Why Do Salespeople Spend So Much Time Lobbying for Low Prices?

Why Do Sales People Spend So Much Time Lobbying for Low Prices?

June 2013

Duncan Simester and Juanjuan Zhang

MIT Sloan School of Management

Why Do Sales People Spend So Much Time Lobbying for Low Prices?

In business-to-business settings a company's sales force often spends considerable time lobbying internally for authorization to charge lower prices. These internal lobbying activities are time consuming, and divert attention from other tasks, such as interacting with customers. We explain why the sales force's internal lobbying activities serve an important role. They help the firm elicit truthful reporting of demand information from the sales force. As a result, it may be profitable for the firm to require lobbying (and make the requirement onerous), even though lobbying is a nonproductive activity that creates an additional administrative burden and imposes a deadweight loss.

Key words: lobbying, influence activities, sales force management, pricing, agency theory, incentives, information elicitation, marketing-sales interface.

§ 1. Introduction

> "I have gradually begun to appreciate that many account managers perceive that it is easier to deal with the customer, compared to the difficulties of negotiating with their own managers and colleagues to get things done on the customer's behalf. Many would argue that internal negotiation is the real crux of the job."
>
> Beth Rogers (2011 at page 82)

Studies of pricing practices in business-to-business settings often refer to the inefficiencies that result from the sales force lobbying internally for lower prices. Crainer and Dearlove (2004 at page 438) report that "more than 80 percent of all cases were 'exceptions' that required internal negotiation between marketing and sales. These constant price negotiations wasted considerable time." Similar examples can be found in Sodhi and Sodhi (2007) and Dietmeyer (2004). Notably, instead of banishing lobbying to reduce bureaucratic inefficiencies, many firms appear to make the process intentionally onerous. We provide an explanation for why firms choose not to banish lobbying and why these apparently nonproductive activities may represent an equilibrium outcome.

The explanation recognizes that the sales force often has private information about the strength of demand. However, if the firm lowers prices when the sales force reports demand is low this may create an incentive for the sales force to understate demand, as it takes less effort to convince customers to buy when prices are low. As a result, the firm must pay the sales force information rents to admit when demand is high. Lobbying is a mechanism that the firm can use to help mitigate these rents. It allows the firm to leverage the private information of the sales force in the low demand condition to reduce the information rents it pays when demand is high.

We model the requirement to lobby for low prices as a requirement to present evidence that demand is low. If it is easier for the sales force to produce this evidence when demand truly is low, then making this evidence a condition of approving a discount may be profitable for the firm. This is true even if the effort incurred to produce this evidence represent a deadweight loss.

We motivate our investigation using examples acquired through a series of interviews with product managers and sales managers.[1] The examples illustrate the different ways that sales people engage in lobbying for low prices, and the mechanisms that firms use to manage this process. We heard many examples of sales people spending as much time negotiating internally as they spend interacting with external customers. Much of this time is spent collecting evidence to justify requests to lower prices. This includes collecting information about competitors' prices, or reviewing historical sales data to highlight examples in which lower prices led to additional sales.

In almost every interview managers acknowledged that their sales force is in a better position to evaluate customers' willingness-to-pay. However, they also recognized the need to manage the sales force's lobbying activity. Many firms report that they do compensate their sales force at least partially on the basis of prices. It is also common for firms to shift the power to make pricing decisions away from the sales force, and pass it to a committee or manager who must approve any discount. Most firms allow "price exceptions," in which the sales force can lobby for price discounts. However, the firm imposes requirements on the sales force when using this exception process. We will illustrate why simply paying the sales force based on prices (or delegating the pricing decision to the sales force) may not fully resolve the incentive problem, and how imposing evidentiary requirements can contribute to higher profits.

Related Literature

Previous studies have recognized the tension between the sales force and marketing. For example, Kotler, Rackham and Krishnaswamy (2006) vividly describe the phenomenon: "In

[1] As additional background research for this study we investigated the prevalence of the lobbying phenomenon by surveying managers attending executive education classes. In particular, we asked whether there was often concern at their firms that "sales people want to charge prices that are too low." Almost three quarters of the respondents agreed with this statement. A more detailed description of these results is provided in the Appendix.

many companies, sales forces and marketers feud like Capulets and Montagues. Salespeople accuse marketers of being out of touch with what customers really want or setting prices too high. Marketers insist that salespeople focus too myopically on individual customers and short-term sales at the expense of longer-term profits." A similar observation prompts Ernst, Hoyer, and Rübsaamen (2010) to call for better cross-functional cooperation among sales, marketing, and R&D in product development.

Homburg and Jensen (2007 at page 124) also recognize that the tendency for sales people to ask for lower prices leads to conflict between the sales force and marketing: "Pioneering qualitative work on the interface between marketing and sales has pointed out that it is highly conflict laden in managerial practice." They cite Dewsnap and Jobber (2000 at page 109): "The marketing-sales relationship, whilst strongly interdependent, is reported as neither collaborative nor harmonious." Similarly, Montgomery and Webster (1997 at page 16) report from a Marketing Science Institute conference that: "Intrafunctional conflict within marketing was a more important topic ... than we had expected. The most frequently discussed issue was the conflict between sales and marketing." Two international surveys of senior executives from different business-to-business industries have identified the tension between sales and marketing as one of the most important organizational challenges facing firms, and that reducing this tension would do the most to improve sales performance (Miller and Gist 2003, Rouziès 2004, cited in Rouziès et al. 2005).

The sales force management literature in the business press frequently cautions that salespeople will tend to ask for lower prices in order to make their tasks easier. For example, Marrs and Kennedy (2012) write: "Sales people often offer discounts before they should – or when they shouldn't at all. They don't get the price that a customer is willing to pay because, in their minds, low price is the only tool they have to close the sale." Similarly, Schweiger, Sandberg, and Ragan (1986) write that faced with price pressure from customers, "sales may be tempted to myopic price cuts (and, thus, revenue and profit sacrifices) if marketing did not act as the devil's advocate."

More generally, our paper contributes to the large academic literature on sales force management. Previous studies have investigated various facets of this problem, including the design of sales force compensation (Basu et al. 1985; Lal and Staelin 1986; Rao 1990; Coughlan and Narasimhan 1992; Raju and Srinivasan 1996), the role of sales assistance in product evaluations (Wernerfelt 1994; Kalra, Shi, and Srinivasan 2003), firms' choice between surveillance and wages (Anderson 1985), firms' assignment of different selling skills to different products (Godes 2003), and the design of sales contests (Kalra and Shi 2001; Lim, Ahearne, and Ham 2009; Lim 2010).[2]

A body of research investigates whether firms should delegate pricing authority to the sales force. Weinberg (1975) shows that when sales outcomes are deterministic a firm can delegate pricing and ensure efficient prices using margin-based wages. Lal (1986) finds that delegation can improve profits if the sales force has better information about the selling environment. Revisiting this conclusion, Joseph (2001) shows that delegation is inefficient if salespeople rely on price discounts to grow sales rather than exert effort to pursue high-valuation customers. Mishra and Prasad (2004) further demonstrate that centralized pricing is profit-maximizing if contracting occurs after the salesperson receives his private information. Extending the investigation to competitive settings, Bhardwaj (2001) finds that delegation can soften price competition, and Mishra and Prasad (2005) prove that there always exists an equilibrium in which all firms choose centralized pricing. In a recent working paper, Lim and Ham (2012) find that delegation benefits the firm because of positive reciprocity of the salespeople.

We contribute to the sales force management literature by explicitly studying lobbying – a widely observed yet under-investigated phenomenon. Our benchmark contract takes advantage of the sales force's private information about demand by delegating the pricing decision to the sales force. To ensure that the sales force charges the correct price the firm must pay an information rent to the sales force in high demand states. We identify conditions

[2] See Mantrala et al. (2010) for a recent survey of the literature on sales force modeling, and Misra and Nair (2011) for a structural model of sales force compensation dynamics.

under which the firm can reduce this information rent by requiring that the sales force lobby for discounts, even when the costs associated with lobbying represent a deadweight loss.

The paper is also closely related to the economics literature on "influence activities." In many organizations significant effort is exerted on influencing organizational decisions, such as capital allocation among competing projects. The literature has largely focused on the inefficiencies caused by influence activities (Milgrom 1988; Meyer, Milgrom and Roberts 1992; Scharfstein and Stein 2000; Wulf 2009). One exception is Laux (2008), who argues that influence activities can benefit the firm's capital budgeting process because a project manager's choice to lobby reveals to the firm which projects are worth defending. Similar to Laux (2008), we find that the seemingly wasteful activity of lobbying can help firms improve profits. The main difference is that in Laux (2008), the screening effect of lobbying comes from the different returns it brings to different projects – better projects offer higher values to justify the same cost of lobbying. In our paper, the screening effect comes from the different costs of lobbying in different demand conditions – it is harder to provide convincing evidence and lobby effectively when demand is high, even if the returns to lobbying are the same across demand conditions.

The paper proceeds in Section 2 with examples that help to illustrate the context and motivate the modeling assumptions. We then introduce the model setup and in preliminary analysis illustrate how price delegation requires that the firm pay information rents to induce the sales force to charge high prices. In Section 3 we show that the lobbying mechanism can improve expected profit beyond price delegation by reducing these information rents. In particular, we show that the firm can achieve this goal by requiring the sales rep to provide evidence of low demand to justify his request for a discount. In Section 4 we consider several extensions to the model, including the possibilities that lobbying activities divert attention from selling activities, that the sales rep is risk averse, or that the firm can collect evidence on its own. In Section 5 we extend the findings to a more general model with a continuous distribution of demand states and minimum functional-form assumptions. The paper concludes in Section 6.

§ 2. Motivating Examples, Model Setup and Preliminary Analysis

To motivate our model, we begin with two examples that arose during background interviews for this research.

A US military contractor sells through a closed bid system with one primary competitor. The sales people commonly spend more time negotiating internal price reductions than they do interacting with the customers. For large discounts the price has to enter an exception process. Obtaining an exception depends upon the sales force presenting sufficient "evidence" to justify the discount. In addition to informal information about the competitor's prices, the sales force develops forecasts using past examples to substantiate claims that lower prices will lead to more transactions with the client. The exception process is intentionally difficult to navigate. This is meant to ensure that "sales people only ask for lower prices when they need it to close the deal, rather than just when it would be easier to close the deal."

Our second example is from the telecommunications industry, where the success of Apple's iPhone had convinced this firm's product managers that it was possible to design a product that would "shift the demand curve." In contrast, the sales force was skeptical that any of the firm's products would shift the demand curve, and focused instead on "where to locate on the demand curve." The sales force spent approximately 75% of their time lobbying internally for lower prices. To support their lobbying they present data on competitors' prices, and use historical sales data to illustrate the relationship between sales and price (the demand curve).

These examples share several common features that form the basis of our analytical model. First, the sales force has better information about demand. Second, lowering prices makes it easier for the sales force to close transactions. The resulting potential for moral hazard leads to an atmosphere of distrust when the sales force requests a discount. Third, the sales force can exert effort to lobby internally, and in equilibrium many sales people spend considerable time on this activity. Finally, the firm can influence these lobbying activities by changing the sales force wages and requiring evidence before approving discounts.

Model Setup

We consider a firm that hires a sales rep to sell its product to a customer. The sales rep chooses whether to invest in selling effort. The customer's willingness-to-pay depends on this selling effort and the customer's intrinsic strength of demand, which is high with probability $u \in (0, 1)$ and low with probability $1 - u$. If demand is high, the customer's willingness-to-pay is v_H if the sales rep incurs selling effort and is v_L otherwise. If demand is low, the customer's willingness-to-pay is v_L if the sales rep incurs selling effort and is 0 otherwise. We assume that $v_H > v_L > 0$, such that both high demand and diligent selling contribute to higher willingness-to-pay.

Selling effort is costly to the sales rep. Let the cost of selling effort be $e_H > 0$ when demand is high and $e_L > 0$ when demand is low. We allow e_H and e_L to be different from each other without imposing a rank order between them (they may also be equal). The firm does not observe the sales rep's selling effort. Neither does the firm observe the demand state because the sales rep has more localized information about the customer (see also Lal 1986).

We consider a game with the following sequence of moves.

1. The firm and the sales rep share a common prior belief that demand is high with probability u.
2. The firm offers a compensation contract. Specifically, the firm determines the sales commission conditional on price. If the sales rep rejects the contract based on the comparison between his expected payoff from the contract and his outside option, the game ends. If the sales rep accepts the offer, the game proceeds.
3. The sales rep privately observes the realized demand state.
4. The sales rep reports to the firm whether demand is high or low.
5. The firm determines the price to be charged to the customer.
6. The sales rep chooses selling effort.

7. The customer decides whether to buy and this decision is commonly observed. The firm receives its profit and the sales rep receives his compensation.

We will compare two mechanisms: *price delegation* and *lobbying*. If the firm implements price delegation, in step 5 above it will simply choose the price following the sales rep's demand report in step 4. Although the firm directly sets the price, the price is effectively chosen by the sales rep. If the firm implements lobbying, the sales rep must provide evidence to justify his demand report in step 4, and the firm in step 5 will follow the sales rep's report only if he has met the evidentiary requirement. We will provide further details of the lobbying mechanism after presenting a set of preliminary analysis.

We assume that demand shocks are i.i.d. across time and so the firm does not learn demand over time. Demand shocks are also i.i.d. across customers and only one sales rep can work with each customer, so that there is no competition between sales people.

We will also initially assume that both the firm and the sales rep are risk-neutral. This ensures that the findings cannot be attributed to the (mere) allocation of risk. We will later show that the findings survive when the agent is risk averse. We normalize the sales rep's outside options to zero. The sales rep holds limited liability to the firm, and is guaranteed to receive nonnegative wages. The limited liability assumption is common in the literature (e.g., Bester and Krähmer 2008; Bergmann and Friedl 2008; Shin 2008; and Simester and Zhang 2010). It rules out the possibility that the firm sells its business to the sales rep. This assumption is also plausible because employees generally retain the right to leave the firm ex post at any time.[3] In particular, if the sales rep can leave the firm before paying any punishment, the firm must design its incentive scheme as if the sales rep were protected with nonnegative wages. We will

[3] For this reason, limited liability has sometimes been justified by laws prohibiting indentured servitude. It also appears to be consistent with what we observe in practice. More recently, the threat of employees leaving has hindered the finance industry in its efforts to introduce negative wages to manage risk taking.

nevertheless also investigate relaxing the limited liability assumption later.[4] Finally, we normalize the firm's marginal cost of producing the good to zero.

First Best

Suppose the firm and the sales rep are integrated and they observe the demand state before they choose whether to incur selling effort. The return on selling effort is $v_H - v_L$ if demand is high, and v_L if demand is low. For the rest of the paper we assume that selling effort is worthwhile in both demand states:[5]

(1) $v_H - v_L > e_H$
(2) $v_L > e_L$

It follows that the integrated entity will exert selling effort and will charge an efficient price of v_H if demand is high and v_L if demand is low. The first-best expected profit is

$$\mathbb{E}\pi^* = u(v_H - e_H) + (1-u)(v_L - e_L)$$

Price Delegation

If the firm and the sales rep are not integrated, the firm must design an incentive scheme to influence the sales rep's reporting of demand and effort decisions. We will focus on settings in which the firm chooses to sell in both demand conditions. Under this assumption (which we will later formalize) the firm will want to elicit demand information from the sales rep, and will pay the sales rep a positive commission conditional on the price charged.[6] In particular, the firm will accept the sales rep's reporting of demand by charging the price v_H and offering a commission of w_H if the sales rep claims that demand is high, and charging v_L and offering a

---

[4] Notice that the joint assumptions of limited liability and the sales rep's outside option being zero cannot be interpreted as a mere re-scaling of the parameters. This is an additional reason for exploring the impact of relaxing the limited liability assumption.
[5] In subsequent analysis, we make analogous assumptions to Conditions (1) and (2) to ensure that the firm wants to induce selling effort in equilibrium.
[6] If the sales rep fails to sell, the firm should optimally pay zero given the limited liability assumption.

commission w_L if the sales rep claims that demand is low. To find w_H and w_L the firm maximizes its expected profit by solving the following problem:

$$\max_{w_H, w_L \geq 0} \ \mathbb{E}\pi_P = u(v_H - w_H) + (1-u)(v_L - w_L)$$

s.t. $w_L - e_L \geq 0$ (IC$_L$)

$w_H - e_H \geq w_L$ (IC$_H$)

$u(w_H - e_H) + (1-u)(w_L - e_L) \geq 0$ (IR)

The IC (incentive compatibility) constraints ensure that the sales rep exerts selling effort and truthfully states the demand condition. When demand is low, the sales rep enjoys a deviation payoff of at most 0 by either shirking selling effort or overstating demand. When demand is high, however, the best deviation payoff is w_L because the sales rep can understate demand, sell at price v_L and receive the commission w_L without making any selling effort. The firm must pay the sale rep an information rent for him to admit that demand is high.

