Sustainable Pioneering Advantage: At What Cost?

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Abstract

In this research we investigate the impact of pioneering on profit, as well as on the underlying components of profit, that is, price and average cost. Consistent with previous theoretical and empirical research we hypothesize that pioneers have a sustainable demand (price or market share) advantage. Prior theoretical and empirical work that examines the effect of pioneering on cost is far more ambiguous. With respect to overall average costs, we conjecture that existence and knowledge of a pioneering-induced demand advantage leads pioneering firms to compete away the demand-side rents. That is, firms spend more money, less efficiently, to win the race to entry and the ensuing demand-side premium. This logic leads us to hypothesize, on average, both higher costs and no sustainable long-term profit advantage for pioneering firms. We first test these hypotheses in the setting of consumer goods. We then examine the robustness of these findings across industry settings. Finally, we examine conditions where we hypothesize the possibility of a positive pioneering-profitability relationship.

In empirically testing our predictions we address an issue of conceptual and methodological interest. That is, whether the entry timing choice should be modeled as exogenous or endogenous. Because order of entry is itself a firm fixed effect, traditional differencing approaches that control for omitted fixed effects cannot be applied. Instead, we use the instrumental-variable estimation procedure developed by Hausman and Taylor (1981) and extended by others.

Our findings indicate that, on average, pioneers have no long-term profit advantage. In particular, pioneering provides a price advantage, but this advantage is more than offset by higher average costs. This finding of no profit advantage due to pioneering, per se, holds both for consumer and industrial goods. However, we do find some conditions where we show a positive relationship between pioneering and profitability. Our results also indicate that entry timing is endogenously determined and that failure to account for the endogeneity of the entry timing decision of whether to pioneer or follow leads to significantly biased results.
1. Introduction

Imagine that firms could introduce an innovative new product offering, e.g., “widgets.” Further, suppose that these widgets exist as a natural resource on a deserted island. Introducing these widgets simply requires a firm to reach the island and get the widgets from the island to market. According to the extensive literature on order-of-entry effects, if the widget market is viable, the first firm to get the widgets to market will receive a lasting demand-side premium. That is, it will either receive a price premium relative to competition for a fixed level of sales, or a market share premium relative to competition for a fixed level of price.

Evidence in support of a demand-side premium for first entrants is both varied and robust. There is considerable consumer behavior-based theoretical evidence in support of this effect, independent of any particular industry structure. For example, the premium could be due to higher risk associated with buying a later entrant’s product (Schmalensee 1982) or shifts in consumer preference structures in the direction of the first entrant (Carpenter and Nakamoto 1989). Similarly, Kardes and Kalyanaram (1992) show that pioneers can influence the way consumers learn about products, leading to a consumer-based pioneering advantage, while Gabszewicz et al. (1992) develop a learning model that produces a loyalty induced pioneering advantage. Likewise, Ratchford’s (1997) model of the economics of consumer knowledge provides a demand-side explanation for pioneering advantage. That is, knowledge about the pioneer lowers consumer search costs and therefore the “full price” of the pioneer’s product relative to a subsequent entrant. Another search-based explanation of pioneering advantage is proposed by Hauser and Wernerfelt (1990), who suggest that entry timing is related to the likelihood of inclusion in the consumer’s consideration set, and therefore is related to likelihood of choice. Yet another demand-side account for pioneering advantage proposed by Samuelson and Zeckhauser (1988) is the possibility of a status quo bias, which favors the incumbent (pioneering) brand.
In addition to these theoretical accounts, empirical findings (e.g., Robinson and Fornell 1985; Urban et al. 1986) strongly suggest an inverse relationship between order of entry and market share, i.e., a market share premium to pioneering firms. In fact, evidence supporting this inverse relationship is so extensive that it now exists as an “empirical generalization” in the marketing literature (Kalyanaram et al. 1995).

Given this prior work, in this research we start with (and test again) the premise that pioneering yields a demand-side advantage. However, our interest in the consequences of the entry timing choice goes beyond this demand-side investigation. In particular, we are interested in identifying whether pioneering, per se, provides a sustainable overall performance advantage. That is, does the strategic choice of pioneering, in and of itself, provide a barrier that enables superior overall firm performance after subsequent competitive entry?

This research focus suggests three things about our ensuing analysis. First, because we want to examine whether the act of pioneering itself erects a competitive barrier, our initial focus is on exploring the effects of entry timing unconditional on industry structure. Further, as noted, much of the theory behind demand-side pioneering advantages is industry-free. Second, because we are interested in sustainability, we want to study long-run pioneering performance, i.e., after competitive entry has occurred. Clearly, the first entrant will have a period of monopoly profits. However, our main interest is in the relative performance of pioneers and subsequent entrants while they compete head-to-head. Third, since we are interested in overall performance, i.e., profitability, we need to explore more than the demand-side implications of pioneering. It is certainly the case that overall performance will be influenced by both demand- and supply-side implications of pioneering.

Consequently, in this research we ask a new question. If a demand-side advantage accrues to pioneers, as suggested above, what does this imply about profitability? All else equal (e.g., costs), it would imply a profit advantage for pioneers. However, reviews of the literature

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1 The Kalyanaram et al. (1995) paper even suggests that the one significant piece of evidence against a pioneering market share advantage (Golder and Tellis 1993) can be reinterpreted to show that surviving pioneers obtain a market share advantage.
repeatedly point to profit implications as one of the key unanswered questions about the effects of pioneering (e.g., Lieberman and Montgomery 1988; Kerin et al. 1992; Robinson et al. 1994). In a recent follow-up to their award winning paper on first-mover advantage (1988), Lieberman and Montgomery (1998) cite empirical tests of profit performance as one of the six remaining key issues in the domain of entry timing research. Presumably, the profitability question is important because “all else” is not safely assumed to be equal for pioneers relative to followers. Further, to assume that market share benefits of pioneering imply higher profits would perhaps be a mistake given complexities revealed by empirical findings on the market share-profit relationship (e.g., Jacobson 1988; Boulding and Staelin 1993).

To examine the profit implications of entry timing, we first examine the effects of entry timing on cost. Returning to our widget example, imagine that firms are aware that the first firm to “manufacture” (obtain) and market these widgets will receive a demand premium. This premium provides a major incentive for firms to win the race to market for widgets. Of interest is, how much would firms be willing to spend to win this race? An equilibrium argument implies that a firm would “spend” just up to the amount of the demand premium it receives relative to the next entrant. As argued elsewhere in the strategy literature (e.g., Wensley 1982; Erickson and Jacobson 1992; Boulding and Staelin 1995), if knowledge about a relationship exists, without what Wensley refers to as “isolating mechanisms,” firms will compete away the returns implied by this relationship. Theoretical and empirical evidence suggests pioneering, per se, yields demand-side “isolating mechanisms.” However, there is no similar evidence, a priori, suggesting the existence of cost-side “isolating mechanisms” due to pioneering. This leads us to conjecture that demand-side returns to pioneering are competed away in the form of higher costs associated with pioneering. In particular, we conjecture that in the long-run pioneers’ costs are higher than followers’ and their profits are no higher.

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2 Unpublished work (Boulding and Moore 1987; Srinivasan 1988) suggests that pioneers do not obtain a profit advantage.

3 As we later elaborate, we envision a tournament with descending demand premium prizes, rather than a “winner take all” race to entry.
To fully explore the mechanisms underlying the conjectured profit outcome, we begin with an in-depth examination of the demand, cost, and profit implications of the entry timing decision. We then focus our attention on the robustness of our observed entry timing-profit relationship. We do this in three ways. First, we examine the robustness of this finding across different model specifications. Second, we look at the entry-timing profit relationship across industry settings, i.e., consumer and industrial goods. Third, we explore market conditions which we hypothesize will alter the previously observed “average” effect of entry timing.

In addition to our substantive and conceptual concerns about the effects of entry timing on firm performance, we focus on a related conceptual issue that becomes an important methodological issue in empirical entry timing research. Specifically, we test and control for the potential endogeneity of the entry timing decision. This is a theoretical issue raised specifically in the pioneering domain by Lieberman and Montgomery (1988) and more generally, in examining the effects of strategic actions on performance by Schmalensee (1989). More recently, Lieberman and Montgomery (1998) cite the need for empirical investigation of entry timing endogeneity as one of the six key remaining issues in entry timing research. They draw this conclusion after linking the “resource-based view” (e.g., Wernerfelt 1984; Barney 1986; Dierickx and Cool 1989; etc.) to the question of first mover advantage.

The basic issue is that firms’ resources and capabilities in all likelihood affect their choice of entry timing. If these same resources and skills have a subsequent direct affect on demand, cost, and profit, the resulting estimates of entry effects will be biased. Thus, the conceptual issue of endogenous entry timing becomes the classic empirical issue of controlling for unobserved firm effects (e.g., see Jacobson 1990). Because order of entry is itself a fixed factor, of primary concern here is controlling for unobserved fixed factors.4 Unfortunately, straightforward methods for controlling for unobserved fixed effects (e.g., Boulding and Staelin 1995) do not work since differencing the data also eliminates the observed fixed pioneering effect. Thus, we

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4 One need not worry about random errors. By definition, current random errors in explaining performance are uncorrelated with events (e.g., entry) in previous periods.
utilize the instrumental variable (IV) approach due to Hausman and Taylor (1981) that enables one to control for unobserved fixed effects while obtaining consistent estimates of an observed fixed effect. Moreover, this procedure allows us to test both whether pioneering is endogenous and whether the obtained IV estimates are themselves free from bias due to omitted fixed factors.

In sum, the focus of this paper is on the empirical relationship between entry timing and profitability. In particular, we want to better understand the underlying mechanisms that produce the observed “average” effect of entry timing on profitability due to the entry timing decision, per se. We then examine the robustness of this result across model specifications and industry settings. We also explore a limited number of conditions that moderate the observed “average” effect. Finally, we are careful to test and control for the possibility of endogeneity bias in our empirical estimation.

