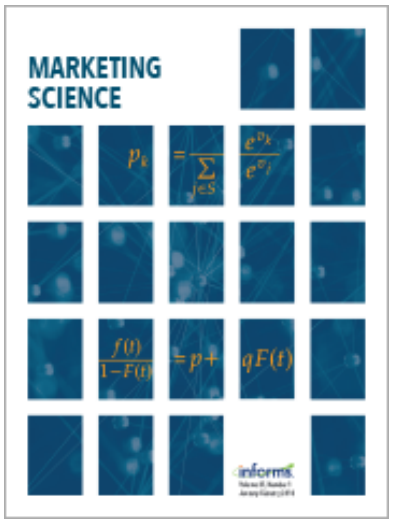

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Disentangling Pioneering Cost Advantages and Disadvantages

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Existing literature discusses a number of possible pioneering cost advantages and disadvantages. In this paper, we empirically test three different sources of long-term pioneering cost advantage—*experience curve effects*, *preemption of input factors*, and *preemption of ideal market space*—and three different sources of pioneering cost disadvantage—*imitation*, *vintage effects*, and *demand orientation*. We disentangle these sources by breaking total cost of a business unit into three different components—purchasing, production, and selling, general, and administrative (SG&A) costs—and identifying conditions that intensify or reduce the effect of the proposed source. Using two samples of business units, one for consumer goods and one for industrial goods, we find support for five of the six sources of pioneering cost advantage and disadvantage in both samples, while the advantage due to preemption of ideal market space is limited to the consumer goods sample. The unconditional analysis shows a pioneering purchasing cost *advantage* but even larger pioneering production and SG&A cost *disadvantages*. The complexity of our obtained findings suggests that managers need to think carefully about their particular conditions before making assumptions about the cost and, therefore, profit implications of a pioneering strategy.

Key words: pioneering; cost effects; preemption; supply chain management; IV-estimation
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1. Introduction

Most research that examines the effects of pioneering on firm performance focuses on demand-side (e.g., market share) advantages accruing to a pioneering strategy. There is little empirical research that examines the cost implications of such a strategy.[1] As an exception, Boulding and Christen (2003) report a long-term average cost disadvantage from pioneering, but do not provide insight as to the source or sources of this disadvantage. Despite the imbalance across demand-side and cost-side studies of pioneering, Lieberman and Montgomery (1988, 1998) suggest that detailed knowledge of cost effects of a pioneering strategy is as important as knowledge of external market effects to understand how to optimize a market entry strategy. The overarching goal of this research is to begin providing detailed knowledge of the cost implications of a pioneering strategy relative to a follower strategy.

Empirical research on cost effects is complicated by three problems. First, the various theories that exist to explain pioneering demand effects (e.g., resolution of risk and uncertainty, memory and learning effects, status quo bias, and so on) lead to predictions of a demand-side *advantage* for a pioneering strategy. In contrast, the entry order literature provides a number of theoretical arguments for pioneering cost advantages and disadvantages (c.f. Lieberman and Montgomery 1988 or Kerin et al. 1992). For example, pioneers may gain a cost advantage from learning curve or preemption effects, whereas they may face a disadvantage due to free riding and imitation from followers.

Second, there are different types of costs, e.g., purchasing, production, selling, etc., which represent different operational components of a business. The various effects of pioneering on cost discussed in the extant literature may influence one type of cost more than another or in a different direction. For example, the potential benefit of factor input preemption should show up as a purchasing cost advantage with no impact on selling cost, whereas spatial preemption of the ideal space in the market should show up as a selling cost advantage with no direct impact on purchasing cost.

Finally, costs are difficult to observe and the availability of detailed cost data for a broad cross-section

[1] For reviews of the literature on entry order effects, see Kalyanaram et al. (1995), Kerin et al. (1992), and Lieberman and Montgomery (1988, 1998).

of firms is quite limited. Detailed data, however, are needed because an aggregate-level examination of the relationship between pioneering and cost may mask the effect of different underlying, but countervailing, forces. Cost results like those reported in Boulding and Christen (2003) only indicate that cost disadvantages of pioneering outweigh the advantages, but not the precise source or sources of this overall effect. For example, the finding of an overall cost disadvantage from pioneering does not imply that preemption or experience curve advantages do not exist. The aggregate-level result is therefore of limited managerial value.

In this research, we disentangle countervailing cost effects and conduct a systematic empirical analysis of differing theoretical predictions with respect to the long-term cost effects of a pioneering strategy at the business unit level. In particular, we focus on three important sources of long-term pioneering cost advantage—*learning curve effects*, *preemption of input factors*, and *preemption of the ideal market space*—and three important sources of pioneering cost disadvantage—*imitation*, *vintage effects*, and *demand orientation*.[2] With the exception of a demand orientation cost disadvantage, these sources of advantage and disadvantage have been discussed extensively in reviews of the entry order literature (c.f. Lieberman and Montgomery 1988). The concept of a demand orientation disadvantage comes directly from Miles and Snow (1978). They argue that innovative firms (prospectors)—in our case, pioneering firms—are typically organized differently and are less concerned with efficiency than firms that enter markets later (defenders and analyzers). Whereas vintage effects are related to operational inertia (Ghemawat 1991), a demand orientation is related to a broader, organizational inertia that can beset innovating firms (Hannan and Freeman 1984, Leonard-Barton 1992).[3]

Our approach to test these different sources is as follows. First, we recognize that an overall, or average, estimate of the cost effect of a pioneering strategy would hopelessly confound different theoretical effects and thus not allow us to test a hypothesis such as "a pioneer benefits from factor input preemption." Moreover, we cannot directly observe a source of interest like factor input preemption. Therefore, we look for conditions that should intensify or diminish the cost effect of one of the six sources that arises solely due to firms' market entry strategy. From an experimental perspective, one could think of this approach as laboratory manipulations of contextual factors that magnify, or minimize, theoretical effects of interest. The conditions we identify are analogous to these manipulations. Through this conditional approach, we isolate and test the presence of the six selected sources of pioneering cost advantage and disadvantage.

Table 1 Definition of Cost Components

Cost component	Definition
Purchasing costs	This cost component includes all cost items related to the purchasing of raw materials, components, and finished goods as well as overhead costs related to the purchasing of these items.
Production costs	This cost component includes all cost items related to manufacturing including manufacturing overhead costs.
SG&A costs	Selling, general, and administrative costs capture costs other than purchasing and production costs. In particular, this component includes marketing, selling, R&D, depreciation, and general overhead costs.

Next, we decompose total cost into the following underlying cost components: (1) purchasing, (2) production, and (3) selling, general and administrative (SG&A). Definitions of these cost components are provided in Table 1. Use of these cost components in our empirical analysis allows us greater precision in isolating and testing our sources of interest. That is, we can map a source (e.g., factor input preemption) to a cost dimension (e.g., purchasing costs) and then identify conditions (e.g., supplier power) that will moderate the cost effect due to the particular source.

We first test our predictions with a sample of consumer goods firms and then test the robustness of these findings with a sample of industrial goods firms. This replication across two independent samples is possible because we choose to test sources that should be invariant to whether a firm is selling consumer versus industrial goods.

In sum, this disentangling approach produces a three-way matrix in setting up our hypotheses. We focus on a particular source of cost advantage or disadvantage, identify a *condition* (moderating factor) that intensifies the absence/presence of this theoretical effect, and identify the *location* (cost component) where we should observe the effect. Thus, our propositions are hypothesized moderating effects of an identified condition on the pioneering cost effects for particular cost components.

With respect to this empirical analysis, we note one important feature. The entry-order decision has long been theoretically considered an *endogenous* choice variable (Lieberman and Montgomery 1988). Boulding and Christen (2003) provide strong empirical evidence

[2] Consistent with existing studies that examine long-term market share effects of pioneering, in this research, we focus on long-term cost effects of pioneering. We are not claiming that we have identified every possible cost effect; however, we are examining major effects previously identified in the literature.

[3] This demand orientation also produces a demand-side pioneering advantage (Kalyanaram et al. 1995, VanderWerf and Mahon 1997). However, the demand-side effect is not the subject of our analysis.

in support of this theoretical argument of endogeneity. Consequently, in our analysis, we treat the entry-order decision as endogenous and use the Hausman-Taylor instrumental variable (IV) estimation (HT-IV estimation) (Hausman and Taylor 1981) to control for unobserved or omitted factors that could also lead to cost differences between pioneers and followers.

To foreshadow our findings, we find support for all hypothesized sources in both samples except for preemption of ideal market space in the industrial goods sample. The combination of precision in testing the hypothesized effects along with the robustness of these effects gives us significant confidence in the obtained results. Importantly, our results imply that a pioneering strategy leads to both cost advantages and disadvantages. This supports Lieberman and Montgomery's (1988, 1998) belief that detailed knowledge of entry order *cost* implications would be important to evaluate different entry strategies. The complexity of our empirical findings suggests that managers need to think carefully about their particular conditions before making assumptions about the cost, and therefore profit, implications of a pioneering strategy.

