Combining Lab Experiments and Industry Data in Transaction Cost Analysis: The Case of Competition as a Safeguard

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Extant empirical work in transaction cost analysis relies almost exclusively on cross-sectional survey data on firm behavior to test predictions about vertical integration, long-run contracts, alliances, and the like. Such designs shed useful light on the causal mechanisms supposedly responsible for the effects, but do not develop the details. Many of these designs also offer scarce insight into the profit implications inherent in the theory. Cognizant of these gaps, we combine a laboratory experiment and cross-sectional industry practice data to offer the first empirical evidence of "invited" competition as a safeguard for buyers' specific investments. Specifically, our lab data offer direct evidence of the suppression of opportunism. As the theory predicts, competition from a licensee holds down price hikes that exploit locked-in buyers in follow-on time periods. The lab data also show that competing with a licensee becomes more attractive to the original monopolist as potential buyers need to make larger supplier-specific expenditures. The reverse is true when the focal product provides buyers with larger economic value. Interestingly, these effects show some systematic deviation from the subgame perfect predictions of the game-theoretic models. Our industry data show that firms behave according to the prediction that products requiring greater levels of supplier-specific investments are more likely to be licensed. We close with a discussion of the economics of safeguards and the methodological implications of the studies.

1. Introduction

A growing literature corroborates the principal refutable implications of transaction cost analysis (TCA). These include investigations of vertical integration of distribution, sales compensation practices, component procurement and the like (see Williamson, 1989, for a review of the recent empirical work). However,
the standard research design relying on expected matches between governance structures and attributes of the transaction is lacking in some respects. To illustrate, in their classic study, Monteverde and Teece (1982) showed that firms integrated backward for components whose production required investment in specific assets. Prompted by the hazards of opportunism, integration constitutes a safeguard because it alters incentives and introduces superior auditing and surveillance capabilities. However, these claims are not directly verified, because neither opportunism or auditing capabilities were measured.

In principle, one could measure these intervening mechanisms. Opportunism in the Monteverde and Teece study might have been measured as price hikes in follow-on periods. Unfortunately, these price path data are difficult to obtain with survey instruments or archival searches. A related weakness of the design is that it provides very little opportunity to assess normative (profit) consequences. A number of factors contribute to this situation. First, it is difficult to associate profits with transactions because accounting systems are rarely set up to track account-level profitability. Second, firms are quite reluctant to release profit data. Not surprisingly, the extant work regarding profits or other normative outcomes is very sparse (for notable exceptions, see Anderson, 1988; and Masten, Meehan, and Snyder, 1991).

Our study adds to the literature in two ways. We develop the first empirical test of "invited" competition from licensees as a safeguard for buyers' specific investments (Farrell and Gallini, 1988; Dutta, 1990). Second, we demonstrate the utility of laboratory markets as a methodological tool in TCA in combination with traditional industry practice data.

To accomplish these goals, we undertake two complementary studies. A laboratory market study tests the prediction that absent the presence of a licensee, monopolistic suppliers will raise prices significantly in follow-on periods to exploit locked-in customers. Industry practice data is then used to test the prediction that products requiring greater levels of supplier-specific investments are more likely to be licensed by monopolists.

2. Institutional and Theoretical Background

2.1 Competition as a Market Safeguard

Two recent studies offer analytic models that describe "invited" competition as a safeguard for buyers' specific investments. Using game-theoretic models, Farrell and Gallini (1988), and Dutta (1990) show that the presence of a second firm offering a functionally equivalent product renders both firms unable to exploit buyers' sunk costs. If either one were to raise prices in a follow-on time period, buyers can readily switch to the other firm. The presence of the second firm constitutes a credible commitment about future prices.

What institutional practice might implement this safeguard? Following Shepard (1987b), these researchers contend that some types of licensing can be understood along these lines. Specifically, they implicate the situation where an original monopolist firm permits another firm to utilize its patents or other proprietary technology to produce and sell a product in direct competition with the focal firm. The arrangement may (not necessarily) include royalty payments.
There are no formal contractual obligations implicated here. Arm's-length market relations exist between the two suppliers as well as between the firms and their customers. No complex "specific performance" clauses have to be enforceable, nor do royalty agreements have to be crafted between these two firms. It encompasses those cases where the focal firm implicitly licenses firms by not mounting legal challenges to firms that sell "cloned" or reverse-engineered products. For instance, neither IBM nor Microsoft formally licensed their MS-DOS/PC-DOS operating system for personal computers to Novell (Digital Research). Yet, Novell sells a "clone" product called DR-DOS without being legally challenged by the original firms. These products compete with each other in the marketplace.

The critical features of this type of licensing can be summarized as follows. First, the licensed and original products are functionally similar enough such that switching costs across them are minimal on repeat-purchase occasions. Second, the two firms must be competing with each other for customers, and thus excludes cases where one firm sells the product in markets that are not served by the other firm.

2.2 Predicted Price Paths

Farrell and Gallini (1988) and Dutta (1990) show that the credible price path for a monopolist involves price hikes in follow-on periods commensurate with buyers' first-period specific investments \( P_2 = P_1 + I \). With a second firm present, the credible price paths involve identical prices over the two periods regardless of specific investments \( P_2 = P_1 \).

2.3 Predicted Profits

In general terms, the attractiveness of inviting competition from licensees reflects a trade-off between the need to craft an efficient safeguard (market enlargement effect) and the erosion of a valuable monopoly position. We focus on two specific predictions.

Farrell and Gallini (1988) and Dutta (1990) show that \( \frac{\partial (\Pi_2 - \Pi_1)}{\partial I} > 0 \). As buyers' specific investments \( I \) increase, the difference in profits to the firm between introducing another firm \( (\Pi_2) \) and going it alone \( (\Pi_1) \) increases correspondingly. The intuition is that buyers are reluctant to incur specific investments that they know will be exploited ex post. Higher levels of such investments deter ever larger numbers of potential buyers. By introducing a second firm, these skeptical buyers are reassured, and the market is enlarged as a consequence. Although the licensor benefits from the enlarged market, there is also an erosion of the monopoly position. The market enlargement effect is more pronounced at higher levels of specific assets, and dominates the monopoly erosion effect at sufficiently high levels of these investments. Notice that the difference in profits itself \( (\Pi_2 - \Pi_1) \) can be positive or negative depending on the specific values of the parameters.

A related result from these two studies is that \( \frac{\partial (\Pi_2 - \Pi_1)}{\partial V < 0} \), that is, the relative profitability of introducing another firm \( (\Pi_2) \) as compared to going it alone \( (\Pi_1) \) is reduced as the economic value \( V \) of the focal item is increased.
When the purchased item in question can significantly increase the value of the buyers' own end product, they are willing to tolerate price hikes that exploit their locked-in condition. Thus, fewer buyers need to be reassured, and the market enlargement effect is smaller. The net effect is to render licensing less attractive to the licensor, all else equal. As before, note that the actual difference in profits between the two options may be positive or negative depending on the magnitudes of the parameters.

