $\pi_{2c} = (p_2 - c)x$ due to the swapping of customers. Solving the resulting system of equations generates the following solution:

$$x = \frac{1}{2} \cdot p_{1c} = p_{2c} = \beta - t + c, \quad \pi_{1c} = \pi_{2c} = \frac{\beta - t}{2}.$$
Using equation 9, 10 and 11, the non-exclusive profit is the minimum of \(2(\pi_{ac} - \pi_{nc})\) and \(2(\pi_{bc} - \pi_{dc})\). Substituting for \(\pi_{ac} - \pi_{nc}\), we obtain \(\beta - \frac{3t}{2}\) and for \(\pi_{bc} - \pi_{dc}\), we obtain \(\beta - \frac{t}{2}\). For all values of \(\beta < 2t\), \(\beta - \frac{3t}{2} < \beta - \frac{t}{2}\). Therefore, the non-exclusive profit is \(2\beta - 3t\) for all values of \(1.5 < \beta t < 2\).

When \(\beta / t\) is greater 2, the non-exclusive profit is \(\beta - t\).

**Non-exclusive Selling of Retention Information Packets**

The non-exclusive profit is the minimum of \(2(\pi_{ar} - \pi_{nr})\) and \(2(\pi_{br} - \pi_{dr})\). Using the equations in the text \(\pi_{ar} - \pi_{nr} = \frac{(t+2\beta t)}{3(\beta +2t)} - \frac{t}{2}\) and \(\pi_{br} - \pi_{dr} = \frac{(7\beta t)}{18(\beta +2t)}\).

Suppose that \(2(\pi_{ar} - \pi_{nr}) < 2(\pi_{br} - \pi_{dr})\). This implies that:

\[
\frac{(t+2\beta)^2}{\beta + 2t} < \frac{\beta(7\beta + 15t)}{18(\beta + 2t)} \Rightarrow \frac{\beta^2}{18(\beta + 2t)} < 0
\]

The last inequality is impossible because the numerator and denominator are both positive. Therefore, \(2(\pi_{br} - \pi_{dr})\) is the minimum of the two terms and equals \(\frac{\beta(7\beta + 15t)}{9(\beta + 2t)}\).

**Non-exclusive Selling of Complete Retention Packets**

The non-exclusive profit for the vendor is the minimum of \(2(\pi_{arc} - \pi_{n})\) and \(2(\pi_{brc} - \pi_{drc})\). The term \(\pi_{arc}\) of course is given by different algebraic expressions depending on the level of \(\beta / t\). The following table summarizes the computation:

<table>
<thead>
<tr>
<th>Range of (\beta / t)</th>
<th>(\pi_{arc})</th>
<th>(\pi_{brc})</th>
<th>(\pi_{drc})</th>
<th>(\pi_{arc} - \pi_{n})</th>
<th>(\pi_{brc} - \pi_{drc})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0, \sqrt{3})</td>
<td>(\frac{(t+2\beta)^2}{\beta + 2t})</td>
<td>(\frac{t + \beta}{2})</td>
<td>(\frac{(t + \beta)^2}{\beta + 2t})</td>
<td>(\frac{(t+2\beta)^2}{\beta + 2t} - \frac{t}{2})</td>
<td>(\frac{\beta(7\beta + 15t)}{18(\beta + 2t)})</td>
</tr>
<tr>
<td>(\sqrt{3}, 3)</td>
<td>(\frac{(\beta + 3t)^2}{18t})</td>
<td>(\frac{t + \beta}{2})</td>
<td>(\frac{(\beta - 3t)^2}{18t})</td>
<td>(\frac{\beta(\beta + 6t)}{18t})</td>
<td>(\frac{5\beta - \beta^2}{6\beta + 2t})</td>
</tr>
<tr>
<td>(&gt;3)</td>
<td>(\beta - t)</td>
<td>(\frac{t + \beta}{2})</td>
<td>0</td>
<td>(\beta - \frac{3t}{2})</td>
<td>(\frac{t + \beta}{2})</td>
</tr>
</tbody>
</table>

Algebraic comparisons then allow us to summarize the profits the vendor makes by setting the optimal price for all possible values of \(\beta / t\).
Identifying the Optimal Strategy

Step 1
For $\beta/t \in [0, \sqrt{3}]$, vendor profit for selling retention information is equal to the profit for selling both retention and conquisting information. Comparisons of this profit to the profits from selling conquisting packets and the profits associated with the selling of a complete packet of information exclusively yields the result that the optimal strategy in this zone is to sell either retention packets or complete packets.