The IR (individual rationality) constraint ensures that the sales rep is willing to accept the contract – his expected net payoff must be no worse than his outside option 0. In equilibrium both IC constraints are binding while the IR and limited liability constraints ($w_H, w_L \geq 0$) hold with slack. It follows that the optimal commissions are $w_L = e_L$ and $w_H = e_H + e_L$, and the firm earns an expected profit of

$$\mathbb{E}\pi_P^* = u(v_H - e_H - e_L) + (1-u)(v_L - e_L) = \mathbb{E}\pi^* - ue_L$$

It can be easily shown that, by Condition (1), price delegation is more profitable than simply charging a low price v_L and offering a commission of e_L all of the time. This would result in the firm selling in both demand states but charging an inefficiently low price when demand is high. However, the firm could serve the high demand condition exclusively by always charging a high price v_H and offering a commission of e_H.[7] To rule out this trivial outcome we assume that the firm prefers to sell in both demand states, which requires that:

(3) $(1-u)v_L > e_L$

In the rest of the paper we will treat the expected profit under price delegation as the benchmark and compare it with the expected profit of lobbying.

We conclude this section with three observations. First, as we discussed earlier, conditioning the price charged on the sales rep's price report is equivalent to delegating pricing authority to the sales rep (Lal 1986). Although the firm actually sets the prices, because it always follows the sales rep's demand report, we obtain the same outcome if the sales rep sets prices directly. Of course, because compensation depends upon the price that the customer pays, the sales rep has an incentive to charge the correct price.

Second, in this solution the sales rep's commission depends upon the price rather than just the unit volume. Notice that in our model where unit sales are either zero or one (and where the marginal cost of production is zero), price-based compensation is equivalent to both revenue-based and margin-based compensation. However, we recognize that in more general settings it may be possible to achieve the same level of revenue with different unit sales, and the role of marginal costs may be nontrivial. It is in these settings that the distinctions between prices, revenue and margins become more meaningful. We abstract away from these distinctions to focus on the key question of interest – when should a firm impose a lobbying process rather than simply delegate the pricing decision to the sales rep?

Finally, it is important to recognize that price delegation cannot on its own restore the first-best profit. Although the firm is able to condition prices on demand information, to elicit demand information it pays the sales rep in the high demand state an information rent of $w_L = e_L$. This

[7] Because of Condition (1) this dominates the alternative of always charging the low price v_L and offering a commission of 0 (and again selling only in the high demand condition).

helps explain why companies often find price delegation inadequate, and represents a standard result in the agency literature (Laffont and Martimort 2002). Indeed, up until this point, we have presented a standard agency model describing the distortions that result from the presence of information asymmetry. In the next section, we depart from this standard model by introducing lobbying as a screening mechanism. In particular, we investigate if the firm can do better than price delegation by requiring that the sales rep lobby for lower prices.

§ 3. Lobbying

A frequent observation from our interviews is that firms require the sales rep to "acquire convincing evidence of low demand" in order to lobby for a lower price. In the telecommunications and military contractor examples, the sales force searches through historical transactions to find evidence that past discounts contributed to additional sales. In modeling terms, we can think of this information acquisition process as the sales rep searching for "signals" to support claims that demand is low and justify the recommendation to lower prices. The sales rep incurs effort to draw signals of demand without knowing whether any individual signal will indicate that demand is high or low. He can continue to search for evidence of low demand by making additional draws.

The firm can decide whether to require evidence of low demand before agreeing to lower prices. We interpret this as a decision about whether to require lobbying. We will show that it may be profitable to require lobbying, even where the cost of lobbying represents a deadweight loss. The firm may also vary *how much evidence* is required before it will lower prices, and in some situations it may also be able to influence the cost of searching for that evidence. We investigate how the firm will make these decisions, and how the outcome will be influenced by the accuracy of the demand signals.

Firm Requires One Signal of Low Demand

We begin by considering whether the firm will require a signal that demand is low. Assume that each demand signal drawn by a sales rep could indicate whether demand is high or low and that the signals are i.i.d. conditional on the true state of demand. In particular, the signal generating process is characterized by the following conditional probabilities:

Pr(high signal | high demand) = Pr(low signal | low demand) = r

where $r \in (1/2, 1)$ measures the precision of demand signals. Demand signals are noisy yet diagnostic of demand.[8]

Given these assumptions, the number of draws needed until the encounter of a low signal follows the negative binomial distribution. The expected number of draws is $1/(1-r)$ if demand is high and is $1/r$ if demand is low. Naturally, fewer draws are needed if demand is truly low. In addition, the more precise the demand signals are (the closer r is to 1), the fewer draws are needed if demand is low, and the more draws are needed if demand is high. That is, more precise demand signals polarize the lobbying costs between the two demand states.

The sales rep incurs a search cost $c > 0$ for each draw of a demand signal. This could represent the cost of researching historical transactions or documenting the intensity of competition in the marketplace. We recognize that besides search cost there may be other costs associated with lobbying. In particular, there may an opportunity cost of foregone time spend on more productive sales activities, such as interacting with customers. We will later consider this possibility as an extension.

We now derive the firm's optimal contract offer under this lobbying mechanism. Let w_H denote the commission for selling at the high price v_H, and let w_L denote the commission for

---

[8] This assumption is consistent with the premise of demand measurement, that market data are noisy yet reflective of the true state of demand.

selling at the discounted price v_L. The firm solves the following optimization problem, where "$E1$" denotes requiring one piece of evidence that demand is low:

$$\max_{w_H,\, w_L \geq 0} \quad \mathbb{E}\pi_{E1} = u(v_H - w_H) + (1-u)(v_L - w_L)$$

$$\text{s.t. } w_L - e_L - c/r \geq 0 \qquad (\text{IC}_L)$$

$$w_H - e_H \geq \max[0, w_L - c/(1-r)] \qquad (\text{IC}_H)$$

$$u(w_H - e_H) + (1-u)(w_L - e_L - c/r) \geq 0 \qquad (\text{IR})$$

We begin with some preliminary observations. The firm will want to induce selling effort in both demand states. If the firm does not induce selling effort when demand is high, the customer's willingness-to-pay can only be v_L or 0, and the firm might as well mandate a constant price of v_L. If the firm induces selling effort when demand is high but does not when demand is low, willingness-to-pay will be v_H if demand is high and 0 otherwise. The firm should then mandate a constant price of v_H. Both outcomes defeat the purpose of enforcing a lobbying mechanism. Moreover, the firm will respond to lobbying by cutting prices, otherwise the sales rep will not engage in costly lobbying in either demand condition.[9] Finally, to elicit truthful reporting of demand information, the firm will want the sales rep to lobby for a low price only when demand is low.

When demand is low, the sales rep earns an expected net payoff of $w_L - e_L - c/r$ by exerting selling effort and lobbying. His best deviation payoff is 0: he will not be able to earn the commission if he shirks selling effort or if he does not lobby. When demand is high, the sales rep earns a net payoff of $w_H - e_H$ by exerting selling effort and not lobbying. However, if he lobbies he can sell effortlessly and earn an expected surplus of $w_L - c/(1-r)$. He is also guaranteed a payoff of 0 by simply doing nothing. Hence the optimal commissions are

$$w_L = e_L + c/r$$

$$w_H = e_H + \max\,[0, e_L - g(r)c]$$

[9] In the extensions section we show that the firm will always respond to lobbying. Also, there is no room for the firm to renegotiate the contract after agreeing to a price cut because the sales rep is left with no rent.

where $g(r) = 1/(1-r) - 1/r$ for notational simplicity. It is easy to show that $g(r) > 0$ and $g(r)' > 0$ over $(1/2, 1)$. Using these optimal commissions, the firm earns an expected profit of

$$\mathbb{E}\pi_{E1}^{*} = \mathbb{E}\pi^{*} - u\max[0, e_L - g(r)c] - (1-u)c/r$$

We are interested in whether this lobbying mechanism can improve the firm's expected profit beyond price delegation. Both mechanisms lead to the same efficient pricing decisions, but differ in their associated payroll costs. With the lobbying mechanism the firm essentially subsidizes the sales rep's expected lobbying cost c/r when demand is low, but pays the sales rep a rent of $\max[0, e_L - g(r)c]$ rather than e_L when demand is high. This amounts to a saving of $\min[e_L, g(r)c]$ in information rent. Hence, this lobbying mechanism improves expected profit beyond price delegation iff

(4) $u\min[e_L, g(r)c] > (1-u)c/r$

Intuitively, through the lobbying mechanism the firm harnesses the sales rep's private information in the low demand condition to avoiding paying information rents in the high demand condition. This benefit is greater when demand is more likely to be high (larger u), and when the information rent is higher under price delegation (larger e_L). In addition, Condition (4) is more likely to hold with higher values of r. When demand signals are more accurate, lobbying is less costly for the sales rep when demand is low and is more costly when demand is high, which makes the lobbying process more effective at eliciting truthful demand information.

It is important to recognize that the firm can choose what represents "evidence" of low demand. This provides an important opportunity to improve the efficiency of the lobbying mechanism. When choosing what represents evidence, the firm should choose signals that are easy to obtain when demand is low, but hard to obtain when demand is high. For example, a manager at the African beverage manufacturer described how his sales force gathers evidence of competitors' "dealer communications" that reveal the competitors' prices. Should the firm accept evidence that a competitor is charging lower prices as evidence of the need to lower the price to all dealers? The answer depends upon how easy it is to find this evidence. If the competitor charges the same price to all dealers, then evidence that this price is low may indeed represent sufficient evidence to lower the price. However, if the competitor charges different prices across dealers, so that it is always possible to find examples of some dealers who are getting lower prices, then the firm should generally not accept this as evidence to lower prices to other dealers.

In an alternative example, customers' willingness-to-pay may depend on word-of-mouth about product performance. To approve any price discount, the firm may require evidence of negative world-of-mouth. The chance of observing negative word-of-mouth signals is higher if product performance is indeed perceived more poorly.[10]

Interestingly, in the Technical Appendix we show that the firm's expected profit can increase with the search cost c. This result reflects a trade-off between two forces. On the negative side, a higher search cost increases the lobbying cost when demand is low, which the firm has to subsidize. On the positive side, it discourages lobbying when demand is high, which reduces the information rent. Higher accuracy of demand signals (r) diminishes the negative side and amplifies the positive side because finding an accurate, negative signal is disproportionately hard if demand is high. Therefore, if evidence is sufficiently accurate, higher search costs can increase the effectiveness of the lobbying system.

The above result leads to the following question – what should the optimal search cost be if the firm is able to influence it? In the context of our examples, the African beverage company can choose how much infrastructural support to provide for its sales reps to visit distributors and dealers, and the military contractor can choose the accessibility of historical transaction data to its sales force. In the Technical Appendix we derive a positive optimal search cost $c^* = e_L/$

---

[10] Recall also the example of the military contractor whose sales force used an example of a past transaction leading to additional sales as evidence that lowering the price to a new customer was justified. If the original customer had the same characteristics as the new customer, then the firm might decide this represents sufficient evidence to justify a discount. However, if the original and new customers are different then the firm may decide not to accept this as sufficient evidence. Other examples include a sales rep's claims that a customer is also requesting prices from competitors. The firm should only lower the price if these claims can be substantiated by evidence (such as customers' printed price comparisons from the Internet).

$g(r)$. This result echoes observations that companies often allow lobbying but make the process "somewhat difficult" for the sales people. If lobbying is too frustrating, sales people who truly face low demand cannot easily communicate this information; if lobbying is reduced to a rubber stamp, sales people in favorable markets will argue for a low price as well.[11]

In some situations, it may be difficult for the firm to directly control the sales rep's search cost. For these firms an alternative is to vary the amount of evidence required before agreeing to lower prices. In terms of our model, the firm can decide how many signals of low demand are required before it is willing to approve a discount. We analyze this decision next.

How Much Evidence of Low Demand Should the Firm Require?

Suppose the firm requires the sales rep to provide n signals of low demand. The firm chooses the value of n as well as the commissions to maximize its expected profit (we will later refer to this model as the "main model" and compare various extensions against it):

$$\max_{w_H,\, w_L, n\geq 0} \; \mathbb{E}\pi_E = u(v_H - w_H) + (1-u)(v_L - w_L)$$

$$\text{s.t. } w_L - e_L - cn/r \geq 0 \qquad (\text{IC}_\text{L})$$

$$w_H - e_H \geq \max[0, w_L - cn/(1-r)] \qquad (\text{IC}_\text{H})$$

$$u(w_H - e_H) + (1-u)(w_L - e_L - cn/r) \geq 0 \qquad (\text{IR})$$

Note that the expected number of draws the sales rep needs is $n/(1-r)$ if demand is high and is n/r if demand is low. The difference, $n/(1-r) - n/r = ng(r)$, increases with n. This result drives the firm's trade-off in deciding how much evidence to require before approving a discount. A higher bar (larger n) raises the lobbying costs in both demand states, which in turn increases the firm's payroll costs. However, a higher bar also increases the discriminatory power of the lobbying mechanism because it is disproportionately difficult to collect many low signals when demand is actually high. To manage this trade-off the firm will want to choose an

---

[11] The firm has no incentive to introduce a fixed cost of lobbying. Doing so exacerbates the deadweight loss of lobbying without improving its screening power, because this fixed cost is the same across demand conditions.

"intermediate" value of n. We solve the firm's optimization problem in the Technical Appendix and obtain the following result.

> **Proposition 1**: If evidence is sufficiently accurate ($r > \frac{1}{1+u}$), the firm should require evidence of low demand before approving a price discount. The optimal number of low demand signals increases with the effort cost in the low demand condition (e_L) and decreases with both the cost of search (c) and the accuracy of evidence (r).
>
> **Proof**: See the Technical Appendix.

The optimal amount of evidence is given by $n^* = e_L/[g(r)c]$.[12] The comparative statics of n^* have intuitive interpretations. First, recall that e_L is the sales rep's information rent in the high demand state under price delegation. The larger this rent, the more the firm wants to extract it with an onerous evidence requirement. Second, the sales rep's search cost c has a similar effect on profit as the required number of low signals; both make the lobbying system more costly yet more discerning as a screening mechanism. Therefore, when acquiring evidence is costly, the firm will reduce the evidentiary requirement. Finally, the more precise demand signals are, the more difficult it is to gather low signals when demand is actually high. As a result, fewer low signals are needed to prevent the sales rep from understating demand.

Notice that the sales rep's search cost is a deadweight loss in this system, yet the firm is willing to introduce this loss in order to reclaim the rent it would otherwise pay when demand is high. When $n = n^*$, the expected profit under the *optimal lobbying mechanism* is

$$\mathbb{E}\pi_E^* = \mathbb{E}\pi^* - (1-u)cn^*/r$$

This optimal lobbying mechanism introduces a deadweight loss of $(1-u)cn^*/r$, which equals the subsidy the firm pays the sales rep to cover his lobbying cost when demand is low.

[12] To facilitate exposition, we ignore the discrete nature of n. The solution for the discrete case can be derived using the same logic.

However, the firm is able to eliminate the sales rep's information rent when demand is high. This result reflects the different implications of the costly lobbying process. From the social efficiency perspective, lobbying is wasteful. From the firm's perspective, the costly nature of lobbying helps it recover information rents from the sales force.

Summary

In this section we have shown that the firm can use the lobbying mechanism to reduce the information rent it pays to the sales rep when demand is high. Lobbying can improve expected profit beyond price delegation, even though it is an unproductive activity that leads to additional bureaucracy. We model the lobbying mechanism as the requirement that the sales rep must provide evidence that demand is low before the firm agrees to a discount. We show that the firm will define what constitutes evidence of low demand by choosing signals that are easy to obtain when demand is truly low, but difficult to obtain if demand is high. The firm can also control how much evidence is required before it will agree to a discount. As long as the evidence is sufficiently accurate, the firm will require substantial evidence. The firm may also make the search for evidence more cumbersome, even though increasing this administrative burden contributes an additional deadweight loss.

§ 4. Extensions

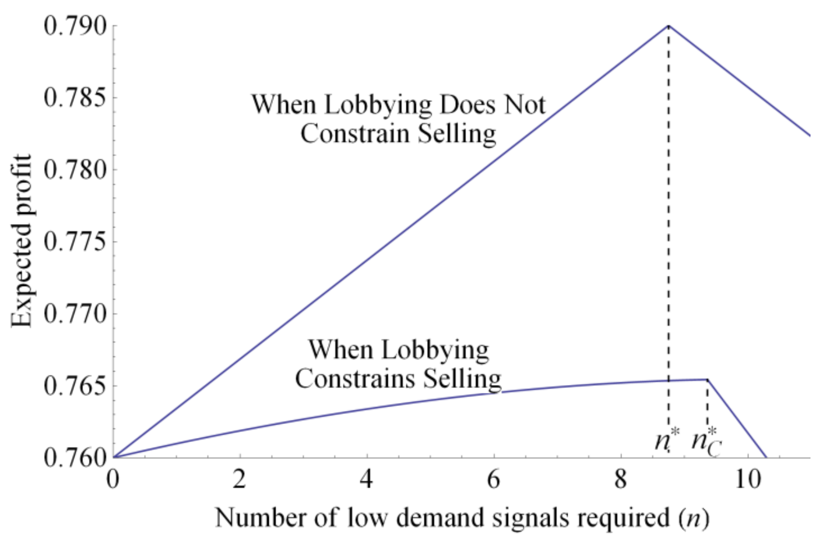
In this section, we explore how the optimal design and the ultimate efficacy of the lobbying mechanism change in the following scenarios: the sales rep's lobbying effort constrains his selling effort, the sales rep is risk averse, the firm can acquire evidence of demand on its own, the firm can punish the sales rep (by paying negative wages), or the firm can respond to lobbying randomly. In each of these scenarios we ask: How much evidence should the firm require in designing its lobbying mechanism? Should the firm use the lobbying mechanism or price delegation?