3. Study I: Experimental Market Study
3.1 Preliminary Considerations
An experimental market offers better internal validity because we can probe the presumed theoretical mechanisms more directly. In the extant case, evidence about the price paths enables us to rule out alternative explanations that have been offered for licensing, including commitment to quality levels (Shepard, 1987b), "network externality" effects (Katz and Shapiro, 1985), and preemption of rivalry (Gallini, 1984). In contrast, matching up licensing decisions with attributes of the transaction does not enable a clear separation of these explanations.

A concern voiced about experimental markets is their apparent lack of external validity. Clearly, a lab setting is quite far removed from the "real marketplace" of firms and managers. However, these concerns often represent a misunderstanding of the design of these studies. In speaking to this issue, Smith (1982: 936) notes that "propositions about the behavior of individuals and the performance of institutions that have been tested in the laboratory ... apply also to nonlaboratory microeconomies where similar ceteris paribus conditions hold." Likewise, Plott (1989: 1165) notes "the simplicity of laboratory markets in comparison with naturally occurring markets must not be confused with questions about their reality as markets."

These remarks clarify the burden on the experimenter. A proper lab test of a theory must implement the critical features of the theory. A superficial similarity between the lab setting and the real world is not the issue. Applying this criterion, we note that the core of our theory deals with economically motivated behavior given a specific structure of exchange. Thus, to ensure the validity of our lab market, our procedures must ensure economically motivated behavior in a setting where vertical integration and long-term contracts do not exist, and arm's-length, price-mediated exchange occurs.1 Within this context, we need to implement specific investments, and the other parameters of the model.

3.2 The Experimental Market Setting
Our subjects played the role of suppliers of electrical transformers purchased by original equipment manufacturers (OEMs) of electrical generating equipment. Subjects could sell these transformers to the OEMs, who then used the

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1. For an interesting experimental market study that looks at the efficacy of relational contracting versus vertical integration under varying informational conditions, see Hackett, Wiggins, and Battalio, 1993.
item in their own end product (an electrical generator). By incorporating the transformer, OEMs added value to their own end product. However, in order to utilize the transformer in their end product, the OEMs had to spend money developing a control panel that was specific to the transformer from a given supplier (or its licensee, if present).

We recruited undergraduate business students with a monetary inducement. They were told they could keep the money earned in the study. On average, subjects made $7.10 for about 50 minutes of work, including the time it took to receive instructions. This is within the range of wages typically earned by these students. Post-study briefings supported our contention that these amounts were sufficient to motivate them monetarily.

One aspect of this inducement should be noted. Since the different experimental conditions do not afford all subjects the opportunity to earn like amounts of money, equity concerns could influence their behavior and contaminate the study. To minimize this possibility, we rely on an established procedure, whereby our subjects earned profits in experimental currency units (francs) that were converted to dollars using individual exchange rates. This created opportunities to take home comparable sums of money. These individual exchange rates (ranging from 90 to 350 francs to a dollar) were not made public knowledge, so as to minimize interpersonal comparisons.

Notice that experimental realism in our study does not depend on our subjects’ expertise about the licensing practices of industrial firms. To the contrary, “demand artifacts” are reduced by the lack of such knowledge because of less hypothesis guessing. However, this is not true of all potential hypotheses. Consider the hypothesis that firms are more likely to introduce a competitor when required to reassure buyers making specific investments. Indeed, this is the type of hypothesis most often tested in extant studies. This hypothesis would require subjects who have some reasonable familiarity with the institutional details of implementing a license arrangement, and thus would probably not be a good candidate for a laboratory market using student subjects. In fact, we consider such a hypothesis later, and turn to a standard design using industry data to test it.

3.3 Experimental Design

The study used a four-factor (2 × 2 × 2 × 2), “mixed” design, consisting of three between-subject factors and one within-subject factor.

3.3.1 Number of Suppliers (S). This between-subjects factor was operationalized as the number of suppliers, viz. one supplier (S1) or a licensor and a licensee (S2).2 In the latter case, the first firm was told that they had licensed another

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2. The underlying model for the market experiment is a location model where the licensor and licensee are fixed at opposite ends of a unit line. Some differentiation between the two suppliers is essential for the results to hold. If the two suppliers were located at the same point, the complete erosion of the monopoly position renders it unprofitable ever to introduce a licensee. Only delayed licensing can be profitable. We disregarded delayed licensing as a plausible implicit contract because of the obvious enforcement problems it poses. It is possible for the two suppliers to locate at
firm to produce and sell the transformer. The second firm had to pay a royalty fee of 10 percent on sales to the first firm.\(^3\)

3.3.2 Specific Investments (\(I\)). This between-subjects factor was operationalized as a one-time cost that buyers incurred for developing the control panel needed to use the transformer. This panel could be used either with the transformer sourced from the first firm or with the transformer from the second firm, if one existed. Subsequent purchases from either supplier did not require them to re-incure this expenditure to capture the sunk cost condition of specific investments. The two levels of these costs represented the low \((I_1 = 60)\) and high \((I_2 = 90)\) specific investment conditions.

3.3.3 Economic Value (\(V\)). This between-subjects factor was operationalized as the increase in unit selling price realized by buyers who incorporate the transformer into their electrical generator end product. A low value \((V_1 = 100)\) and a high value \((V_2 = 120)\) were manipulated as two levels of this factor.

3.3.4 Time Period (\(T\)). This within-subject factor was operationalized as the initial \((T_1)\) and follow-on \((T_2)\) time periods.

3.4 Procedure

A total of 120 subjects were randomly assigned to one of the eight between-subjects conditions. Since the duopoly conditions required twice as many subjects, the assignment procedure reflected this requirement. This yielded 10 observations per cell.

3.4.1 Instructions to Subjects. Each subject was given an instruction packet that varied across conditions to reflect the differences in their circumstances. These instruction packets implemented the common knowledge requirement of the study. McCabe, Porter, and Smith (1990) describe common knowledge as consisting of two components; common information (i.e., all actors have the same public information) and common expectations (i.e., all actors have convergent public expectations). Parenthetically, common knowledge is distinct from institutional knowledge, which refers to the subjects' familiarity and understanding of the institutional mechanism under study.

3.4.2 Market Behavior. The packet described 12 buyers who varied in their geographical location. Each buyer faced a different transportation cost to ship the component from the supplier to their plant. These buyers are described as shopping for the best deals possible. Appendix 1 shows sample tables from these packets.