Step 2
For $\beta/t > \sqrt{3}$, we can show that the profits associated with selling complete packets of information strictly dominate the profits associated with all three of the alternate options (selling conquisting packets non-exclusively, selling retention packets non-exclusively or selling a complete packet exclusively). Q.E.D.

Appendix B:

In this appendix we provide an example of how the various downstream equilibria of section 3 of the paper can be identified. We have chosen the case when one firm has the ability to implement conquisting modifications to illustrate this because it highlights much of the non-standard aspects of the analysis.

Equilibrium when one firm has the ability to implement Conquisting Modifications

The equilibrium for the case where the implementing firm cannot monopolize the market (i.e., the no-switch case) follows directly from the text.
The Monopolization (Switch) Case ($\beta t > 1.5$)

**Step 1:**

To determine $\pi_{ac}$ and $\pi_{dc}$, we first solve the simultaneous optimization problem for both firms. Equilibrium demand and prices are:

$$x = \frac{1}{2} + \frac{\beta}{6(2t - \beta)}, \quad p_{ic} = t + c - \frac{\beta}{3}, \quad p_{zc} = t + c - \frac{2\beta}{3}.$$  

At levels of $\beta > 1.5t$, this solution is associated with negative demand and prices less than marginal cost for the firm facing a modified product (in this case Firm 2). Therefore, the modifications are sufficiently powerful when $\beta > 1.5t$ such that Firm 2 is forced out of the market resulting in a corner solution.

**Step 2**

Suppose that the equilibrium is a corner solution in which the firm with the modified product (Firm 1) sets price at $\beta t + c$. At this price, Firm 2 cannot attract any customers, even by pricing at marginal cost (since the surplus for the customer at $x=1$ is $R$ from both firms, any customer located at a position where $x<1$ will strictly prefer the offering from Firm 1).

We now show that Firm 1 has no incentive to change its price. The profit function for Firm 1 is $\pi_{ac} = x^* p = 1^* (\beta - t - c)$ when it sets a price of $\beta t + c$. A drop in price will not increase its demand and will simply lower its profit. Therefore Firm 1 will not drop price below $\beta t + c$. We now consider a rise in price. In this region,

$$x = \frac{p_2 - p_1 + t}{2t - \beta} \Rightarrow \pi_{ac} = \frac{p_2 - p_1 + t}{2t - \beta} \ast (p_1 - c) \Rightarrow \frac{\partial \pi_{ac}}{\partial p_1} = \frac{p_2 - 2p_1 + t + c}{2t - \beta} = 0$$

This generates the reaction function for Firm 1: $p_1 = (p_2 + t + c)/2$. Similarly, we obtain the reaction function for Firm 2: $p_2 = (p_1 + t + \beta + c)/2$. The intersection is at $(p_1, p_2) = (t+c, t+c-2\beta/3)$. This point lies in the region where $p_1 \leq \beta t + c$. In fact, when $\beta t = 1.5$, the functions intersect at $(p_1, p_2) = (\beta t + c, c)$, and when $\beta t > 1.5$, the functions intersect at $p_1 = c$. Therefore, for $\beta t > 1.5$, the reaction function of Firm 2 is discontinuous with $p_2 = (p_1 + t + \beta + c)/2$ for $p_2 > c$ and $p_2 = c$ otherwise. As a result, the reaction functions of the two firms intersect at $(p_1, p_2) = (\beta t + c, c)$ for all $\beta t > 1.5$ and this is the unique Nash equilibrium. Thus, when one firm has the ability to implement conqueting modifications and $\beta t > 1.5$, the firm implementing the changes captures the entire market and a profit ($\pi_{ac}$) of $\beta t + c$. The other firm makes zero profit.