When Lobbying Constrains Selling

The time and energy a sales rep spends on lobbying might limit the extent of effort he can invest in other (more productive) selling activities. How should the firm adjust its evidentiary requirement for lobbying? One might expect the firm to lower its requirement because searching for more evidence is especially wasteful when it results in an opportunity cost. However, we find that the opposite may be true. We collect the full analysis in the Technical Appendix, and present an example in Figure 1.

The upper curve of Figure 1 plots the firm's expected profit as a function of its evidentiary requirement when searching for evidence does not constrain selling, where n^* denotes the optimal number of low signals required. The lower curve corresponds to the case in which searching for evidence does constrain selling. The optimal number of low signals required, as denoted by n_C^*, is higher. Notice that the firm can waive the evidentiary requirement altogether ($n = 0$) and implement price delegation. The fact that $n_C^* > 0$ in Figure 1 indicates that the lobbying mechanism can generate higher expected profit than price delegation.

Figure 1: The Firm May Raise Its Evidentiary Requirement If Lobbying Constrains Selling



Notes: This figure sets $v_H = 1$, $v_L = 0.8$, $e_H = e_L = 0.1$, $c = 0.006$, $u = 0.6$, and $r = 0.7$.

When lobbying prevents the sales rep from exerting full selling effort, the firm must offer a higher commission w_L in the low demand state to compensate the sales rep for the risk of losing this commission. A higher w_L makes it more attractive for the sales rep to claim that demand is low. Raising the evidentiary requirement helps the firm counter this tendency, although it also increases the lobbying cost when demand is actually low. We prove the following result.

> **Proposition 2**: The firm may require more evidence of low demand when the search for evidence constrains selling effort than when it does not.
>
> **Proof**: See the Technical Appendix.

Recall that the socially efficient amount of lobbying is zero. The surprising insight of Proposition 2 is that the equilibrium amount of lobbying may increase further if lobbying is more wasteful. When lobbying erodes selling, the lobbying mechanism is less effective as a screening device, and the firm may raise the evidentiary bar to restore its discriminatory power.

When the Sales Rep is Risk Averse

The lobbying mechanism begets uncertainty. In either demand state, the sales rep's search for signals of low demand is governed by a random process, and the cost of lobbying is a random variable. In contrast, the sales rep's payoff in each demand state is deterministic under price delegation. If the sales rep is risk averse, this may affect the design of the lobbying mechanism and the firm's choice between price delegation and lobbying.[13]

We present the analysis in the Technical Appendix. In summary, a risk averse sales rep derives a disutility from the inherent uncertainty of the search process. To induce the sales rep to

---

[13] The sales rep faces ex ante demand uncertainty under both price delegation and lobbying. However, the sales rep's ex post participation constraint is satisfied because of the limited liability assumption, which in turn means that the sales rep's ex ante participation constraint is satisfied regardless of his risk preferences. Therefore, risk aversion only affects the lobbying mechanism (and the firm's choice between price delegation and lobbying) through the search process.

lobby when demand is low, the firm must offer a commission greater than the sales rep's cost of selling and expected cost of search. The higher the evidentiary requirement, the greater this extra commission. This effect is in favor of lowering the evidentiary requirement or abandoning lobbying altogether (in favor of price delegation).

However, there is a countervailing effect. Due to the disutility of uncertainty, a risk averse sales rep is also reluctant to search when demand is high. Moreover, searching for low demand signals is associated with greater uncertainty when demand is high than when demand is low. To fulfill the requirement of n signal of low demand, the number of draws needed is associated with a variance of $\frac{nr}{(1-r)^2}$ when demand is high and a lower variance of $\frac{n(1-r)}{r^2}$ when demand is low. Therefore, a higher evidentiary requirement serves to strengthen the screening power of the lobbying mechanism.

The tradeoff between these two effects determines the optimal design of the lobbying mechanism and the firm's choice between price delegation and lobbying. For concreteness, we assume that the sales rep's utility function is exponential such that the sales rep exhibits constant absolute risk aversion. The exponential utility function is often adopted for its analytical tractability. This allows us to derive the firm's optimal contract in closed form and to analyze the comparative statics with respect to the sales rep's degree of risk aversion.

As the sales rep's degree of risk aversion increases, the firm must offer a greater commission for the low demand state to induce lobbying. Meanwhile, the screening power of the lobbying mechanism also increases, and a lower evidentiary requirement suffices to fully extract the sales rep's rent in the high demand state. The second effect dominates in the case of exponential utilities. The net result is that the firm's expected profit from the lobbying mechanism increases with the sales rep's degree of risk aversion.

Finally, recall that the firm's expected profit under price delegation does not depend on the sales rep's degree of risk aversion. Therefore, as risk aversion increases the firm may end up being more willing to choose lobbying over price delegation, although lobbying looms as a more "risky" mechanism to the sales rep.

When the Firm Can Acquire Evidence on Its Own

In some markets the firm may be able to acquire evidence of demand on its own. The question is whether doing so can improve profit beyond lobbying. In particular, we consider the following "verification" mechanism – the sales rep makes a claim about the state of demand. If the sales rep claims that demand is low, the firm verifies this claim by acquiring evidence of demand on its own. The firm will approve the price discount if and only if there is "sufficient evidence" of low demand.

Note that the firm could also conduct a "blanket search" – it could acquire evidence of demand on its own without conditioning its search decision on the sales rep's claims of demand. However, blanket search is strictly dominated by verification. We present the proof in the Technical Appendix. This is because verification helps the firm elicit demand information from the sales rep, and this information saves the firm the cost of search when demand is high.

We start with a simple verification mechanism to gain more intuition. Consider the following contract. If the sales rep asks for a high price v_H, the firm will always agree. If the sales rep asks for a low price v_L, the firm will search for *one* signal of demand on its own. If the signal is low, the firm will agree to charge a low price. If the signal is high, the firm will charge the high price instead. The sales rep does not need to collect evidence of low demand. To facilitate comparison, assume that the firm and the sales rep incur the same search cost c for each draw of demand signals.

The verification process gives the firm greater contractual freedom in setting its commissions. A sale now occurs in three possible ways: the sales rep requests (and always obtains) the high price, requests and obtains the low price, requests the low price but obtains the high price.

Correspondingly, the firm offers a commission of w_H, w_L, and w'_H upon sale. The firm chooses these commissions to maximize the expected profit of this simple verification mechanism:

$$\max_{w_H,\, w'_H,\, w_L \geq 0} \ \mathbb{E}\pi_{V1} = u(v_H - w_H) + (1-u)[r(v_L - w_L) - c]$$

$$\text{s.t. } r(w_L - e_L) \geq 0 \qquad (\text{IC}_\text{L})$$

$$w_H - e_H \geq r\max(w'_H - e_H, 0) + (1-r)w_L \qquad (\text{IC}_\text{H})$$

$$u(w_H - e_H) + (1-u)r(w_L - e_L) \geq 0 \qquad (\text{IR})$$

This optimization problem is interpreted as follows. If demand is low and the sales rep asks for a low price, the firm will approve this price with probability r, which equals the probability that the firm finds a signal of low demand in one draw. The sales rep earns 0 by not exerting selling effort, and $w_L - e_L$ by exerting selling effort once the discount is approved; he has no incentive to make selling effort if the discount is turned down.[14] Meanwhile, the sales rep earns a maximum surplus of 0 by asking for a high price. Therefore, to induce the sales rep to request a low price and exert selling effort (once the request is approved), the firm must offer $w_L = e_L$.

If demand is high and the sales rep asks for a low price, with probability r he will fail verification. In this case, he will earn $w'_H - e_H$ if he exerts selling effort and 0 otherwise.[15] with probability $1 - r$ he will obtain the low price and earn the commission w_L without selling effort. Therefore, the sales rep earns an expected surplus of $r\max(w'_H - e_H, 0) + (1-r)w_L$ if he asks for a low price. If the sales rep asks for a high price, he earns $w_H - e_H$ if he exerts selling effort and 0 if he does not. To induce the sales rep to request a high price and exert selling effort, the firm must offer $w'_H \in [0, e_H]$ and $w_H = e_H + (1-r)e_L$.

It follows that the simple verification mechanism generates an expected profit of

---

[14] The firm will prefer to let the sales rep condition his selling effort on the outcome of verification. If the sales rep must choose his selling effort before observing the outcome of verification, the firm will have to offer a higher commission w_L to induce selling effort.

[15] We derive the optimal value of w'_H assuming that the firm can commit to its commission offers. If the firm cannot commit, it will want to offer $w'_H = e_H$ to induce selling effort in case demand is high. However, this does not change the firm's optimal choice of w_H or its expected profit from the verification mechanism. The key is that the sales rep earns zero surpluses whenever his discount request fails verification, which discourages the sales rep to understate demand.

$$\mathbb{E}\pi_{V1}^* = \mathbb{E}\pi^* - u(1-r)e_L - (1-u)(1-r)(v_L - e_L) - (1-u)c$$

This profit function illustrates the pros and cons of the verification mechanism. On the positive side, when demand is high the firm pays less information rent (in the amount of $(1-r)e_L$ as opposed to e_L), because the possibility of failing verification makes it less tempting for the sales rep to understate demand. On the negative side, when demand is low the firm faces the possibility of not granting a truly needed low price and thus losing the customer. In addition, the firm must pay for its own cost of search. Given these pros and cons, how should the firm choose between verification and lobbying? To answer this question, we next derive the optimal verification mechanism.

The key decision for the firm is what amounts to "sufficient evidence" of low demand. Without loss of generality, sufficient evidence is defined as "finding at least n signals of low demand within the first k draws" – given the demand signal generating process, the sequence by which these signals arrive does not affect the probability of observing sufficient evidence. The probability of passing verification is $\phi_L(n,k) = \sum_{i=n}^{k}\binom{k}{i} r^i (1-r)^{k-i}$ if demand is low and is $\phi_H(n,k) = \sum_{i=n}^{k}\binom{k}{i} r^{k-i}(1-r)^i$ if demand is high.

Following the same logic of the simple example above, we derive the firm's optimal commission offers as $w_L = e_L$, $w_H' \in [0, e_H]$, and $w_H = e_H + \phi_H(n,k)e_L$. The optimal verification mechanism generates an expected profit of[16]

$$\mathbb{E}\pi_V^* = u(v_H - w_H) + (1-u)[\phi_L(n,k)(v_L - w_L) - ck]$$
$$= \mathbb{E}\pi^* - u\phi_H(n,k)e_L - (1-u)[1-\phi_L(n,k)](v_L - e_L) - (1-u)ck$$

[16] Note that random verification is never optimal. Suppose the firm can commit to a verification probability $\gamma \in [0,1]$. It follows that the firm will pay an information rent of $[1-\gamma+\gamma\phi_H(n,k)]e_L$ in the high demand state, loses the business with probability $\gamma[1-\phi_L(n,k)]$ in the low demand state, and incurs an expected search cost of $(1-u)\gamma ck$. The firm's expected profit is linear in γ. Therefore, the optimal value of γ is either 1 or 0: the firm either always verifies the sales rep's claims of low demand or never verifies these claims – a scenario equivalent to price delegation.

Intuitively, the firm will want to make it easy for the sales rep's discount request to pass verification when demand is low, and make it difficult when demand is high. This amounts to increasing $\phi_L(n,k)$ and decreasing $\phi_H(n,k)$. Meanwhile, the firm will want to reduce its total search cost (lower k). We derive the optimal values of n and k in the Technical Appendix and obtain the following result.

> **Proposition 3**: If evidence of demand is sufficiently accurate (r sufficiently high), the firm should use the lobbying mechanism instead of verification.
>
> **Proof**: See the Technical Appendix.

The intuition is as follows. First, verification as a screening mechanism inherently begets errors. There is always a positive chance that the sales rep will fail verification even if demand is low (Type 1 error) and pass verification even if demand is high (Type 2 error). As a result, verification can never eliminate the sales rep's information rent when demand is high, and it always leads to lost sales when demand is low. In comparison, the lobbying mechanism eliminates the sales rep's information rent if demand signals are sufficiently accurate, because the difficulty of meeting the evidentiary requirement makes lobbying infeasible to the sales rep. Moreover, the lobbying mechanism does not erode sales when demand is low, because the firm will always respond to lobbying in equilibrium.[17]

There is a second and more subtle reason. It has to do with the deadweight cost of search generated by either mechanism. When demand signals are sufficiently accurate, the sales rep does not have to search too "redundantly" to meet the evidentiary threshold – to collect n signals of low demand, he needs n/r draws in expectation, which gets closer to n when r approaches 1. Under the verification mechanism, however, the firm cannot set the total

[17] This is true unless the sales rep faces a binding effort capacity such as when lobbying diverts attention from selling. But even in this case lobbying is still more profitable than verification if demand signals are sufficiently accurate. Under the lobbying mechanism, the firm eliminates the sales rep's information rent when demand is high, and does not require excessively redundant search when demand is low. Finally, if demand signals are sufficiently accurate, a minimum evidentiary requirement suffices, which allows the sales rep to spend more effort on selling. See Figure V1 in the Technical Appendix for an example.

number of draws k too close to the evidentiary threshold n. In fact, the optimal value of k is more than twice as large as n (for reasons that we explain in the Technical Appendix). This fact makes verification a more "wasteful" mechanism than lobbying when demand signals are sufficiently accurate.

When the Firm Can Punish the Sales Rep

We have assumed that the sales rep earns a minimum wage of zero. We extend the analysis by allowing the firm to punish the sales rep up to some amount $F > 0$. We continue to assume that the sales rep's outside opportunity is normalized as zero. In addition, once the sales rep has accepted the contract, he is "locked in" with the firm over the contract duration (otherwise the negative wage would be meaningless). For the sales rep to accept the contract in the first place, his ex ante expected surplus must be nonnegative.

We present the full analysis in the Technical Appendix. In equilibrium, the firm always punishes the sales rep if he fails to sell. In addition, we derive a cutoff value $\hat{F} = ue_L$. If the firm is allowed to severely punish the sales rep ($F \geq \hat{F}$), it should use price delegation. In doing so, the firm will be able to restore the first-best expected profit. If the firm is only allowed to moderately punish the sales rep ($F < \hat{F}$), it should require lobbying if evidence of demand is sufficiently accurate ($r > 1/(1+r)$) and use price delegation otherwise. Compared with the main model of Section 3, the lobbying mechanism imposes a lower evidentiary threshold and generates a higher expected profit, although it still cannot restore the first-best expected profit.

The intuition is as follows. In the main model, under price delegation the sales rep enjoys an information rent when demand is high. Lobbying helps the firm reduce this information rent. Punishment serves as an alternative rent-reduction device. Being able to punish the sales rep allows the firm to induce selling effort with smaller commissions in both demand states. Moreover, cutting the commission in the low demand state makes it less attractive for a sales rep in the high demand state to pretend that demand is low. If the firm is able to severely punish the sales rep, price delegation suffices to restore the first-best expected profit.

If punishment is limited, so is its rent-extraction power. The firm will have to rely on a combination of punishment and lobbying if demand signals are precise enough. However, even if punishment is limited, punishment allows the firm to lower its evidentiary requirement. This increases the firm's profits because the firm ultimately bears the cost of searching for evidence. We conclude that our assumption that the sales rep cannot be punished is stricter than we require. We only require a limit on how large any negative wage can be.

Would the Firm Respond to Lobbying Randomly?

In the main model, the firm always responds to lobbying and lowers the price if the sales rep meets the evidentiary threshold. Can the firm improve its expected profit by responding to lobbying stochastically? We present the full analysis in the Technical Appendix and find the answer to be no. This is because stochastic response to lobbying achieves the same effect as increasing the evidentiary threshold in terms of regulating the sales rep's incentives. Both make it more costly for the sales rep to obtain a price discount. In fact, if the firm requires n signals of low demand and responds to lobbying with probability θ, this mechanism in equilibrium is equivalent to requiring n/θ signals of low demand but always responding to lobbying. We show in the Technical Appendix that the sales rep receives the same commissions in equilibrium as in the main model. However, stochastic response to lobbying brings an additional cost to the firm. When demand is truly low, with probability $1-\theta$ the firm will ignore lobbying and miss the sale. Therefore, the firm will respond to sufficient evidence by lowering the price, and will control the lobbying mechanism by adjusting the evidentiary threshold.