\(^3\) It should be noted that the theory holds with or without royalty payments.
In the monopoly conditions, buyers could buy only from the monopolist. In the duopoly conditions, the packet informed the subjects that they were one of two firms. The firm located in California had already licensed their proprietary product to the firm that was located in New York. In return, the licensee was required to pay 10 percent of revenues to the licensor.

Appendix 1 illustrates the transportation cost differences between the buyers. We set up these differences to implement the location model in Dutta (1990). Imagine these 12 buyers located at equal intervals along a road with a supplier at each end. Two buyers were located at the mid-point, such that if both suppliers quoted the same price, they each sold to one of these two buyers. Buyers closer to a firm will prefer to buy from that firm.

3.4.3 Subjects’ Decisions. The packets informed the subjects that they would have the opportunity to make sales to these 12 buyers for two consecutive time periods. They were required to post their selling price in each time period, and sell to all interested buyers at that price. No bargaining or other communication with buyers was allowed. Each subject was seated in a room alone. After reading the instructions, the subjects were given time to consider their price for the first time period. When they announced their asking price, the experimenter left the room to inform the buyers of the price, and then returned with purchase orders from the buyers who had elected to purchase the item. These purchase orders contained information on orders by specific buyers, and revenues. In the duopoly conditions, subjects were provided with data on their own prices, orders, and revenues as well as these data for the other firm. No direct communication between the two firms was permitted.

After being allowed to inspect the first-period outcomes, the subjects were asked to post their selling price for the second period. Following the same routine, the experimenter took the prices to another room, and returned with purchase orders for the second time period. Second-period market shares and revenues were reported back to the subjects.

3.4.4 Market Response. Unknown to the subjects, a confederate played the role of the 12 buyers. The confederate applied a formula-based decision rule for each buyer, which operationalized expected prices and costs over the relevant horizon. Described in Appendix 2, this formula computes the net gain for each buyer by comparing the economic value of the item against the sum of the announced first-period price, the expected second-period price, and the transportation cost for each of the possible sources of supply. The result determined the purchase outcome for each buyer. This was repeated for each period, except that there was no relevant future period in the second period.

3.5 Price Path Hypotheses
Recall that monopolists should increase second-period prices to take advantage of locked-in buyers.4 In contrast, the duopolists will be unable to raise prices

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4. This locked-in buyer problem is similar in spirit to the lowballing problem in an audit market. For market experiments on lowballing, see Schatzberg (1990) and Davis (1988).
in the second period. Using the first firm's prices as the dependent variable, our data should show a $T \times S$ interaction effect between time period and number of suppliers.

3.6 Profit Hypotheses
Recall that higher specific investment levels made licensing relatively more attractive. Using the total two-period profits of the first firm as the dependent variable, our data should show a two-way interaction ($S \times I$) between the number of supplying firms ($S$) and the level of specific investments ($I$).

The second profit prediction held that licensing a competitor becomes increasingly less profitable as the value of the item to the buyers increases. We should observe a two-way interaction ($S \times V$) between the number of supplying firms ($S$) and the economic value of the item to the buyers ($V$).

4. Results
4.1 Price Path Results
The dependent variable is the price charged by the first firm. Figures 1 and 2 show the prices charged by the lab subjects. Evidently, the monopolist subjects increased prices, while no such pattern is evident in the duopoly conditions.

To test the expected $S \times T$ interaction, we estimated a repeated-measures, analysis of variance (ANOVA) model with three between-subjects factors ($S, I, V$), and one within-subject factor ($T$). The results are summarized in Table 1. As expected, we see a strong $S \times T$ interaction ($F(1, 72) = 332.9, p < .00$).
Combining Lab Experiments and Industry Data in TCA

Examining this interaction in detail, we find that when there is only one firm
\((S = 1)\), the second-period price \((77.41)^5\) is significantly higher than the first-
period price \((12.52; F(1, 79) = 637.02; p < .01)\). In contrast, when there are
two firms present, the second-period price \((41.57)^6\) is not significantly different
from the first-period price \((43.0; F(1, 79) = 0.22; p > .64)\). The subjects
behave as expected, and exploit the locked-in buyers unless checked by the
presence of the second firm.

4.2 Profit Results

The profits of the first firm in the different conditions are shown in Figure 3.

To test the hypotheses, we estimated an analysis of variance model. Unlike
the previous model, this is a \(2 \times 2 \times 2\) between-subjects design. Since the
dependent measure is the total profit summed over the two periods \((T_1\) and \(T_2)\),
the within-subject factor, \(T\), is no longer relevant. Table 2 shows the analysis
of variance results for these data. As per our first hypothesis, we find a strong \(S \times I\)
interaction \((F(1, 72) = 30.4, p < .00)\). The difference in profits \((\Pi_2 - \Pi_1)\)
increasingly favors the two-firm option as specific investments increase. From
Figure 3, at the low level of \(I\), the gap is \(530.1 ((767.31 + 1248.46)/2 -
\{484.8 + 670.73\}/2)\), but it diminishes to \(30.5 ((185.52 + 810.2)/2 -
\{413.67 + 521.26\}/2)\) for the high level of \(I\).

5. Averaged across all the four conditions in Figure 1.
6. Averaged across all the four conditions in Figure 2.
Table 1. ANOVA Results for Price

<table>
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<th>Effect</th>
<th>df</th>
<th>F</th>
<th>p value</th>
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</thead>
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<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>1</td>
<td>32.40</td>
<td>( p &lt; 0.00 )</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>7.451</td>
<td>( p &lt; 0.00 )</td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>0.805</td>
<td>( p &lt; 0.37 )</td>
</tr>
<tr>
<td>Vi</td>
<td>1</td>
<td>0.747</td>
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<tr>
<td>VS</td>
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<td>0.680</td>
<td>( p &lt; 0.41 )</td>
</tr>
<tr>
<td>IS</td>
<td>1</td>
<td>0.239</td>
<td>( p &lt; 0.63 )</td>
</tr>
<tr>
<td>VIS</td>
<td>1</td>
<td>0.085</td>
<td>( p &lt; 0.77 )</td>
</tr>
<tr>
<td>Error</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Subject</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>1</td>
<td>304.464</td>
<td>( p &lt; 0.00 )</td>
</tr>
<tr>
<td>TV</td>
<td>1</td>
<td>3.547</td>
<td>( p &lt; 0.06 )</td>
</tr>
<tr>
<td>TI</td>
<td>1</td>
<td>18.60</td>
<td>( p &lt; 0.00 )</td>
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<td>TS</td>
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<td>332.867</td>
<td>( p &lt; 0.00 )</td>
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<tr>
<td>TVI</td>
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<tr>
<td>TVIS</td>
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<td>3.547</td>
<td>( p &lt; 0.06 )</td>
</tr>
<tr>
<td>Error</td>
<td>72</td>
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</table>

Figure 3. Licensor profits.

