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# Sustainable Pioneering Advantage? Profit Implications of Market Entry Order

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There is strong theoretical and empirical evidence supporting the idea that “first-to-market” leads to an enduring market share advantage. In sharp contrast to these findings, we find that at the business unit level being first-to-market leads, on average, to a long-term *profit disadvantage*. This result holds for a sample of consumer goods as well as a sample of industrial goods and leads to questions about the validity of first mover advantage, in and of itself, as a strategy to achieve superior performance. We replicate the typical demand-side pioneering advantage but find an even *greater average cost disadvantage*, which is the source of the pioneering profit disadvantage. In an extended analysis, we show that first-to-market leads to an *initial profit advantage*, which, depending on the sample or profit measure, lasts for about 12 to 14 years before turning into a disadvantage. Moreover, we show that pioneers differentially benefit from a lack of consumer learning, a strong market position and patent protection. These three moderating factors together can actually help pioneers achieve a sustainable profit advantage over later entrants. Finally, we find strong support for the theoretical argument that the entry order decision should be treated as endogenous in empirical estimation.

(*Pioneering Advantage; Firm Performance; New Product Marketing; IV-Estimation*)

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## 1. Introduction

“First mover advantage” is an oft-cited strategic principle for achieving superior performance. This principle is often high on managers’ list of arguments to justify strategic moves such as, for example, the entry into emerging markets such as China, or the recent rush into e-business. Moreover, an impressive body of research in marketing, strategy and economics supports the validity of this principle. For example, at both the business unit level and the brand level, a strong inverse relationship between order of market entry and long-run market share has been found (e.g., Robinson and Fornell 1985, Urban et al. 1986). Empirical evidence is so extensive that this relationship exists as an “empirical generalization” in the marketing literature (Kalyanaram et al. 1995). At the consumer level, experiments have shown that

the order of entry can have a significant impact on customer preferences, memory, learning, and judgment (Carpenter and Nakamoto 1989, Kardes and Kalyanaram 1992, Zhang and Markman 1998).

Surprisingly, there exists virtually no empirical research about the effect of entry order on business profit, even though reviews of the entry order literature have repeatedly pointed to profit implications as one of the key unanswered questions in this area of research (Lieberman and Montgomery 1988, 1998; Kerin et al. 1992; Robinson et al. 1994).<sup>1</sup> Whether a market share advantage is sufficient to support the existence of a sustainable profit advantage is questionable given the uncertainties in both the market share-profit relationship (e.g., Jacobson

<sup>1</sup> Unpublished work (Boulding and Moore 1987, Srinivasan 1988) suggests that pioneering does not provide a profit advantage.

1988, Boulding and Staelin 1993) and the entry order-cost relationship (Lieberman and Montgomery 1988).

The main objective of this paper is to address this gap in the literature and empirically examine the long-term profit implications of the order of market entry for a *business unit*. Consistent with the existing literature, we focus on the long-term consequences to identify whether profit differences persist even after competitive entry. A significant difference would suggest, for example, that part of today's profit difference in cola beverages between the Coca-Cola Company and PepsiCo could be attributed to the fact that the former created the cola market about 10 years before the latter entered. Our analysis, therefore, provides insights about the profit implications of entry order strategies.

To be precise, our interest is in looking at profit differences between pioneers and followers solely attributable to the timing of market entry, and not differences due to other characteristics (e.g., resources) of pioneers and followers. In all likelihood, these differences exist because, as first noted by Lieberman and Montgomery (1988), firms' resources and capabilities affect their choice of entry timing. That is, entry timing is an endogenous choice variable. For example, Sony generally tries to create new markets, while Matsushita pursues a strategy of following Sony into these markets. Therefore, Sony and Matsushita likely differ in ways that reflect the difference in their market entry strategies. More formally, the resource-based-view literature (e.g., Wernerfelt 1984, Barney 1986) suggests that an enduring competitive advantage must be due to differences in underlying resources. This literature is explicit in stating that there can be *no* pioneering advantage without heterogeneity in resources across firms (Barney 1991), and empirical research supports the presence of systematic firm differences associated with entry strategies (Robinson et al. 1992, Murthi et al. 1996).

This endogeneity question of the order of market entry has been cited as another key unresolved issue in empirical research (Lieberman and Montgomery 1998). In contrast to theoretical work that explicitly considers entry timing an endogenous decision variable, most empirical studies treat it as exogenous.

Thus, a second objective of this study is to test (and statistically control) for the possible endogeneity of the order of market entry.