The remainder of the paper is organized as follows. Next, we summarize the various arguments for the six selected sources of pioneering cost advantage and disadvantage provided in the existing pioneering literature and integrate them into our conditions/cost components matrix to produce specific hypotheses. We then describe the average cost equation and the data derived from the profit impact of market strategies (PIMS) database, including the particular measures that enable estimation of our model to test the various hypotheses. In §5, we present our estimation results. We conclude by discussing various implications of our findings.

2. Pioneering Cost Advantages and Disadvantages

This section describes the six different sources of pioneering cost advantage and disadvantage of interest in this research. We start by reviewing theoretical arguments and relevant empirical findings about a source, then describe the conditional setting that should intensify or reduce the effect of this source, and finally articulate where the effect should arise with respect to particular cost components. We conclude this discussion in two ways: first, with specific hypotheses with respect to predicted effects and, second, with a matrix presented in Table 2 that summarizes our predictions.

2.1. Sources of Pioneering Cost Advantage

2.1.1. Preemption of Factor Inputs. For nonmobile assets (e.g., land or retail location), the pioneering firm can earn Ricardian rents. Main (1955) cites the nickel industry as an example of such preemption. More generally, the pioneering firm can also earn rents from mobile assets if they can lock in the more favorable, lower cost suppliers relative to later entrants that are then forced to go to higher cost alternatives. Pioneers may also lock in more favorable terms with suppliers if the information asymmetry between buyer and supplier is greater at the inception of a market. At market inception, relative to later stages of market development, the buyer (pioneer) is typically more knowledgeable about the end user

Table 2 Summary of Pioneering Cost Effects[†]

	Conditional factor	Purchasing cost	Production cost	SG&A cost	Total cost
Source of pioneering cost advantage					
Preemption of factor inputs	Low supplier power versus high supplier power	Improve (H1)	na	na	Improve (H7)
Preemption of ideal market space	Strong market share position versus weak market share position	na	na	Improve (H2)	Improve (H8)
Experience curve effects	Strong market share position versus weak market share position	na	Improve (H3)	na	Improve (H8)
Source of pioneering cost disadvantage					
Imitation	Process patent protection versus no process patent protection	na	Improve (H4)	na	Improve (H9)
Vintage effects	New plant and equipment versus old plant and equipment	na	Improve (H5)	na	Improve (H10)
Demand orientation	Low vertical integration versus high vertical integration	Improve (H6)	Improve (H6)	Improve (H6)	Improve (H11)
Total pioneering advantage/disadvantage		?	?	?	Disadvantage*

[†]The matrix indicates where we hypothesize a conditional factor to *improve* the pioneering cost effect (i.e., either increase pioneering advantage or reduce pioneering disadvantage); *na* indicates cases for which no hypothesis is offered.

*Boulding and Christen (2003).

than its upstream supplier. The better knowledge of the pioneer can allow it to absorb more of the supplier's risk in return for more favorable conditions (Cachon 2003). Thus, one might expect pioneering firms to have lower purchasing costs for factor inputs relative to followers given a preemption effect.[4]

Labor is another factor input. If the pioneering firm can decrease the mobility of the asset, for example, by signing long-term contracts or including noncompete clauses, it could have lower production cost (where labor cost is included in production cost). In practice, however, labor seems to be fairly mobile. Guasch and Weiss (1980) argue that later entrants face lower labor cost because they can hire away employees from the earlier entrants who have made the investments in screening and training. In the long run, this effect should be less relevant.

Given the discussion above, preemption of input factors should most noticeably affect the purchasing cost component rather than production cost, which contains labor costs. As discussed later, the purchasing cost component is also subject to a potential pioneering disadvantage. As a result, the overall effect of pioneering on average purchasing cost is not necessarily evidence for or against the presence of a pioneering cost advantage from preemption of input factors. For this reason, we examine the impact of a conditional factor that will allow us to specifically identify preemption effects. The conditional factor used in our analysis is the degree of supplier power (SP). A pioneer can profitably preempt followers in relationships with suppliers of input factors when it can limit the mobility of these suppliers or take advantage of information asymmetries. This ability is limited when SP is high. In this case, suppliers can more easily take their business elsewhere or extract the rents created by the pioneer. In either case, the ability of pioneers to benefit from preemption is reduced. Conversely, when SP is low, a pioneer can better lock in more favorable sources of supply. In other words, if pioneers gain a cost advantage relative to followers due to factor input preemption, low SP will magnify this effect. Thus, our analysis does not concentrate on the main effects of either pioneering or SP on purchasing cost; instead, we contrast the difference in average purchasing cost between pioneers and later entrants under low SP with the difference in entry order effects under high SP. If factor input preemption is a source of a pioneering cost advantage, the pioneering effect should be more favorable under low SP. Note, because we do not know the overall effect of pioneering at the cost component level, we use in all the hypotheses that follow the term more favorable, which means either a pioneering cost advantage or less of a pioneering cost *dis*advantage. This leads to our first hypothesis.

[4] With limited capacity, it is also optimal for a supplier to quote the first buyer a lower price than subsequent buyers because the opportunity cost of capacity is lower.

Hypothesis 1 (H1). *Pioneering leads to more favorable average purchasing costs* (*relative to following*) *when SP is low.*

2.1.2. Preemption of Ideal Market Space. A pioneer may identify and locate in the ideal market space, or even define it. As discussed in the literature, switching costs due to quality uncertainty (Schmalensee 1982) or brand loyalty (Gabszewicz et al. 1992) and more favorable perceptions of a pioneer's products (Carpenter and Nakamoto 1989) have been shown to create and/or provide a demand-side advantage for the pioneer both at the brand level and the business unit level (Kalyanaram et al. 1995). This demand advantage could have cost implications with respect to the marketing cost associated with overcoming the pioneer's advantage. If the pioneer occupies more favorable perceptual spaces, all else equal, the marginal selling effort required for the same unit sales should be less for pioneers than for followers. Given the existence of switching costs, more marketing effort must be put forward by the follower to induce switching. In other words, at the margin, marketing activities would be less effective for followers. Thus, for example, the per customer (average) advertising and sales force costs should be lower for the pioneering firm relative to later entrants.

With respect to the location of this cost effect, we should observe strongest ideal space preemption effects for the *SG&A cost* component, as this is the cost component that contains marketing and selling expenditures. A fair amount of empirical evidence is consistent with the notion of a pioneering advertising advantage (e.g., Bowman and Gatignon 1996, Comanor and Wilson 1974, Fornell et al. 1985). In the short run, the size of this advantage could be mitigated if followers can free ride on the pioneer's buyer education activities. However, in the long run which is the focus of our analysis, when buyer education is no longer an issue, this factor should provide a pioneering advantage for average SG&A cost.

As before, we examine a conditional factor that intensifies the absence/presence of the ideal space preemption effect. One outcome measure that identifies the degree to which a firm occupies ideal market space is the market share relative to competitors, otherwise known as market share position (MP). All else equal, a strong MP indicates that the firm is at or near the ideal market position. If the pioneer occupies this space, they preempt this space and face lower marketing costs compared to followers. In contrast, for a follower to occupy this same high MP, the cost

of obtaining and defending this high share position will be greater. Under the assumption of diminishing returns to marketing expenditures, a high MP will therefore magnify the existence of a pioneering cost advantage.[5]

Hypothesis 2 (H2). *Pioneering leads to more favorable average SG&A costs* (*relative to following*) *with a strong MP.*

2.1.3. Experience Curve Effects. As the first mover, a pioneer can accumulate experience earlier than later entrants, which should lead to lower average production cost. Theoretical work, however, indicates that learning benefits are diminished by interfirm diffusion of technology (Ghemawat and Spence 1985, Lieberman 1987) or by revealing private information (Fershtman et al. 1990). Lieberman and Montgomery (1988) conclude that interfirm diffusion "…occurs rapidly in most industries, and learning based advantages are less wide-spread than was commonly believed in the 1970s" (p. 43). However, the conclusion that those experience-based benefits dissipate for pioneering firms has not been tested empirically.

A classic representation of experience curve benefits is cost on the Y axis and cumulative production on the X axis. As noted by Henderson (1979) in discussing experience curve effects, one condition that captures cumulative production in an industry is a firm's market share relative to competition, i.e., a firm's MP. Note that, by definition, a pioneer has an initial experience advantage. However, over time, if the pioneer does not maintain a high MP, one cannot say that the pioneer has higher cumulative production relative to followers and, therefore, lower production costs. On the other hand, with a strong MP, the likelihood that the pioneer not only starts ahead of followers on the experience curve but also stays ahead increases. Thus, if experience curve benefits exist for pioneers relative to followers, this advantage should be magnified with a strong MP.