Notice, however, that the absolute level of profit nevertheless favors the monopoly option at both levels of \( I \) averaged across \( V \). This is still consistent
Table 2. ANOVA Results for Profits

<table>
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<th>Effect</th>
<th>df</th>
<th>F</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
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<td>93.373</td>
<td>(p &lt; 0.00)</td>
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<tr>
<td>I</td>
<td>1</td>
<td>73.429</td>
<td>(p &lt; 0.00)</td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>40.526</td>
<td>(p &lt; 0.00)</td>
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<tr>
<td>VI</td>
<td>1</td>
<td>0.203</td>
<td>(p &lt; 0.65)</td>
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<td>VS</td>
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<td>IS</td>
<td>1</td>
<td>30.448</td>
<td>(p &lt; 0.00)</td>
</tr>
<tr>
<td>VIS</td>
<td>1</td>
<td>2.355</td>
<td>(p &lt; 0.13)</td>
</tr>
<tr>
<td>Error</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

with the theory. To recall, the sign of the profit difference depends on the magnitudes of the parameters.

Turning to the second profit prediction, as expected, there is a significant \(S \times V\) interaction \(F(1, 72) = 31.5, p < .00\) in Table 2. The difference in profits between the two-firm and single-firm options \((\Pi_2 - \Pi_1)\) increasingly favors the single-firm option as the economic value of the item to buyers \((V)\) increases. From Figure 3, at the low level of \(V\), the gap is 27.02 \((176.31 + 185.52)/2 - (484.8 + 413.67)/2\), but this increases dramatically to 433.34 \((1248.46 + 810.2)/2 - (670.73 + 521.26)/2\) for the high level of \(V\).

4.3 Additional Analysis

4.3.1 Reneging on Implicit Contracts. The strength of a theory test corresponds to the opportunity for disconfirmation that is afforded by the design. Applying that criterion to our lab study, we need to ask whether the manipulations and procedures afford the opportunity to disconfirm the prediction that a second firm’s presence will hold down opportunistic price hikes. Could our subjects have gained by deviating from the theoretically correct behavior? Does the setting so tightly constrain plausible courses of action that a subject is merely following instructions rather than acting on his or her own motivation to earn money?

Our experimental design offered duopolist subjects the possibility of significant gains by deviating from the predicted subgame perfect behavior. Suppose, for instance, that the duopolists were to renge on their implicit contract in the second period. Our subjects could have raised second-period prices to the point where buyers’ net economic value goes to zero without sacrificing the enlargement effect. Consider, for instance, a simple pricing rule whereby subjects set second-period prices as equal to announced first-period prices plus the amount of the specific investment \((I)\) made by buyers. Such a rule would have yielded the subjects about twice as much money as they earned from the predicted Nash behavior.\(^7\)

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\(^7\) We are not offering a full-blown alternative ex ante hypothesis. Rather, the strength of the design is being assessed.
If our subjects had deviated from the predicted pattern in this fashion, then the statistical analysis of the price data in Table 1 should show only a main effect of time period \((T)\) on the price dependent variable, and not the \(T \times S\) interaction of time period with number of supplying firms. Table 1 confirms our position that the safeguard worked to hold down prices despite this potential for reneging. Indeed, the data do show a significant main effect of \(T \) \((F(1, 72) = 304.5, p < .00)\), but the \(T \times S\) interaction is also significant \((F(1, 72) = 332.9, p < .00)\).8 The latter refutes the reneging idea. Apparently, the safeguard was strong enough to overcome this possibility.

4.3.2 Closeness of Fit to Subgame Perfect Predictions. Laboratory experiments have often found that subjects deviate from individual utility-maximizing behavior predicted by game-theoretic models. Some subjects appear to act out of “fairness” or consideration for others (for an extended discussion of this issue in lab experiments, see Hoffman and Spitzer, 1982). If this were widespread, it weakens the need to rely on invited competition to hold down price hikes on locked-in buyers. We tested this possibility in our data.

Figures 1 and 2 plot the predictions made from the game-theoretic analysis in Farrell and Gallini (1988) and Dutta (1990). In their models, the second-period price charged by monopolistic suppliers should be exactly equal to the first-period price plus the specific investment of the buyer \((I)\). Suppliers are completely opportunistic and appropriate the full value of the buyers’ specific investments.

Figures 1 and 2 show the prices quoted by monopolistic subjects. Second-period prices are indeed higher than first-period prices. They are not significantly different from the predicted second-period price at the 95 percent level. However, a number of subjects did price considerably lower than the predicted price. Using a nonparametric sign test to assess this, we find a significant number of monopolist subjects quoted prices lower than the predicted second-period price. This is particularly evident in the low-value/high-sunk-cost cells. These subjects were not fully opportunistic. Consistent with past findings, some degree of “fairness” or forbearance was present. In contrast, the duopolist subjects do not show any systematic deviation across the possible comparisons of actual and predicted prices. Overall, these deviations from the subgame perfect predictions do not appear widespread enough to obviate the need for invited competition to hold down price hikes on locked-in customers.

4.4 Summary

Overall, these results provide good support for the predictions. Introducing a licensee attenuates opportunistic price hikes, and leads to profit outcomes consistent with the theory. Although forbearance is exhibited to some degree by monopolist suppliers facing locked-in customers, the game-theoretic anal-

8. Although we point out the “significant” main effect, its interpretation is ambiguous in the presence of a significant interaction effect.
ysis provides a reasonable description of subject behavior in the laboratory. It remains to be seen whether the model’s predictions are also descriptively accurate in predicting actual licensing decisions made by firms. We turn to this task below.

5. Study II: Data on Firm Behavior

5.1 Hypothesis

According to the theory, licensing is undertaken to safeguard buyers’ specific investments when (a) backward vertical integration into components is infeasible and (b) long-term price contracts with buyers are impractical to write and enforce. Do firms behave in accordance with this prescription? Casual empiricism, based on trade press accounts, offers some support for this prediction. Electronics firms who are likely to be locked in after adopting a supplier’s new product “routinely insist, before incorporating a seller’s component into equipment which the buyer manufactures, that the seller demonstrate the existence of at least one other substantial seller that can supply the product” (Taylor, 1984: 564). We capitalize on these observations to undertake a more systematic analysis of licensing behavior in this industry.

5.2 Design of Study

The prediction of interest is not suitable for a laboratory market study because a decision-maker’s choice of the licensing option is undoubtedly influenced by prior knowledge and familiarity with the institutional mechanism. Thus, we would have to induce a level of expertise in our subjects that reasonably approximates the level of actual managers in the field. Inducing expertise in lab subjects is a difficult and controversial undertaking. Hence, a nonexperimental design is more appropriate here.