The conceptual issue of endogenous entry order becomes the classic empirical issue of controlling for unobserved differences between business units (Boulding 1990, Jacobson 1990). Unfortunately, existing methods in the marketing literature that control for unobserved effects (see Boulding and Staelin 1995) do not work when the effect of theoretical interest is itself fixed over time. Instead, we utilize the instrumental variable (IV) approach due to Hausman and Taylor (1981) that enables one to control for unobserved fixed effects while still obtaining consistent estimates of fixed effects of theoretical interest, in our case, the effect of entry order. Moreover, this procedure allows us to explicitly test both whether entry order is endogenous and whether the obtained estimates are likely free from bias due to omitted fixed factors.

We start our analysis by determining the effect of entry order on profit for an average business unit. For two samples of business units derived from the PIMS database—a sample of consumer goods and a sample of industrial goods—we find a *long-term profit disadvantage of pioneering* for the average business unit. This result holds for both net income and ROI when used as measures of business unit profit. Given the strong evidence in the literature for the existence of a long-term demand-side advantage, this profit result implies that first-to-market must lead to a long-term average cost disadvantage. Thus, for both samples and with the same estimation methodology, we estimate the effect of entry order on demand and average cost, i.e., the economic components of profit, and find strong support for this conjecture. Pioneering leads to a long-term demand advantage and an even larger long-term cost disadvantage. We test the robustness of these results by varying the model specification and the instruments used to obtain consistent estimates. This sensitivity analysis strongly confirms the long-term profit disadvantage due to an average cost disadvantage.

We then examine conditions for which a pioneering profit advantage can exist. First, given the long-term profit disadvantage, it appears that pioneering a new

market makes sense for the average business only if an early profit advantage exists (assuming rational decision making). We therefore examine the time path of profits for pioneers and find, for both samples and profit measures, an initial profit advantage, which decreases over time and turns into a disadvantage after 12 to 14 years. Second, we examine the moderating effect on the long-term profit difference for three factors: the likelihood of customer learning, the market share position of a business unit, and the presence of patent protection. Based on the existing literature, we hypothesize that these factors enable pioneering firms to avert the long-term profit disadvantage or even sustain a profit advantage.

In sum, this paper provides the first detailed empirical analysis of the profit implications of the order of market entry at the business unit level. Furthermore, we use an estimation procedure that allows us to control for various unobserved effects as deemed necessary by Boulding and Staelin (1995). Specifically, we introduce to the marketing literature an estimation procedure, pioneered by Hausman and Taylor (1981), which controls for potential endogeneity when the independent variable of interest is fixed (over time) for a business. Such a procedure is highly relevant for empirical strategy research because many endogenously determined business decisions are fixed over the typical research horizon. In the numerous models estimated for our analysis we find that in an overwhelming number of cases the entry order is *endogenous* and failing to treat it this way leads to biased, and different, conclusions.

The remainder of the paper is organized as follows. First, we briefly summarize the extensive literature on entry timing and discuss different scenarios for the profit implications of the market entry order. We then formally specify equations that allow us to empirically examine these profit implications as well as the effect of entry order on demand and average cost. Next, we describe our data derived from the PIMS database and the particular measures that enable estimation of our model, followed by a discussion of estimation issues, with particular focus on the Hausman-Taylor estimation procedure. In the two results sections we first present the profit, demand and average cost results

for the “average” pioneering business unit, including analyses that check the robustness of our findings. Next, we provide the results for the conditional analysis, including the effect of time. We conclude by discussing implications of our findings and making suggestions for future research.

## 2. Pioneering Advantages and Disadvantages

An extensive theoretical and empirical literature investigates the effects of the market entry order. This literature has been well summarized in various review articles (Lieberman and Montgomery 1988, Kerin et al. 1992, Robinson et al. 1994, Kalyanaram et al. 1995). Rather than repeat these findings, we very briefly point to two findings of relevance to the research herein.

First, as noted, there is an extensive list of theoretical arguments in favor of a pioneering demand advantage. These theoretical arguments are supported by strong empirical evidence, including findings based on experiments that are not subject to methodological problems raised in the literature (see Golder and Tellis 1993). Second, there is no unambiguous theoretical prediction about the effect of entry order on cost. The literature points to possible advantages due to patents, accumulation of experience, and preemption of scarce resources. At the same time, the literature also points to possible disadvantages due to followers’ ability to free ride on information and market building efforts and incumbent inertia. Further, in contrast to the empirical generalization of a pioneering market share (demand) advantage (Kalyanaram et al. 1995), there is no systematic empirical evidence with respect to the effect of entry order on cost. Because of this ambiguity in the effects of entry order on cost, the effect of entry order on overall profit is also uncertain, and we next consider two possible profit scenarios.