Competition for the Sales Rep's Services

In this model we have restricted attention to a single firm. However, in some markets there are multiple competing firms, which raises the issue of competition for the sales rep's services. If the sales rep's switching costs are sufficiently low and the sales rep acquired the private information before contracting, then this could result in the firms competing on how much surplus the sales rep receives. One way that the firms might compete is by offering the sales rep more of the information rent in the high-demand state. If the payoffs in the high-demand state are more attractive, then the sales rep has less incentive to deviate, which will lower the level of evidence that the firm will require before agreeing to a discount. However, if there are multiple potential agents to hire and they agree on the contract before getting their private information we effectively return to the game that we model.

Summary

We have explored the boundaries of our argument by investigating how our results change when we relax different model assumptions. The findings reveal that the profitability of lobbying is robust under a broad range of conditions. In particular, it may remain profitable to require lobbying for lower prices when: the sales force is risk averse, the firm can conduct its own verification, limited punishments (negative wages) are enforceable when sales goals are unmet, or even when there is an opportunity cost of engaging in lobbying. Perhaps surprisingly, the relative profitability of lobbying may even increase in these scenarios if a lower evidentiary threshold suffices to induce truthful reporting of demand.

In the next section we show that the intuition underlying the lobbying mechanism extends to a general model with minimum functional form assumptions.

§ 5. General Model

While our model has focused on two demand states, in general demand will take on a broader range of possible states. This potentially complicates the design of the lobbying process as a single evidentiary threshold is no longer sufficient to discriminate between all of the demand states. Instead, a complete screening mechanism will require a different evidentiary threshold for each of the demand states. In this section we allow for a continuous distribution of demand states, which requires a continuous function of evidentiary thresholds in order for the firm to completely take advantage of the sales rep's private information.

We generalize the model in the following way. We continue to assume that a customer's willingness-to-pay depends on the strength of demand v and the sales rep's selling effort. However, we allow the demand states v to follow a generic p.d.f. $f(v)$ and c.d.f. $F(v)$ over [$\underline{v}$, $\overline{v}$]. Meanwhile, let the function $\varepsilon(p, v)$ describe the cost of selling effort the sales rep must incur for a customer in demand state v to be just willing to buy at price p. We assume that, for a given price, less selling effort is required if demand is higher:

(5) $\frac{\partial \varepsilon(p,v)}{\partial v} < 0$

Extending the main model, we use $n(\tilde{v}) \geq 0$ to denote the number of low demand signals the sales rep must provide in order to claim that demand is $\tilde{v}$. Meanwhile, the sales rep has a probability $b(v)$ of finding a low signal in one shot of search when demand is v. Search cost is again $c > 0$ per draw. Therefore, to claim that demand is $\tilde{v}$ when it is actually v, the sales rep must incur an expected lobbying cost of

$$l(\tilde{v}, v) = c\frac{n(\tilde{v})}{b(v)}$$

Following the sales rep's demand report $\tilde{v}$, the firm sets the price $p(\tilde{v})$ and offers a commission $w(\tilde{v})$ if the sales rep is able to sell at this price. In equilibrium, the sales rep will incur just enough selling effort $\varepsilon[p(\tilde{v}), v]$ to earn this commission.

The firm chooses the evidentiary threshold, price scheme and commission scheme to maximize its expected profit $\mathbb{E}\pi_G$ ("G" for general):[18]

$$\max_{n(v),p(v),w(v)\geq 0} \quad \mathbb{E}\pi_G = \int_{\underline{v}}^{\overline{v}} [p(v) - w(v)]dF(v)$$

$$\text{s.t. } w(v) - \varepsilon[p(v), v] - l(v, v) \geq w(\tilde{v}) - \varepsilon[p(\tilde{v}), v] - l(\tilde{v}, v), \qquad \forall\, \tilde{v} \neq v \qquad \text{(IC)}$$

$$w(v) - \varepsilon[p(v), v] - l(v, v) \geq 0, \qquad \forall\, v \qquad \text{(IR)}$$

[18] To simplify exposition, we assumed that the firm intends to serve consumers in all demand states. This is analogous to Condition (3) of the main model.

where $l(\tilde{v}, v) = cn(\tilde{v})/b(v)$.

Let $S(v)$ denote the *indirect* surplus function given the sales rep's truthful reporting of demand:

$$S(v) = w(\tilde{v}) - \varepsilon[p(\tilde{v}), v] - l(\tilde{v}, v)\, |_{\tilde{v}=v}$$

It follows from the envelope theorem (Mirrlees 1971) that

$$(6)\quad S'(v) = -\frac{\partial \varepsilon[p(\tilde{v}), v]}{\partial v} - \frac{\partial l(\tilde{v}, v)}{\partial v}\, |_{\tilde{v}=v}$$

We will begin by establishing that a necessary requirement for lobbying to be profitable is that evidence of low demand is harder to obtain in high demand states. In particular, a necessary condition is that the probability a single search draw yields evidence that demand is low, $b(v)$, decreases with demand: $b'(v) < 0$. It follows that the sales rep's lobbying cost to obtain a given price $p(\tilde{v})$ is higher in higher demand states: $\frac{\partial l(\tilde{v}, v)}{\partial v} = -c\frac{n(\tilde{v})b'(v)}{b(v)^2} > 0$ irrespective of the firm's choice of the evidentiary threshold function as long as $n(\tilde{v}) > 0$.

Proposition 4: The lobbying mechanism can only improve expected profit over price delegation if evidence of low demand is harder to obtain in higher demand states: $b'(v) < 0$.

Proof: We prove this result by contradiction. Suppose $b'(v) \geq 0$ such that $\frac{\partial l(\tilde{v}, v)}{\partial v} \leq 0$. Given (5) and (6), we have $S'(v) > 0$. Thus the IR constraint is binding in equilibrium for the lowest demand state: $S(\underline{v}) = 0$. We can then rewrite the sales rep's surplus as

$$S(v) = S(\underline{v}) + \int_{\underline{v}}^{v} S'(x)dx = \int_{\underline{v}}^{v}(-\varepsilon_x^{'} - l_x^{'})dx$$

where $\varepsilon_x^{'} = \frac{\partial \varepsilon[p(\tilde{v}), x]}{\partial x}|_{\tilde{v}=x}$ and $l_x^{'} = \frac{\partial l(\tilde{v}, x)}{\partial x}\, |_{\tilde{v}=x}$ for notational convenience. Substituting in the sales rep's surplus function, the firm's expected profit becomes

$$\mathbb{E}\pi_G = \int_{\underline{v}}^{\overline{v}} \{p(v) - S(v) - \varepsilon[p(v), v] - l(v, v)\} \, dF(v)$$

The above transformation simplifies the firm's objective function by eliminating $w(v)$. However, $\int_{\underline{v}}^{\overline{v}} S(v)dF(v)$ still involves double integrals. For further simplification, we use "integrating by parts" and obtain

$$\int_{\underline{v}}^{\overline{v}} S(v)dF(v) = \int_{\underline{v}}^{\overline{v}} \int_{\underline{v}}^{v} (-\varepsilon_x^{'} - l_x^{'})dx \, dF(v)$$

$$= \int_{\underline{v}}^{v} (-\varepsilon_x^{'} - l_x^{'})dx \, F(v) \, |_{\underline{v}}^{\overline{v}} - \int_{\underline{v}}^{\overline{v}} F(v) \, (-\varepsilon_v^{'} - l_v^{'})dv$$

$$= \int_{\underline{v}}^{\overline{v}} (-\varepsilon_x^{'} - l_x^{'})dx - \int_{\underline{v}}^{\overline{v}} F(v) \, (-\varepsilon_v^{'} - l_v^{'})dv$$

$$= \int_{\underline{v}}^{\overline{v}} (-\varepsilon_v^{'} - l_v^{'})[1 - F(v)]dv$$

Combining terms yields

$$\mathbb{E}\pi_G = \int_{\underline{v}}^{\overline{v}} \{p(v) - \varepsilon[p(v), v] - l(v, v)\}dF(v) - \int_{\underline{v}}^{\overline{v}} (-\varepsilon_v^{'} - l_v^{'})[1 - F(v)] \, dv$$

$$= \int_{\underline{v}}^{\overline{v}} (\{p(v) - \varepsilon[p(v), v]\}f(v) + \varepsilon_v^{'}[1 - F(v)])dv + Y$$

where $Y = -\int_{\underline{v}}^{\overline{v}} l(v, v)f(v)dv + \int_{\underline{v}}^{\overline{v}} l_v^{'}[1 - F(v)]dv$. Since $l_v^{'} \leq 0$, we have $Y \leq 0$. It follows that

$$\mathbb{E}\pi_G \leq \int_{\underline{v}}^{\overline{v}} (\{p(v) - \varepsilon[p(v), v]\}f(v) + \varepsilon_v^{'}[1 - F(v)])dv$$

But the right-hand side of the above inequality is the expected profit under price delegation given the induced price scheme $p(v)$. (We can derive the expected profit under price delegation by repeating the above analysis and omitting all terms associated with lobbying cost.) This expected profit, in turn, is weakly lower than the optimal expected profit under price delegation by definition. Therefore, we have established a contradiction. **Q.E.D.**

This result states that the *necessary* condition for lobbying to improve expected profit beyond price delegation is that lobbying is more costly when demand is high than when demand is low, other things being equal. This is a general result that does not depend upon the particular evidentiary process that we have modeled; it simply requires that $\frac{\partial l(\tilde{v},v)}{\partial v} > 0$.

We conclude this section by deriving the optimal lobbying mechanism. First we prove in the Technical Appendix that the sales rep's IR constraint must be binding in the lowest demand state: $S(\underline{v}) = 0$. Intuitively, the sales rep enjoys no information rent when demand is $\underline{v}$. A positive surplus $S(\underline{v})$ can thus only come from the lobbying mechanism, and the firm has the incentive to adjust $n(v)$ to extract this surplus.

Given that $S(\underline{v}) = 0$, we can derive the firm's expected profit $\mathbb{E}\pi_G$ following the same analysis presented in the proof of Proposition 4. Rearranging terms yields $\mathbb{E}\pi_G = \int_{\underline{v}}^{\overline{v}} y(v)dv$ where

$$y(v) = \{p(v) - \varepsilon[p(v), v] - l(v, v)\}f(v) + (\varepsilon_v^{'} + l_v^{'})[1 - F(v)]$$

$$= \left\{p(v) - \varepsilon[p(v), v] - c\frac{n(v)}{b(v)}\right\}f(v) + \left[\varepsilon_v^{'} - c\frac{n(v)b'(v)}{b(v)^2}\right][1 - F(v)]$$

The firm's optimization problem amounts to choosing $p(v)$ and $n(v)$ to maximize $y(v)$ for each v. Taking derivatives yields

$$\frac{dy(v)}{dp(v)} = \{1 - \varepsilon_p'[p(v), v]\}f(v) + \varepsilon_{pv}^{''}[1 - F(v)]$$

$$\frac{dy(v)}{dn(v)} = -c\frac{1}{b(v)}f(v) - c\frac{b'(v)}{b(v)^2}[1 - F(v)] = \frac{c[1-F(v)]}{b(v)}\left[-\frac{f(v)}{1-F(v)} - \frac{b'(v)}{b(v)}\right]$$

The firm's optimal price scheme $p(v)$ can be derived from the first derivative. Notice also that the second derivative does not depend upon n and the scalar $\frac{c[1-F(v)]}{b(v)}$ is always nonnegative. Therefore, the firm should require evidence (i.e. set $n(v) > 0$) to approve price $p(v)$ iff:

(7) $\frac{-b'(v)}{b(v)} \geq \frac{f(v)}{1-F(v)}$

Specifically, if Condition (7) holds the firm will increase $n(v)$ until the IR constraint is just binding for the sales rep in demand state v. (Recall that the sales rep's IC constraint is satisfied by the envelope theorem.) In the Technical Appendix we illustrate how to calculate the optimal $n(v)$ for explicit functions of $f(v)$, $b(v)$ and $\varepsilon(p, v)$. If Condition (7) does not hold the firm should not require any evidence before approving the price $p(v)$.

The interpretation of Condition (7) again reflects the intuition of the main model. The firm should require evidence before approving price $p(v)$ in the following situations. First, it is relatively much harder to produce evidence of low demand as demand increases (larger $\frac{-b'(v)}{b(v)}$). Second, the focal demand condition v is less likely to occur (smaller $f(v)$), so that the firm expects to incur the corresponding lobbying cost with a lower probability. Third, there is a greater probability that demand is higher than v (larger values of $1 - F(v)$). This increases the expected importance of recapturing the information rents in these higher demand states. In contrast, Condition (7) never holds in the highest demand state $\overline{v}$ as long as $b'(\overline{v})$ is bounded. This result is again intuitive; the firm should waive evidentiary requirements if the sales rep volunteers to report that demand is at its highest level.

Summary

We illustrate how to extend the model to multiple demand states using a continuous-state model. The results generalize the intuition of the main model. Recall that in the two-state model lobbying only operates as an effective screening mechanism if it is harder in the higher demand state to produce evidence that demand is low. The same condition is also a necessary condition in the continuous-state model. In the continuous-state model the conditions under which the firm will require evidence again reflect the trade-off between extracting information rents from the sales rep in the high demand states and the cost of reimbursing the sales rep for the burden of lobbying.

§ 6. Conclusions

We began this paper by illustrating how price delegation can help the firm harness the sales force's private information about demand. To ensure that prices increase when demand is high, the firm must pay information rents to the sales force. The focus of the paper is on exploring what internal mechanisms the firm can use to reduce these rents. The key finding is that lobbying serves this role. We model the requirement to lobby for low prices as a requirement to present evidence that demand is really low. The profitability of this mechanism depends upon how easily the sales force can acquire this evidence in different demand states. If the evidence is a lot easier to produce in the low demand state than in the high demand state, then lobbying is a more efficient mechanism.

The findings are robust to a broad range of extensions. Although these extensions may initially appear to make the lobbying mechanism more costly, many of them actually strengthen the mechanism by making it more efficient. For example, we might expect that risk aversion would make lobbying more costly as it exposes the sales force to uncertainty in the process of collecting evidence. The firm indirectly incurs this cost as it must reimburse the sales force for this uncertainty when demand is low. However, risk aversion can also make lobbying more profitable by making it less appealing when demand is high.

We also demonstrate that the key findings in the paper extend to a continuous-demand model in which the firm uses a continuous evidence threshold to distinguish between the different demand states. When setting this evidentiary threshold the firm faces the same trade-offs in the continuous model as in the main model with discrete demand states. Increasing the evidence requirement makes it less attractive to understate demand in high demand states, but the firm must reimburse the sales force for the cost of producing evidence when demand is low. In both of the models, a necessary condition for lobbying to be profitable is that the firm can identify sources of evidence that are more accessible to the sales force when demand is truly low.

Throughout the paper we assume that the sales rep knows the state of demand. The search for evidence is socially wasteful as it does not bring any new information into the system. Future research might consider markets in which the sales rep's prior information about demand is imperfect, but he can update his information by collecting demand signals. This possibility may yield interesting effects. On the one hand, the sales rep's private information is of worse quality, which reduces the firm's incentive to elicit this information through a costly evidentiary process. On the other hand, the sales rep now has a private incentive to acquire more information, which means the firm might not need to fully reimburse these costs. It would be interesting to investigate these effects in future research.

References

Anderson, Erin (1985), “The Salesperson as Outside Agent or Employee: A Transaction Cost Analysis,” *Marketing Science*, 4(3), 234-254.

Basu, Amiya K., Rajiv Lal, V. Srinivasan, and Richard Staelin (1985), “Salesforce Compensation Plans: An Agency Theoretic Perspective,” *Marketing Science*, 4(4), 267-291.

Bergmann, Rouven and Gunther Friedl (2008), “Controlling innovative Projects with Moral Hazard and Adverse Selection,” *Research Policy*, 37, 1504-1514.

Bester, Helmut and Daniel Krähmer (2008), “Delegation and Incentives,” *RAND Journal of Econmomics*, 39(3), 664-682.

Bhardwaj, Pradeep (2001), “Delegating Pricing Decisions,” *Marketing Science*, 20(2), 143-169.

Bull, Jesse L., and Joel Watson (2007), “Hard Evidence and Mechanism Design,” *Games and Economics Behavior*, 58(1), 75-93.

Coughlan, Anne, and Chakravarthi Narasimhan (1992), “An Empirical Analysis of Salesforce Compensation Plans,” *Journal of Business*, 65(1), 93-121.

Crainer, Stuart and Des Dearlove (2004), *Financial Times Handbook of Management*, Financial Times/Prentice Hall.

Deneckere, Raymond, and Sergei Severinov (2008), “Mechanism Design with Partial State Verifiability,” *Games and Economic Behavior*, 64(2), 487-513.