5.2.1 Industry Setting. A good test site requires that vertical integration and/or long-term contracts are unlikely or impractical. Consider the semiconductor industry in these respects. Semiconductors are electronic circuit devices such as memory chips, microprocessors, logic devices, etc. that are sold to a large number of OEMs for use as components in an immense variety of end products. The majority of semiconductors are purchased by OEMs from semiconductor manufacturers, rather than produced in-house (Bogart and Zieber, 1982). Only the very largest user firms like IBM integrate backward into chip manufacturing because of the huge economies of scale in semiconductor manufacturing.

As for long-term contracts, short product life cycles, product complexity, and rapid technological advances combine to make it difficult to write and enforce such agreements. This sentiment is echoed in remarks in trade journals. Buyers bemoan the fact that “[a contract] doesn’t mean that you get [the component] at the price, in the quantity, at the time you contracted for last year” (Electronic News, 1984, quoted in Shepard, 1987a). These characteristics make this industry a particularly appropriate setting for our purposes.
5.3 Measures and Hypotheses

We constructed measures of the independent and dependent variables from *DATA Digest* [Data Analysis and Tabulation Associates (DATA), 1989], an industry handbook of semiconductor devices which lists and classifies thousands of available semiconductor devices from merchant vendors. The devices are categorized as memory devices, logic devices, microprocessor devices, and the like. Each category is further subdivided into finer classes.

5.3.1 Independent Variable. Our measure of buyer investment in supplier-specific assets capitalizes on Shepard’s (1987a) analysis of this industry. She argues that microprocessors require considerably greater specific investments by buyers compared to memory devices. Our field interviews with electronics engineers at two major semiconductor users confirmed this point. The logic is straightforward.

Microprocessors are “computers on a chip.” As such, their use involves a heavy commitment of resources to design hardware and software around the specific requirements of the particular microprocessor. For instance, it has been estimated that the choice of any particular 16-bit microprocessor family in a system is usually a 5- to 10-year commitment to that family and will entail an investment of $10 million to $20 million (*Electronic News*, 1980). Further, this investment is not recoverable in the event that the firm switches to another microprocessor. The software and support chips are specific to each microprocessor. In contrast, memory devices require much lower levels of supplier-specific investment. Relatively little redesign work has to be undertaken to substitute another vendor’s memory device in the end product.

There are a large number of other types of semiconductor devices, such as application-specific integrated circuits (ASICs) and logic chips. These devices fall somewhere between memory devices and microprocessors in terms of their complexity. However, these other categories are very diverse, and it is difficult to characterize the relative level of specific investments associated with them. Thus, we confine our analysis to devices at the extreme ends of this continuum, viz. microprocessors and memory devices. We constructed a dummy variable, DEVICE, coded 0 for memory devices and 1 for microprocessor devices, to classify components from these two categories listed in the handbook.

5.3.2 Dependent Variable. The dependent variable is the licensing decision. Since de facto licensing and formal contracts are not distinguished in the theory, we cannot rely on Shepard’s approach (1987a) of content analyzing published accounts of licensing contracts to derive our measure. Instead, our measure relies on the presence or absence of functionally equivalent products from firms other than the firm that originated the product.

To accomplish this, we capitalize on the DATA handbook’s assignment of a unique *generic part number* to all the devices that it lists as *interoperable*. This generic part number is in addition to the vendor-specific part number attached to the item. The handbook defines interoperability as the ability of users to substitute devices with the same generic part number regardless of the
vendor-specific part number without incurring any significant redesign or other engineering switchover cost. Interviews with technical personnel at two major semiconductor user firms confirmed the validity of the handbook's assignment of generic part numbers and the interoperability of devices listed as such.

We constructed a measure, NFIRMS, coded as 1 when devices from multiple vendors were listed for a given generic part number and 0 when a single vendor was listed for a given generic part number. We reemphasize that the presence of multiple vendors for a given generic part number does not imply that formal licenses have been granted. The item might simply have been "cloned" or reverse-engineered.

5.3.3 Results. Recall the prediction is that microprocessors will be available from multiple vendors more often as compared to memory devices. Table 3 tabulates the DATA handbook information in these respects.

There are 2,444 individual generic part numbers assigned to microprocessors and memory devices. Among the 238 generic part numbers in the microprocessor category, 32 percent of them have more than one firm listed as offering that item. In contrast, among the 2,206 generic part numbers in the memory device category, 14.6 percent of them have more than one firm listed as offering that item. Microprocessors are more than twice as likely to have multiple vendors selling interoperable items compared to memory devices. A chi-square test shows that the proportion of microprocessors with multiple sources is significantly higher than the proportion for memory devices ($\chi^2(1) = 49.587$, $p < .05$).

Establishing this association does not allow us to disentangle the safeguarding interpretation from other explanations, such as network externalities or improved delivery-time commitment. It is plausible to suppose that network externality effects are greater for microprocessors than memory devices. This could account for our results. However, the combination of the lab data and the industry data constitute more robust evidence about licensing as a safeguard, by including evidence on the price paths, subsequent profits, as well as the
actual behavior of firms. Taken together, these are not consistent with the other explanations.

6. Conclusions and Limitations
Two complementary studies have been presented to test the contention that “invited” competition is a safeguard for buyers’ specific investments. The specific institutional mechanism to implement this safeguard was the introduction of a licensee as a competitor. Below, we expand on the substantive and methodological implications of our work.

6.1 The Economics of Safeguards
The fundamental economic issue addressed here concerns the means by which firms commit to nonopportunistic behavior ex post. Traditionally, TCA work on this issue has focused on efficiency gains from crafting appropriate safeguards. While our work is in this tradition, it exposes the importance of the trade-off between monopoly rents and efficiency. Notice that our monopolist firm faces a trade-off between enlargement of the market and erosion of monopoly rents. In Figure 3, we see that for sufficiently high economic value, the introduction of the licensee leaves the monopolist worse off regardless of the level of sunk costs. The erosion of rents is simply not offset enough by market enlargement.

This trade-off is beginning to be explicitly considered in the literature. Helper and Levine (1992) offer a model of industrial buyers with large monopoly rents who sacrifice efficient relationships with suppliers on account of this trade-off. However, apart from the present data, there is no empirical evidence on these matters. Hopefully, future work will pick up on these issues, and begin to redress the growing imbalance between theoretical accounts and evidence.

One line of inquiry prompted by our results would be to use different implementations of the incumbent’s monopoly position. In order to be faithful to the spatial location model in Dutta (1990), our firms do not choose location(s) endogenously. More complex formulations are possible, including endogenous location choice, entry, and the like. We know from existing analytic models that their predictions are quite sensitive to their specific structure. Are our lab results robust across these other formulations?