The remainder of the paper is organized as follows. First, we elaborate on our conceptualization and generate predictions about the effects of pioneering on demand, total average costs, and profits. We then summarize and formalize this conceptualization via specification of a system of equations that allows us to test our predictions. Next, we describe our data and the particular measures that enable estimation of our theoretical model. We then discuss estimation issues, with particular focus on the Hausman-Taylor (hereafter referred to as HT) estimation procedure, along with addressing issues of heterogeneity in pioneering effects and simultaneity in observed equilibrium prices, costs, and quantities. In the result section we first present results for the “average” effects, including analysis that checks the robustness of our findings, followed by an extension to different industry settings. We also briefly explore conditions that moderate the observed average effect of entry timing on profitability in our sample. We conclude by discussing the implications of our findings.

### 2. The Pioneering-Performance Relationship

We begin our discussion by noting that in accordance with economic theory any pioneering advantage must be reflected in a firm’s demand function and/or supply function, and
should be measured accordingly. Based on this view, we decompose the effect of pioneering on firm performance into its price and cost effects.

Pioneering and Demand

As discussed, a considerable amount of theoretical work suggests a demand-side pioneering advantage. Extensive empirical evidence also suggests a demand-side pioneering advantage, though Golder and Tellis (1993) argue that this advantage is upward biased due to survivor bias. A meta-analysis by VanderWerf and Mahon (1997) did not find evidence of a survivor bias. Still, to state it conservatively, all evidence seems to indicate that surviving pioneers obtain a demand premium. We believe we can replicate this result in the context of a formal demand function, and offer the following hypothesis:

\[ H_1: \text{Market pioneers have higher prices, all else equal.} \]

In stating this, we recognize that observed prices are an equilibrium result of underlying supply and demand. Consequently, any empirical test of this hypothesis must control for changes in price that reflect shifts in firm costs.

Pioneering and Costs

We begin with the assumption that pioneering leads to a demand-side advantage. We then conjecture that knowledge of this demand advantage leads to a race to entry that dissipates these economic rents via higher costs of pioneering. We also examine whether conjectures can be made about the effects of pioneering on costs without this “race to entry” logic.

Knowledge of a sustainable price advantage for pioneering firms should entice firms to invest more heavily, or perhaps take shortcuts (i.e., invest with incomplete information), in an effort to win the race to market and the ensuing demand premium. In thinking of this entry race we envision an economic tournament with a bigger demand “prize” for being first, rather than a “winner take all” innovation race as sometimes modeled in the economics literature (e.g., Reinganum 1989). The “winner takes all” model would be appropriate in markets with
defendable patents. However, this “winner takes all” assumption has been criticized as inconsistent with empirical evidence. For example, Lieberman and Montgomery (1988) suggest that patents are important in only a few industries (e.g., pharmaceuticals) because they are typically easy to circumvent.

In sum, knowing that a demand premium awaits the first entrant, firms should be willing to make more expensive investments in uncertain process technologies to win the race to entry. The logic here is essentially an efficient markets argument. The increased cost of pioneering should in the long run offset the demand premium that accrues to the market pioneer thereby competing away the demand-side rents to pioneering. Thus, we conjecture:

C2: Pioneering firms have higher average costs, all else equal.

Again, we recognize that observed costs are an equilibrium outcome of underlying supply and demand. Therefore, any test of this conjecture must control for changes in cost due to changes in underlying demand. Also, note the distinction of “conjecture” from “hypothesis.” As discussed below, the results on costs are in some sense an empirical question.

The conjecture above depends on the logic of a race to entry that erodes economic rents. However, one might reasonably ask what happens to costs of the pioneering firm if there is no race to entry. In particular, what if, as argued by Alchian (1950), innovation is due to luck? If so, pioneers do not face cost-side competition that increases their cost of entry. Thus, it is reasonable to investigate whether, more generally, there are pioneering cost advantages or disadvantages.

Lieberman and Montgomery (1988) suggest three sources of first mover advantage: “(1) technological leadership, (2) preemption of scarce assets, and (3) buyer switching costs” (p. 41/42). They also articulate four sources of pioneering disadvantage: “(1) the ability to ‘free-ride’ on first-mover investments, (2) resolution of technological and market uncertainty, (3) technological discontinuities that provide ‘gateways’ for new entry, and (4) various types of ‘incumbent inertia’ that make it difficult for the incumbent to adapt to environmental change” (p.
Thus, the following discussion allows us to explore the cost implications of entry under a pure “luck” model.

We first examine the potential for pioneering cost advantages. Learning curve effects fall under the category of technological leadership. Theoretical work indicates that first-mover learning benefits are diminished by inter-firm diffusion of technology (Ghemawat and Spence 1985; Lieberman 1987) or information (Fershtman et al. 1990). Further, empirical evidence suggests that process technology diffuses fairly rapidly, i.e., within a year (Mansfield 1985), and enables late entry (Lieberman 1982). Based on their synthesis of empirical and theoretical evidence, Lieberman and Montgomery conclude that “It is now generally recognized that diffusion occurs rapidly in most industries, and learning based advantages are less wide-spread than was commonly believed in the 1970s.” (p. 43). Note that learning is not a function of pioneering, per se, but rather, time in market or cumulative production. Therefore, a pioneering learning advantage could be eroded over time as later entrants approach (in a limit sense) the pioneer’s degree of experience. For this reason, in our empirical model we will control for time in market for all firms.

Similar to learning, patents obtained by pioneers provide potential technological leadership. However, as previously noted, Lieberman and Montgomery (1988) suggest that in reality patents offer very little protection that can yield a cost advantage. In fact, in a study consisting of 48 innovative chemical, electrical, and pharmaceutical products, Mansfield et al. (1981) found that imitating firms were able to match patented innovations, at a rate of 65% of the innovator’s cost.

In sum, theoretically, technological leadership could yield a cost advantage. However, limited empirical evidence suggests that these advantages rapidly dissipate. Thus, although an empirical question, one might conjecture that technological leadership does not confer a long run cost advantage to pioneering firms.
Next, we consider the possible cost advantage that accrues to pioneers due to preemption of scarce assets. In considering cost implications, this preemption could be in the form of production inputs such as raw material or labor. For non-mobile assets (e.g., land), the pioneering firm can earn Ricardian rents. Main (1955) cites the nickel industry as an example of such preemption. The pioneering firm can also earn rents from mobile assets (e.g., labor) if it can decrease the mobility of the asset, e.g., a favorable long term supply contract. However, in practice, input assets may be fairly mobile. For example, Guasch and Weiss (1980) argue that later entrants face lower labor costs because they can hire away employees from the earlier entrants who have made the investments in screening and training. Thus, with mobile input assets, the pioneering firm can actually face a cost disadvantage.

Alternatively, preemption could be in the form of investment in plant and equipment that deters entry. However, citing evidence by Gilbert (1986) and Lieberman (1987), Lieberman and Montgomery (1988) conclude “These investment tactics do not seem to be particularly important in practice” (p. 45). In sum, one might conjecture that unless the pioneering firm has “immobile” assets obtained under favorable terms, that preemption of assets does not necessarily confer a long run cost advantage upon pioneers.

Finally, we consider the possible pioneering cost advantage due to buyer switching costs. As discussed, the pioneering advantage due to buyer switching costs typically manifests itself as a demand-side advantage. However, it could also have cost implications with respect to the marketing costs associated with overcoming the pioneers advantage, i.e., at the margin marketing activities would be less effective for the following firms. Thus, for example, the per customer (average) advertising costs should be lower for the pioneering firm than later entrants. A fair amount of empirical evidence is consistent with the notion of a pioneering advertising advantage (e.g., Bowman and Gatignon 1996; Buzzell and Farris 1977; Comanor and Wilson 1974; Fornell et al. 1985). In the short run, the size of this advantage could be mitigated if followers are able to free-ride on the pioneer’s buyer education activities. However, in the long run, if buyer
education is no longer an issue and a pioneering demand advantage persists, we should observe a pioneering advertising cost advantage.\(^5\)

We now address the cost implications of pioneering disadvantages. Note that none of these arguments depend on our previous “race to entry” logic. We begin with free-riding effects. Generally speaking, this effect of benefiting or learning from the innovator leads to lower cost of imitation relative to innovation. As indicated earlier, Mansfield et al. (1981) find the cost of imitation to be 65% of the cost of innovation. Based on the ability of followers to free-ride, Lieberman and Montgomery (1988) conclude that, generally speaking (i.e., exceptions may exist), costs of imitation are lower than those associated with innovation.

Another potential pioneering disadvantage is the follower’s ability to wait for resolution of technological uncertainties (e.g., industry standards). Choosing the dominant design standard as suggested by customer preferences is typically considered a demand-side issue. However, resolution of industry standards can have cost implications. In particular, resolution of industry standards allows the following firms to effectively focus their expenditures, while the pioneer may have to invest more in maintaining design and production flexibility that allows the pioneer to move in the direction of market demand.

Technological discontinuities represent another potential pioneering disadvantage. Empirical work by Bevan (1974) and Yip (1982) suggests that these discontinuities allow “gateways” to entry for followers. A particular “gateway” to entry is that more recent production technology has greater efficiency. Within the economics literature these production technology discontinuities are called “vintage effects” (Intrilligator 1992; McLean and Riordan 1989). They result in lower costs for the later entrant. Indeed, one might argue that if later entrants are aware of the sustainable demand-based advantage accruing to pioneers, they should be unwilling to enter a market unless they are more cost efficient and can therefore be competitive in the pioneer’s market. Further, recent theoretical work in marketing (Bohlmann 1997) suggests that

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5 In fact, though not reported herein, when we examine advertising costs we find a pioneering cost advantage.
under certain conditions the cost discontinuity associated with vintage effects can lead to a follower advantage.

Incumbent inertia represents the final potential pioneering disadvantage. Incumbent inertia can be both rational and “irrational.” The case for rational inertia is as follows. Firms make investments in specific production and delivery assets. That is, they have sunk costs. Thus, switching costs faced by the pioneer (e.g., disposal of existing processes) may make adoption of new practices less attractive than such practices would be for a later entrant. In particular, under conditions with fixed assets in place (i.e., the pioneer) incremental changes often look more attractive than wholesale changes. Therefore, the firm’s sunk costs may make it optimal for a firm to continue with less efficient production and delivery systems. Tang (1988) presents a formal model of rational inertia in the setting of the U.S. steel industry, where steel producers continued to invest in a demonstrably less efficient furnace technology. McMillan (1983) makes similar arguments in the setting of the health care industry.