Dewsnap, Belinda, and David Jobber (2000), “The Sales-Marketing Interface in Consumer Packaged-Goods Companies: A Conceptual Framework,” *Journal of Personal Selling and Sales Management*, 20(2), 109-119.

Dietmeyer, Brian (2004), *Strategic Negotiation: A Breakthrough Four-Step Process for Effective Business Negotiation*, Dearborn Trade Publishing, Chicago IL.

Ernst, Holger, Wayne D. Hoyer, and Carsten Rübsaamen (2010), “Sales, Marketing, and Research-and-Development Cooperation across New Product Development Stages: Implications for Success,” *Journal of Marketing*, 74(5), 80–92.

Glazer, Jacob, and Ariel Rubinstein (2006), “A Study in the Pragmatics of Persuasion: A Game Theoretical Approach,” *Theoretical Economics*, 1, 395-410.

Godes, David (2003), “In the Eye of the Beholder: An Analysis of the Relative Value of a Top Sales Rep across Firms and Products,” *Marketing Science,* 22(2), 161-187

Homburg, Christian, and Ove Jensen (2007), “The Thought Worlds of Marketing and Sales: Which Differences Make a Difference?” *Journal of Marketing*, 71(3), 124-142.

Joseph, Kissan (2001), “On the Optimality of Delegating Pricing Authority to the Sales Force,” *Journal of Marketing*, 65(1), 62-70.

Kalra, Ajay, and Mengze Shi (2001), “Designing Optimal Sales Contests: A Theoretical Perspective,” *Marketing Science*, 20(2), 170-193.

Kalra, Ajay, Mengze Shi, and Kannan Srinivasan (2003), "Salesforce Compensation Scheme and Consumer Inferences," *Management Science*, 49(5), 655-672.

Kartik, Navin (2009), "Strategic Communication with Lying Costs," *Review of Economic Studies*, 76, 1359-1395.

Kartik, Navin, and Olivier Tercieux (2012), "Implementation with Evidence," *Theoretical Economics*, 7, 323–355.

Kotler, Philip, Neil Rackham, and Suj Krishnaswamy (2006), "Ending the War between Sales and Marketing," *Harvard Business Review reprint*, No. R0607E, HBS Publishing, Cambridge MA.

Laffont, Jean-Jacques, and David Martimort (2002), *The Theory of Incentives: The Principal-Agent Model*, Princeton University Press, Princeton NJ.

Lal, Rajiv (1986), "Delegating Pricing Responsibility to the Salesforce," *Marketing Science*, 5(2), 159-168.

Lal, Rajiv, and Richard Staelin (1986), "Salesforce Compensation Plans in Environments with Asymmetric Information," *Marketing Science*, 5(3), 179-198.

Laux, Volker (2008), "On the Value of Influence Activities for Capital Budgeting," *Journal of Economic Behavior & Organization*, 65(3-4), 625-635.

Lim, Noah (2010), "Social Loss Aversion and Optimal Contest Design," *Journal of Marketing Research*, 47(4), 777-787.

Lim, Noah, Michael J. Ahearne and Sung H. Ham (2009), "Designing Sales Contests: Does the Prize Structure Matter?" *Journal of Marketing Research*, 46(3), 356-371.

Lim, Noah, and Sung H. Ham (2012), "Relationship Organizations and Price Delegation: An Experimental Study," working paper, University of Wisconsin-Madison.

Mantrala, Murali, Sönke Albers, Fabio Caldieraro, Ove Jensen, Kissan Joseph, Manfred Krafft, Chakravarthi Narasimhan, Srinath Gopalakrishna, Andris Zoltners, Rajiv Lal, Leonard Lodish (2010), "Sales force Modeling: State of the Field and Research Agenda," *Marketing Letters*, 21(3), 255-272.

Marrs, Jason, and Dan S. Kennedy (2012), "Is Your Staff Sabotaging Your Pricing Strategy," http://www.entrepreneur.com/article/223410#ixzz2RrapbZ92, April 30, 2012.

Meyer, Margaret, Paul Milgrom, and John Roberts (1992), "Organizational Prospects, Influence Costs, and Ownership Changes," *Journal of Economics and Management Strategy*, 1(1), 9-35.

Milgrom, Paul R. (1988), "Employment Contracts, Influence Activities, and Efficient Organization Design," *Journal of Political Economy*, 96(1), 42-60.

Miller, Tory G., and Erick P. Gist (2003), *Selling in Turbulence Times*, New York: Accenture-Economist Intelligence Unit Survey.

Mirrlees, James A. (1971), "An Exploration in the Theory of Optimum Income Taxation," *Review of Economic Studies*, 38(2), 175-208.

Mishra, Birendra K., and Ashutosh Prasad (2004), "Centralized Pricing versus Delegating Pricing to the Salesforce under Information Asymmetry," *Marketing Science*, 23(1), 21-27.

Mishra, Birendra K., and Ashutosh Prasad (2005), “Delegating Pricing Decisions in Competitive Markets with Symmetric and Asymmetric Information,” *Marketing Science*, 24(3), 490-497.

Misra, Sanjog, and Harikesh Nair (2011), “A Structural Model of Sales-Force Compensation Dynamics: Estimation and Field Implementation,” *Quantitative Marketing and Economics*, 9(3), 211-257.

Montgomery, David B. and Frederick E. Webster Jr. (1997), “Marketing’s Interfunctional Interfaces: The MSI Workshop on Management of Corporate Fault Zones,” *Journal of Market- Focused Management*, 2(1), 7-26.

Raju, Jagmohan S., and V. Srinivasan (1996), “Quota-Based Compensation Plans for Multiterritory Heterogeneous Salesforces,” *Management Science*, 42(10), 1454-1462.

Rao, Ram C. (1990), “Compensating Heterogeneous Salesforces: Some Explicit Solutions,” *Marketing Science*, 9(4), 319-341.

Rogers, Beth (2011), *Rethinking Sales Management: A Strategic Guide for Practitioners*, Google eBook edition, Feb 15, 2011, John Wiley & Sons: Hoboken NJ.

Rouziès, Dominique (2004), “Observatoire de la relation marketing-commercial” [Special Report by the Center for the Study of Sales and Marketing Relationships], White paper, ADETEM, BT-Syntegra, HEC-Paris, Microsoft and Novamétrie.

Rouziès, Dominique, Erin Anderson, Ajay K. Kohli, Ronald E. Michaels, Barton A. Weitz, and Andris A. Zoltners (2005), “Sales and Marketing Integration: A Proposed Framework,” *Journal of Personal Selling & Sales Management*, XXV(2), 113–122.

Scharfstein, David S., and Jeremy C. Stein (2000), “The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment,” *Journal of Finance*, 55(6), 2537-2564.

Schweiger, David M., William R. Sandberg, and James W. Ragan (1986), “Group Approaches for Improving Strategic Decision-Making: A Comparative Analysis of Dialectical Inquiry, Devil’s Advocacy, and Consensus,” *Academy of Management Journal*, 29(1), 51-71.

Shin, Dongsoo (2008), “Information Acquisition and Optimal Project Management,” *International Journal of Industrial Organization*, 26, 1032-1043.

Simester, Duncan, and Juanjuan Zhang (2010), “Why Are Bad Products So Hard to Kill?” *Management Science*, 56(7), 1161-1179.

Sodhi, ManMohan S., and Navdeep S. Sodhi (2007), *Six Sigma Pricing: Improving Pricing Operations to Increase Profits*, FT Press: Upper Saddle River, NJ.

Weinberg, Charles B. (1975), “An Optimal Commission Plan for Salesmen’s Control over Prices,” *Management Science*, 21(April), 937-943.

Wernerfelt, Birger (1994), “On the Function of Sales Assistance,” *Marketing Science*, 13(1), 68-82.

Wulf, Julie (2009), “Influence and Inefficiency in the Internal Capital Market,” *Journal of Economic Behavior and Organization*, 72(1), 305-321.

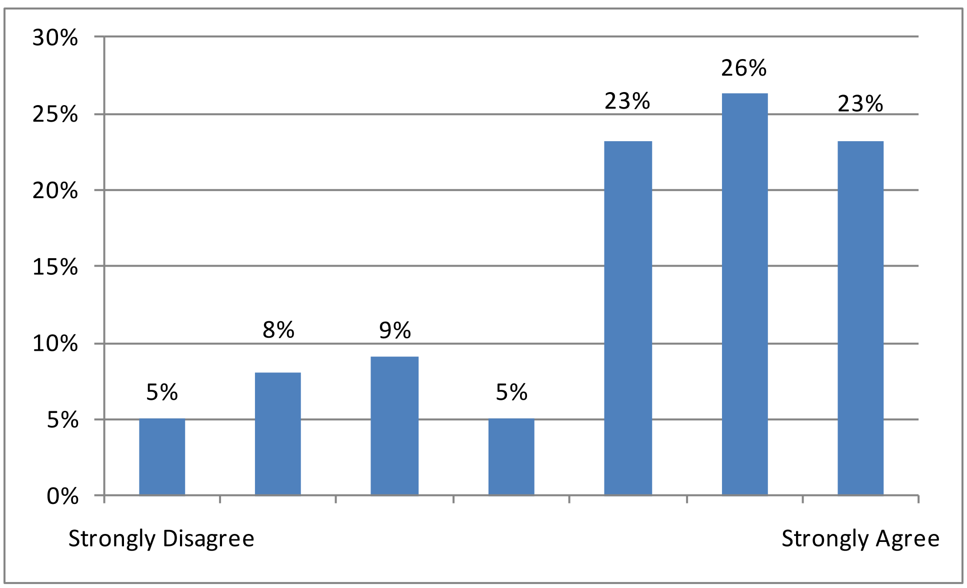
Appendix

Survey Findings

A sample of 99 managers attending "Strategic Marketing" Executive Education programs at a major university were asked whether they agreed with the following statement about their organizations:

"Managers are often concerned that sales people want to charge prices that are too low."

Responses were recorded using a 7-point Likert scale, anchored by "strongly agree" and "strongly disagree". The responses are summarized in the figure below.



Why Do Sales People Spend So Much Time Lobbying for Low Prices?

Technical Appendix

June 2013

Duncan Simester and Juanjuan Zhang

MIT Sloan School of Management

Lobbying (Main Model of Section 3)

Result 1: Suppose the lobbying mechanism requires that the sales rep provide one signal of low demand to obtain a price discount. The firm's expected profit can increase with the sales rep's cost of search c.

Proof of Result 1: First define $c^* = \frac{e_L}{g(r)}$. If $c \geq c^*$, then $\mathbb{E}\pi_{E1} = \mathbb{E}\pi^* - (1-u)c/r$, so that $\frac{d\mathbb{E}\pi_{E1}}{dc} < 0$. If $c < c^*$, then $\mathbb{E}\pi_{E1} = \mathbb{E}\pi^* - u[e_L - cg(r)] - (1-u)c/r$, so that $\frac{d\mathbb{E}\pi_{E1}}{dc} = \frac{r(1+u)-1}{r(1-r)}$, which is positive if $r > \frac{1}{1+u}$ and negative otherwise. **Q.E.D.**

Result 2: Suppose the lobbying mechanism requires that the sales rep provide one signal of low demand to obtain a price discount. If evidence is sufficiently accurate ($r > \frac{1}{1+u}$) then the firm should choose the lobbying mechanism over price delegation. If the firm has control over the sales rep's search cost, it should impose a positive search cost of $c^* = \frac{e_L}{g(r)}$.

Proof Result 2: Since $\mathbb{E}\pi_{E1}$ decreases with c over (c^*, ∞) for all values of r, the optimal c must fall within $(0, c^*]$. Given Condition (4), the firm prefers lobbying over price delegation iff

$$u\, e_L \min\left(1, \frac{c}{c^*}\right) > (1-u)\frac{c}{r}$$

Since $c \leq c^*$ in equilibrium, Condition (4) becomes

$$u\frac{e_L}{c^*} > (1-u)\frac{1}{r}$$

Rearranging terms, the above condition is equivalent to

$$r > \frac{1}{1+u}$$

However, from the proof of Result 1 we know that $\mathbb{E}\pi_{E1}$ increases with c over $(0, c^*]$ when $r > \frac{1}{1+u}$. Therefore, the optimal c equals c^*. **Q.E.D.**

Proof of Proposition 1: It is easy to show that the IC constraints are binding in equilibrium and the IR constraint holds with slack. Hence the optimal commissions are

$$w_L = e_L + cn/r$$

$$w_H = e_H + \max[0, w_L - cn/(1-r)]$$

Given these optimal commissions, the firm's optimization problem is reduced to

$$\max_{n \geq 0} \ \mathbb{E}\pi_E = \mathbb{E}\pi^* - u\max[0, e_L - g(r)cn] - (1-u)cn/r$$

Deriving n^* from $e_L = g(r)cn$, we obtain

$$n^* = \frac{e_L}{g(r)c}$$

If $n \geq n^*$, then $\mathbb{E}\pi_E = \mathbb{E}\pi^* - (1-u)cn/r$, which decreases with n. Therefore, the optimal n must fall within $[0, n^*]$. The firm's optimization problem becomes

$$\max_{n \in [0,n^*]} \ \mathbb{E}\pi_E = \mathbb{E}\pi^* - u[e_L - g(r)cn] - (1-u)cn/r$$

It follows that

$$\frac{d\mathbb{E}\pi_E}{dn} = ucg(r) - (1-u)c/r$$

which is positive iff $r > \frac{1}{1+u}$.

Therefore, the firm should set $n = n^*$ if $r > \frac{1}{1+u}$ and set $n = 0$ (i.e., using price delegation) otherwise. **Q.E.D.**

When Lobbying Constrains Selling

In this section we examine the case in which selling and lobbying are competing activities. First, we further parameterize the model setup to capture the "bounded" nature of selling effort. We assume that the sales rep can choose his level of selling effort $s \in [0, 1]$. If demand is high, the customer will pay v_H with probability s and pay v_L with probability $1 - s$. If demand is low, the customer will pay v_L with probability s and pay 0 with probability $1 - s$. The sales rep's marginal cost of selling effort is e_H if demand is high and is e_L is demand is low. It is easy to verify that this alternative specification does not change the results of the main model presented in Section 3. In particular, given Conditions (1) and (2), the firm will induce the sales rep to incur full selling effort ($s = 1$) in equilibrium.

Next we introduce lobbying effort that constrains selling. We assume that the sales rep's *total* selling and lobbying effort cannot exceed 1. Following the same argument of the main model, in equilibrium the firm will want the sales rep to lobby if and only if demand is low; it will charge a price of v_L if the sales rep lobbies, and v_H otherwise. The firm will pay the sales rep a commission of w_L if he sells at price v_L, and a commission of w_H if he sells at price v_H. The firm pays zero if the sales rep fails to sell. To approve the price v_L the firm requires that the sales rep provide n signals of low demand. Below we derive the optimal commissions w_L and w_H and the optimal evidentiary threshold n.

When demand is low, the sales rep earns a surplus of zero if he does not lobby. He earns a surplus of $(w_L - e_L)s - cn/r$ if he lobbies and exerts selling effort s, which cannot exceed $1 - cn/r$. For this sales rep to be willing to exert selling effort, the firm must ensure that $w_L \geq e_L$. The sales rep will in turn put in the maximum available selling effort of $s = 1 - cn/r$, and will earn a surplus of $(w_L - e_L)(1 - cn/r) - cn/r$. Therefore, to induce the sales rep in the low demand state to lobby and exert selling effort, the firm needs to offer a commission equal to

$$w_L = e_L + cn/(r - cn)$$

When demand is high, by lobbying, the sales rep can sell without effort and thus earns a surplus of $w_L - cn/(1-r)$. By not lobbying, the sales rep earns a surplus of $(w_H - e_H)s$ if he exerts selling effort s. To induce selling effort, the firm must offer $w_H \geq e_H$. The sales rep's highest-possible surplus from not lobbying is thus $w_H - e_H$, whereby he maximizes his selling effort as $s = 1$. Therefore, to induce the sales rep to work and not to lobby when demand is high, the firm must offer

$$w_H = e_H + \max[0, e_L + cn/(r - cn) - cn/(1-r)]$$

By enforcing a lobbying process when lobbying constrains selling (denoted as "C"), the firm earns an expected profit of

$$\mathbb{E}\pi_C = u(v_H - e_H - \max[0, e_L + cn/(r - cn) - cn/(1-r)])$$
$$+(1-u)[(1 - cn/r)(v_L - e_L) - cn/r]$$

Let n_C^* denote the value of n that solves $0 = e_L + cn/(r - cn) - cn/(1-r)$. That is, by requiring n_C^* low signals before cutting prices, the firm is just able to reduce the high-demand sales rep's information rent to zero.