Whereas MP is the same conditional factor identified to test for the presence of ideal market space preemption, this time our focus is on experience effects. Therefore, our cost location of interest is the production *cost* component, which is where we would expect to observe experience effects. Note that we cannot claim an absolute production cost advantage for pioneers. To foreshadow our discussion of vintage effects, followers may enter the market on a different (lower) experience curve. However, a pioneer with a strong MP should be farther down an experience curve relative to followers than a pioneer with a weak MP. Specifically,

Hypothesis 3 (H3). *Pioneering leads to more favorable average production costs* (*relative to following*) *with a strong MP.*

2.2. Sources of Pioneering Cost Disadvantage

2.2.1. Imitation. For a variety of reasons, the cost of imitation tends to be lower than the cost of innovation. First, even patented innovations tend to be copied fairly rapidly and at a lower cost. For example, in a study consisting of 48 innovative chemical, electrical, and pharmaceutical products, Mansfield et al. (1981) found that imitating firms matched patented innovations at a rate of 65% of the innovator's cost. Second, although our focus is on long-run effects, in the short-term, a pioneer has to build a market which includes important investments in customer education and market infrastructure. For example, any coffee shop in the United States today can benefit to some extent from Starbucks' effort to persuade Americans that good coffee is worth a significant premium. In China, Motorola created the market for mobile phones by educating consumers ("Motorola" in Chinese even meant mobile handset) and manufacturers. Chinese handset makers such as Ningbo Bird benefited from this effort.[6] Third, a follower can wait and make important investment decisions after product and/or process technologies are established and customer preferences and market size are known, i.e., with much better information. Again, short-term, we would expect initial R&D cost to be lower for later entrants. In the long run, the spillover of product, process, and market information seems to be most important, which should enable a follower to establish a more efficient operation. For example, the follower can build production plants that are closer to minimum efficient scale because of more accurate market size information, thereby lowering average production cost.

While every aspect of a business is potentially subject to imitation, we focus on imitation of production processes and therefore the *production cost* component. Imitation of products or product concepts is a well-established phenomenon. One factor that should sharply reduce the ease of imitation and the degree of spillover from pioneers to followers in the area of production is the existence of process patents (PPs).

[5] In situations where switching costs are low and followers can readily and credibly claim to offer the same benefits as a pioneer, the preemption cost advantage can disappear. Generic drugs provide an example of this. We thank an anonymous reviewer for alerting us to this issue which is further discussed in §6.

[6] Existing research shows that the reward for successful pioneers for their market building efforts is a demand-side advantage which, as argued earlier, can also lead to a cost-side advantage. The existence of such an advantage does not preclude the existence of a cost disadvantage in other places.

In this situation, followers cannot imitate the pioneer's production process as easily because they have to innovate around the pioneer's process patent. To be precise, our interest is whether a process patent is more beneficial for a pioneer relative to a follower with respect to production costs. Because of entry order, more information flows from pioneers to followers than vice versa. Therefore, a process patent should be a more effective information barrier for pioneers if imitation is an important factor in this area. Formally,

Hypothesis 4 (H4). *Pioneering leads to more favorable average production costs* (*relative to following*) *with PP protection*.

2.2.2. Vintage Effects. Empirical work by Bevan (1974) and Yip (1982) suggests that technological discontinuities provide gateways to entry for later entrants. 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 (Johansen 1959, McLean and Riordan 1989) and result in lower production cost for the later entrant. Even with the advent of more efficient production technologies, a pioneer may face switching costs or other economic incentives that make existing production technologies look more attractive than newer technologies (Ghemawat 1991). This suggests the existence of rational inertia on the part of the pioneering firm. 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. More recent marketing work suggests that under some conditions the cost discontinuity associated with vintage effects can lead to a follower advantage with respect to market share and survival rate (Bohlmann 1997, Bohlmann et al. 2002).

In combination, this research suggests vintage effects should produce higher production costs for pioneers. Thus, in studying this theoretical effect, our location of focus is again the production cost component. In looking at production costs, one conditional factor that should magnify the presence of vintage effects is the age of plant and equipment (APE). When pioneering firms have old plant and equipment (P&E) we should see a strong pioneering production cost disadvantage, all else equal. On the other hand, we should see a reduction of this disadvantage for pioneering firms with relatively new P&E. When both followers and pioneers have relatively new plants and equipment, it increases the likelihood that both have the latest production technology. When both have relatively old P&E, vintage effects favor the follower, i.e., on average, old "follower technology" is of a newer vintage than old "pioneer technology." Thus, we offer the following hypothesis:

Hypothesis 5 (H5). *Pioneering leads to more favorable average production costs* (*relative to following*) *with new P&E*.

2.2.3. Demand Orientation. When establishing its organization, a pioneer's primary concern has to be the successful creation of a market. Compared to that, concerns about cost and organizational efficiency take a back seat. The higher market and technology uncertainty requires a pioneer to invest more in maintaining design and production flexibility that allows it to move in the direction of market changes (Bhattacharya et al. 2008). Production capacity is more likely expanded in an incremental fashion as a market grows. In contrast, better information allows the followers to effectively focus their expenditures on achieving greater efficiency. Indeed, one might argue that if later entrants are aware of the sustainable demand-side 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. These arguments are consistent with the categorization of firms suggested by Miles and Snow (1978); successful pioneers—prospectors—are found to be less cost efficient than successful followers—defenders and analyzers.

Thus, overall, the consequence of a demand orientation should be higher average cost for pioneers relative to followers. Because this is an overall organizational effect, one might reasonably argue that it should operate across the board—less efficiency in managing purchasing, production, and SG&A *costs*. The challenge for a pioneer is transforming itself over time from a successful market creator to an efficient operator. In this transformation, the pioneer's core capability can turn into core rigidity, an event that is more likely to happen the more complex the organization (Leonard-Barton 1992). Thus, a conditional factor that should magnify the effect on costs due to a demand orientation is the degree of vertical integration (VI) of a firm. More extensive requirements for integration of different activities imply greater organizational complexity. As the scope of the organization increases, the loss in efficiency due to a demand orientation should be magnified. Thus, with a high level of VI, a pioneering strategy should lead across the board to more unfavorable cost effects relative to a follower strategy with the same level of VI. With a low level of VI, managing organizational efficiency is generally easier which reduces the magnitude of the disadvantage for the pioneering firm. More formally,

Hypothesis 6 (H6). *Pioneering leads to more favorable average purchasing, production, and SG&A costs* (*relative to following*) *with a low level of VI.*

2.3. Summary of Pioneering Cost Advantages and Disadvantages

Table 2 summarizes the previous discussion. The rows present the six sources together with the conditional factors that we argue should magnify or reduce the effects of the sources. The columns indicate the specific location of the effects, i.e., the relevant cost component. Visual inspection of Table 2 is of some interest. First, 7 of the 15 cost component cells do not contain a specific hypothesis. (Because there are only five conditional factors for the six sources, three cells for MP are redundant.) While they are not directly subject to hypotheses, we expect to find insignificant conditional effects in these cells. This way, these results support the appropriateness of the conditional factors, similar to manipulation checks in experiments.

Second, looking down the cost component columns suggests the impossibility of unambiguously identifying the direction of the overall effect of pioneering at the cost component level. Because, for each cost component, we have entries under the heading of both pioneering cost advantages and disadvantages, summing down the columns does not produce clear predictions. This result lends credence to our earlier claim that an aggregate-level analysis of the effects of pioneering on cost can mask countervailing effects. Cost decomposition alone does not solve this masking problem, given the variety of theoretical effects operating simultaneously. For example, a production cost disadvantage could be due to imitation, vintage effects, or a pioneer's demand orientation, but these disadvantages could be softened or perhaps even overcome due to a pioneering experience curve advantage. Combining this cost decomposition with the conditional analysis does, however, allow us to disentangle these competing effects. The question marks in the last row of Table 2 indicate that the overall, unconditional effects cannot be predicted and are empirical questions.

Third, summing across the rows of Table 2 suggests that we can offer additional hypotheses with respect to the conditional effects of pioneering on *total average cost*, as shown in the far right column. Specifically, because we do not see countervailing effects of pioneering across the cost components for a conditional factor, we should be able to hypothesize overall cost effects. For example, because we predict no moderating effect of SP for production and SG&A costs, the moderating effect on purchasing cost should drive the effect for average total cost. Formally,

Hypothesis 7 (H7). *Pioneering leads to more favorable average total cost* (*relative to following*) *when SP is low.*

Similarly, we can offer a hypothesis about the moderating effect of MP on pioneers average total cost.[7] Specifically,

Hypothesis 8 (H8). *Pioneering leads to more favorable average total cost* (*relative to following*) *with a strong MP.*

With regard to imitation and vintage effects, we predict a moderating effect of process patent and APE, respectively, for production cost and no effects for the other cost components. Thus, we should observe the same effects for average total cost.

Hypothesis 9 (H9). *Pioneering leads to more favorable average total cost* (*relative to following*) *with PP protection.*

Hypothesis 10 (H10). *Pioneering leads to more favorable average total cost* (*relative to following*) *with new P&E.*

Finally, we predict that due to a pioneer's demand orientation, there is a moderating effect of VI on all cost components. Logically, we should observe the same effect for average total cost.

Hypothesis 11 (H11). *Pioneering leads to more favorable average total cost* (*relative to following*) *with a low level of VI.*

In sum, we have eleven hypotheses with respect to the effect of pioneering relative to entering later on costs as moderated by our conditional factors. Unlike the six hypotheses about the effects on cost components, the five hypotheses for the effects on total average cost are not of immediate theoretical interest. However, they do offer an important robustness check for the estimation results. We reiterate that we cannot offer any predictions about the main effects of pioneering on any of the cost components. From Boulding and Christen (2003), we know that pioneering leads to an overall total cost disadvantage (noted in the bottom right cell of Table 2). However, our conceptual development implies that such an effect is an empirical question.