In addition to rational inertia, firms can fail to adapt when, from an economic perspective, adaptation is appropriate. In particular, we point to the likelihood of stickiness in organizational practices and structures. Hannan and Freeman (1984) formally outline factors that lead to incumbent inertia. These factors include development of standard operating procedures and internal political considerations. These factors may cause firms to fail to recognize the need for adaptation. Moreover, even if firms recognize the need for change, inertia can interfere with implementation of change. For example, it is well known that organizations and their employees are highly resistant to change (e.g., Strebel 1996). In support of this statement, Cooper and Schendel (1976) examined 15 incumbents committed to adoption of new technologies. Of these, only two were successful in implementing the intended change, the other 13 were derailed by organizational inertia.

In summary, a variety of factors could lead to pioneering cost advantages or disadvantages. Based on these factors, Lieberman and Montgomery (1988) conclude “Unless the pioneer can protect its innovations through patents, copyrights, or secrecy, followers will
ultimately be able to duplicate these innovations at lower cost” (p. 54). Thus, there are certainly instances where one might expect lower costs for pioneers. However, as noted, evidence suggests that patents do not matter in most industries and that proprietary technology typically diffuses throughout an industry. Consequently, even if entry were based on a pure “luck” model, one might reasonably conjecture that, on average, we would not expect to observe a pioneering cost advantage. As a practical matter, first-movers are a mixture of firms with good luck and firms that won races to entry. Because we predict higher costs for the entry race winners and fail to predict a cost advantage for lucky firms, we maintain our stated conjecture that, on average, a pioneer’s costs are higher than those of later entrants’.  

**Pioneering and Profitability**

Our equilibrium argument suggests that the costs associated with pioneering should increase to the point where all rents that accrue from the consumer-based advantage have been competed away. Having said this, we again ask, what if innovation is due to luck? In this case, the innovator/pioneer would receive a demand advantage. Further, without a race to entry it is not clear that this advantage would be fully competed away via offsetting costs. However, in the event of a race to entry, we note the possibility of an interesting phenomenon. That is, every firm engaged in a race to entry makes an estimate of the demand prize available to the winner. As noted by Weigelt and Camerer (1988), “Economists have long recognized that entrants decide to enter new markets based on their expectations of post-entry profitability” (p. 446). Presumably, the firm with the largest estimate of the ensuing prize will spend the most money to win the prize. Of direct relevance here is the observed “winner’s curse” in bidding situations (Gilley et al. 1986). That is, the winning “entry bid” may, on average, be too high. 

Furthermore, work suggests that settings with fewer bidders exacerbate the winner’s curse.

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6 In fact, entry race winners may have lower overall costs due to unobserved resources and capabilities. We subsequently control for these unobserved resources and capabilities while identifying the cost of entry timing, per se.

7 Use of the “winner’s curse” logic assumes that there is a common value of pioneering across firms.
(Wilson 1977, 1992). Consequently, costs could more than fully offset the obtained demand premium in settings where only a few firms “bid” to become the first mover.\footnote{Firms that badly overestimate the demand returns to pioneering would then become failing pioneers.}

Thus, if innovation occurs due to luck, one could conjecture that pioneers are more profitable because they obtain a demand advantage without fully offsetting costs, although this itself is an empirical question. If, however, the pioneering firm wins a race to entry, one would observe no pioneering profit advantage if the firm correctly estimates the demand premium, and a pioneering profit disadvantage if the firm falls victim to the “winner’s curse.” In our view, the effect of pioneering on profits is an empirical question that depends on the proportion of innovation that occurs due to luck or deterministic effort. We take the position that the entry decision is more often due to deterministic effort than luck and thus offer the following conjecture:

\textbf{C}_3: \textbf{Pioneers’ profits are no greater than those of later entrants, all else equal.}

\section*{3. Model}

We now specify a model that allows us to test our hypotheses and conjectures. Because prices, costs, quantities, and profits are jointly determined in equilibrium, we specify a simultaneous system of three equations consisting of the following inverse demand function:

\begin{equation}
\begin{aligned}
P_{it} &= \beta_{01} \cdot Q_{it}^{\delta} \cdot \exp(\gamma_{i1} \cdot \text{Pion}_i + X_{it} \beta_1 + \alpha_{i1} + \eta_{1it}), \\
\end{aligned}
\end{equation}

\begin{equation}
\gamma_{i1} = \gamma_{Di} + \gamma_{01},
\end{equation}

the following average cost function:\footnote{Note that this functional form does not allow for a quadratic quantity term. When we relax the assumed form we are able to specify a quadratic term.}

\begin{equation}
\begin{aligned}
AC_{it} &= \beta_{02} \cdot Q_{it}^{\delta_2} \cdot \exp(\gamma_{i2} \cdot \text{Pion}_i + X_{2it} \beta_2 + \alpha_{2i} + \eta_{2it}), \\
\gamma_{i2} &= \gamma_{Ci} + \gamma_{02},
\end{aligned}
\end{equation}

and the following profit function:
\( \text{NI}_{it} = \beta_{03} \cdot Q_{it}^{\delta_3} \cdot \exp(\gamma_{13} \cdot \text{Pion}_{it} + X_{3it} \beta_3 + \alpha_3 + \eta_{3it}) \), where

\( \gamma_{13} = \gamma_{P_1} + \gamma_{03} \), with

\( P_{it}, AC_{it}, NI_{it} \) = firm i’s average price, average cost and net income, respectively, in year t,

\( Q_{it} \) = quantity sold in units by firm i in year t,

\( \text{Pion}_{it} \) = pioneering indicator variable, where \( \text{Pion}_{it} = 1 \) if a pioneer, otherwise \( \text{Pion}_{it} = 0 \),

\( X_{ji} \) = a vector of other factors in equation j,

\( \beta_{0j}, \beta_j, \gamma_{ip}, \gamma_{0i}, \gamma_{ci}, \gamma_{pi}, \gamma_{0j}, \delta_i \) = model parameters,

\( \alpha_{ji} \) = unobserved fixed factors, and

\( \eta_{ji} \) = unobserved random factors.

There are several elements worth noting about equations (1) to (3). First, the parameter \( \gamma_{01} \) is the parameter of interest with respect to our first hypothesis. This parameter captures the average, i.e., generalizable, effect of pioneering on demand (price). The parameter of interest with respect to our cost conjecture is \( \gamma_{02} \), which captures the average firm effect of pioneering on average cost. The parameter \( \gamma_{03} \) is the parameter of interest with respect to our profit conjecture. It captures the average firm effect of pioneering on profit.

Second, this specification acknowledges heterogeneity in the effects of pioneering across firms, i.e., see the firm specific parameter vectors \( \gamma_{0i}, \gamma_{ci}, \text{and} \gamma_{pi}, \) respectively. As we later indicate, we do not estimate these firm specific effects of pioneering, but control for their possible biasing effects on our estimate of the average effect. Related to this point, to obtain a consistent estimate of this average effect in our empirical analysis we want to ensure that the pioneering variables are independent of any empirical error term.

Third, with appropriate estimation (i.e., simultaneous) this formulation allows us to control for movement along a firm's demand curve that may occur due to underlying changes in supply (i.e., cost) and movement along a firm’s average cost curve that may occur due to underlying changes in demand. Thus, quantity is considered an endogenous variable in this specification. Of interest is whether pioneers have different demand and cost than later entrants.
due to shifts in the respective curves (i.e., holding quantity fixed). To understand the importance of controlling for movement along a curve, consider that in equilibrium, marginal revenue equals marginal cost. If, as hypothesized, pioneers obtain an outward shifted demand curve, then even without shifts in cost they should operate at a higher equilibrium marginal cost position. Thus, we must control for this possibility in our analysis.

Fourth, the functional forms of the equations are quite specific. Although they are consistent with earlier empirical work (e.g., Boulding and Staelin 1993), we later relax the assumed functional form. Moreover, we examine whether the profit results are robust to the profit measure employed in equation (3) by exploring whether the use of other measures of profitability change the substantive insights.

4. Data

Empirical research of the effect of strategic elements on firm performance should be addressed at the business unit level (Aaker and Jacobson 1987). In this research we use PIMS data on business units to test our hypotheses. The PIMS database has received much criticism (e.g., Anderson and Paine 1978; Ramanujam and Venkatraman 1984). However, work suggests that many of its perceived limitations can be eliminated due to the panel nature of PIMS data (e.g., Boulding and Staelin 1995). Moreover, PIMS provides the most diverse sample of industry data available in the public domain, with detailed descriptions of company, customer, competitor, and market factors.

Since we are interested in the long-term effects of pioneering on price and average cost, we limit our attention to business units that compete in mature and declining markets. Also, because previous research indicates that the effect of pioneering differs in consumer and industrial markets (Robinson 1988), we initially restrict our analyses to durable and non-durable consumer products. The final estimation sample contains data for 381 different business units with 1,162 observations that can be used for estimation after data transformations. After detailed analysis of equations (1) to (3), we broaden our setting to include firms selling industrial goods.
In choosing this sample we note an additional benefit deriving from our use of PIMS data. Specifically, our data are consistent, other than the longitudinal aspect, with data used in previous empirical work (e.g., Robinson and Fornell 1985; Moore et al. 1991) that examines the effects of pioneering on firm performance. In noting this benefit, we also note a potential drawback in using PIMS data. Golder and Tellis (1993) show that PIMS analyses yield results substantially biased in support of a pioneering advantage. This is because PIMS only includes data on surviving pioneers and because firms classified as pioneers in PIMS could in fact be misclassified early followers. Thus, we caution the reader that the results obtained herein are biased in favor of a pioneering performance advantage. While this bias works in favor of $H_1$ (pioneering demand-side advantage) it works against $C_2$ (pioneering cost-side disadvantage) and $C_3$ (no pioneering profit advantage). Thus, use of PIMS data makes tests of our conjectures about cost and profit more conservative. Moreover, of primary interest in this research is the effect of pioneering on profit.