### Entry Order Profit Scenarios

We propose two possible profit scenarios capture the current state of knowledge about pioneering effects, i.e., a demand advantage and an ambiguous cost

effect.<sup>2</sup> Under the first scenario, we assume that motivation to enter first is driven by the likelihood of obtaining the “known” demand-side advantage, an advantage shown in both theoretical and empirical work. As argued in the strategy literature (e.g., Wensley 1982, Erickson and Jacobson 1992), if knowledge about a strategic relationship exists, (e.g., first entrants are more profitable), then without what Wensley refers to as “isolating mechanisms,” firms will compete away the returns implied by this relationship. Thus, knowledge about a demand-side pioneering advantage could lead to a race to entry that competes away this advantage through cost disadvantages. In sum, this scenario argues for a demand advantage, a cost disadvantage, and no significant long-term profit differences due to the order of market entry.

This same profit prediction emerges from the resource-based view of the firm. Given this view strategic actions like the decision to create a new market are contingent on business unit resources. Thus, there can be no sustainable advantage to the entry strategy, *per se*, unless firms have inimitable resources, because the entry strategy itself is perfectly imitable (Barney 1991). Consequently, after controlling for resource differences across firms (as we do in our empirical analysis), there should be no effect of entry order on profit. Importantly, if entry choices are driven by differences in firm resources, the market entry order must be an endogenous decision.

In addition to a sustainable demand advantage, the first entrant can also benefit from a period of monopoly profits that are eroded over time as later entrants make inroads. However, if in fact competition dissipates differences in lifetime profits due to entry order, this leads to an interesting prediction. Specifically, we should observe an initial profit advantage for the pioneering firm that is offset by a profit

disadvantage in later years. While profit differences can exist at any given point in time, dissipation of economic rents should occur over time and there should be no lifetime profit differences due to entry order.

Six testable implications emerge from this scenario: (1) a null effect of entry order on lifetime profit; (2) an initial profit advantage; (3) a subsequent (long-term) profit disadvantage; (4) a long-term pioneering demand advantage; (5) a long-term pioneering cost disadvantage; and (6) endogenously determined entry order.

Our second scenario predicts a sustainable profit advantage. Here, we assume that innovation, and therefore first-to-market, is frequently due to luck (Alchian 1950). If so, two implications follow from “lucky” entry. First, the pioneer can benefit from the demand advantages without a compensating cost disadvantage. This happens because entry is a surprise and expected rents are not eroded via cost competition, and leads to an unambiguous prediction of a long-term pioneering profit advantage. Second, if innovation results largely from luck, then the entry decision would be a random event and therefore exogenously determined. In sum, three testable predictions arise from this scenario: (1) a long-term pioneering demand advantage; (2) a long-term pioneering profit advantage; and (3) exogenously determined entry order.

We note that this second scenario of higher profits of pioneering could also occur without the assumption of luck-driven innovation. For example, pioneering is presumably riskier than following. Given a positive risk-return relationship, if analysis is restricted to surviving pioneers (as is the case in the analysis herein), one could observe higher profits for pioneers.

### 3. Model

Following earlier work (e.g., Boulding and Staelin 1993), we use the following profit function:

$$\Pi_{it} = \exp[\beta_{0i} + \gamma_{i1} \cdot \text{Pion}_i + X_{1it}\beta_1 + \varepsilon_{1it}],$$

with  $\gamma_{i1} = \gamma_{Pi} + \gamma_1$ . (1)

To assess the effect of market entry order on the components of profit, we also specify a system of two

<sup>2</sup> To be complete, one could posit a pioneering profit disadvantage, which could be explained by two different effects. First, an ex-ante overvaluation of the demand advantage could lead to overspending to obtain this advantage (i.e., the winner’s curse). Second, loss aversion could lead to an ex-post overvaluation of the demand advantage and overspending to defend market share in the face of competitive entry. This could happen if the pioneer’s initial market share provides the reference point and changes in market share after competitive entry fall in the loss domain.

simultaneous equations consisting of the following inverse demand function:

$$P_{it} = Q_{it}^{\delta_2} \cdot \exp[\beta_{02} + \gamma_{i2} \cdot \text{Pion}_i + X_{2it}\beta_2 + \varepsilon_{2it}],$$

with  $\gamma_{i2} = \gamma_{Di} + \gamma_2$ , (2)

and the following average cost function:

$$AC_{it} = Q_{it}^{\delta_3} \cdot \exp[\beta_{03} + \gamma_{i3} \cdot \text{Pion}_i + X_{3it}\beta_3 + \varepsilon_{3it}],$$

with  $\gamma_{i3} = \gamma_{Ci} + \gamma_3$ . (3)