If $n \geq n_C^*$, then

$$\mathbb{E}\pi_C = u(v_H - e_H) + (1-u)[(1 - cn/r)(v_L - e_L) - cn/r]$$

where $\mathbb{E}\pi_C$ decreases with n. Therefore, the optimal n must fall within $[0, n_C^*]$. It follows that $w_H = e_H + e_L + cn/(r - cn) - cn/(1-r)$. The firm's expected profit becomes

$$\mathbb{E}\pi_C = u(v_H - e_H - e_L - cn/(r - cn) + cn/(1-r)])$$
$$+(1-u)[(1 - cn/r)(v_L - e_L) - cn/r]$$

It can be shown that $d^2\mathbb{E}\pi_C/dn^2 < 0$, so that $\mathbb{E}\pi_C$ is concave in n over $[0, n_C^*]$.

Next, we compare n_C^* with n^*, where n^* is the optimal number of low demand signals required when lobbying does not constrain selling. From the proof of Proposition 1, we know that n^* solves $0 = e_L + cn/r - cn/(1-r)$. The right-hand side of the equation decreases with n and is negative when $n = n_C^*$. Therefore, $n^* < n_C^*$.

Finally, it can be shown that there exist parameter values that satisfy the following conditions. First, $d\mathbb{E}\pi_C/dn > 0$ when $n = n^*$. Second, lobbying costs are such that $cn^*/r < 1$ and $cn^*/(1-r) < 1$, which satisfies the normalization assumption that the sum of selling and lobbying cost cannot exceed 1. Third, $\mathbb{E}\pi_C^* > \mathbb{E}\pi_P^*$ such that the firm prefers lobbying over price delegation, where $\mathbb{E}\pi_C^*$ equals $\mathbb{E}\pi_C$ evaluated at $n = n_C^*$. Figure 1 in the paper presents one such example.

When the Sales Rep is Risk Averse

To capture risk aversion, let $U(x)$ denote the utility that the sales rep derives from his net payoff x, which equals the commission he earns net of any cost of selling and cost of lobbying. The utility function $U(x)$ exhibits the usual properties of risk aversion: $U'' < 0$, $U' > 0$, and $U(0) = 0$. The firm is risk neutral, following the convention in the literature (e.g., Lal 1986). We continue to assume that the firm intends to tailor prices to demand (as opposed to mandating a high price). The firm's optimization problem ("R" for risk aversion) is as follows.

$$\max_{w_H, w_L, n} \ \mathbb{E}\pi_R = u(v_H - w_H) + (1-u)(v_L - w_L)$$

s.t.

$$U(w_H - e_H) \geq \max\left[0, \mathbb{E}_{z_H} U\big(w_L - c(n + z_H)\big)\right] \qquad (\text{IC}_\text{H})$$

$$\mathbb{E}_{z_L} U\big(w_L - e_L - c(n + z_L)\big) \geq 0 \qquad (\text{IC}_\text{L})$$

$$uU(w_H - e_H) + (1-u)\mathbb{E}_{z_L} U\big(w_L - e_L - c(n + z_L)\big) \geq 0 \qquad (\text{IR})$$

$$w_H, w_L \geq 0 \qquad (\text{Limited Liability})$$

$$n \geq 0$$

The constraints of the optimization problem are interpreted as follows. The IC_H constraint ensures that the sales rep will exert selling effort and will not lobby when demand is high. In doing so, the sales rep earns a utility of $U(w_H - e_H)$. Alternatively, if the sales rep shirks selling effort and does not lobby, he will earn a utility of $U(0) = 0$. If the sales rep lobbies, he can sell without selling effort but will have to provide n signals of low demand. We use z_H to denote the number of unsuccessful draws needed before the sales rep is able to collect n signals of low demand when demand is actually high. z_H follows the negative binomial distribution with parameters $(n, 1-r)$. The sales rep's total search cost is $c(n + z_H)$. His expected deviation utility, computed over the distribution of z_H, is $\mathbb{E}_{z_H} U\big(w_L - c(n + z_H)\big)$.

Similarly, the IC_L constraint ensures that the sales rep will exert selling effort and will lobby when demand is low. In doing so, the sales rep earns an expected utility of $\mathbb{E}_{z_L} U\big(w_L - e_L -$ $cn+zL$. Here zL denotes the number of unsuccessful draws needed before the sales rep is able to collect n signals of low demand when demand is indeed low. z_L follows the negative binomial distribution with parameters (n, r). Alternatively, if the sales rep deviates by either shirking selling effort or not lobbying, he will earn a utility of at most 0.

The IR constraint ensures that the sales rep is willing to accept the firm's contract offer. His ex ante expected utility, before knowing the realized demand state, must be greater than or equal to his outside option 0. Note that the sales rep's ex post participation constraint is trivially satisfied because he is guaranteed a minimum wage of zero.

Finally, note that the above incentive structure subsumes both price delegation and lobbying. The firm chooses $n \geq 0$, the number of low demand signals to require before approving the low price, to maximize its expected profit $\mathbb{E}\pi_R$. If the optimal n equals 0, the optimal contract is price delegation. If the optimal n is positive, the optimal contract is lobbying.

The set of constraints can be simplified. First, note that the IR and Limited Liability constraints are both redundant given IC_H and IC_L. Second, IC_H and IC_L must bind in equilibrium, otherwise the firm can decrease w_H or w_L, respectively, by a small amount and increase expected profit without violating any constraint.

How does risk aversion affect the optimal contract? Before solving the optimization problem, we comment on a number of interesting observations. First, from the binding IC_L constraint and Jensen's inequality we have

$$\mathbb{E}_{z_L}U\big(w_L - e_L - c(n + z_L)\big) = 0 < U\big(\mathbb{E}_{z_L}[w_L - e_L - c(n + z_L)]\big)$$

whereas $\mathbb{E}_{z_L}[w_L - e_L - c(n + z_L)] = w_L - e_L - cn/r$. It follows that, with risk aversion, the optimal commission w_L more than covers the sales rep's selling effort and expected lobbying cost in the low demand state:

$$w_L > e_L + cn/r$$

However, with risk aversion, a lower evidentiary requirement also suffices to extract the sales rep's information rent (w_L) in the high demand state. To see this, we again apply Jensen's inequality and obtain

$$\mathbb{E}_{z_H}U\big(w_L - c(n + z_H)\big) < U\big(\mathbb{E}_{z_H}[w_L - c(n + z_H)]\big)$$

where $\mathbb{E}_{z_H}[w_L - c(n + z_H)] = w_L - cn/(1 - r)$. Let n_R^* denote the value of n that solves $\mathbb{E}_{z_H}U\big(w_L - c(n + z_H)\big) = 0$. We have

$$cn_R^*/(1 - r) < w_L$$

In summary, the sales rep needs extra incentive to be willing to lobby in both demand states because of risk aversion. The net effect on the efficacy of lobbying is ambiguous. For concreteness, below we impose further functional form assumptions on the sales rep's utility.

We assume that the sales rep has exponential utility:

(R1) $\quad U(x) = 1 - e^{-\alpha x}$

where $\alpha > 0$ is the coefficient of absolute risk aversion. A larger α means that the sales rep is more risk averse.

We want to derive the optimal contract in closed form. To do so, first we express the optimal commission w_L as a function of n. Let $CE[w_L - e_L - c(n + z_L)]$ denote the certainty equivalent of the net payoff $w_L - e_L - c(n + z_L)$ through the exponential utility function, such that

$$\mathbb{E}_{z_L}U\big(w_L - e_L - c(n + z_L)\big) = U(CE[w_L - e_L - c(n + z_L)])$$

It follows from Equation (R1) that

$$\mathbb{E}_{z_L}U\big(w_L - e_L - c(n + z_L)\big) = \mathbb{E}_{z_L}\big\{1 - e^{-\alpha[w_L - e_L - c(n+z_L)]}\big\}$$

$$= 1 - e^{-\alpha(w_L - e_L - cn)}\mathbb{E}_{z_L}e^{\alpha c z_L}$$

Since z_L follows the negative binomial distribution with parameters (n, r), we have

$$\mathbb{E}_{z_L} e^{\alpha c z_L} = \sum_{z_L=0}^{\infty} \binom{z_L + n - 1}{z_L} (1-r)^{z_L} r^n e^{\alpha c z_L}$$

$$= \sum_{z_L=0}^{\infty} \binom{z_L + n - 1}{z_L} [(1-r)e^{\alpha c}]^{z_L} r^n$$

$$= \frac{r^n}{[1-(1-r)e^{\alpha c}]^n} \sum_{z_L=0}^{\infty} \binom{z_L + n - 1}{z_L} [(1-r)e^{\alpha c}]^{z_L} [1-(1-r)e^{\alpha c}]^n$$

But $\binom{z_L + n - 1}{z_L} [(1-r)e^{\alpha c}]^{z_L} [1-(1-r)e^{\alpha c}]^n$ is the p.m.f. of the negative binomial distribution with parameters $(n, 1-(1-r)e^{\alpha c})$.[1] Therefore

$$\mathbb{E}_{z_L} e^{\alpha c z_L} = \frac{r^n}{[1-(1-r)e^{\alpha c}]^n}$$

Substituting terms yields

$$\mathbb{E}_{z_L} U\big(w_L - e_L - c(n + z_L)\big) = 1 - e^{-\alpha(w_L - e_L - cn)} \frac{r^n}{[1-(1-r)e^{\alpha c}]^n}$$

$$= 1 - e^{-\alpha\left[w_L - e_L - cn - \frac{n}{\alpha}\ln\frac{r}{1-(1-r)e^{\alpha c}}\right]}$$

Therefore, by definition of the certainty equivalent, we have

$$CE[w_L - e_L - c(n + z_L)] = w_L - e_L - cn - \frac{n}{\alpha}\ln\frac{r}{1-(1-r)e^{\alpha c}}$$

In addition, the fact that IC_L is binding means that $CE[w_L - e_L - c(n + z_L)] = 0$. Combining terms yields

(R2) $\quad w_L = e_L + cn\, m(\alpha, r)$

where $m(\alpha, r) = 1 + \frac{1}{\alpha c}\ln\frac{r}{1-(1-r)e^{\alpha c}}$.

It is easy to verify that the "multiplier" term $m(\alpha, r) > 0$. Therefore, $\frac{\partial w_L}{\partial n} > 0$. The firm must promise a higher commission for the low demand state to compensate the sales rep for meeting a higher evidentiary requirement.

Next we want to rewrite the optimal commission w_H as a function of n. Following the same strategy of the above analysis, we obtain

$$CE[w_L - c(n + z_H)] = w_L - cn\left(1 + \frac{1}{\alpha c}\ln\frac{1-r}{1-re^{\alpha c}}\right)$$

The binding IC_H constraint thus becomes

$$U(w_H - e_H) = \max\left[0, U\left(w_L - cn\left(1 + \frac{1}{\alpha c}\ln\frac{1-r}{1-re^{\alpha c}}\right)\right)\right]$$

---

[1] We assume that $(1-r)e^{\alpha c} < 1$. Subsequently, we also assume $re^{\alpha c} < 1$ in order to evoke the same derivation strategy. We maintain both assumptions for the rest of this section because the purpose of the analysis is to prove existence.

Let n_R^* denote the value of n that solves $w_L - cn\left(1 + \frac{1}{\alpha c}\ln\frac{1-r}{1-re^{\alpha c}}\right) = 0$. Rearranging terms we obtain

$$w_L - cn\left(1 + \frac{1}{\alpha c}\ln\frac{1-r}{1-re^{\alpha c}}\right) = e_L + cn\left(1 + \frac{1}{\alpha c}\ln\frac{r}{1-(1-r)e^{\alpha c}}\right) - cn\left(1 + \frac{1}{\alpha c}\ln\frac{1-r}{1-re^{\alpha c}}\right)$$
$$= e_L - n\frac{1}{\alpha}\ln\frac{(1-r)[1-(1-r)e^{\alpha c}]}{r(1-re^{\alpha c})}$$

We define the following notation

(R3) $$h(\alpha, r) = \frac{1}{\alpha c}\ln\frac{(1-r)[1-(1-r)e^{\alpha c}]}{r(1-re^{\alpha c})}$$

The $h(\alpha, r)$ term is the counterpart of $g(r)$ of the main model – both terms measure the relative disutility of collecting a low demand signal when demand is high as opposed to low. Because $r \in (1/2, 1)$ and $\alpha > 0$, it can be verified that $h(\alpha, r) > 0$. In other words, gathering a low demand signal generates greater disutility when demand is high than when demand is low. Therefore, a higher evidentiary threshold improves the screening power of the lobbying mechanism. The firm will be able to extract the sales rep's entire rent in the high demand state when the evidentiary threshold reaches

(R4) $$n_R^* = \frac{e_L}{h(\alpha,r)c}$$

In equilibrium, n must be less than or equal to n_R^*, otherwise the firm can always decrease n by a small amount, decrease w_L, and improve expected profit. It follows that

$$U(w_H - e_H) = U\left(w_L - cn\left(1 + \frac{1}{\alpha c}\ln\frac{1-r}{1-re^{\alpha c}}\right)\right)$$

which in turn implies that

(R5) $$w_H = e_H + w_L - cn\left(1 + \frac{1}{\alpha c}\ln\frac{1-r}{1-re^{\alpha c}}\right) = e_H + e_L - nc\, h(\alpha, r)$$

So far we have rewritten optimal commissions as functions of n. It remains to maximize the firm's expected profit with respect to n. To use the first-order condition, note that

$$\frac{d\mathbb{E}\pi_R}{dn} = -u\frac{dw_H}{dn} - (1-u)\frac{dw_L}{dn} = c[u\, h(\alpha, r) - (1-u)\, m(\alpha, r)]$$

For any given value of α, there exist parameter values for $\frac{d\mathbb{E}\pi_R}{dn}$ to be positive. For example, when u is sufficiently high, $\frac{d\mathbb{E}\pi_R}{dn} > 0$ because $h(\alpha, r) > 0$. Therefore, for any degree of risk aversion, there exist parameter values under which the firm prefers the lobbying mechanism over price delegation.

Finally, having derived the optimal contract in closed form, it is straightforward to verify that $\frac{\partial m(\alpha,r)}{\partial \alpha} > 0$, $\frac{\partial h(\alpha,r)}{\partial \alpha} > 0$, $\frac{\partial n_R^*}{\partial \alpha} < 0$, and $\frac{\partial \mathbb{E}\pi_R^*}{\partial \alpha} > 0$, where $\mathbb{E}\pi_R^*$ is the firm's expected profit when setting its evidentiary requirement to n_R^*.

When the Firm Can Acquire Evidence on Its Own

Deriving the Optimal Verification Mechanism

The firm's optimization problem is

$$\max_{n,k} \mathbb{E}\pi_V = \mathbb{E}\pi^* - u\phi_H(n,k)e_L - (1-u)[1-\phi_L(n,k)](v_L - e_L) - (1-u)ck$$

$$\text{s.t.} \quad n \geq 0, n \leq k$$

$$k \geq 0$$

Taking partial derivatives with respect to n yields[2]

$$\frac{\partial \mathbb{E}\pi_V}{\partial n} = -ue_L \frac{\partial \phi_H(n,k)}{\partial n} + (1-u)(v_L - e_L)\frac{\partial \phi_L(n,k)}{\partial n}$$

where

$$\frac{\partial \phi_H(n,k)}{\partial n} = -\binom{k}{n} r^{k-n}(1-r)^n$$

$$\frac{\partial \phi_L(n,k)}{\partial n} = -\binom{k}{n} r^{n}(1-r)^{k-n}$$

Note that $\frac{\partial \phi_H(n,k)}{\partial n} < 0$ and $\frac{\partial \phi_L(n,k)}{\partial n} < 0$. That is, increasing the number of low demand signals required makes it harder to pass verification in both demand states. It follows that

$$\frac{\partial \mathbb{E}\pi_V}{\partial n} > 0 \text{ if and only if } \frac{(1-u)(v_L - e_L)}{ue_L} < \frac{\frac{\partial \phi_H(n,k)}{\partial n}}{\frac{\partial \phi_L(n,k)}{\partial n}}$$

Collecting terms yields the following condition: $\frac{\partial \mathbb{E}\pi_V}{\partial n} > 0$ if and only if

(V1) $\quad \frac{(1-u)(v_L - e_L)}{ue_L} < \left(\frac{r}{1-r}\right)^{k-2n}$

Let $n_V^*(k)$ denote the value of n that solves $\frac{\partial \mathbb{E}\pi_V}{\partial n} = 0$ for a given value of k. We have

(V2) $\quad n_V^*(k) = \frac{k}{2} - \frac{\ln\frac{(1-u)(v_L - e_L)}{ue_L}}{2\ln\left(\frac{r}{1-r}\right)}$

Recall that $\frac{(1-u)(v_L - e_L)}{ue_L} > 1$ by Condition (3), hence

(V3) $\quad n_V^*(k) < \frac{k}{2}$

In addition, rearranging (V1) yields that $\frac{\partial \mathbb{E}\pi_V}{\partial n} > 0$ if and only if $n < n_V^*(k)$. Therefore, for a given value of k the firm's optimal choice of n over the interval $[0, k]$ is $n^*(k)$ if $n_V^*(k) > 0$ and is 0 otherwise. If the optimal choice of n is 0, the firm will set $k = 0$ and essentially implement

---

[2] For the clarity of presentation, we ignore the discrete nature of n when using the first-order-condition approach. The solution for the discrete case can be derived following the same logic.

price delegation. Hence it remains to derive the optimal choice of k for the case of $n_V^*(k) > 0$. The firm's optimization problem becomes

$$\underset{k}{\text{Max}}\ \mathbb{E}\pi_V = \mathbb{E}\pi^* - u\phi_H(n_V^*(k), k)e_L - (1-u)[1-\phi_L(n_V^*(k), k)](v_L - e_L) \\ -(1-u)ck$$

$$\text{s.t.} \qquad k \geq 0$$

In other words, Equation (V2) reduces the firm's optimal design of the verification mechanism to a univariate optimization problem. Although closed-form solutions are not available, this problem can be solved numerically for any parameter values.