Several variables relevant to our specified models are measured and reported in PIMS, but are disguised. This requires first transforming the disguised data to obtain consistent estimates. The log-first difference transformation to make these data usable suggested in Moore and Boulding (1987) and employed by Boulding and Staelin (1993) does not work, since pioneering itself is a fixed effect and would drop out in the differencing transformation. In the following paragraphs we describe the dependent and independent PIMS measures used and discuss the potential impact of the disguised variables on the estimation results.

**Dependent Variables**

All of the dependent measures in our structural equations (1) to (3) are disguised. First, PIMS does not contain a direct measure for price, $P_{it}$. However, a price index, $PI_{it}$, is available that satisfies the identity $PI_{it} \equiv P_{it}/P_{Bi}$, where $P_{Bi}$ is a firm-specific, time invariant, unknown base price. After linearizing by taking the log, the actual dependent price measure used to estimate (1) is

\[
\log PI_{it} \equiv \log P_{it} - \log P_{Bi},
\]
implying that the nuisance term, \( \log P_{B_i} \), is added to the fixed error term.

Second, PIMS reports no direct information on average cost \( AC_{it} \). However, in a manner similar to the derivation of the price index measure, one can calculate an average cost index, \( AC_{it} \) (see Appendix A for its derivation). After linearizing equation (2) by taking logs, the dependent average cost measure used in estimation is

\[
(5) \quad \log AC_{it} = \log AC_{it} - \log P_{B_i}
\]

again implying that the nuisance term, \( \log P_{B_i} \), is added to the fixed error term.

Fortunately, the potentially biasing effect of this nuisance term \( \log P_{B_i} \) (i.e., if the fixed base price is correlated with the order-of-entry variable) in (4) and (5) is controlled for by the Hausman and Taylor (1981) – HT – estimation procedure. Therefore, we can estimate the inverse demand and average cost functions without bias due to measurement error in the dependent variable.

Finally, the dependent measure for profits is derived from the net income index, \( NII_{it} \), available in PIMS. After linearizing equation (3) by taking logs the net income measure becomes

\[
(6) \quad \log NII_{it} = \log NI_{it} + \log K_i
\]

where the nuisance term \( \log K_i \) (the firm specific, time invariant disguise factor) becomes a part of the fixed error term. However, equation (3) presents a unique estimation issue because net income can take on negative values. This requires us to transform the net income measure before we can linearize equation (3) by taking logs.

We do this via the \( \zeta \)-transformation introduced by Cooper and Nakanishi (1983). This transformation consists of two steps. We first standardize the net income measure within each business unit and then apply the \( \zeta \)-transformation to these standardized z-values, i.e.,

\[
(7) \quad z_{it} = \frac{NII_{it} - \bar{NII}_i}{\sigma_{NII_i}} = \frac{K_i(NI_{it} - \bar{NI}_i)}{\sigma_{NI_i}} \quad \text{and}
\]
This transformation eliminates all negative net income values by mapping them into the 0-1 range. It also eliminates the disguise factor \( K_i \) as can be seen in (7). Thus, we substitute \( \zeta_{it} \) for net income and take logs to linearize equation (3).

**Independent Variables**

Pioneering is the independent variable of central interest. PIMS provides a measure that defines pioneers as those business units that were one of the pioneers in their categories at the time of entry.\(^{10}\) For business units that fall into this category, we set the pioneering variable, \( \text{Pion}_{i} \), to 1, for all other business units to 0.

We have no theoretical interest in the quantity independent variable, but it is important because it controls for movements along the demand and average cost curves. Further, we recognize that quantity is correlated with unobserved contemporaneous omitted variables. In particular, quantity is simultaneously determined in the demand, cost, and profit equations. Thus, following Jacobson (1990) we use an IV procedure for quantity where instruments are of a higher order lag than any contemporaneous (time varying) error appearing in the empirical error term.

Quantity is not directly available in the PIMS database, which necessitates use of a quantity index measure for estimation purposes (see Appendix A). Again, the potentially biasing effect of the nuisance term that is added to the fixed error component is controlled for by the HT procedure.

The other independent variables, described as \( X_{ijt} \), \( j = 1...3 \) in equations (1) to (3), consist of variables included for control purposes and those included mainly for identification purposes. The former set of variables contains a business unit’s market position (MP), competitive environment (CE), product quality (PQ), and years of experience (YFE). Of particular interest as a control variable is the years of experience variable. The years of experience variable indicates

\[(7a) \quad \zeta_{it} = \left(1 + z_{it}^2\right)^{1/2} \text{ if } z_{it} \geq 0 \quad \text{and} \quad \zeta_{it} = \left(1 + z_{it}^2\right)^{-1/2} \text{ if } z_{it} \leq 0.\]

\(^{10}\) The actual PIMS measure is described more fully in Robinson and Fornell (1985).
the years from the firm’s initial entry, and controls for possible learning curve effects due to time in market rather than pioneering, *per se*. Market position, MP, represents internal firm effects on the demand and average cost functions and is measured by a business unit’s market share relative to its three largest competitors. This variable is transformed such that the standard deviation equals 1 and the minimum (worst possible market position) equals zero. The measure of competitive environment, CE, represents firm external effects and builds on Porter’s (1980) framework for assessing the competitive structure of an industry. For components of this construct and a description of the exact definition we refer the reader to Boulding and Staelin (1993, 1995). The scaling is such that “zero” represents the most intense competitive environment found in the PIMS database.

For identification purposes, we also utilize the following four relative cost variables, measured as a percent of revenues: purchase (SR), production (PR), R&D (RR) and marketing cost (MR). These variables help us ensure that the models are over-identified to apply the HT specification test. These ratio variables are likely independent of any fixed firm factors, i.e., the fixed firm components cancel out in the numerator and denominator. Importantly, this is a testable conjecture. The exact specification of each model, including the final choice of instruments, is shown in Appendix B. Finally, all nominal dollar amounts are transformed to constant dollar amounts by use of a GNP deflator.

5. Estimation

Testing our hypotheses about the effects of pioneering on firm performance requires an appropriate estimation method. As noted, of particular importance is to ensure that these effects are free from bias due to omitted fixed effects, e.g., differing skill and resource profiles of pioneers and later entrants that correlate with the entry timing decision. At issue here is whether fixed firm factors that influence the entry timing decision continue to influence current measures of performance. As shown elsewhere in the strategy literature (e.g., Boulding 1990; Jacobson
1990; Erickson and Jacobson 1992; Boulding and Staelin 1995), failure to appropriately account for this endogeneity of variables in estimation leads to biased estimates.

The maintained hypothesis in this research is that the entry timing decision is not independent of the unobserved fixed effect. Specifically, we subscribe to the resource-based view that argues entry timing and subsequent performance are related to the core resources and capabilities of the firm. In addition to the extensive resource-based view literature, both theoretical (e.g., Lieberman and Montgomery 1988) and empirical (e.g., Kalyanaram et al. 1995) evidence specifically suggests that skill and resource profiles differ across pioneers and later entrants. For example, Lieberman and Montgomery suggest that “First-mover advantages arise endogenously...” and “The first-mover opportunity may occur because the firm possesses some unique resources or foresight, or simply because of luck” (p. 41). Similarly, an emerging empirical generalization proposed in the literature is that pioneers and later entrants differ in their resource and skill profiles (Kalyanaram et al. 1995).

H₄: Entry timing and subsequent firm performance are both related to firm resources and capabilities, i.e., entry timing is endogenous.

Of course, if true, this hypothesis implies that failure to control for unobserved firm resources and capabilities produces biased estimates of the effects of entry timing. Thus, the conceptual and empirical arguments from above have led to several efforts to address what becomes an estimation issue.

One estimation strategy has been to measure firm resources and skills and include them in the entry-performance equation (e.g., Robinson et al. 1992; Murthi et al. 1996). The drawback to such an approach is that one must assume all relevant firm skill and resource variables are included. The resulting entry timing effects can, therefore, only be considered unbiased by assumption.

A second estimation strategy has been to use an instrumental variable approach to break dependence between the pioneering variable and the unobserved fixed effect. Unfortunately, the
one example of this approach in the literature (Moore et al. 1991) is based on cross-sectional data. Though these authors show that significant bias exists in the exogenous pioneering estimates, given reliance on cross-sectional data, they must make an assumption that the instruments themselves are free of the unobserved fixed effect. Thus, even these endogenously modeled pioneering effects can only be considered unbiased by assumption.

A third strategy has been to use cross-sectional/time series data and first- or mean-differencing procedures to ensure that the transformed variables are free of the omitted fixed effect. This has been done when studying the effects of other strategic variables of interest, e.g., R&D (Erickson and Jacobson 1992; Boulding and Staelin 1995). However, such differencing transformations only work with time varying independent variables, precluding application to the order-of-entry domain.

Because of this limitation, Hausman and Taylor (1981) developed an instrumental variable (IV) procedure that enables consistent estimation of the effects of time-fixed variables while controlling for unobserved fixed factors. A key feature of this procedure is that it allows the researcher to test the validity of the chosen instruments. We now discuss this estimation procedure and the specification test that provides a direct test of $H_4$.

**The Hausman-Taylor Estimation Procedure**

The estimation procedure for each model consists of seven steps. We explain these steps in detail for the demand equation (1), but the same procedure is applied to all other equations.

We start by taking logs to linearize the model (1) resulting in the following equation:

\[
\log P_{it} = \log \beta_{0i} + \delta_1 \cdot \log Q_{it} + X_{it} \beta_i + \gamma_{0i} \cdot \text{Pion}_i + \epsilon_{it}, \quad \text{where}
\]

\[
(8a) \quad \epsilon_{it} = \alpha_i + \gamma_{0i} \cdot \text{Pion}_i + (1 + \delta) \log P_{it} + \delta K_i + \eta_{it}.
\]

The error term (8a) follows from the heterogeneity in the pioneering parameter (1a) and the definitions of the price measure (4) and quantity measure (Appendix A). Second, we instrument $\log Q_{it}$ using lags t-1 and higher and use $\log Q_{it}^{\text{fit}}$ to control for contemporaneous simultaneity between the price, cost, and profit equations.
The specification test relies on the fact that consistent estimates of $\beta_i$ and $\delta_i$ can be obtained from the within estimator, i.e., by mean-differencing (8) and estimating
\begin{equation}
\log P_i - \log P_i^* = \delta_i \left( \log Q_i^* - \log Q_i^* \right) + \left( X_{ii} - \bar{X}_{ii} \right) \beta_i + (\eta_{ii} - \bar{\eta}_{ii})
\end{equation}
against which the IV estimator can be compared. Thus, in the third step we estimate (9) and record the resulting estimate $\hat{\beta}_{1W}$ (which includes $\hat{\delta}_i$).