3. Empirical Model

Following earlier work (e.g., Boulding and Staelin 1993, Boulding and Christen 2003), we use the following specification for average total cost and its various components:

$$AC_{ljit} = Q_{lit}^{\delta_{lj}} \cdot \exp[\beta_{0lj} + \gamma_{lji} \cdot Pion_{li} + X_{ljit}\beta_{1lj} + \varepsilon_{ljit}], \quad \text{with } \gamma_{lji} = \gamma_{lj} + \nu_{lji} \ (j = 0, \ldots, 3). \quad (1)$$

[7] We acknowledge the possibility that high MP increases buyer power, thus operating as the flip side of the coin described by our SP discussion for H1. If so, this effect of high MP on pioneering purchasing costs goes in the same direction as the other cost effects, allowing us to safely propose the ensuing hypothesis.

The elements of the different equations are defined as follows:

AC_{ljit}: average cost component j of business unit i in year t and condition l,

Q_{lit}: quantity sold in units by business unit i in year t and condition l,

$Pion_{li}$: indicator variable, where $Pion_{li} = 1$ if i is a pioneer, else $Pion_{li} = 0$,

X_{ljit}: vector of other potentially relevant factors,

δ_{lj}, β_{0lj}, β_{1lj}, γ_{lji}, γ_{lj}, ν_{lji}: model parameters for condition l.

Average total cost ($j = 0$) is decomposed into the following three components: purchasing cost ($j = 1$), production cost ($j = 2$), and SG&A cost ($j = 3$). For each equation j, we assume three different sources of error: unobserved fixed factors α_{lji} and unobserved random factors η_{ljit} that consist of a first-order autoregressive component with parameter ρ_{lj} (to capture dissipating effects) and a random component ω_{ljit}. In other words, the error component is $\varepsilon_{ljit} = \alpha_{lji} + \eta_{ljit}$ and $\eta_{ljit} = \rho_{lj} \cdot \eta_{ljit-1} + \omega_{ljit}$.

There are several points worth noting about these cost equations. First, estimation of Equation (1) allows us to address the effects of pioneering on different cost components, where the parameter γ_{lj} is the parameter for component j and condition l. These parameters capture the conditional effect of pioneering on the particular average cost component. By estimating Equation (1) for different conditions as specified by the various conditional factors discussed in §2, we can determine the moderating effect of these conditional factors and test our 11 hypotheses. Second, the specification allows for heterogeneity in the effects of pioneering across firms, i.e., we include the firm-specific parameter ν_{lji}. We do not estimate these firm-specific effects of pioneering but we control for their possible biasing effects on our estimate of the average effect γ_{lj} (for technical details, please see Boulding and Christen 2003). Third, we treat quantity Q as endogenous and include variables that are unique to the average cost equations to control for movements along an average cost curve that could occur due to underlying changes in demand. The elements in X_{ljit} that ensure identification are discussed in the next section.[8] Finally, we use an estimation procedure that ensures that the pioneering variable is independent of any empirical error term in order to obtain a consistent estimate of the average effects γ_{lj}.

[8] We do not explicitly estimate a demand function, but by treating quantity as endogenous and including variables that are unique to the cost functions, we can identify the different average cost functions.

4. Data and Estimation

We use PIMS data on business units to test our hypotheses about the cost effects of a pioneering strategy. Despite criticism (e.g., Ramanujam and Venkatraman 1984) and age of the observations, PIMS still provides the most diverse sample of industry data available in the public domain, with detailed descriptions of company, customer, competitor, and market factors. Furthermore, many of its perceived limitations can be eliminated (Boulding and Staelin 1995).

Because we are interested in the long-term effects of pioneering, we limit our attention to business units that compete in mature markets. Our theoretical arguments are independent of the industry setting. To test the robustness of our findings, we estimate our equations separately for a sample of business units selling durable and nondurable consumer products and for a sample of business units selling industrial products. The former sample contains data for 359 different business units with 1,104 observations that can be used for estimation after data transformations. The latter sample contains data for 820 different business units with 2,681 observations. The PIMS database contains business unit data from typical Fortune 500 companies. The annual observations cover the years 1974 to 1987 and consist of businesses that have been operating anywhere from one to more than 60 years.

These data samples are consistent with data used in previous empirical work (e.g., Robinson and Fornell 1985, Moore et al. 1991, Boulding and Christen 2003) to examine the effects of pioneering on business unit performance. Thus, our results can be benchmarked against existing findings. Golder and Tellis (1993) argue that PIMS analyses yield results that are potentially biased in support of a pioneering advantage because PIMS only includes data on surviving pioneers (and followers) and because business units classified as pioneers could in fact be misclassified early followers. Thus, we caution the reader that the results obtained herein could be biased in favor of a pioneering advantage.[9]

4.1. Cost Variables

Although the different average cost measures are not directly available in the PIMS database given disguising of the data, a series of papers have shown that these measures are usable for analysis purposes. We follow the same procedures reported in Boulding and Christen (2003) for using these disguised variables. Note that any potentially biasing effect of using these disguised data is controlled for by our use of the

[9] Whether a pioneering strategy is riskier and thus subject to a higher failure rate is not entirely clear (Kalyanaram et al. 1995, Robinson and Min 2002). In a meta-analysis of different empirical studies, VanderWerf and Mahon (1997) do not find evidence for a survivor bias.

Hausman and Taylor (1981) estimation procedure (see Appendix A for the derivation of dependent variables). Therefore, we can estimate the different average cost equations without bias due to measurement error in the dependent variable.

4.2. Explanatory Variables

Pioneering is the independent variable of central interest. PIMS provides an indicator measured at the business unit level 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 (*Pion*) to 1, for all other businesses to 0.

The quantity variable (Q) allows us to control for movement along the average cost curves due to demand shifts. It is also important to separate the effect of market position from volume effects. We further include a number of variables that are intended to capture factors specific to the business unit and factors representing the particular industry structure that likely influence the performance of a business unit and could be correlated with pioneering. These variables are denoted as X in Equation (1). The set of variables specific to the business unit include a business unit's MP, the relative product quality, and the log of the age of the business unit (log AGE), where the age is defined as years since market entry. The last variable is of particular interest because it directly controls for possible learning curve effects due to time in market rather than due to the effects of pioneering, which is the focus of this research. MP represents internal firm effects 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 one and the minimum (worst possible MP) equals zero. Industry structure is captured by a summary measure of competitive environment (CE) that builds on Porter's framework for assessing the competitive structure of an industry (Porter 1980). 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 CE found in the PIMS database.

Finally, to help ensure identification in estimation, we add the following supply-side factors to the average cost functions (Equation (1)): productivity of employees (EP), the percent change in output per hour of the entire economy (OUT), the percent change in unit labor cost (ULC), process R&D intensity (PSI), supply intensity (SI), and production intensity (PI).[11] The intensity variables are measured by the specific expenditure as a percent of revenues. For example, SI is the ratio of purchasing cost to revenues of business unit i in year t. For individual cost components, we exclude the corresponding intensity variable. For example, SI is excluded from the estimation equation of average purchasing cost. All these identifying variables vary over time and, with the exception of ULC and OUT, are all measured at the business unit level. Table 3 provides summary statistics of various variables.[12]

4.3. Conditional Factors

The PIMS database also contains variables that allow us to examine the different hypothesized conditional effects. First, we construct an index for SP from three available time-fixed but firm-specific variables: the sales from the largest three suppliers (S3S), the availability of alternative supply sources (ASS), and the degree of suppliers' forward integration (SFI). The first variable is a percentage variable and varies between 0 and 100. The second variable is an indicator variable, where 0 indicates the absence of alternative supply sources, 1 a limited availability of alternative supply sources, and 2 a high availability of alternative supply sources. The third variable is an indicator variable, where 0 indicates the absence of supplier forward integration, 1 forward integration in unrelated markets, and 2 forward integration in related markets. The exact index is $SP_i = (S3S_i + 50(2 - ASS_i) + 50SVI_i)/300$ and thus varies between 0 and 100. All other variables are directly available in the PIMS database. The existence of a PP is indicated by an indicator variable. The average APE is defined as the ratio of net book value to gross book value of P&E and varies between 0 and 100. VI is indicated relative to leading competitors, with 1 indicating less integration, 2 the same degree, and 3 more integration. We combine observations from the last two groups into a single group to test the effect of this factor. Finally, the MP variable has been discussed above. With the exception of this last variable, all conditional factors are time invariant for the horizon of observations in our samples (and thus do not have a subscript t for time), which has implications for the approach we use to estimate the conditional effects.

4.4. Estimation Approach

To obtain consistent estimates for the various cost effects of a pioneering strategy, we need to control for different potential estimation issues. First, based

[10] The actual PIMS measure is described more fully in Robinson and Fornell (1985).

[11] Data for the ULC and OUT variables were obtained from various government sources through http://www.economagic.com (Econo*magic*.com).

[12] All variables in nominal dollars are transformed into constant (real) dollar values by use of the consumer price index deflator. None of the bivariate correlations is high enough to cause estimation problems.