The Optimal Value of k is More Than Twice as Large as n

Inequality (V3) suggests that the optimal value of k is more than twice as large as n. The reason is as follows. Holding k constant, increasing n makes it harder to pass verification in both demand states. Specifically, $\phi_H(n,k)$ and $\phi_L(n,k)$ decline at a relative rate of $r^{k-n}(1-r)^n$ to $r^n(1-r)^{k-n}$. When n exceeds $k/2$, $\phi_L(n,k)$ declines faster than $\phi_H(n,k)$. Intuitively, finding half of the signals to be low is an unlikely event in the high demand state anyway, hence the marginal effect of an even more stringent evidentiary threshold is relatively small. Meanwhile, Condition (3) implies that the reduced information rent associated with a lower $\phi_H(n,k)$ is not worth the lost business from the low-demand customer associated with a lower $\phi_L(n,k)$. Therefore, the firm will want to keep n below $k/2$. Equivalently, for any evidentiary threshold n the firm will want to search redundantly on purpose ($k > 2n$).

Proof of Proposition 3

Suppose the optimal verification mechanism is given by $k^* > 0$ and $n_V^*(k^*) > 0$. The firm's expected profit under this optimal verification mechanism is

$$\mathbb{E}\pi_V^* = \mathbb{E}\pi^* - u\phi_H(n_V^*(k^*), k^*)e_L - (1-u)[1-\phi_L(n_V^*(k^*), k^*)](v_L - e_L) \\ -(1-u)ck^*$$

Note that $\phi_H(n_V^*(k^*), k^*) > 0$ and $\phi_L(n_V^*(k^*), k^*) < 1$ for any $k^* > 0$, $n_V^*(k^*) > 0$ and any $r \in (1/2, 1)$. Therefore, we obtain

$$\mathbb{E}\pi_V^* < E\pi^* - (1-u)ck^*$$

This above result, together with Inequality (V3), implies that

$$\text{(V4)} \qquad \mathbb{E}\pi_V^* < E\pi^* - (1-u)c2n_V^*(k^*)$$

Now consider the lobbying mechanism L', in which the sales rep must collect $n_V^*(k^*)$ signals of low demand to obtain a price discount. The firm's expected profit under this lobbying mechanism is

$$\mathbb{E}\pi_{L'} = \mathbb{E}\pi^* - u\max[0, e_L - g(r)cn_V^*(k^*)] - (1-u)cn_V^*(k^*)/r$$

For any $n_V^*(k^*) > 0$, there exists an $\hat{r} \in (1/2, 1)$ such that $e_L = g(\hat{r})cn_V^*(k^*)$. Since $g(r)$ increases with r, for any $r > \hat{r}$ we have

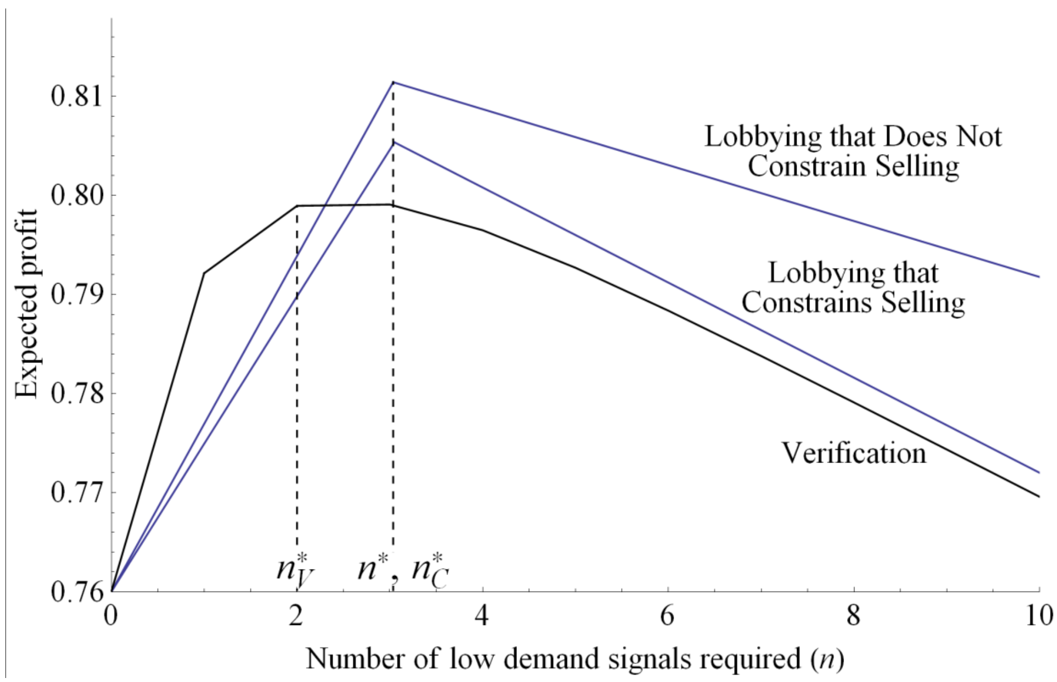
$$\mathbb{E}\pi_{L'} = \mathbb{E}\pi^* - (1-u)cn_V^*(k^*)/r$$

But the fact that $r > 1/2$ in turn implies that

(V5) $$\mathbb{E}\pi_{L'} > E\pi^* - (1-u)c2n_V^*(k^*)$$

Combining (V4) and (V5) we obtain that $\mathbb{E}\pi_{L'} > E\pi_V^*$ for any $r > \hat{r}$. However, $\mathbb{E}\pi_{L'}$ is by definition weakly lower than the firm's expected profit under the optimal lobbying mechanism ($\mathbb{E}\pi_E^*$). Therefore, for any $r > \hat{r}$ we have $\mathbb{E}\pi_E^* > E\pi_V^*$. **Q.E.D.**

Figure V1: Lobbying Is More Profitable than Verification If Demand Signals Are Accurate



Notes: This figure sets $v_H = 1$, $v_L = 0.8$, $e_H = e_L = 0.1$, $c = 0.006$, $u = 0.6$, and $r = 0.85$. n_V^* denotes the optimal number of low demand signals required before the firm approves the price discount under verification.

Verification Dominates Blanket Search

In this section we prove that verification generates higher expected profit than blanket search, where the firm acquires evidence of demand on its own without conditioning its search decision on the sales rep's claims of demand.

Acquiring evidence on its own allows the firm to update its posterior belief about demand. Recall from Section 2 that the firm has two options based on its posterior belief: it will simply abandon the low-demand customer if it believes that demand is sufficiently likely to be high, and will implement price delegation otherwise.

The firm's posterior belief about demand is determined by the number of high versus low demand signals (the sequence by which these signals arrive does not matter). Therefore, a blanket search strategy can be defined as follows without loss of generality: the firm will draw k demand signals, and will implement price delegation if there is sufficient evidence of low demand and will abandon the low-demand customer otherwise, where sufficient evidence of low demand is defined as "finding at least n signals of low demand within k draws." We will show that this blanket search strategy is strictly dominated by the verification mechanism that is based on the same values of n and k.

First note that the firm's ex ante probability of finding sufficient evidence of low demand in a blanket search is

$$\bar{\phi}(n,k) = u\phi_H(n,k) + (1-u)\phi_L(n,k)$$

Conditioning on finding sufficient evidence of low demand, the firm's posterior belief about demand is given by Bayes' rule as follows

$$u_1 = \frac{u\phi_H(n,k)}{\bar{\phi}(n,k)}$$

Similarly, conditioning on not finding sufficient evidence of low demand, the firm's posterior belief about demand is

$$u_2 = \frac{u[1-\phi_H(n,k)]}{1-\bar{\phi}(n,k)}$$

Therefore, blanket search (denoted as "B") generates an expected profit of

$$\begin{aligned}
\mathbb{E}\pi_B &= \bar{\phi}(n,k)[u_1(v_H - e_H - e_L) + (1-u_1)(v_L - e_L)] + [1-\bar{\phi}(n,k)]u_2(v_H - e_H) - ck \\
&= u\phi_H(n,k)(v_H - e_H - e_L) + (1-u)\phi_L(n,k)(v_L - e_L) \\
&\qquad + u[1-\phi_H(n,k)](v_H - e_H) - ck \\
&= u(v_H - e_H) - u\phi_H(n,k)e_L + (1-u)\phi_L(n,k)(v_L - e_L) - ck \\
&= \mathbb{E}\pi_V - uck \\
&< \mathbb{E}\pi_V
\end{aligned}$$

The verification mechanism based on n and k, by definition, is weakly dominated by the optimal verification mechanism. This is true for any blanket search mechanism (any n and k). Therefore, verification strictly dominates blanket search. **Q.E.D.**

When the Firm Can Punish the Sales Rep

When the firm wants to elicit truthful reporting of demand (through price delegation or lobbying), it pays the sales rep an information rent. Ex post, the sales rep enjoys a positive surplus when demand is high and zero surplus when demand is low. Ex ante, the sales rep earns a positive surplus. If negative wages are allowed, the firm will be able to improve profit by reducing the sales rep's ex ante surplus. The idea is to make the sales rep earn a negative surplus when demand is low, which helps to reduce his information rent when demand is high. The firm solves the following optimization problem.

$$\max_{w_H, w_L, w_F, n} \ \mathbb{E}\pi_F = u\,(v_H - w_H) + (1-u)(v_L - w_L)$$

s.t.

$$w_L - e_L - cn/r \geq w_F \qquad (\text{IC}_L)$$

$$w_H - e_H \geq \max[w_F, w_L - cn/(1-r)] \qquad (\text{IC}_H)$$

$$u(w_H - e_H) + (1-u)(w_L - e_L - cn/r) \geq 0 \qquad (\text{IR})$$

$$w_H, w_L, w_F \geq -F \qquad (\text{Limited Liability})$$

$$n \geq 0$$

This optimization problem is interpreted as follows. The firm should offer to pay the sales rep w_H if he sells at the high price v_H, w_L if he sells at the low price v_L, and w_F if he fails to sell. The firm could further condition the value of w_F on the price being charged. However, since the sales rep can always charge either price and shirk, it is the higher w_F that regulates his work incentives, which reduces w_F to a single instrument. All these commissions should be greater than or equal to $-F$ to satisfy the limited liability constraint.[3]

Note that the above incentive structure subsumes both price delegation and lobbying. The firm chooses $n \geq 0$, the number of low demand signals to require before approving the low price, to maximize its expected profit $\mathbb{E}\pi_F$. If the optimal n equals 0, the optimal contract is price delegation. If the optimal n is positive, the optimal contract is lobbying.

Following the same reasoning as in the main model, the firm will always induce selling effort and will induce the sales rep to ask for a low price only when demand is low. The sales rep's ex ante expected surplus, anticipating this outcome, must be greater than or equal to 0.

Suppose demand is low. By lobbying the sales rep earns an expected surplus of $w_L - e_L - cn/r$ with selling effort and $w_F - cn/r$ otherwise. Without lobbying, sale is impossible and the sales rep will shirk selling effort to earn w_F. Therefore, the sales rep's best deviation payoff is w_F.

Now suppose demand is high. By accepting a high price, the sales rep earns an expected surplus of $w_H - e_H$ with selling effort and w_F otherwise. By lobbying, the sales rep earns an

[3] If $F \geq \mathbb{E}\pi^*$, the firm can sell its entire business to the sales rep at the price of $\mathbb{E}\pi^*$. The firm earns the first-best expected profit $\mathbb{E}\pi^*$, and the sales rep earns a surplus of zero. We will show that the firm can restore the first-best expected profit under the milder condition of $F \geq ue_L$, where $ue_L < E\pi^*$ by Condition (3).

expected surplus of $w_L - cn/(1-r)$ without selling effort. Therefore, the sales rep's best deviation payoff is $\max[w_F, w_L - cn/(1-r)]$.

We solve the optimization problem below. IC_L implies that $w_L \geq w_F$ and IC_H implies that $w_H \geq w_F$. Therefore, the limited liability constraint is reduced to

$$w_F \geq -F \qquad \text{(Limited Liability)}$$

There are two possible cases, depending on whether the limited liability constraint is binding.

Case 1: First suppose the limited liability constraint holds with slack. It follows that the IR constraint must be binding. Otherwise, the firm can reduce w_H, w_L, and w_F by the same small amount and improve expected profit without violating any constraint. This firm's optimization problem thus becomes

$$\max_{w_H, w_L, w_F, n} \ \mathbb{E}\pi_F = \mathbb{E}\pi^* - (1-u)cn/r$$

s.t.

$$w_L - e_L - cn/r \geq w_F \qquad (IC_L)$$

$$w_H - e_H \geq \max[w_F, w_L - cn/(1-r)] \qquad (IC_H)$$

$$u(w_H - e_H) + (1-u)(w_L - e_L - cn/r) = 0 \qquad (IR)$$

$$n \geq 0$$

The firm should set $n = 0$ and make sure the commissions satisfy the remaining constraints:

$$w_L - e_L \geq w_F \qquad (IC_L)$$

$$w_H - e_H \geq \max(w_F, w_L) \qquad (IC_H)$$

$$u(w_H - e_H) + (1-u)(w_L - e_L) = 0 \qquad (IR)$$

where $\max(w_F, w_L) = w_L$ by IC_L. From IR we obtain $w_H - e_H = -(1-u)(w_L - e_L)/u$. IC_H hence becomes $w_L \leq (1-u)e_L$. IC_L and IC_H are thus jointly rewritten as

$$e_L + w_F \leq w_L \leq (1-u)e_L$$

For the above inequalities to hold we need $w_F \leq -ue_L$. This result establishes the following cutoff value

$$\hat{F} = ue_L$$

For the limited liability constraint to hold with slack we need $F > \hat{F}$. The firm should use price delegation ($n = 0$) and choose commissions such that $w_F \in (-F, -\hat{F}]$, $w_L \in [e_L + w_F, (1-u)e_L]$ and $w_H = e_H - (1-u)(w_L - e_L)/u$. The firm reduces the sales rep's ex ante surplus to zero, and restores the first-best expected profit:

$$\mathbb{E}\pi_F^* = \mathbb{E}\pi^*$$

Case 2: It remains to analyze the case of $F \leq \hat{F}$, in which the limited liability constraint is binding: $w_F = -F$. The firm's optimization problem becomes

$$\max_{w_H, w_L, n} \ \mathbb{E}\pi_F = u(v_H - w_H) + (1-u)(v_L - w_L)$$

s.t.

$$w_L - e_L - cn/r \geq -F \qquad (IC_L)$$

$$w_H - e_H \geq \max[-F, w_L - cn/(1-r)] \qquad (\text{IC}_\text{H})$$

$$u(w_H - e_H) + (1-u)(w_L - e_L - cn/r) \geq 0 \qquad (\text{IR})$$

$$n \geq 0$$

Adding the slack variables $x_1, x_2 \geq 0$, we rewrite the IC constraints as

$$w_L - e_L - cn/r = -F + x_1 \qquad (\text{IC}_\text{L})$$

$$w_H - e_H = \max[-F, w_L - cn/(1-r)] + x_2$$

$$= -F + \max[0, e_L - g(r)cn + x_1] + x_2 \qquad (\text{IC}_\text{H})$$

The firm's optimization problem becomes

$$\max_{x_1, x_2, n} \ \mathbb{E}\pi_F = \mathbb{E}\pi^* - u\,(w_H - e_H) - (1-u)(w_L - e_L)$$

$$= \mathbb{E}\pi^* + F - u\{\max[0, e_L - g(r)cn + x_1] + x_2\} - (1-u)(cn/r + x_1)$$

s.t. $-F + u\{\max[0, e_L - g(r)cn + x_1] + x_2\} + (1-u)x_1 \geq 0$ (IR)

$$n \geq 0$$

$$x_1, x_2 \geq 0$$

Note that $e_L - g(r)cn + x_1$ must be nonnegative in equilibrium, otherwise the firm can profitably deviate by reducing n slightly. The firm's optimization problem thus becomes

$$\max_{x_1, x_2, n} \ \mathbb{E}\pi_F = \mathbb{E}\pi^* + F - x_1 - u[e_L - g(r)cn + x_2] - (1-u)cn/r$$

s.t. $-F + x_1 + u[e_L - g(r)cn + x_2] \geq 0$ (IR)

$$n \in [0,\ (e_L + x_1)/(g(r)c)]$$

$$x_1, x_2 \geq 0$$

Rearranging terms yields $\text{sign}(d\mathbb{E}\pi_F/dn) = \text{sign}(r - 1/(1+u))$. There are two sub-cases.