Next, we estimate (8) using two-stage least squares. Following Breusch et al. (1989), we form the set of instruments as follows. For $\log Q_i^*$ and $X_i$ we can use the respective mean difference $\log Q_i^* - \log Q_i^*$ and $X_{ii} - \bar{X}_{ii}$ as instruments. This is equivalent to estimating (9).

To obtain a consistent estimate of $\gamma_{oi}$, we have to assume that a subset of the eight variables $X_i$ is independent of the fixed part of the error term (8a). *Importantly, this assumption is later tested.* For this subset $X_i'$ of $X_i$ we also include the group means, $\bar{X}'_i$, as instruments. As shown by Amemiya and MaCurdy (1986) and Breusch et al. (1989), it is also possible to include each observation $X'_{i1}$, $X'_{i2}$, etc. of the variables $X'_i$ as an instrument.\(^\text{11}\)

We also have to correct for the presence of a fixed error component, which leads to a block-diagonal error matrix. From the estimated residuals, $\hat{\epsilon}_{1it}$, we calculate the weighting matrix and transform equation (8). (See HT or Breusch et al. (1989) for details on this transformation). So in a fifth step we re-estimate the transformed version of (8) with two-stage least squares and the same set of instruments. This yields estimates of $\delta_i$, $\beta_i$ and $\gamma_{oi}$, i.e., $\hat{\beta}_{1IV}$ (which includes $\hat{\delta}_i$) and $\hat{\gamma}_{oi}$.

Sixth, an important aspect of this estimation procedure is that the assumptions underlying the selection of instruments can be tested. From estimating equation (9) we have a consistent benchmark, namely $\hat{\beta}_{1W}$, for the HT estimator, $\hat{\beta}_{1IV}$. A large difference $\hat{q} = \hat{\beta}_{1IV} - \hat{\beta}_{1W}$ casts doubt on the selection of instruments. The test statistic under the null hypothesis that the instruments are valid, $\hat{m} = \hat{q} [\text{cov}(\hat{q})]^+ \hat{q}$, is distributed $\chi^2_d$ with $d = k_1 - 1$ degrees of freedom, where $[ ]^+$ indicates the generalized inverse and $k_1$ is the number of instruments from the subset.

\(^\text{11}\) Since we do not have the same number of observations for each business unit, we only consider the first two observations as potential instruments.
Obviously, the specification test requires overidentification, i.e., \( k > 1 \). Note that finding an acceptable set may take several iterations of steps four to six where the selected instruments are tested for independence from the fixed error term.

In the seventh and final step, we repeat steps four to six with the inclusion of the pioneering variable as an instrument. This is equivalent to treating pioneering as exogenous and therefore, provides a direct test of \( H_4 \)—any significant changes in the specification test statistic \( \hat{m} \) must be attributed to pioneering.

In sum, we jointly estimate a total of three equations using the seven-step procedure outlined above: (i) the price model derived from equation (1); (ii) the average cost model derived from equation (2); and (iii) the profit model derived from equation (3). Before presenting results from this estimation we call attention to several aspects of the estimation.

First, though highly intensive, this cost of estimation is far outweighed by the benefit of knowing that the selected instruments are themselves free of the fixed effect. That is, all assumptions about candidates for instruments are tested. Second, when the appropriate instruments are identified, it allows the researcher to test and control for potential endogeneity bias in the effect of the theoretical variable of interest.

Third, our estimation procedure recognizes that supply and demand jointly determine prices, costs, quantities, and profits. Further, this allows us to examine our hypothesized shifts in the specified demand and average cost equations while controlling for movement along these curves.

Fourth, we acknowledge possible heterogeneity in pioneering effects while estimating a consistent estimate of the average, or generalizable, effect for our sample. Because we do not estimate these firm specific effects they go into the fixed error term. This could lead to correlation with the included pioneering term and therefore potentially lead to bias in our estimated average effect. However, as noted above, we test for and identify a set of instruments that breaks the correlation between the included pioneering variable and the fixed error term.
Fifth, we note that measurement error in the quantity and pioneering variables potentially leads to bias in their associated coefficients if not appropriately addressed. However, we note that instrumental variable (IV) estimation is a classic solution to the errors-in-variables problem. Therefore, the HT-IV procedure has a secondary benefit of addressing this potential issue.

6. Results

Table 1 presents the results for the three estimated equations relevant to our stated hypotheses and conjectures. It also includes the results from the model in which ROI instead of net income is used as the profitability measure. Complete estimation results for these equations are provided in Appendix B.

[Insert Table 1 Here]

Before turning to the estimates of substantive interest, we begin by assessing the appropriate estimation treatment of the pioneering effect. Hypothesis H4 states that entry timing is endogenous. The results of the HT-specification tests used to test this hypothesis are shown in columns 2 and 4 of Table 1. Column 2 shows the test results for the endogenous specification of the entry variable. These results indicate that we cannot reject the suitability of the instruments used for these estimates, i.e., the test indicates that the instruments selected are themselves free of the fixed effect. Thus, we can conclude that none of the presented results in column 1, i.e., where entry is considered endogenous, are biased due to omitted fixed unobserved factors.

Knowing that the validity of the set of instruments used when entry is considered endogenous, we then add the entry variable itself to the set of instruments. Column 3 presents the estimates based on this assumption of exogenous entry timing, and column 4 presents the test of this assumption. The column 4 results indicate that the assumption of exogenous entry is rejected at a p<.01 level in all four of the estimated equations. Thus, we find strong, significant support for H4. Furthermore, this implies that all the column 3 estimates are known to suffer from bias. Therefore, we do not discuss these estimates any further, other than to note that these estimates deviate from the consistent estimates in column 1.
To address our hypotheses of substantive interest, we now turn attention to the results reported in column 1 of Table 1. Importantly, we know these estimates to be free from bias due to omitted fixed effects. H1 states that pioneers have higher prices, i.e., their demand functions are shifted outward. Table 1 indicates support for H1, since the effect of pioneering in the inverse demand function is positive and highly significant. Therefore, our results replicate, within the framework of a formal demand model, the well-established finding that pioneers obtain a consumer-based demand advantage.

C2 suggests a pioneering cost disadvantage. The effect of pioneering in the average cost equation is positive and highly significant, providing support for C2.

Finally, and of greatest interest, C3 states that due to offsetting price and cost effects, pioneers’ profits will be no greater than those of later entrants. Results from the net income equation show that pioneers obtain no profit advantage. The estimated pioneering effect on profit is actually negative and significant, as shown in Table 1. Thus, we find support for conjecture C3 that pioneers have no profit advantage, but do not support the argument that competition for market entry exactly offsets the demand-side advantage. We return to this issue in the discussion section.

Because of the importance of this finding, we checked the sensitivity of this result to the particular choice of profit variable. For example, ROI is frequently used as a measure of firm performance in marketing studies. We find that the effect of pioneering on ROI is also negative and significant. Finally, we examine whether our results are an artifact of profit measures that include fixed costs. In particular, one could argue that pioneering effects are more appropriately examined by testing the influence of entry timing on margins. Thus, we examine yet a third measure of profitability, “value added.” This measure is formed by taking the ratio of price minus unit costs divided by price. When using this measure we again find a significant negative

12 Whenever we test a hypothesis that makes a clear directional prediction for the pioneering effect, we use a one-tail t-test. In other words, all significance values for the pioneering effects are based on one-tail tests, with the exception of the effect on profitability (net income, ROI, etc.).
effect of pioneering on profitability (-0.361, p < .05). These findings suggest that the results are robust to our selection of the measure of profitability. In particular, we can address the possibility that the obtained results are an artifact of a measure that changes the impact of marginal versus fixed costs.

We further examine the sensitivity of the findings to our assumptions by repeating estimation for equations (1) to (3) with different functional forms. Specifically, we estimated an exponential model with quantity in the exponent (i.e., $y_{it} = \exp[\beta_0 + \delta Q_{it} + \gamma Pion_i + \alpha_i + \eta_{it}]$), a linear model (i.e., $y_{it} = \beta_0 + \delta Q_{it} + \gamma Pion_i + \alpha_i + \eta_{it}$), and a multiplicative model (i.e., $y_{it} = \beta_0 \cdot Q_{it}^\delta \cdot Pion_i^\gamma \cdot X_{it}^\alpha \cdot e^{\eta_{it}}$) for all four equations reported in Table 1. This provides 12 additional estimates of the effects of pioneering. Results from this analysis are summarized in Table 2 and indicate that the results are robust to selection of functional form. In particular, the 12 new estimates of the effects of pioneering all exhibit the same sign as the original four effects reported in Table 1. Moreover, 10 of these 12 estimates reach significance at the .05 level or higher. In addition, we find that pioneering must be considered endogenous in all 12 of the new models.

Note that the exponential and linear models allow us to include a quadratic term for quantity. In addition, we vary the relative cost variables included in the specification. Thus, we also investigate the sensitivity of the pioneering estimates to the exact model specification (included variables) along with differing functional forms. Though not reported here in detail, we summarize the estimates of a total of 45 new models in Table 3. Of these, all 45 produce the same signs as the pioneering effects reported in Table 1. Further, 87% of these pioneering effects reach significance at the .10 level, and we found that pioneering must be considered endogenous in 96% of the 45 new models estimated (the HT test for endogeneity was typically not significant in cases with non-significant pioneering effects). We take these results as strong evidence in support of the robustness of our findings.

We thank the Editor for suggesting we use such a measure.
7. Extended Analysis

Given the robustness of the findings for our sample of consumer goods’ firms we now extend our analysis in two ways. First, we examine whether our profit findings generalize over different industry settings. Second, we briefly examine conditions that may moderate our observed average effect of pioneering.