Table 3 Summary Statistics for Selected Variables[1]

	Consumer goods (1,104)				Industrial goods (2,681)			
	Pioneers (620)		Nonpioneers (484)		Pioneers (1,592)		Nonpioneers (1,089)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Avg total cost	1.81	0.8/11.3	1.82	0.7/3.9	1.86	0.2/6.8	2.06	0.2/6.3
Avg purchasing cost	0.88	0.1/6.8	0.92	0.1/2.4	0.87	0.1/5.2	1.08	0.1/4.9
Avg production cost	0.48	0.1/2.2	0.45	0.1/1.6	0.59	0.1/1.7	0.62	0.1/2.1
Avg SG&A cost	0.44	0.1/2.4	0.45	0.1/1.8	0.39	0.1/4.1	0.36	0.1/1.7
Market share	28.80	1/70	17.82	1/70	30.03	1.9/70	22.07	1.9/70
Market share position	0.98	0/4.52	0.47	0/4.50	1.05	0/4.52	0.61	0/4.52
Comp. environment[2]	4.71	1.2/8.7	4.30	1.1/8.0	5.13	2.0/9.6	4.91	1.5/9.1
Product quality	0.28	−0.35/0.95	0.20	−0.35/0.95	0.28	−0.35/0.95	0.19	−0.35/0.95
Age of business	36.37	3/66	27.19	1/63	36.26	2/66	29.78	3/67
Supply intensity	43.47	15/77	47.05	15/80	41.41	15/80	47.55	15/80
Production intensity	24.69	6/55	23.08	4/55	28.59	4/55	28.13	4/55
Process R&D intensity	0.49	0/5	0.45	0/5	0.73	0/5	0.49	0/5
Product R&D intensity	1.04	0/10	1.10	0/10	1.95	0/10	1.67	0/10
R&D intensity	1.53	0/12	1.55	0/12	2.73	0/12	2.19	0/12
Marketing intensity	13.60	1/40	13.14	1/40	7.79	1/40	6.67	1/37
Employee productivity	40.79	10/150	40.07	10/150	40.28	10/150	41.66	10/150
Process patent	0.18	0/1	0.19	0/1	0.26	0/1	0.13	0/1
Learning index	5.19	0/13	4.68	1/12	7.74	1/16	7.88	1/16
ΔGDP[3]	2.10	−4.1/7.5	1.99	−4.1/7.5	2.04	−4.1/7.5	1.89	−4.1/7.5
ΔOutput of economy[3]	2.40	−0.8/5.0	2.40	−0.8/5.0	2.35	−0.8/5.0	2.22	−0.8/5.0
ΔUnit labor cost[3]	7.34	−0.2/11.6	7.48	−0.2/11.6	7.31	−0.2/11.6	7.51	−0.2/11.6

[1]Number of observations is reported in parentheses in the column heads.
[2]Higher number indicates a lower degree of competitiveness.
[3]Data from U.S. government sources; all other data from PIMS database.

on the evidence provided in the entry order literature (Boulding and Christen 2003, Murthi et al. 1996), we consider the order of entry endogenously determined. This complicates the estimation because pioneering is itself a fixed factor. Second, we need to control for the heterogeneity of pioneering effects across businesses. Third, we need to control for measurement problems in the pioneering variable and the disguised cost measures. Boulding and Christen (2003) developed a multistage IV procedure based on the work by Hausman and Taylor (1981), which can address all three problems.

To apply this estimation approach, we first need to control for omitted and potentially biasing time-varying effects, η_{ljit}. Following Jacobson (1990), we test and control for omitted contemporaneous factors. We do this with a standard IV procedure for all endogenous time-varying variables included in our equations. We use instruments that are lagged two periods and thus independent of contemporaneous omitted factors.[13] We keep the fitted values for the endogenous variables and then control for omitted first-order autoregressive effects (i.e., dissipating returns) by ρ-differencing these data.[14] This removes the correlation between independent variables and time-varying effects η_{ljit}.

The main challenge is to find instruments to control for the correlation between pioneering and fixed effects α_{lji}. The estimation approach requires the assumption that a subset of the time-variant independent variables X_{ljit} is uncorrelated with the fixed unobserved factors α_{lji} to obtain such instruments. For these variables, the mean within a cross-section $\overline{X}_{lji.}$ becomes a valid instrument for time-invariant variables like the pioneering variable.[15] The advantage of the IV estimation approach by Hausman and Taylor (1981) is that the selection of such instruments can be tested with a specification test.[16] Fixed-effect estimation yields consistent estimates $\hat{\beta}_{lj1}^{\mathrm{FE}}$. Fixed-effect

[13] Testing reveals that most variables in our models are correlated with contemporaneous factors, with the exception of age of business unit, change in labor cost, and change in labor output in the cost equation. These variables therefore act as exogenous cost shifters to help identify the cost equations and control for observed changes in cost that are due to demand shifts.

[14] The estimates of ρ tend to be small, which is consistent with prior research using the same database (see Appendix B for details).

[15] Under more restrictive assumptions, it is possible to increase the number of instruments by using not just the business unit means, but each observation of these time-variant variables as instruments, yielding more efficient estimates (Amemiya and MaCurdy 1986, Breusch et al. 1989).

[16] In light of the evidence that such specification tests can lack power (Holly 1982), we use a conservative 0.20 level of statistical significance to reject a particular set of instruments.

estimation cannot yield an estimate $\hat{\gamma}_{lj}$ for the pioneering variable, but it provides a benchmark for the IV estimates $\hat{\beta}_{lj1}^{\mathrm{IV}}$. A large difference, $\hat{\beta}_{lj1}^{\mathrm{IV}} - \hat{\beta}_{lj1}^{\mathrm{FE}}$, relative to the respective standard errors suggests that the set of instruments is not independent of the fixed error term and is therefore invalid.[17]

4.5. Hypotheses Tests

To test for the different hypothesized conditional effects, we use two different approaches. With the exception of the MP variable, all conditional variables are fixed for the observation period. We use these variables to split the samples and separately estimate the pioneering effects for the resulting subsamples. A Wald test is then used to contrast the different conditional pioneering effects and test our hypotheses. To estimate the conditional effects of SP and APE, we split the samples in three roughly equal groups to indicate low, medium, and high levels. In this case, we contrast the low group with the high group. PP protection and VI have only two levels to be contrasted. Because a firm's MP is a time-varying variable in the data set, we include its interaction effect with pioneering (P × MP) in Equation (1) to test this conditional factor.[18]

5. Results

5.1. Average Cost Effects

Table 4 presents the average or unconditional long-term effects of pioneering on the three average cost components as well as on average total cost for both data samples. (We present the full results from our estimation equations for these main effects in Appendix B.) While we were unable to offer specific hypotheses with respect to these unconditional effects, they are of empirical interest. Results show a high degree of consistency between the two samples, which is consistent with research on market share effects of pioneering (Robinson and Fornell 1985, Robinson 1988, Urban et al. 1986). We find a pioneering advantage for average purchasing cost and pioneering disadvantages for average production cost and average SG&A cost. Finally, we note that the finding of an average total cost pioneering disadvantage is consistent with the result in Boulding and Christen (2003) and the sum of the three cost component effects.[19]

[17] For more details about the estimation approach, we refer the reader to Appendix A in Boulding and Christen (2003).

[18] We repeated the analysis of MP by splitting the sample in a similar fashion as for SP or APE. The estimation results are less efficient but lead to the same conclusions.

[19] For both samples, purchasing cost accounts for about 42% of total cost, production cost for about 32%, and SG&A cost for about 26%.

Table 4 Pioneering Effects on Average Total Cost and Its Components†

Sample	Purchasing cost	Production cost	SG&A cost	Total cost
Consumer goods	−97.8[a] (37.1)	124.4[a] (33.8)	72.1[a] (18.0)	40.2[a] (10.3)
Endogenous spec.[1]	0.43 (1) 0.51	0.91 (2) 0.63	1.22 (3) 0.75	0.32 (4) 0.99
Exogenous spec.[1]	32.8 (2) <0.001	20.8 (3) <0.001	16.9 (4) 0.002	19.7 (5) 0.001
Industrial goods	−79.1[a] (21.1)	108.6[b] (44.1)	63.5[a] (23.7)	61.6[b] (29.6)
Endogenous spec.[1]	0.33 (2) 0.85	0.90 (2) 0.64	0.99 (3) 0.80	0.91 (4) 0.92
Exogenous spec.[1]	10.4 (3) 0.015	10.6 (3) 0.014	6.00 (4) 0.20	10.7 (5) 0.058

†Standard error is reported in parentheses.

[a]Significant at 0.01 level; [b]significant at 0.05 level; [c]significant at 0.10 level (all 2-tail t-tests).

[1]First number indicates χ^2-test statistic with number of degree of freedom in parentheses; second number indicates p-value of test.

Table 4 also shows the results for the HT-specification test (Hausman and Taylor 1981) both for the endogenous specification of pioneering (in this case, we cannot reject the selected instruments) and the exogenous specification of pioneering. These findings provide clear evidence that pioneering (entry order) should be considered endogenous in estimation when examining the effects of pioneering on total cost and its underlying components. This suggests that treating pioneering as an exogenous variable in estimation leads to biased estimates. We do not discuss the biased parameter estimates from the exogenous specification except for remarking that the conclusions would be different.