6.2 Methodological Implications
Experimental markets offer considerable promise for assessing TCA predictions. The dominant methodological tool for empirical work in TCA has been the cross-sectional industry questionnaire and/or archival data. As our own results demonstrate, the lab can complement the traditional approach. It enables us to work directly with the causal mechanisms, and disentangle alternative explanations. Some specific suggestions for future studies can be gleaned from our experience.

To begin, experimental markets are better suited for assessing subtle multiperiod effects like the opportunistic pricing behavior studied in our experiment. It is extraordinarily difficult to get industry data on multiperiod phenomena. Other multiperiod mechanisms are prominent in the TCA literature and could
be studied with this approach. For instance, the Klein and Leffler (1981) repeat-purchase mechanism is widely cited in TCA models, but has never been subjected to empirical verification.

Of course, the precision and control afforded by market experiments also incurs some costs. A prominent disadvantage is that the implemented constructs are fairly narrow in scope. For instance, specific investments were implemented as the one-time dollar costs of adapting the purchased component into the end product. This does not capture other interpretations of the construct, such as social asset specificity or learning by doing. Likewise, opportunism is also defined narrowly as price hikes which exploit locked-in buyers. Other forms of opportunism such as delivery-time delays, quality shading, or perfunctory compliance were not implemented. Each of these interpretations need to be implemented in separate studies. We caution that a laboratory market with "noisy" implementations that combine multiple interpretations would be self-defeating.

A subtler limitation of market experiments is more difficult to overcome. Recall that our subjects did not require any knowledge of the institutional features of licensing beyond that provided in the instructions. However, this is not always the case. If the hypothesis being investigated involves a choice between institutional alternatives (e.g., outsourcing versus internal production), then the instruction task is more difficult. Indeed, it may not be possible to acquaint lab subjects sufficiently to implement these decisions in experimental markets. Experimental market researchers have spent a good deal of effort sorting through these issues (see Plott, 1989, for an extended discussion), and future research must pay close attention to these discussions.

Appendix 1: Sample Instructions to Subjects
The instructions to the subjects are reproduced here. The “General Introduction” was seen by all subjects. The “Market Description” varied according to the role of the subject; we show the text provided to licensors. The description of “Your Tasks in the Experiment” also varied depending on whether a licensee was present; we show the text provided to the duopolist subjects. The “Market Characteristics” tables (Tables A.1 and A.2) also varied by subject. We show the tables for subjects in the condition with high economic value (V2), low specific investments (I1), and two suppliers (S2).

A1.1 General Introduction
Welcome to this experiment. As a participant in this experiment you will act as a seller of a product. You will be given a description of the market, i.e., a description of the buyers and the other seller. Your role as a seller will be to quote a price given the market description. Based on the price you quote you will make some profit (i.e., price times the number of buyers who buy from you). Your profit level will depend on how appropriately you price the product after you have read the market description.

You will be paid according to the profits you make. So please read the following market description and the specific task description carefully because you
Table A.1. Buyers’ Value and Costs for Purchases from the Firm in California

<table>
<thead>
<tr>
<th>Buyer; Firm; Location</th>
<th>First-Time Purchase</th>
<th>Second Purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
<td>CZ_I</td>
</tr>
<tr>
<td>Mr. Olson; SAIL; CA</td>
<td>120</td>
<td>2.2</td>
</tr>
<tr>
<td>Mr. Reiz; TRAL CA</td>
<td>120</td>
<td>4.1</td>
</tr>
<tr>
<td>Mr. Collins; XTE AZ</td>
<td>120</td>
<td>5.5</td>
</tr>
<tr>
<td>Mr. Miller; AML OR</td>
<td>120</td>
<td>8.3</td>
</tr>
<tr>
<td>Mr. Goldman; BIS NE</td>
<td>120</td>
<td>11</td>
</tr>
<tr>
<td>Mr. Rooney; SIM TX</td>
<td>120</td>
<td>16.5</td>
</tr>
<tr>
<td>Mr. Ramsy; RIG TX</td>
<td>120</td>
<td>16.5</td>
</tr>
<tr>
<td>Mr. Feick; REEL KS</td>
<td>120</td>
<td>22</td>
</tr>
<tr>
<td>Mr. Wies; LEM MN</td>
<td>120</td>
<td>24.8</td>
</tr>
<tr>
<td>Mr. Gentry; NES OH</td>
<td>120</td>
<td>27.5</td>
</tr>
<tr>
<td>Mr. Rogers; TICO NY</td>
<td>120</td>
<td>28.8</td>
</tr>
<tr>
<td>Mr. Hill; CAM ME</td>
<td>120</td>
<td>30.8</td>
</tr>
</tbody>
</table>

Note: V is economic value; CZ\_I is transportation cost; I is control panel development cost.

can make more money if you quote an appropriate price. You will participate in a number of markets with similar characteristics as practice runs (i.e., six practice runs). After the practice runs you will get to play for real money. The amount you will get at the end of the experiment will be the total profit you make in all the markets you play for real money.

The currency in these markets is francs. You will be paid in dollars. Each dollar is worth 100 francs to you.

Note: After reading the following market description and then the task description, if you have any clarifications please ask the experimenter before you start quoting prices in the different markets.

A1.2 Market Description

*Your Firm:* You are one of the two suppliers of a type of transformer and located in California. The other supplier is a firm whom you have licensed to produce the same type of transformer and from whom you charge a royalty of 10% on his unit selling price. Your licensee is located in New York. Both you and
Table A.2. Buyers’ Value and Costs for Purchases from the Firm in New York

<table>
<thead>
<tr>
<th>Buyer; Firm; Location</th>
<th>First-Time Purchase</th>
<th>Second Purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value minus costs</td>
<td>Value minus</td>
</tr>
<tr>
<td></td>
<td>( V - CZ_I - I )</td>
<td>( V - CZ_I - I )</td>
</tr>
<tr>
<td>Mr. Olson; SAIL; CA</td>
<td>120 30.8 60 29.2</td>
<td>120 30.8 0 89.2</td>
</tr>
<tr>
<td>Mr. Reiz; TRAL; CA</td>
<td>120 28.9 60 31.2</td>
<td>120 28.9 0 91.1</td>
</tr>
<tr>
<td>Mr. Collins; XTE; AZ</td>
<td>120 27.5 60 32.5</td>
<td>120 27.5 0 92.5</td>
</tr>
<tr>
<td>Mr. Miller; AML; OR</td>
<td>120 24.9 60 35.1</td>
<td>120 24.9 0 95.1</td>
</tr>
<tr>
<td>Mr. Goldman; BIS; NE</td>
<td>120 22 60 38</td>
<td>120 22 0 98</td>
</tr>
<tr>
<td>Mr. Rooney; SIM; TX</td>
<td>120 16.5 60 43.5</td>
<td>120 16.5 0 103.5</td>
</tr>
<tr>
<td>Mr. Ramsy; RIG; TX</td>
<td>120 16.5 60 43.5</td>
<td>120 16.5 0 103.5</td>
</tr>
<tr>
<td>Mr. Felck; REEL; KS</td>
<td>120 11 60 49</td>
<td>120 11 0 109</td>
</tr>
<tr>
<td>Mr. Wies; LEM; MN</td>
<td>120 8.3 60 51.7</td>
<td>120 8.3 0 111.7</td>
</tr>
<tr>
<td>Mr. Gentry; NES; OH</td>
<td>120 5.5 60 54.5</td>
<td>120 5.5 0 114.5</td>
</tr>
<tr>
<td>Mr. Rogers; TICO; NY</td>
<td>120 4.1 60 55.9</td>
<td>120 4.1 0 115.9</td>
</tr>
<tr>
<td>Mr. Hill; CAM; ME</td>
<td>120 2.2 60 57.8</td>
<td>120 2.2 0 117.8</td>
</tr>
</tbody>
</table>