Until now our analysis has focused on firms selling consumer goods. We now examine whether the same profit implications of entry timing hold for industrial goods. Thus, we use a sample of PIMS firms selling industrial goods that consist of 2,864 observations from 885 business units. The results reported in Table 4 suggest that the entry timing profit implications for industrial goods are essentially identical to those for consumer goods, where the column one results again provide the consistent estimates of the entry effects. In particular, whether we use net income (-0.975, p<.01) or ROI (-0.825, p<.01), the effect of pioneering on profitability is negative and significant. Furthermore, note that the coefficient values are quite similar across industry groups.14 The results for the “value added” measure of profitability is also consistent with what we observe for the consumer goods sample (-0.365, p<.05). Thus, we conclude that our profit results generalize across both consumer and industrial goods. Specifically, the pioneer, on average for our sample of consumer and industrial good firms, appears to have a long-run profit disadvantage.

Given this surprising result, we next explore whether we can identify conditions under which pioneers obtain a profit advantage. In particular, we explore the effects of two variables that potentially moderate the entry-profitability relationship. These moderators are time in market and likelihood of customer learning.

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14 The differences between the parameter estimates across the consumer and industrial goods samples are not statistically significant.
Our choice of time in market variable as a moderator of the entry timing effect was motivated by strong evidence and beliefs that first-mover advantages dissipate over time (e.g., Robinson and Fornell 1985; Lieberman and Montgomery 1998). Perhaps the long-run profit disadvantage for pioneers that we observe is masking a pioneering profit advantage during an earlier window of time subsequent to entry. Therefore, we ran additional models for both the consumer and industrial goods samples that include a main effect for pioneering, plus pioneering interactions with the years from entry (YFE) and years from entry squared (YFE$^2$). We predict a positive coefficient for the main effect of pioneering, as this would suggest a profit advantage at the time of initial entry. We predict a negative coefficient for the linear interaction term, as this would indicate an eroding profit advantage that eventually becomes a profit disadvantage. Finally, we predict a positive coefficient for the quadratic interaction term, as this would indicate the difference between pioneers’ and followers’ profits asymptotes to zero in the very long run.

The pattern of results we obtain is the same regardless of the profit measure we use. Therefore, for parsimony, we focus on the ROI results, which we report in Table 5. These results show that both the consumer and industrial goods samples demonstrate the same pattern of results. The main effect of pioneering is positive, the linear interaction with year from entry is negative, and the quadratic interaction is positive. All three effects are significant (p<.05 or better) in the consumer goods sample, while all three effects are marginally significant in the industrial goods sample (p<.20 or better). As expected, the main effect is positive, since this indicates the pioneering profit advantage at the time of initial entry. Also as expected, the linear interaction is negative, since this suggests the pioneering profit advantage dissipates over time. Finally, as expected, the quadratic interaction term is positive, suggesting that in the very long run entry timing effects on profitability become indistinguishable.

[Insert Table 5 here]

These coefficients allow us to estimate the length of time following entry that pioneers enjoy a profit advantage. For firms selling consumer goods pioneering firms enjoy a profit advantage for a period of about 13 years before this advantage vanishes and then becomes a
profit disadvantage. The pioneering profit advantage is somewhat longer-lived for firms selling industrial goods. Here, pioneering firms maintain a profit advantage for 17.4 years before the advantage hits zero and then becomes negative. Because the mean number of years from entry for pioneering firms in our sample is far greater than the empirical turning points (32.5 and 33.4 years in the consumer goods’ and industrial goods’ samples, respectively), this suggests why our “average” results mask a period of early profitability for pioneering firms. In the very long run the disadvantage disappears. For consumer goods the disadvantage vanishes after 51.8 years (the results for Net Income indicate a longer disadvantage of 69.1 years). For industrial goods the disadvantage disappears after 73.3 years. Since the longest time in market in our sample is 66 years for consumer goods and 67 years for industrial goods, we are at the limits of the data in our sample. Thus, we cautiously interpret this second turning point as evidence that differences in profits between pioneering and following firms’ asymptotes to zero in the very long run.

Our second moderating variable of interest is likelihood of consumer learning. Much of the theoretical work suggesting a pioneering demand advantage ties back to consumer learning. If consumers first learn about the pioneering brand and then, for a variety of reasons, do not learn about subsequent entrants, this produces a first mover demand advantage. Thus, we conjecture that pioneering advantages will be strongest when customers are unable and/or unmotivated to learn about alternatives after initial adoption of the first-mover’s product. To test this conjecture we create a “likelihood of learning index” based on three underlying components: frequency of purchase, purchase amount, and fraction of total purchases that the product represents. Our belief is that more frequent purchases leads to more learning opportunities, while higher purchase amounts and greater importance of the product (as captured by its percentage of the customer’s spending budget) leads to greater motivation to learn.

In sum, we create an index from these three underlying variables where lower values indicate little ability/interest in learning and high values indicate high ability/interest in learning.\textsuperscript{15} This index ranges from a low value of 0 to a high value of 13. The mean value of the

\textsuperscript{15} Results showed little sensitivity to changes in the specification of this index.
index is 4.97 and 7.81, for consumer and industrial goods’ firms, respectively. We conjecture that firms operating in markets with low index values will have greater benefits from pioneering than firms operating in markets with high index values. Consequently, we specify a model that includes a main effect of pioneering and its interaction with the likelihood of learning index variable, where we predict a positive coefficient on the main effect and a negative coefficient on the interaction. We predict a positive main effect because the main effect captures the effect of pioneering when the likelihood index equals zero, indicating a low likelihood of learning. We predict a negative effect for the pioneering interaction term, as we expect the pioneering advantage to dissipate as the likelihood of consumer learning increases. We estimate this model for both the consumer and industrial goods samples and report these results in Table 5.

Once again the pattern of results for the main effect and interaction effect are identical across our three measures of profit performance. Thus, we again focus on the ROI results. These results indicate support for both predictions. The main effects of pioneering are positive for both the consumer and industrial goods’ samples (but only significant for the industrial goods’ sample), while the pioneering interactions terms are negative and significant in both samples.

Thus, we have again identified conditions where the pioneering firm may obtain a profit advantage. However, in the consumer goods’ sample this only occurs for firms with a likelihood of learning index less than 1.5. For the industrial goods sample this occurs for firms with a likelihood of learning index slightly less than 6.0.

8. Discussion

We believe this work brings several interesting insights to the pioneering literature. It examines the impact of pioneering not on market share, but on price (demand), average cost, and profits. Thus, we examine the effects of pioneering on firm performance in new ways.

We also call attention to our research method. We show that to obtain consistent estimates of pioneering effects on firm performance, pioneering must be treated as endogenously
determined. Exogenous treatment of pioneering leads to biased estimates. Several papers in marketing have shown how to control for omitted fixed factors when the strategic action of interest varies over time. To our knowledge, this is the first paper in marketing that controls for unobserved fixed factors when the strategic action of interest is itself fixed over time, i.e., pioneering.

We believe the resulting empirical findings are of substantive interest. The results support our argument that in consumer goods’ markets, on average, pioneers have a consumer-based demand advantage that allows them to obtain a long-run price premium or market share advantage relative to later entrants. Specifically, our results are consistent with the arguments that firms can influence consumer preferences and/or that learning about new products creates a switching cost that followers’ products must overcome. Thus, we find support for previous research that suggests a consumer-based demand advantage for the pioneering firm.

However, it would be a mistake to conclude on the basis of this demand-side evidence that pioneers are more profitable in the long run. In fact, for the average pioneering firm, our results show just the opposite. The long-run demand advantage is more than offset by higher long-run average costs for pioneering firms. Thus, we find no long-run profit advantage for pioneers. Consequently, like Golder and Tellis (1993), we conclude that an overall pioneering advantage is more “legend” than “logic.” Unlike Golder and Tellis, we propose a different underlying mechanism for this lack of advantage, i.e., higher costs facing the pioneering firm. Furthermore, our results are more conservative than Golder and Tellis’. Despite being subjected to survivor bias and misclassification bias (which both increase the pioneering advantage), our results still show that pioneers do not obtain a long-run profit advantage. This result generalizes across industry groups, model specifications, and differing profit measures, indicating the result is robust.

We believe the results are compatible with our “logic” behind the lack of a pioneering advantage. Knowing that pioneering produces demand-side rents, the consumer goods firms compete away these rents in the form of higher costs. Furthermore, due to the stickiness of
initial investments, pioneering firms, on average, are unable to lower their costs to the level of later entrants, i.e., are less able to incorporate new information into their operations. This result is consistent with the idea that followers have better information available to establish more efficient operations. The cost results are also consistent with the empirical evidence summarized by Lieberman and Montgomery (1988) showing that it is difficult to sustain advantages based on production experience or blocking access to resource inputs. We note one exception to this cost disadvantage facing pioneering firms. In particular, though not reported here, we find a pioneering cost advantage with respect to advertising spending. However, this advertising advantage connects to the pioneer’s consumer-based demand advantage.

With respect to profitability, we conjectured that pioneering, per se, would not lead to sustainable excess returns. Instead, we find that, for the average pioneering firm in our sample, pioneers have lower long-term rates of profitability. We speculate that two different explanations could account for this result. First, we caution the reader that we do not examine the impact of pioneering on lifetime profits. Thus, our estimate of the average effect of pioneering does not necessarily show lower lifetime profits accruing to pioneers. Pioneers have a period of monopoly profits prior to competitive entry that our analysis does not incorporate. Furthermore, our conditional analysis suggests that for a reasonable period of time subsequent to entry (12-17 years), pioneering firms may have a profit advantage. However, our analysis clearly does indicate that, on average, pioneering, per se, does not lead to a sustainable profit advantage.

The second explanation relates to the previous discussion of the winner’s curse. In particular, winners of market entry races may be overestimating the ensuing demand premium relative to the true value of this premium. If so, it would account for the difference between the cost disadvantage and the price advantage. Clearly, this explanation makes one less sanguine about the overall profit implications of pioneering. However, the idea of a winner’s curse does potentially explain how inefficient pioneering choices persist, as implied by our profit results. In this regard we note an interesting parallel with the economic effects of acquisition choices. As reported in the finance literature, acquiring shareholders earn negative abnormal returns from
mergers (e.g., see Loughran and Vijh 1997 for a review of this literature). 16 Perhaps the two phenomena are related—after all, both internal product development and mergers involve acquiring capabilities for market entry.