5.2. Conditional Cost Effects

Table 5 presents the results for our sample of consumer goods of the conditional pioneering cost effects, which are the effects of interest to test our hypotheses.[20] As previously noted, we use the time-fixed conditional variables to split the samples and estimate separate pioneering effects for the subsamples. To test our hypotheses, we test whether these on/off conditions for our two subsamples yield significant differences in the pioneering effects in the direction predicted by the hypotheses. For the time-varying variable MP, we directly estimate an interaction effect between MP and pioneering. Before we present the conditional results, note that we present results for all of the cost components, even in the instance where we have no explicit predictions. We do this as a check on whether we obtain the expected null results.

[20] Detailed estimation results for the numerous conditional analyses are available from the authors.

Table 5 Conditional Pioneering Cost Effects for Consumer Goods†

Condition††	Purchasing cost	Production cost	SG&A cost	Total cost
Supplier power	H1✓	✓	✓	H7✓
High (398)	−65.6[b] (31.6)	140.5[b] (58. 9)	64.7[b] (33.0)	54.9[b] (24.9)
Low (384)	−184.4[a] (53.2)	116.1[b] (53.9)	77.1[b] (37.0)	−8.17 (20.4)
Difference*	7.43[a]	0.19	0.12	7.65[a]
Market share position		H3✓	H2✓	H8✓
Interaction effect	−14.2[a] (4.61)	−12.4[b] (6.04)	−18.2[a] (5.53)	−15.4[a] (3.24)
Weak	−96.2[b]	126.1[a]	67.8[a]	48.4[a]
Strong	−39.4	76.5[b]	−5.0	−13.2
Process patent	✓	H4✓		H9✓
No (902)	−99.6[b] (39.4)	137.6[a] (34.2)	15.1[b] (6.40)	92.9[a] (21.5)
Yes (202)	−133.4[b] (56.8)	−32.6 (79.7)	113.2[b] (56.7)	−88.3[c] (47.1)
Difference*	0.61	13.7[a]	15.5[a]	42.0[a]
Age of plant and equip.	✓	H5✓	✓	H10✓
Old (384)	−132.1[c] (77.7)	149.9[b] (60.6)	83.5[a] (27.5)	51.6[a] (15.0)
New (364)	−109.0[c] (59.2)	31.1 (35.9)	63.2[b] (30.3)	16.2 (22.1)
Difference	0.11	5.62[b]	0.49	3.56[c]
Vertical integration	H6	H6✓	H6✓	H11✓
High (879)	−110.2[a] (39.4)	133.6[a] (46.8)	73.6[a] (21.2)	55.5[a] (13.0)
Low (225)	−155.1[a] (53.7)	−6.2 (33.2)	−17.8 (35.7)	−42.1[b] (21.1)
Difference*	1.09	12.6[a]	8.92[a]	42.1[a]

†Standard error is reported in parentheses.

††Number of observations in parentheses; for market share position, the indicated conditional effect is calculated using MP = 0 for a weak position and MP = 4 for a strong position.

[a]Significant at 0.01 level; [b]significant at 0.05 level; [c]significant at 0.10 level (2-tail t-tests for parameter estimates).

*Shows test statistic for differences between parameter estimates for the two groups. It is distributed χ^2-test with one degree of freedom.

✓ indicates results that are consistent with our hypotheses or the expected null effect.

We start with the effect of SP (see the first row in Table 5). Comparing the low and high SP conditions allows us to test H1 and H7. We find strong support for these two hypotheses. Specifically, a pioneering strategy leads to significantly lower average purchasing and average total cost under conditions of low SP relative to conditions of high SP. Note, these results say nothing about the main effect of SP (which is not of interest in this research). They suggest that pioneers benefit more from low SP than followers because of the order of entry. This provides indirect support for the argument that a business, through pioneering, obtains a cost benefit due to factor input preemption. Although our analysis cannot eliminate with certainty that this result is not caused by some other unobserved factor than preemption, we have taken great care in our estimation approach to control for various unobserved factors. Moreover, the absence of moderating effects of SP on the other two cost components suggests that any alternative explanation influences pioneering effects on purchasing cost but does not influence pioneering effects on the other cost components.

Next, we consider the conditional effect of a firm's MP (see the second row in Table 5), which concerns H2, H3, and H8. Here, we report the estimate for the "Pioneering × MP" interaction term. Consistent with the argument that a pioneer can benefit from ideal space preemption effects (H2), we find that a stronger MP significantly reduces the SG&A cost disadvantage of a pioneering strategy. Likewise, consistent with the argument that a pioneer can benefit from experience curve effects due to pioneering (H3), we find that a stronger MP significantly decreases the average production cost disadvantage of a pioneering strategy. With regard to the moderating effect of MP on average total cost (H8), Table 5 shows that a stronger MP leads to a significantly lower average total cost disadvantage for pioneers. To make the results for this conditional factor comparable with the other results reported in Table 5, we also report the calculated pioneering effects for weak (MP = 0) and strong MP (MP = 4). Thus, we find strong support for all three hypothesized moderating effects of MP. Although not predicted, a stronger MP also significantly increases the pioneering average purchasing cost advantage. As discussed in Footnote 7, this is perhaps due to an increase in buyer power in the buyer-supplier relationship, producing a factor preemption result similar to that predicted by the conditional SP analysis (H1).

Next, we call attention to the conditional analysis involving PPs to test H4 and H9, as shown in the third row of Table 5. Results reveal that a pioneering strategy without continuing PP protection leads to significant average production cost and average total cost disadvantages, while the presence of PP protection

eliminates these two pioneering cost disadvantages. Thus, the obtained results provide strong support for H4 and H9 and the argument that imitation of production processes leads to a pioneering production cost disadvantage. We find no significant moderating effect of PPs on the pioneering effect for average purchasing cost. Conversely, we find that PP protection significantly increases the SG&A cost disadvantage for pioneers. This suggests that it is more costly for a pioneering business to have PP protection. The source of this disadvantage is not immediately obvious. It could be the result of a pioneer's demand orientation.

The conditional effects for the APE are shown in the fourth row of Table 5. These results are relevant to H5 and H10, which concern the argument that a choice of pioneering leads to a cost disadvantage due to vintage effects. As hypothesized, we find that the pioneering production cost disadvantage is reduced for pioneering firms with new P&E. This moderating effect filters through to the total cost level as hypothesized in H10. As expected, we find no significant differences between our two conditions for average purchasing cost and average SG&A cost.

Finally, the last row of Table 5 presents our findings for the conditional effects of VI. These results are relevant to H6 and H11, which concern the argument that a demand orientation that supports a successful pioneering strategy leads to a cost disadvantage. Increased VI suggests more purchasing, production, and fixed cost (SG&A) activities to manage within the firm, causing higher overhead cost relative to lower levels of VI. Thus, if a demand orientation effect exists, we expect more pronounced effects in situations of high VI. Thus, all three cost components and, as a result, the average total cost are relevant to test these hypotheses. As expected, we find negative moderating effects of VI for all cost components. Even though the moderating effect for average purchasing cost is not significant, the results provide support for the negative effect of a demand orientation.

In all, to examine our hypothesized effects, we conducted 13 significance tests based on our parameter estimates. For the consumer goods sample, the parameter estimates are directionally consistent with all of our hypotheses and 12 of the 13 tests are statistically significant at the 0.06 level or better, supporting the presence of all six hypothesized sources of pioneering effects on costs. In addition, five of the seven moderating effects, for which we expected a null effect, are indeed insignificant. To check on the robustness of our results, we now replicate our estimation procedure using the industrial goods sample.

5.3. Replication Results

We repeat our estimation procedure in an identical fashion, with the only difference that our sample consists of industrial goods rather than consumer goods. We present these results in Table 6.

Table 6 Conditional Pioneering Cost Effects for Industrial Goods†

Condition++	Purchasing cost	Production cost	SG&A cost	Total cost
Supplier power	H1✓	✓	✓	H7✓
High (863)	−46.6[b] (23.1)	138.4[b] (57.0)	123.4[a] (41.0)	91.3[b] (40.6)
Low (810)	−132.5[b] (52.7)	77.7[c] (41.6)	67.6[c] (37.6)	−24.2 (26.9)
Difference*	4.55[b]	1.47	2.01	11.1[a]
Market share position	✓	H3✓	H2	H8✓
Interaction effect	−0.38 (4.25)	−6.32[c](4.12)	0.90 (5.80)	−3.65 (3.43)
Weak	−78.4[a]	117.7[a]	62.0[b]	65.7[b]
Strong	−80.0[a]	92.4[a]	65.6[b]	51.1[c]
Process patent	✓	H4✓	✓	H9✓
No (2,135)	−92.9[a] (21.0)	177.3[a] (69.0)	91.3[a] (29.7)	93.1[b] (47.9)
Yes (546)	−51.9 (40.4)	−205.0[b] (92.7)	80.9[c] (46.9)	−106.9[b] (51.5)
Difference*	2.46	26.4[a]	0.09	16.9[a]
Age of plant and equip.	✓	H5✓	✓	H10✓
Old (870)	−83.0[b] (36.0)	132.3[a] (40.3)	67.5[b] (32.1)	71.7[a] (22.7)
New (891)	−59.4[a] (32.2)	9.5 (67.1)	63.5 (41.8)	−3.9 (29.9)
Difference*	0.48	4.89[b]	0.01	8.11[a]
Vertical integration	H6✓	H6	H6✓	H11✓
High (2,010)	−66.0[a] (24.9)	113.9[a] (41.4)	99.3[a] (33.3)	119.8[b] (48.4)
Low (671)	−122.3[a] (50.2)	92.0[c] (59.8)	16.1 (30.1)	1.3 (25.1)
Difference*	2.89[c]	0.22	6.53[a]	7.35[a]

†Standard error is reported in parentheses.