Note: \( V \) is economic value; \( CZ_I \) is transportation cost; \( I \) is control panel development cost.

the licensee sell the same product to a set of buyers located across the country. There are other types of transformers as well.

Your Profit: Your profit will depend on two factors. The first factor is the price (which you will quote) times the number of buyers who will buy from you. The second factor is the royalty payment of 10% on your licensee’s profit.

Buyers Description: Your buyers are representatives of firms which produce electrical generators and use either your transformer or that of your licensee as one component in their final product offering, i.e., in their generators. They purchase these transformers in each of two periods. Your buyers may buy at most one unit of the product in the initial period (period 1) and then again at most one unit of the product in the second period (period 2). In order to incorporate your transformer or that of your licensee’s in their product they have to initially (period 1) invest in resources (e.g., manpower) to develop control panels. These control panels are specific to your transformer and the transformer made by your licensee, i.e., they can be used only with your firm’s
transformer and the transformer sold by your licensee, but cannot be used with
the other types of transformers offered by other firms.

Similarity Across Buyers: All the buyers have the same economic value for
the product they buy from you or from your licensee.

What is economic value? Roughly speaking it is the additional money they
make by using your product or your licensee’s. More precisely, the buyer’s
economic value is defined as the increase in unit selling price for the generator
that the buyer receives as a result of incorporating your transformer or that of
your licensee.

All the buyers also incur the same initial development cost in period 1 to
develop the control panel before they can use either your product or that of
your licensee.

Differences Across Buyers: The buyers are located in different parts of the
country and they incur different transportation costs whether they purchase the
product from you or your licensee.

Buyers’ Initial Purchase Decision: The buyers will decide to purchase the
product initially only if their expected net value for the product exceeds zero.

What is expected net value? Expected net value is defined as the buyers’
economic value for the product over the two periods, minus their initial control
panel development cost, the transportation cost incurred by them when they buy
in the first period, the transportation cost incurred by them again when they buy
in the second period, the price you or the licensee quote in the first period, and
the price the buyers expect you or the licensee to quote in the second period.
They expect competition between the two suppliers to keep down any price
hike in the second period.

Who will the buyers buy from initially? The buyers will buy from the supplier
from whom they get a higher expected net value.

For example, Mr. Kravetz from LATEX, located in Washington state, has an
economic value of 90 francs for each unit of the transformer that he purchases
either from you or your licensee, and incurs an initial control panel development
cost of 65 francs before he can use your product or that of your licensee. Mr.
Kravetz, however, incurs a transportation cost of 7.5 francs each time he
purchases the product from you, but incurs a transportation cost of 15 francs
each time he purchases the product from your licensee.

Mr. Fitzgerald from RAMS, located in New York, has the same (i.e., as
Kravetz) economic value of 90 francs for each unit of the transformer that he
purchases either from you or your licensee and incurs the same (i.e., as
Kravetz) initial control panel development cost of 65 francs before he can use
either your product or that of your licensee. However, Mr. Fitzgerald incurs a
transportation cost of 20 francs each time he purchases the product from you
but a transportation cost of only 5 francs each time he purchases the product
from your licensee (since your licensee is located in New York).

Will Kravetz or Fitzgerald Buy At All? For example, if you quote a price of
45 francs in the first period and both Kravetz and Fitzgerald expect that you
will quote 45 francs again in the second period, then Mr. Kravetz from LATEX
will buy the product from you because his expected net value for the product
is greater than zero (i.e., $2 \times 90 - 65 - 2 \times 7.5 - 45 - 45 = 10$). However, Fitzgerald will not buy from you because his expected net value for the product with respect to you is less than zero (i.e., $2 \times 90 - 65 - 2 \times 20 - 45 - 45 = -15$).

**Who Will Kravetz or Fitzgerald buy from in the initial period?** Kravetz or Fitzgerald will buy from the supplier who they (i.e., buyers) think will give them a higher expected net value.

For example, if both you and the licensee quote 45 francs in the first period and Kravetz and Fitzgerald both expect that you and the licensee are likely to quote 45 francs again in the second period, then Kravetz from \textsc{latex} will buy the product from you because his expected net value for the product is greater if he buys from you (i.e., $2 \times 90 - 65 - 2 \times 7.5 - 45 - 45 = 10$) than if he buys from your licensee (i.e., $2 \times 90 - 65 - 2 \times 15 - 45 - 45 = -5$).

However, Mr. Fitzgerald from \textsc{RAM} will not buy from you but will buy from your licensee because his expected net value for the product is less if he buys from you (i.e., $2 \times 90 - 65 - 2 \times 20 - 45 - 45 = -15$) than if he buys from your licensee (i.e., $2 \times 90 - 65 - 2 \times 5 - 45 - 45 = 15$).

**Buyers Repeat-Purchase Decision:** Buyers will buy from you or the licensee again in the second period only if their second-period net value is greater than zero.

**What is second-period net value?** Second-period net value is defined as the buyers' economic value for the product in the second period minus the transportation cost he incurs when he buys either from you or your licensee and the price quoted by you or the licensee in the second period.

**Who will the buyers buy from in the second period?** The buyers will buy from the supplier who gives them a higher second-period net value.

For example, if you quote a price of 45 francs in the second period but the licensee quotes a price of 30 francs in the second period, then Kravetz will not buy from you because his second-period net value is greater if he buys from your licensee (i.e., $90 - 15 - 30 = 45$) than if he buys from you the licensor (i.e., $90 - 7.5 - 45 = 37.5$). Thus even though Kravetz bought from you in the first period, he switches to your licensee in the second period because the licensee gives Kravetz a better deal in the second period. Note that as long as he is buying from the licensee in the second periodKravetz does not have to incur any fresh control panel development cost.