In sum, we hope this paper provides a definitive answer to the question of whether pioneering, per se, leads to a sustainable advantage, on average, in overall firm performance. Consistent with prior work, we find that it does lead to a sustainable demand advantage for consumer goods firms. However, this finding is not sufficient to suggest an overall profit advantage, because we find a long-term cost disadvantage for these same firms. Given this result, we believe that future research should look beyond the average effects of pioneering on firm performance. The choice of pioneering, in and of itself, does not lead to a sustainable long run overall performance advantage. Therefore, it becomes important to identify conditions that do yield a sustainable profit advantage for the pioneering firm.

In this regard, we present two findings. First, there is a window of opportunity of between 12-17 years after initial market entry where pioneers appear to earn higher profits. Subsequent to this, they have lower rates of profitability. This profitability pattern would seem to have important strategic consequences. Second, drawing from the extensive theoretical work suggesting search/learning based pioneering advantages, we identify conditions under which pioneers do sustain higher rates of profitability.

Thus, we certainly do not conclude that pioneering necessarily is bad. However, consistent with theoretical conjectures, our empirical evidence suggests that pioneering can be bad. There are many theoretical conjectures about conditions when pioneering can be good, e.g., in the presence of network externalities. However, we caution that future empirical work needs to account for both the demand and cost implications of pioneering under these conditions—as the results herein show, the overall results can be surprising.

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16 The latest research in this area by Loughran and Vijh (1997) suggests that this result is conditional on whether payment is in stock or cash. They find that for payment in stock the acquiring firm earns a significantly negative excess return of 25.0 percent.
APPENDIX A

Derivation of Dependent Variables

PIMS reports no direct information on quantity, $Q_{it}$, total costs, $TC_{it}$, or average costs $AC_{it}$. A usable quantity measure, $Q_{Iit}$, can be derived from the accounting identity $Q_{it} = R_{it}/P_{it}$ and their disguised PIMS measures, where $R_{it}$ is the business unit i’s revenues:

\[
Q_{Iit} = \frac{R_{it} \cdot K_{i}}{P_{it}} = \frac{R_{it} \cdot K_{i}}{P_{it}/P_{Bi}} = \frac{Q_{it} \cdot P_{Bi} \cdot K_{i}}{}.
\]

where $K_{i}$ is the firm-specific disguise factor.

Total cost, $TC_{it}$, can be calculated as the difference between revenues and net income, i.e., $TC_{it} = R_{it} - NI_{it}$. (An alternative cost measure can be obtained by adding the individual cost components of purchasing, production and marketing cost.) Both measures are available in disguised form. The total cost measure and the quantity index (B1) yield the following measure for average costs, $AC_{Iit}$:

\[
AC_{Iit} = \frac{TC_{Iit}}{Q_{Iit}} = \frac{TC_{it} \cdot K_{i}}{R_{it} \cdot K_{i}/P_{it}} = \frac{TC_{it} \cdot P_{it}}{R_{it} \cdot P_{Bi}} = \frac{AC_{it}}{P_{Bi}}.
\]

Linearizing (B2) by taking logs results in equation (5).
**APPENDIX B**

Estimation Results For Consumer Goods

(Model: \( y = \beta_0 \cdot Q^\delta \cdot \exp(\beta_1 X + \gamma \text{Pion} + \epsilon) \))

<table>
<thead>
<tr>
<th>Variables</th>
<th>Demand</th>
<th>Average Cost</th>
<th>Net Income</th>
<th>ROI</th>
<th>Value Addedc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.19336***</td>
<td>-0.04614</td>
<td>1.41810***</td>
<td>1.32680***</td>
<td>-0.46539</td>
</tr>
<tr>
<td></td>
<td>(0.02323)</td>
<td>(0.03667)</td>
<td>(0.13066)</td>
<td>(0.15923)</td>
<td>(0.32268)</td>
</tr>
<tr>
<td>Quantity (Q^{it})</td>
<td>-0.03893***</td>
<td>-0.02253*</td>
<td>-0.05462</td>
<td>-0.05016</td>
<td>-0.07825</td>
</tr>
<tr>
<td></td>
<td>(0.01357)</td>
<td>(0.01405)</td>
<td>(0.04817)</td>
<td>(0.05220)</td>
<td>(0.05755)</td>
</tr>
<tr>
<td>Market Position (MP)</td>
<td>0.01631</td>
<td>-0.01948</td>
<td>0.01999</td>
<td>-0.04102</td>
<td>0.10416**</td>
</tr>
<tr>
<td></td>
<td>(0.01195)</td>
<td>(0.01246)</td>
<td>(0.03997)</td>
<td>(0.04236)</td>
<td>(0.04641)</td>
</tr>
<tr>
<td>Competitive Environment (CE)</td>
<td>-0.00572</td>
<td>-0.01801***</td>
<td>0.09226***</td>
<td>0.10777***</td>
<td>0.12615***</td>
</tr>
<tr>
<td></td>
<td>(0.00710)</td>
<td>(0.00694)</td>
<td>(0.02500)</td>
<td>(0.02539)</td>
<td>(0.03025)</td>
</tr>
<tr>
<td>Product Quality (PQ)</td>
<td>-0.00056***</td>
<td>-0.00077***</td>
<td>0.00038</td>
<td>0.00030</td>
<td>-0.00033</td>
</tr>
<tr>
<td></td>
<td>(0.00026)</td>
<td>(0.00029)</td>
<td>(0.00079)</td>
<td>(0.00078)</td>
<td>(0.00082)</td>
</tr>
<tr>
<td>Years From Entry (YFE)</td>
<td>-0.01078**</td>
<td>0.00685</td>
<td>0.01526</td>
<td>0.03395*</td>
<td>0.02033</td>
</tr>
<tr>
<td></td>
<td>(0.00547)</td>
<td>(0.00718)</td>
<td>(0.01917)</td>
<td>(0.02072)</td>
<td>(0.01695)</td>
</tr>
<tr>
<td>YFE^2</td>
<td>0.00009</td>
<td>-0.00014</td>
<td>-0.00010</td>
<td>-0.00028</td>
<td>-0.00021</td>
</tr>
<tr>
<td></td>
<td>(0.00007)</td>
<td>(0.00011)</td>
<td>(0.00024)</td>
<td>(0.00026)</td>
<td>(0.00024)</td>
</tr>
<tr>
<td>Supply Cost/Revenue (SR)</td>
<td>-0.00086</td>
<td>0.00908***</td>
<td>-0.05500***</td>
<td>-0.05026***</td>
<td>-0.05026***</td>
</tr>
<tr>
<td></td>
<td>(0.00076)</td>
<td>(0.00071)</td>
<td>(0.00263)</td>
<td>(0.00283)</td>
<td>(0.00283)</td>
</tr>
<tr>
<td>Production Cost/Revenue (PR)</td>
<td>-0.00234***</td>
<td>0.00809***</td>
<td>-0.04672***</td>
<td>-0.04583***</td>
<td>-0.04583***</td>
</tr>
<tr>
<td></td>
<td>(0.00077)</td>
<td>(0.00078)</td>
<td>(0.00246)</td>
<td>(0.00246)</td>
<td>(0.00246)</td>
</tr>
<tr>
<td>R&amp;D Cost/Revenue (RR)</td>
<td>0.00112</td>
<td>0.01693***</td>
<td>-0.09159***</td>
<td>-0.08220***</td>
<td>-0.00314</td>
</tr>
<tr>
<td></td>
<td>(0.00526)</td>
<td>(0.00518)</td>
<td>(0.01449)</td>
<td>(0.01541)</td>
<td>(0.01182)</td>
</tr>
<tr>
<td>Marketing Cost/Revenue (MR)</td>
<td>-0.00405***</td>
<td>0.00918***</td>
<td>-0.06004***</td>
<td>-0.06258***</td>
<td>0.00018</td>
</tr>
<tr>
<td></td>
<td>(0.00107)</td>
<td>(0.00115)</td>
<td>(0.00321)</td>
<td>(0.00451)</td>
<td>(0.00173)</td>
</tr>
<tr>
<td>Pioneering Firm</td>
<td>0.27930***</td>
<td>0.36462***</td>
<td>-0.98392***</td>
<td>-0.75971***</td>
<td>-0.36054***</td>
</tr>
<tr>
<td></td>
<td>(0.08599)</td>
<td>(0.10488)</td>
<td>(0.21092)</td>
<td>(0.21712)</td>
<td>(0.15885)</td>
</tr>
<tr>
<td># observations</td>
<td>1,162</td>
<td>1,162</td>
<td>1,162</td>
<td>1,149</td>
<td>1,128</td>
</tr>
</tbody>
</table>

**Instruments**

- MP, PQ, PR, MR
- MP, PQ, SR, PR, MR
- MP, PQ, RR, MR
- MP, PQ, PR, RR
- PQ, RR, MR

---

**a)** Standard errors are in parentheses.

**b)** The group means, \( \bar{X}_i \), and in some cases the first two observations, \( X_{i1} \) and \( X_{i2} \), of the listed variables were used as instruments for pioneering.