- $r < 1/(1+u)$: The firm should again use price delegation ($n = 0$). Meanwhile, the firm should set $x_1 = x_2 = 0$, which means $w_L = e_L - F$ and $w_H = e_H + e_L - F$. The IR constraint holds because $F \leq \hat{F}$. The firm earns an expected profit of

$$\mathbb{E}\pi_F^* = \mathbb{E}\pi^* + F - \hat{F}$$

- $r > 1/(1+u)$: Ignore the constraint $n \in [0,\ (e_L + x_1)/(g(r)c)]$ for now. The firm should increase n until IR is binding: $n = [e_L + x_2 - (F - x_1)/u]/[g(r)c]$. But then since $\mathbb{E}\pi_F = \mathbb{E}\pi^* - (1-u)cn/r$ the firm will set $x_1 = x_2 = 0$. It follows that $n = n_F^*$ where

$$n_F^* = n^* - F/[ug(r)c]$$

Note that $n_F^* \in [0,\ (e_L + x_1)/(g(r)c)]$. Hence n_F^* is indeed the optimal solution to n when $F \leq \hat{F}$ and $r > 1/(1+u)$. The optimal commissions are $w_L = e_L + cn_F^*/r - F$ and $w_H = e_H + F(1-u)/u$. The firm earns an expected profit of

$$\mathbb{E}\pi_F^* = \mathbb{E}\pi^* - (1-u)cn_F^*/r$$

When $F = \hat{F}$, we have $n_F^* = 0$ and $\mathbb{E}\pi_F^* = \mathbb{E}\pi^*$.
For any $F \in (0, \hat{F})$, we have $n_F^* \in (0, n^*)$, and $\mathbb{E}\pi_F^* \in (\mathbb{E}\pi_E^*, \mathbb{E}\pi^*)$.

Would the Firm Respond to Lobbying Randomly?

Assume that the firm can commit to responding to lobbying with probability $\theta \in (0, 1)$. The firm offers a commission w_H if the sales rep sells without lobbying, and offers w_L if the sales rep lobbies and sells at the discounted price. In addition, the firm now has a new contractual instrument – if the sales rep lobbies but fails to obtain a price discount, the firm will offer a commission $\widetilde{w}_H$ upon sale, which may differ from the commission w_H. To lobby, the sales rep must provide n signals of low demand. Below we first derive the firm's optimal choices of the commissions and the evidentiary threshold, and then compare the expected profit of the resulting lobbying mechanism from that of the main model of Section 3.

As in the main model, it is easy to show the firm will want to induce lobbying if and only if demand is low, and will always want to induce selling effort. If demand is low, the sales rep earns an expected surplus of $\theta(w_L - e_L) - cn/r$ if he lobbies and exerts selling effort; he earns a maximum surplus of 0 otherwise. To induce the sales rep to lobby and exert selling effort, the firm must offer

$$w_L = e_L + \frac{cn}{r\theta}$$

If demand is high and the sales rep lobbies, with probability θ he will obtain the price discount and earn the commission w_L without selling effort. With probability $1 - \theta$ he will fail to obtain the price discount. In this case, he will earn $\widetilde{w}_H - e_H$ if he exerts selling effort and 0 otherwise. Therefore, the sales rep earns an expected surplus of $\theta w_L + (1 - \theta)\max(\widetilde{w}_H - e_H, 0) - cn/(1 - r)$ if he lobbies. The sales rep earns $w_H - e_H$ if he does not lobby but exerts selling effort, and 0 if he neither lobbies nor exerts selling effort. To induce the sales rep to not lobby but to always exert selling effort, the firm must offer[4]

$$\widetilde{w}_H \in [0, e_H]$$

$$w_H = e_H + \max[0, \theta e_L - g(r)cn]$$

It follows that by responding to lobbying stochastically (denote as "S") the firm earns an expected profit of

[4] We derive the optimal value of $\widetilde{w}_H$ assuming that the firm can commit to its commission offers. If the firm cannot commit, it will want to offer $\widetilde{w}_H = e_H$ to induce selling effort in case demand is high. However, this does not change the firm's optimal choice of w_H or its expected profit.

$$\mathbb{E}\pi_S = u(v_H - w_H) + (1-u)\theta(v_L - w_L)$$
$$= u(v_H - e_H) - u\max[0, \theta e_L - g(r)cn] + (1-u)\theta\left(v_L - e_L - \frac{cn}{r\theta}\right)$$

In equilibrium we must have $\theta e_L - g(r)cn \geq 0$, otherwise the firm can profitably deviate by reducing n infinitesimally. Therefore,

$$\mathbb{E}\pi_S = u(v_H - e_H) - u[\theta e_L - g(r)cn] + (1-u)\theta\left(v_L - e_L - \frac{cn}{r\theta}\right)$$

It follows that

$$\frac{d\mathbb{E}\pi_S}{dn} = ug(r)c - (1-u)c/r$$

The firm's equilibrium choice of n is thus in corner solutions. As in the main model, if $r < \frac{1}{1+u}$, the firm should use price delegation ($n = 0$); if $r > \frac{1}{1+u}$, the firm should use lobbying and should set its evidentiary threshold to

$$n_S^* = \frac{\theta e_L}{g(r)c}$$

By adopting the evidentiary threshold n_S^* and responding to lobbying stochastically, the w_L and w_H commissions are the same as in the main model:

$$w_L = e_L + \frac{e_L}{rg(r)}$$

$$w_H = e_H$$

The firm's resulting expected profit is

$$\mathbb{E}\pi_S^* = u(v_H - e_H) + (1-u)\theta\left(v_L - e_L - \frac{e_L}{rg(r)}\right)$$

Note that the term $v_L - e_L - \frac{e_L}{rg(r)}$ is positive given Condition (3) and the fact that the firm chooses lobbying ($r > \frac{1}{1+u}$). Therefore, for any $\theta \in (0,1)$ the firm can always improve its expected profit by increasing θ. In comparison, by always responding to lobbying (as in the main model), the firm earns

$$\mathbb{E}\pi_E^* = u(v_H - e_H) + (1-u)\left(v_L - e_L - \frac{e_L}{rg(r)}\right)$$

which is greater than $\mathbb{E}\pi_S^*$ for any $\theta \in (0,1)$. Therefore, we conclude that the firm cannot improve its expected profit by responding to lobbying stochastically.

General Model

Proof that $S(\underline{v}) = 0$

We establish this result by contradiction. Suppose $S(\underline{v}) > 0$. It follows that there must exist $v_0 \in (\underline{v}, \overline{v}]$ such that $S(v_0) = 0$. This is because the IR constraint must be binding for at least one demand state, otherwise the firm can cut the commission for all demand states by the same infinitesimal amount, and improve profit without violating any IR or IC constraints.

Since $S(v_0) = 0$, we can rewrite the sales rep's surplus function as

$$S(v) = \int_{v_0}^{v} S'(x)dx = \int_{v_0}^{v} (-\varepsilon_x^{'} - l_x^{'})dx$$

The firm's expected profit is

$$\mathbb{E}\pi_G = \int_{\underline{v}}^{\overline{v}} \{p(v) - S(v) - \varepsilon[p(v), v] - l(v, v)\}\, dF(v)$$

Integrating by parts, we obtain

$$\int_{\underline{v}}^{\overline{v}} S(v)dF(v) = \int_{\underline{v}}^{\overline{v}} \int_{v_0}^{v} (-\varepsilon_x^{'} - l_x^{'})dx\, dF(v)$$

$$= \int_{v_0}^{v} (-\varepsilon_x^{'} - l_x^{'})dx\, F(v)\, |_{\underline{v}}^{\overline{v}} - \int_{\underline{v}}^{\overline{v}} F(v)\,(-\varepsilon_v^{'} - l_v^{'})dv$$

$$= \int_{v_0}^{\overline{v}} (-\varepsilon_x^{'} - l_x^{'})dx - \int_{\underline{v}}^{\overline{v}} F(v)\,(-\varepsilon_v^{'} - l_v^{'})dv$$

$$= \int_{v_0}^{\overline{v}} (-\varepsilon_x^{'} - l_x^{'})dx - \int_{\underline{v}}^{\overline{v}} F(v)\,(-\varepsilon_v^{'} - l_v^{'})dv$$

$$= \int_{\underline{v}}^{\overline{v}} (-\varepsilon_v^{'} - l_v^{'})[\mathbb{I}(v > v_0) - F(v)]dv$$

where $\mathbb{I}(\cdot)$ is the indicator function which equals 1 if the argument is true and 0 otherwise.

Combining terms yields

$$\mathbb{E}\pi_G = \int_{\underline{v}}^{\overline{v}} \{p(v) - \varepsilon[p(v), v] - l(v, v)\}dF(v) - \int_{\underline{v}}^{\overline{v}} (-\varepsilon_v^{'} - l_v^{'})[\mathbb{I}(v > v_0) - F(v)]\, dv$$

Let $\mathbb{E}\pi_G = \int_{\underline{v}}^{\overline{v}} z(v)dv$ where

$$z(v) = \{p(v) - \varepsilon[p(v), v] - l(v, v)\}f(v) + (\varepsilon_v^{'} + l_v^{'})[\mathbb{I}(v > v_0) - F(v)]$$

$$= \left\{p(v) - \varepsilon[p(v), v] - c\frac{n(v)}{b(v)}\right\} f(v) + \left[\varepsilon_v^{'} - c\frac{n(v)b'(v)}{b(v)^2}\right][\mathbb{I}(v > v_0) - F(v)]$$

The firm's optimization problem amounts to choosing $p(v)$ and $n(v)$ to maximize $z(v)$ for each v. Taking derivative with respect to $n(v)$ yields

$$\frac{dz(v)}{dn(v)} = -c\frac{1}{b(v)}f(v) - c\frac{b'(v)}{b(v)^2}[\mathbb{I}(v > v_0) - F(v)]$$

For all $v \leq v_0$ this derivative becomes

$$\frac{dz(v)}{dn(v)} = -c\frac{1}{b(v)}f(v) + c\frac{b'(v)}{b(v)^2}F(v) < 0$$

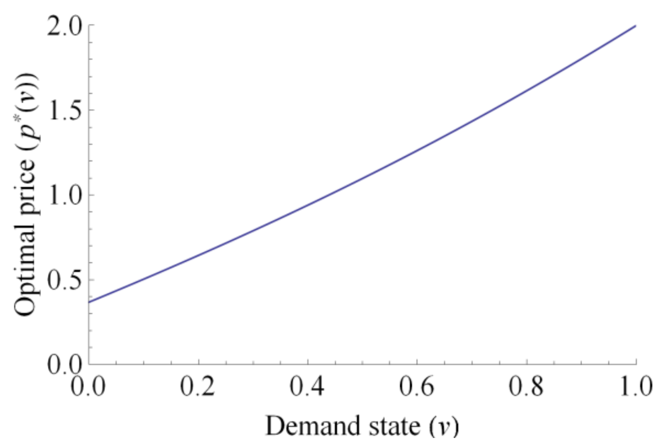
Therefore, the firm will set $n(v) = 0$ for all $v \leq v_0$. This result implies that $l_v' = 0$ such that $S'(v) = -\varepsilon_v' > 0$ for all $v \leq v_0$. However, we have assumed that $S(\underline{v}) > 0$ and $S(v_0) = 0$, which is a contradiction. **Q.E.D.**

Illustration of the Optimal Lobbying Mechanism

We illustrate the optimal lobbying mechanism for explicit functional forms. Assume that demand v is distributed over $[0,1]$ following the p.d.f. $f(v) = \alpha v + 1 - \frac{\alpha}{2}$, where $\alpha \in (-2,2)$. A larger α means that demand is more likely to be high in the sense of first-order stochastic dominance. Meanwhile, suppose the sales rep finds a low demand signal with probability $b(v) = -\beta v + \frac{1+\beta}{2}$ for each draw, where $\beta \in (0,1)$. Similar to the parameter r of the main model, a higher β means that demand signals are more accurate. Finally, let the sales rep's cost of selling effort be $\varepsilon(p,v) = [\max(0,\ p - v)]^3/3$. The sales rep will incur just enough effort so that the customer in demand v is willing to buy at price p. The firm hence has no incentive to set p below v.

From the first-order condition $\frac{dy(v)}{dp(v)} = 0$ we derive the optimal price scheme $p^*(v)$. The second-order condition is satisfied. It can be shown that $p^*(v) > v$ and increases with v for any $v \in [0,1]$ and $\alpha \in (-2,2)$. Intuitively, the firm charges a higher price in a higher demand state. The analytical expression of $p^*(v)$ is complex, and we illustrate it with Figure G1.

Figure G1: Optimal Price in the General Model – An Illustration



Notes: This figure sets $\alpha = 0.3$ and $\beta = 0.9$.

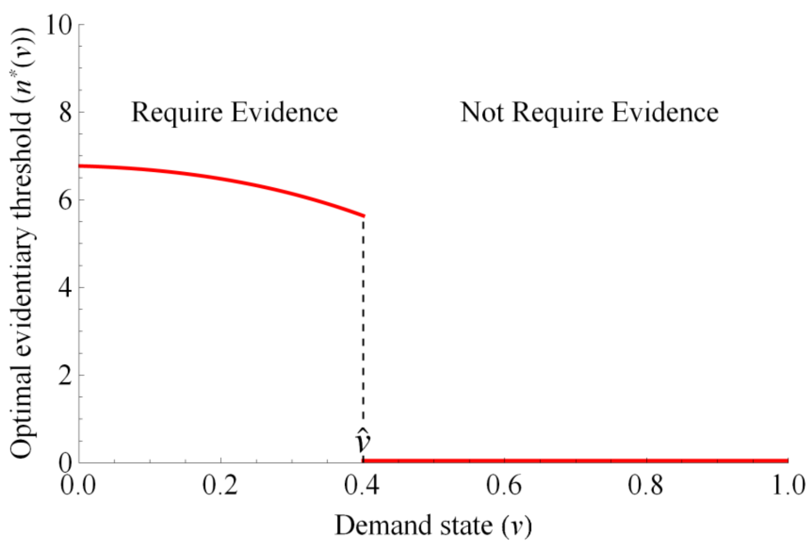
Next we derive the condition under which the firm should require evidence. Given the functional form assumptions, Condition (7) becomes $J(\alpha,\beta,v) \geq 0$ where $J(\alpha,\beta,v) = \frac{\alpha\{1+\beta-2v[1+(1-v)\beta]\}-2(1-\beta)}{(1-v)(2+\alpha v)[1+(1-2v)\beta]}$. It can be shown that $J_\alpha' > 0$ and $J_\beta' > 0$. In other words, the firm is more prone to require evidence when demand is more likely to be high and when demand signals are more accurate, which echoes the findings from the main model.

Moreover, we show that $J_v' < 0$ for any $v \in [0,1]$, $\alpha \in (-2,2)$ and $\beta \in (0,1)$. This result establishes a cutoff property of the optimal lobbying mechanism: if the firm is indifferent whether to require evidence for demand state $\hat{v} \in (0,1)$, then the firm should require evidence for all demand states lower than $\hat{v}$ and waive the requirement for all demand states higher than $\hat{v}$. Such a cutoff demand state $\hat{v}$ does exist when α and β are sufficiently high. For example, $\hat{v} = 0.4$ when $\alpha = 0.3$ and $\beta = 0.9$.

It remains to derive the optimal evidentiary threshold. If $J(\alpha,\beta,v) < 0$, the firm should set $n^*(v) = 0$. If $J(\alpha,\beta,v) \geq 0$, the firm should raise $n(v)$ until $S(v) = 0$, which implies that $S'(v) = 0$ for all $v \in [0,\hat{v}]$. Given the functional form assumptions, $S'(v) = [p(v) - v]^2 - c\beta n(v)/\left[-\beta v + \frac{1+\beta}{2}\right]^2$. Substituting $p^*(v)$ into $S'(v) = 0$ allows us to derive the optimal evidentiary threshold $n^*(v)$ in closed form for $v \in [0,\hat{v}]$.

We present an example of the optimal evidentiary threshold in Figure G2. The firm will not require any evidence if the sales rep is willing to admit that demand is higher than $\hat{v}$, but will require evidence if the sales rep claims that demand is lower than $\hat{v}$. In the latter case, the lower demand the sales rep wants to claim, the more evidence of low demand he must provide.[5]

Figure G2: Optimal Evidentiary Threshold in the General Model – An Illustration



Notes: This figure sets $\alpha = 0.3$, $\beta = 0.9$ and $c = 0.02$.

[5] Note however that the optimal evidentiary threshold does not always decrease with demand. Its slope depends on parameter values and functional form assumptions.