Fitzgerald will also not buy from you because his second-period net value is greater if he buys from the licensee (i.e., $90 - 5 - 30 = 55$) than if he buys from you the licensor (i.e., $90 - 20 - 45 = 25$).

A.1.2.1 Summary of Factors Affecting Buyers' Purchase Decision. The factors that affect buyers' purchase decision in the first period are as follows:

1. The sum of buyers' economic value for your product or that of your licensee's in the first period (EV1) and in the second period (EV2). The economic value is the same in each period. See table on market [shown here as Tables A.1 and A.2].
2. The initial cost to develop control panels with respect to you and the
licensure, before they can use your product or that of your licensure, say $F$. See table on market.

3. The transportation cost incurred in period 1 (C1) and in period 2 (C2) when the buyers buy from either you or the licensure. Transportation cost is the same in each period. See table on market.

4. The actual price you or the licensure quote in the first period (this is your choice and your licensure's choice).

5. The price the buyers expect you or the licensure to quote in the second period (say EXP2). The buyers expect that competition between you and your licensure will keep down any price hike in the second period (recall that buyers have a higher second-period net value because they do not incur any control panel development cost when they buy a second time).

6. The buyers will buy from the supplier who they think will give them a higher expected net value (i.e., EV1 + EV2 - F - C1 - C2 - P1 - EXP2).

Factors that affect buyers' purchase decision in the second period are:

1. The buyers' economic value in the second period (EV2) for your product or that of your licensure's. See table on market.
2. The buyers' transportation cost in the second period (C2) with respect to you or your licensure. See table on market.
3. The actual price (P2) quoted by you or your licensure in the second period (this is your choice and your licensure's choice).
4. The buyers will buy from the supplier who will give him a higher second-period net value (i.e., EV2 - C2 - P2).

A1.3 Your Tasks in the Experiment

1. Your tasks in one market:
   
   (a) You quote a price for the first period and at the same time the licensure quotes a price too. The experimenter then informs you of your profit in the first period (this consists of price times the number of buyers who have bought from you and the royalty of 10% which you get on the licensure's unit selling price) and the licensure's price and profit (which is price times the number of buyers who buy from him minus the royalty he pays you).

   (b) You then quote a price for the second period. The experimenter then again informs you of your profit in the second period (this consists of price times the number of buyers who have bought from you and the royalty of 10% which you get on the licensure's unit selling price) and the licensure's price and profit (which is price times the number of buyers who buy from him minus the royalty he pays you).

   (c) This completes your task for this market.

   (d) Your profit in this market is the sum of the profit you make over the two periods, based on the prices you quote.
2. You will play six practice runs in six different markets which have similar characteristics.
3. After the practice runs you will play for real money in a number of markets which are similar to the ones you have encountered earlier.

Appendix 2: Decision Rules for Buyers

A2.1 Robot Buyers
Our buyers are "robots" that employ a decision rule based on Dutta (1990) and Farrell and Gallini (1988). In their models, buyers are atomistic price takers, although they do take into account the supplier's likely pricing behavior. Critically, there is no strategic bargaining. In this respect, past experiments have found that when subjects become aware that their trading partners are making large profits in comparison to them, strategic bargaining behavior is induced. Subjects will forgo trade to drive prices down, rather than take smaller profits (Smith, 1980: 357-60; Isaac and Plott, 1981: 448-59). This is problematic because the theoretical models do not incorporate bargaining. Previous experimental work has also resorted to robot buyers for these reasons (e.g., Isaac and Reynolds, 1988; Guler and Plott, 1988).

A2.2 Buyers' First-Period Purchase Decision Rule
A purchase occurs if and only if the buyer's net gain over the relevant horizon is positive. For a first-period purchase, this horizon consists of two periods. The formula for the i-th buyer in the monopolist conditions is \( 2V - 2CZ_i - P_1 - E(P_2) - I \). Here, \( V \) is the economic value in use of the product, \( CZ_i \) is the transportation cost incurred by buyer \( i \) for each purchase, \( P_1 \) is the announced first-period price and \( I \) is the first-period sunk investment. \( E(P_2) \) is the expected second-period price, and is set equal to \( P_1 + I \). This is based on the two theoretical studies cited above.

In the duopoly conditions, the same formula is used, except that the purchase will be made from the supplier who offers the greater expected positive net value. The formula compares the gain of \( (2V - 2CZ_{i1} - P_{11} - E(P_{12}) - I) \) for a purchase from the licensor, with a gain of \( (2V - 2CZ_{i2} - P_{21} - E(P_{22}) - I) \) for a purchase from the licensee. Note the transportation cost and prices are different for each of the two suppliers. Here, \( CZ_{i1} \) is buyer \( i \)'s transportation cost from the first firm's plant, and \( CZ_{i2} \) is the transportation cost from the second firm's plant. \( P_{11}(P_{21}) \) is the announced first-period price of the first (second) firm. \( E(P_{12})\{E(P_{22})\} \) is the expected second-period price of the first (second) firm. Unlike the monopoly case, these second-period prices are set equal to their announced first-period price \( E(P_{12}) = P_{11} \) and \( E(P_{22}) = P_{21} \), as per the theoretical studies cited.

A2.3 Buyers' Second-Period Purchase Decision Rule
Here, the relevant horizon is just one period, and a purchase occurs if and only if that buyer's net value is greater than or equal to zero. In the monopolist conditions, purchases occur if \( V - CZ_{i1} - P_1 \geq 0 \). Notice the absence of a new set-up cost here. For the duopoly conditions, the supplier offering the
greater positive net value will be selected (i.e., \( V - CZ_{11} - P_{12} \) from the first firm is compared to \( V - CZ_{12} - P_{22} \) from the second firm). \( P_{12} \) and \( P_{22} \) are the announced second-period prices of the first and second firms, respectively.

A2.4 Cover Story

Although a confederate played the role of the 12 buyers and applied the formula derived above, the subjects were told that buyers were in another room making their purchase decisions. In post-study briefings, we did not find that subjects guessed the presence of formula-based rather than live buyers. Such cover stories are uncommon in experimental markets, but are the norm in social psychology experiments. We used the cover story to minimize potential demand characteristics. This term refers to aspects of a study’s design and procedures that might lead the subject to guess the hypotheses under study, and result in subjects behaving in a manner that they think is consistent with the experimenter’s wishes. In offering a social psychologist’s critique of experimental economics studies, Kahneman (1988) notes that the lack of cover stories renders demand characteristics a real possibility, and suggests that experimental economists need to pay more attention to this issue. Our cover story minimizes the possibility that subjects would guess the wishes of the experimenter.

References