**c)** Due to the construction of the dependent variable, SR and PR were excluded from the model.

*** Significant at 0.01 level;

** significant at 0.05 level;

* significant at 0.1 level;

two-tail t-tests except for the effect of pioneering in the Demand and Average Cost equations.
APPENDIX B (CONTINUED)

Estimation Results For Industrial Goods

(Model: \( y = \beta_0 Q^\delta \cdot \exp(\beta_1 X + \gamma \text{Pion} + \epsilon) \))

<table>
<thead>
<tr>
<th>Variables</th>
<th>Net Income</th>
<th>ROI</th>
<th>Value Added^c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.15130***</td>
<td>1.46460***</td>
<td>0.27621***</td>
</tr>
<tr>
<td></td>
<td>(0.10667)</td>
<td>(0.13414)</td>
<td>(0.06720)</td>
</tr>
<tr>
<td>Quantity (Q^δ)</td>
<td>-0.08678***</td>
<td>-0.10010***</td>
<td>-0.04201*</td>
</tr>
<tr>
<td></td>
<td>(0.02232)</td>
<td>(0.02265)</td>
<td>(0.02411)</td>
</tr>
<tr>
<td>Market Position (MP)</td>
<td>0.10778***</td>
<td>0.05534**</td>
<td>0.03975***</td>
</tr>
<tr>
<td></td>
<td>(0.02610)</td>
<td>(0.02694)</td>
<td>(0.01854)</td>
</tr>
<tr>
<td>Competitive Environment (CE)</td>
<td>0.05231***</td>
<td>0.06440***</td>
<td>0.02341</td>
</tr>
<tr>
<td></td>
<td>(0.01325)</td>
<td>(0.01381)</td>
<td>(0.01595)</td>
</tr>
<tr>
<td>Product Quality (PQ)</td>
<td>-0.00037</td>
<td>-0.00044</td>
<td>0.00153****</td>
</tr>
<tr>
<td></td>
<td>(0.00056)</td>
<td>(0.00055)</td>
<td>(0.00044)</td>
</tr>
<tr>
<td>Years From Entry (YFE)</td>
<td>0.02046</td>
<td>0.01440</td>
<td>0.00017</td>
</tr>
<tr>
<td></td>
<td>(0.01791)</td>
<td>(0.01858)</td>
<td>(0.00342)</td>
</tr>
<tr>
<td>YFE^2</td>
<td>-0.00017</td>
<td>-0.00012</td>
<td>0.00002</td>
</tr>
<tr>
<td></td>
<td>(0.00022)</td>
<td>(0.00023)</td>
<td>(0.00004)</td>
</tr>
<tr>
<td>Supply Cost/Revenue (SR)</td>
<td>-0.04102***</td>
<td>-0.04049***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00148)</td>
<td>(0.00133)</td>
<td></td>
</tr>
<tr>
<td>Production Cost/Revenue (PR)</td>
<td>-0.04646***</td>
<td>-0.04729***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00160)</td>
<td>(0.00167)</td>
<td></td>
</tr>
<tr>
<td>R&amp;D Cost/Revenue (RR)</td>
<td>-0.05126***</td>
<td>-0.05025***</td>
<td>-0.02903***</td>
</tr>
<tr>
<td></td>
<td>(0.00632)</td>
<td>(0.00616)</td>
<td>(0.00961)</td>
</tr>
<tr>
<td>Marketing Cost/Revenue (MR)</td>
<td>-0.06738***</td>
<td>-0.06295***</td>
<td>-0.02291***</td>
</tr>
<tr>
<td></td>
<td>(0.00453)</td>
<td>(0.00471)</td>
<td>(0.00595)</td>
</tr>
<tr>
<td>Pioneering Firm</td>
<td>-0.97518***</td>
<td>-0.82478***</td>
<td>-0.36477***</td>
</tr>
<tr>
<td></td>
<td>(0.22127)</td>
<td>(0.19323)</td>
<td>(0.15067)</td>
</tr>
<tr>
<td># observations</td>
<td>2,864</td>
<td>2,837</td>
<td>2,836</td>
</tr>
<tr>
<td>Instruments^b</td>
<td>CE, PQ, RR</td>
<td>CE, PQ, SR, RR</td>
<td>MP, CE, PQ, YFE</td>
</tr>
</tbody>
</table>

^a) Standard errors are in parentheses.
^b) The group means, \( \bar{X}_i \), and in some cases the first two observations, \( X_{i1} \) and \( X_{i2} \), of the listed variables were used as instruments for pioneering.
^c) Due to the construction of the dependent variable, SR and PR were excluded from the model.

*** Significant at 0.01 level;
** significant at 0.05 level;
* significant at 0.1 level;
two-tail t-tests except for the effect of pioneering in the Demand and Average Cost equations.
<table>
<thead>
<tr>
<th>Equation</th>
<th>Endogenous Specification</th>
<th>Exogenous Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pioneering Effect(^a)</td>
<td>HT Specification Test(^b)</td>
</tr>
<tr>
<td>Demand</td>
<td>0.279*** (0.086)</td>
<td>(\hat{m} = 1.17) (7)</td>
</tr>
<tr>
<td>Average Cost</td>
<td>0.365*** (0.105)</td>
<td>(\hat{m} = 1.58) (8)</td>
</tr>
<tr>
<td>Net Income</td>
<td>-0.984*** (0.211)</td>
<td>(\hat{m} = 4.83) (14)</td>
</tr>
<tr>
<td>ROI</td>
<td>-0.760*** (0.217)</td>
<td>(\hat{m} = 0.91) (9)</td>
</tr>
</tbody>
</table>

\(^a\) Standard errors are in parentheses.
\(^b\) This test statistic is distributed \(\chi^2\); degrees of freedom are in parentheses.

*** Significant at 0.01 level;
** significant at 0.05 level;
* significant at 0.1 level;
one-tail t-test for Demand and Average Cost equations and two-tail t-test for Net Income and ROI equations.

**TABLE 1**

*Summary of Results For Consumer Goods*
TABLE 2
Sensitivity of Pioneering Effects to Choice of Functional Form

<table>
<thead>
<tr>
<th>Equation</th>
<th>Exponential Form</th>
<th>Linear Form</th>
<th>Multiplicative Form</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$y = \exp(\delta Q + \beta X + \gamma \text{Pion} + \epsilon)$</td>
<td>$y = \delta Q + \beta X + \gamma \text{Pion} + \epsilon$</td>
<td>$y = Q^\delta X^\beta \gamma^\text{Pion} \epsilon$</td>
</tr>
<tr>
<td></td>
<td>Pioneering Effect</td>
<td>HT-Test</td>
<td>Pioneering Effect</td>
</tr>
<tr>
<td>Demand</td>
<td>0.222*** (0.0839)</td>
<td>132.7 (5)</td>
<td>0.552*** (0.204)</td>
</tr>
<tr>
<td></td>
<td>p = 0.000</td>
<td>p = 0.000</td>
<td>p = 0.000</td>
</tr>
<tr>
<td>Average Cost</td>
<td>0.288*** (0.0821)</td>
<td>35.7 (5)</td>
<td>0.560*** (0.192)</td>
</tr>
<tr>
<td></td>
<td>p = 0.000</td>
<td>p = 0.001</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>Net Income</td>
<td>-1.380*** (0.253)</td>
<td>89.6 (4)</td>
<td>-0.0832 (0.217)</td>
</tr>
<tr>
<td></td>
<td>p = 0.000</td>
<td>p = 0.020</td>
<td>p = 0.000</td>
</tr>
<tr>
<td>ROI</td>
<td>-0.795*** (0.225)</td>
<td>31.1 (4)</td>
<td>-0.450*** (0.163)</td>
</tr>
<tr>
<td></td>
<td>p = 0.000</td>
<td>p = 0.000</td>
<td>p = 0.000</td>
</tr>
</tbody>
</table>

a) Reported estimates are for the endogenous pioneering specification. Standard errors are in parentheses.

b) Indicates result for specification with exogenous pioneering. The test statistic is distributed $\chi^2$. Degrees of freedom are in parentheses. HT-specification test with endogenous pioneering is in all cases not significant.

*** Significant at 0.01 level;
** significant at 0.05 level;
* significant at 0.1 level;
   one-tail t-test for Demand and Average Cost equations and two-tail t-test for Net Income and ROI equations.
### TABLE 3
Summary of Sensitivity Analysis

<table>
<thead>
<tr>
<th>Equation</th>
<th>Functional Forms</th>
<th>Number of Additional Models</th>
<th>Pioneering Effect as in Table 1</th>
<th>Significant Effects</th>
<th>Endogenous Pioneering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Average Cost</td>
<td>4</td>
<td>11</td>
<td>11</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Net Income</td>
<td>4</td>
<td>13</td>
<td>13</td>
<td>69 %</td>
<td>92 %</td>
</tr>
<tr>
<td>ROI</td>
<td>4</td>
<td>13</td>
<td>13</td>
<td>85 %</td>
<td>92 %</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>45</td>
<td>45</td>
<td>87 %</td>
<td>96 %</td>
</tr>
<tr>
<td>Equation</td>
<td>Endogenous Specification</td>
<td>Exogenous Specification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------</td>
<td>-------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pioneering Effect&lt;sup&gt;a&lt;/sup&gt;</td>
<td>HT Specification Test&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Pioneering Effect&lt;sup&gt;a&lt;/sup&gt;</td>
<td>HT Specification Test&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Net Income</td>
<td>-0.975*** (0.221)</td>
<td>̂m = 1.35 (6) p = 0.969</td>
<td>-0.127*** (0.0357)</td>
<td>̂m = 27.2 (7) p = 0.000</td>
<td></td>
</tr>
<tr>
<td>ROI</td>
<td>-0.825*** (0.193)</td>
<td>̂m = 0.53 (10) p = 0.999</td>
<td>-0.256*** (0.082)</td>
<td>̂m = 14.2 (11) p = 0.222</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Standard errors are in parentheses.

<sup>b</sup> The test statistic is distributed χ²; degrees of freedom are in parentheses.

*** Significant at 0.01 level;
** significant at 0.05 level;
* significant at 0.1 level;
two-tail t-test.
TABLE 5
Conditional Pioneering Effects on ROI

<table>
<thead>
<tr>
<th></th>
<th>Effect of Years in Market (YFE)</th>
<th></th>
<th>Effect of Consumer Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pioneering</td>
<td>Pioneering x YFE</td>
<td>Pioneering x YFE²</td>
</tr>
<tr>
<td>Consumer Goods a</td>
<td>3.477**</td>
<td>-0.339***</td>
<td>0.0052***</td>
</tr>
<tr>
<td></td>
<td>(1.886)</td>
<td>(0.137)</td>
<td>(0.0021)</td>
</tr>
<tr>
<td>Industrial Goods a</td>
<td>1.815°</td>
<td>-0.129*</td>
<td>0.0014*</td>
</tr>
<tr>
<td></td>
<td>(1.885)</td>
<td>(0.099)</td>
<td>(0.0012)</td>
</tr>
</tbody>
</table>

a) Standard errors are in parentheses.

*** Significant at 0.01 level;  
** significant at 0.05 level;  
* significant at 0.1 level;  
° significant at 0.2 level; one-tail t-test.
References