++Number of observations in parentheses; for market share position the indicated conditional effect is calculated using MP = 0 for a weak position and MP = 4 for a strong position.

[a]Significant at 0.01 level; [b]significant at 0.05 level; [c]significant at 0.10 level (2-tail t-tests for parameter estimates).

*Shows test statistic for differences between parameter estimates for the two groups. It is distributed χ^2-test with 1 degree of freedom.

✓ indicates results that are consistent with our hypotheses or the expected null effect.

As before, we conduct 13 significance tests for our 11 hypotheses. The parameter estimates underlying these tests are directionally consistent with our hypotheses in 12 of the 13 cases, where the one inconsistent sign is insignificant. The results provide significant support for our hypotheses in 10 of the 13 sets of parameter estimates at the 0.09 level or better. With respect to the specific hypotheses, we find significant support for all except H2 and H8 (preemption of ideal market space). The obtained effect for H8 is directionally correct, but fails to reach traditional levels of significance. Finally, all seven null moderating effects are insignificant, as expected.

Combining the results from the two samples, we find that 25 of 26 estimates are directionally consistent with our hypothesized effects, and that 22 of our 26 tests reach statistical significance. Overall, we take the stability of these estimates as evidence of the robustness of our obtained results. Furthermore, the strength of these findings suggests support for our predictions with respect to the effects of a pioneering strategy on cost. The source for which we only obtain partial support—preemption of ideal market space—is less conclusive and begs further discussion. We probe more deeply into this issue when next discussing the general implications of our findings.

6. Discussion

An extensive body of both theoretical and empirical research examines the effects of entry order on demand-side performance measures. While we see many theoretical arguments about cost implications of a pioneering strategy, we see very little systematic empirical research in this domain. Compared to the demand-side entry effects, the cost side differs in several important ways. First, we see opposing theoretical predictions for the effects of a pioneering strategy on cost. This point is made clear by Table 2. Looking down any particular cost component column, we see theoretical predictions for both pioneering cost advantages and disadvantages. As a consequence, any empirical finding that looks at the overall effects of pioneering on cost is, quite reasonably, subject to the counter-argument: "The theoretical premise for your empirical finding is Theory X, but Theory Y predicts the opposite result. Therefore, why should anyone believe this empirical result?"

It is also important to recognize that there are very different types of costs, some variable and some fixed, some relating to inputs to production, some relating to production itself, and some relating to general administration and selling. As shown in Table 2, the different sources of pioneering cost advantages and disadvantages are not expected to equally influence these various cost components. Finally, while sales or market share data are often publicly available, cost data are generally tightly guarded by firms. Further complicating empirical research is that, unlike customer-based pioneering effects, cost effects cannot be easily studied with the help of laboratory experiments.

Thus, empirical research that examines the pioneering-cost relationship faces unique issues relative to demand-side analysis. We address these issues with a two-way decomposition of the empirical relationship between pioneering and cost. First, we move away from average effects to conditional effects of the pioneering decision on cost as suggested by Lieberman and Montgomery (1998). Second, we try to precisely target the location of the cost effects via a decomposition of average total cost into its underlying components. In doing this, we note that despite all the issues raised with the PIMS database, it is still the most comprehensive source to analyze performance implications of different marketing strategies, providing not only various cost measures but also data about various contextual factors and time series information that can be used as control factors for estimation.

The strategy behind our conditional analysis is to identify settings that would intensify or weaken the presence of an underlying theoretical effect. We acknowledge that the direct theoretical source remains unobserved and we can only provide indirect evidence for its existence. However, three aspects of our empirical approach bolster our confidence in the validity of the obtained results. First, the findings are robust across two different samples of firms. Second, we took great care in estimation to avoid potentially biasing factors: endogeneity of the decision to pioneer or follow; potential time-varying and fixed omitted variables; and measurement error in our entry order construct. Third, the conditional effects are generally limited to the specific cost component where the theory would predict an effect.

Our findings offer strong support for five of the six sources previously discussed in the literature and tested in this paper. By entering a market early, pioneers benefit on the cost side from factor input preemption and experience curve effects. On the other hand, they suffer disadvantages due to imitation, vintage effects, and a demand orientation. Thus, one cannot claim an unambiguous theoretical and empirical effect of the pioneering decision on cost. The effects vary and depend very much on the particular setting facing the pioneer. Overall, all one can say is that, on average, there is a pioneering cost disadvantage.

The effect of preemption of the ideal market space on average SG&A costs only received support in the consumer goods sample. As argued earlier, markets differ with respect to the extent to which an incumbent pioneer can block entry of followers. In pharmaceuticals, generic drugs can enter as soon as a patent

expires. The generic drug is obviously the same as a branded drug and prescribing doctors and buyers can easily understand that. However, even in this industry, generic drugs are not always able to easily enter and compete against a pioneering drug. An important factor that enhances the pioneering demand-side advantage is the extent to which quality is ambiguous to a customer (Carpenter and Nakamoto 1989). This factor could also influence the extent to which a pioneer can obtain cost-side benefits from preemption of the ideal market space. This could explain the difference between our obtained consumer goods and the industrial goods market preemption results because, in general, consumer goods are more subject to ambiguity and thus more subjectively perceived than industrial goods. If this argument about ambiguity is true, then a factor capturing a customer's motivation and/or ability to learn about products should also moderate the result for the consumer goods sample. Specifically, high motivation and/or ability to learn would eliminate ambiguity and thus the market preemption effect due to pioneering. Therefore, we conjecture that pioneers benefit, in the form of more favorable SG&A costs, from market preemption in markets where consumers have low ability/motivation to learn.

To test this, we create a learning index (for details see Boulding and Christen 2003) and re-estimate the moderating effect of MP on average SG&A cost for the consumer goods sample for two different sub-samples—one with low ability/motivation to learn (376 observations) and one with high ability/motivation to learn (477). Results support our conjecture: The moderating effect of MP is -39.3 ($p < 0.001$) for the low condition and -2.9 ($p = 0.75$) for the high condition. The difference between the two estimates is highly significant ($\chi^2 = 14.6$; $p < 0.001$). Thus, a deeper look at this issue via more refined conditional analysis appears to lend added support for the predicted effect of pioneering and preemption of market space on SG&A costs. In other words, pioneers face more favorable SG&A cost conditions when market position is strong and customer lack ability and/or motivation to learn about a market.

The finding of an overall pioneering advantage for purchasing cost is perhaps also worthy of further research. Our results show that this absolute advantage does not go away even under conditions of high SP. The supply chain management literature makes a number of arguments that could be used to explain this empirical result. For example, information asymmetries play a key role in structuring contracts and splitting supply chain profits (Cachon 2003). These asymmetries differ at a market's inception relative to in established markets, and favor the pioneer. Similarly, due to learning, the greater product expertise of pioneers perhaps allows them to write more precise specifications, which could lead to persistently lower purchasing costs. Empirical analysis in greater detail of these supply-chain issues exceeds the scope of this paper. However, given the growing interest in empirical research in the supply-chain literature, our findings could provide the basis for future exploration in this area.

Looking at our findings from a managerial perspective, it is clearly the case that choosing a pioneering strategy relative to a follower strategy can have negative cost consequences. Managers need to think very carefully about why, in their particular case, a pioneering strategy should lead to a sustainable profit advantage. The severity of negative cost effects depends on the specific setting facing the market pioneers. To evaluate whether cost disadvantages due to pioneering will be offset by the pioneering cost advantages along with the pioneering demand advantages, the magnitude of advantages and disadvantages needs to be forecasted. Since our analysis focuses on cost-side disadvantages, it is not fully sufficient to guide managers through the maze of pioneering advantages and disadvantages. This requires the simultaneous analysis of demand and cost effects for a particular strategy. For example, Boulding and Christen (2008) present this type of analysis for the choice of product line breadth.

In sum, this paper offers an in-depth analysis of pioneering effects on various cost components. This in-depth look produces not only answers but also more questions. Even though more than two decades of research on pioneering effects has yielded many important insights about the effects of pioneering on consumers and firms, we agree with Hauser et al. (2006) and Keller and Lehmann (2006) that more research is still needed. We expect future research to continue the process of sorting out the complexities pointed out by our research and helping managers better understand the relative benefits and costs of pioneering and following strategies under various environmental conditions.

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Appendix A. Derivation of Average Cost Variables

PIMS does not report direct information on quantity Q_{it}, total costs TC_{it}, or average costs AC_{it}.[21] PIMS reports disguised measures for revenue, price, and all the cost components used in this paper. The reported price index PI_{it} is the actual price relative to a base price, i.e., $PI_{it} = P_{it}/PB_i$, where

[21] To simplify the notation, we omitted the j and l subscripts.

the base price is time invariant. A usable quantity measure QI_{it} can be derived from the accounting identity $Q_{it} \equiv R_{it}/P_{it}$ and their disguised PIMS measures, where $R'_{it} = R_{it} \cdot K_i$ is the disguised revenue measure for business unit i

$$QI_{it} = \frac{R_{it} \cdot K_i}{PI_{it}} = \frac{R_{it} \cdot K_i}{P_{it}/P_{Bi}} = Q_{it} \cdot P_{Bi} \cdot K_i, \tag{A1}$$

where K_i is the firm-specific disguise factor. In other words, using QI_{it} instead of Q_{it} adds the nuisance terms P_{Bi} and K_i to the empirical error term.

Total cost TC_{it} can be calculated as the difference between revenues and net income, i.e., $R_{it} - NI_{it}$. Both measures are available in disguised form. The total cost measure and the quantity index (A1) yield the following measure for average costs ACI_{it}

$$ACI_{it} \equiv \frac{TCI_{it}}{QI_{it}} \equiv \frac{TC_{it} \cdot K_i}{R_{it} \cdot K_i/PI_{it}} \equiv \frac{TC_{it} \cdot P_{it}}{R_{it} \cdot P_{Bi}} \equiv \frac{AC_{it}}{P_{Bi}}. \tag{A2}$$

Using ACI_{it} instead of AC_{it} adds the nuisance term P_{Bi} to the empirical error term. Inserting Equations (A1) and (A2) in Equation (1) leads to the following error term:

$$\varepsilon_{it} = \alpha'_i + \eta_{it}, \tag{A3}$$

$$\alpha'_i = \alpha_i + \gamma_i \cdot Pion_i - (1+\delta) \cdot \log P_{Bi} - \delta \cdot \log K_i$$

and

$$*\eta_{it} = \rho \eta_{it-1} + \omega_{it}.$$

In all cases, IV estimation controls for the nuisance terms in α'_i. To calculate the average purchasing and production cost components, we respectively divide the reported but disguised values for total purchasing and total production costs by the quantity index. Average SG&A costs are calculated as the sum of R&D, marketing, and other costs divided by the quantity index.

Appendix B

Table B1 Detailed Estimation Results—Main Effects for Consumer Goods

	Average purchasing cost	Average production cost	Average SG&A cost	Average total cost
Constant	7.415[a]	−12.407[a]	−4.679[c]	9.093[a]
	2.244	*2.476*	*2.517*	*2.058*
Quantity (log *Q*)	−1.922	2.457	2.296	−0.071
	2.610	*3.506*	*3.040*	*1.827*
Market position (MP)	−1.218	−6.038[a]	−6.357[a]	−6.032[a]
	1.828	*2.530*	*2.162*	*1.287*
Competitive environment (CE)	9.442[c]	4.396[c]	−1.752	3.794
	5.712	*2.354*	*2.110*	*4.392*
CE-squared	−0.732[c]			−0.451
	0.481			*0.449*
Product quality (PQ)	0.014	0.054	−0.276[a]	−0.056
	0.054	*0.075*	*0.057*	*0.039*
log (Age of business unit)	−20.562[a]	−17.812[a]	−21.422[a]	−8.284[a]
	5.704	*6.921*	*4.606*	*2.639*
Supply intensity (SI)		−0.178	−0.303[c]	0.019
		0.177	*0.175*	*0.105*
Production intensity (PI)	−0.190		−0.624[a]	−0.209[c]
	0.157		*0.202*	*0.112*
Process R&D intensity (RSI)	−3.871[b]	5.216[b]		−0.663
	1.949	*2.504*		*1.407*
Employee productivity (EP)	0.022	−0.126	0.278[a]	0.039
	0.068	*0.099*	*0.083*	*0.049*
% Change in unit labor cost (ULC)[4]	0.678[a]	0.143	0.208	0.305[b]
	0.184	*0.254*	*0.228*	*0.145*
% Change in labor output (OUT)[4]	0.443[c]	−0.481	1.047[a]	0.628[a]
	0.248	*0.341*	*0.304*	*0.191*
Pioneering effect (*Pion*)	−97.837[a]	124.366[a]	72.073[a]	40.200[a]
	37.107	*33.813*	*18.043*	*10.251*
Autoregressive coefficient (ρ)	0.036	0.041	0.12[a]	0.094[a]
	0.033	*0.037*	*0.031*	*0.034*
Observations	1,104	1,104	1,104	1,104
F-test[1]	6.03 ($p < 0.001$)	4.00 ($p < 0.001$)	11.4 ($p < 0.001$)	7.30 ($p < 0.001$)
Instruments[2]	CE, PI	log AGE, SI, PI	log AGE, MP_1, MP_2, PI	log AGE, MP_1, MP_2, PI_1, PI_2
HT-specification test[3]				
Endogenous specification	0.43 (1)	0.91 (2)	1.22 (3)	0.32 (4)
	$p = 0.51$	$p = 0.63$	$p = 0.75$	$p = 0.99$
Exogenous specification	32.8 (2)	20.8 (3)	16.9 (4)	19.7 (5)
	$p < 0.001$	$p < 0.001$	$p = 0.002$	$p = 0.001$

Table B2 Detailed Estimation Results—Main Effects for Industrial Goods

	Average purchasing cost	Average production cost	Average SG&A cost	Average total cost
Constant	5.623[c]	−11.951[a]	−17.915[a]	5.301[a]
	3.527	*2.043*	*3.008*	*1.458*
Quantity (log *Q*)	−9.788[a]	−7.889[a]	−7.120[a]	−9.759[a]
	1.745	*2.122*	*2.284*	*1.486*
Market position (MP)	4.059[a]	4.726[b]	3.263	4.280[a]
	1.893	*2.456*	*2.860*	*1.711*
Competitive environment (CE)	4.384[a]	5.778[a]	0.102	3.253[a]
	1.341	*1.572*	*1.575*	*1.107*
Product quality (PQ)	−0.064	0.007	−0.047	−0.039
	0.047	*0.058*	*0.064*	*0.041*
log (Age of business unit)	−4.013	−4.806[b]	−14.779[a]	−8.695[c]
	6.478	*2.140*	*5.422*	*4.820*
Supply intensity (SI)		−0.006	0.152	0.143[c]
		0.134	*0.145*	*0.093*
Production intensity (PI)	0.121		0.003	0.051
	0.113		*0.143*	*0.092*
Process R&D intensity (RSI)	−3.973[a]	−1.904		−4.181[a]
	1.314	*1.527*		*1.064*
Employee productivity (EP)	0.143[a]	−0.081	0.295[a]	0.236[a]
	0.050	*0.063*	*0.069*	*0.044*
% Change in unit labor cost (ULC)[4]	0.981[a]	0.128	−0.013	0.356[a]
	0.166	*0.192*	*0.214*	*0.135*
% Change in labor output (OUT)[4]	0.500[b]	0.060	1.587[a]	0.592[a]
	0.216	*0.248*	*0.278*	*0.175*
Pioneering effect (*Pion*)	−79.125[a]	108.564[a]	63.474[a]	61.586[b]
	21.050	*44.073*	*23.726*	*29.567*
Autoregressive coefficient (ρ)	0.047[b]	0.062[a]	0.143[a]	0.051[5]
	0.022	*0.021*	*0.026*	*0.027*
Observations	2,681	2,681	2,681	2,681
F-test[1]	13.7 ($p < 0.001$)	3.95 ($p = 0.002$)	12.2 ($p < 0.001$)	10.8 ($p < 0.001$)
Instruments[2]	MP, CE, PI	log AGE, CE_1, CE_2	log AGE, CE, PQ, PI	log AGE, CE_1, CE_2, PI_1, PI_2
HT-specification test[3]				
Endogenous specification	0.33 (2)	0.90 (2)	0.99 (3)	0.91 (4)
	$p = 0.85$	$p = 0.64$	$p = 0.80$	$p = 0.92$
Exogenous specification	10.4 (3)	10.6 (3)	6.00 (4)	10.7 (5)
	$p = 0.015$	$p = 0.014$	$p = 0.199$	$p = 0.058$

*Standard errors are in italics.

[a]Significant at 0.01 level; [b]significant at 0.05 level; [c]significant at 0.10 level (based on two-tail *t*-test).

[1]*F*-test statistic for the benchmark fixed-effect estimation model is reported as an indication of model significance (*p*-value in parentheses).

[2]In the HTIV-estimation, either the group means or the first two observations (indicated by a subscript) of the listed variables are used as instruments for the pioneering effect. The exogenous specification includes pioneering as an instrument.

[3]χ^2-value of HT-specification test with degrees of freedom given in parentheses.

[4]Exogenous with respect to unobserved contemporaneous effects; other variables are endogenous.

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