The elements of the different equations are defined as follows:

$P_{it}, AC_{it}, \Pi_{it}$	price, average cost and profit, respectively, of business unit $i$ in year $t$
$Q_{it}$	quantity sold in units by business unit $i$ in year $t$
$\text{Pion}_i$	indicator variable, where $\text{Pion}_i = 1$ if business unit $i$ is a pioneer, else $\text{Pion}_i = 0$
$X_{jit}$	a vector of other potentially relevant factors in equation $j$
$\beta_j, \gamma_{ij}, \gamma_{Di}, \gamma_{Ci},$ $\gamma_{Pi}, \gamma_j, \delta_j$	model parameters ( $j = 1 \dots 3$ ).

Consistent with previous research (e.g., Boulding and Staelin 1993, Jacobson 1990), we assume three different sources of error: unobserved fixed factors,  $\alpha_{ji}$ , and unobserved random factors,  $\eta_{jit}$ , that consist of a first-order autoregressive component with parameter  $\rho_j$  (to capture dissipating returns) and a random component,  $\omega_{jit}$ . In other words,  $\varepsilon_{jit} = \alpha_{ji} + \eta_{jit}$  and  $\eta_{jit} = \rho_j \cdot \eta_{jit-1} + \omega_{jit}$  ( $j = 1 \dots 3$ ).

There are several points worth noting about Equations (1) to (3). First, estimation of Equation (1) allows us to address the overall profit implications, where the parameter  $\gamma_1$  is the parameter of interest with respect to the order of market entry. This parameter captures the average (i.e., generalizable) effect of pioneering on profit. The parameter of interest with respect to demand implications of entry order is  $\gamma_2$ , while the parameter  $\gamma_3$  is the parameter of interest with respect to the cost implications. Second, the three specifications allow for heterogeneity in the effects of pioneering across firms, i.e., we include the firm specific parameter  $\gamma_{Pi}$ ,  $\gamma_{Di}$ , and  $\gamma_{Ci}$ , respectively. We do

not estimate these firm specific effects of pioneering but control for their possible biasing effects on our estimate of the average effect,  $\gamma_j$ ,  $j = 1 \dots 3$  (technical details are provided in Appendix A). Third, we use net income as well as ROI as profit measures for Equation (1). The latter measure controls for possible differences in investment levels. Fourth, simultaneous estimation of the inverse demand Equation (2) and the average cost Equation (3) allows us to control for movements along a demand curve that may occur due to underlying changes in supply (i.e., cost) and movements along an average cost curve that may occur due to underlying changes in demand. Thus, quantity is considered endogenous in this specification. The elements in  $X_{2it}$  and  $X_{3it}$  that ensure identification are discussed in the next section. 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 effect,  $\gamma_j$ .

## 4. Data

We use PIMS data on business units to examine the profit implications of entry order. The PIMS database has received much criticism (e.g., Anderson and Paine 1978, Ramanujam and Venkatraman 1984). However, other work suggests that many of its perceived limitations can be eliminated when taking advantage of 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.

Because we are interested in the *long-term* effects of pioneering, 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 estimate our three 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 363 different business units with 1,109 observations that can be used for estimation after data transformations. The latter

sample contains data for 858 different business units with 2,788 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.

In choosing these samples we note an additional benefit and a potential drawback 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 business unit performance. Thus, our results can be benchmarked against existing findings. However, Golder and Tellis (1993) show that PIMS analyses yield results that are potentially biased in support of a pioneering advantage because PIMS includes only data on surviving pioneers and because business units classified as pioneers could in fact be misclassified early followers. Thus, we caution the reader that the results obtained herein are potentially biased *in favor of* a pioneering advantage.

### Dependent Variables

Except for ROI, all dependent measures are available only in disguised form in the PIMS database. For example, the available dependent measure for net income is an index variable, which satisfies the identity  $NI'_{it} \equiv NI_{it} \cdot K_i$ , where  $K_i$  is the constant disguise factor for business unit  $i$ . Similarly, a price index,  $P'_{it}$ , is available that satisfies the identity  $P'_{it} \equiv P_{it}/P_{Bi}$ , where  $P_{Bi}$  is an unknown base price that is specific to business unit  $i$  and time invariant. The potentially biasing effect of these nuisance factors,  $K_i$  and  $P_{Bi}$ , is controlled for by the Hausman and Taylor (1981) estimation procedure (see Appendix A). Therefore, we can estimate the different equations without bias due to measurement error in the dependent variable.

Equation (1) presents another estimation issue because both net income and ROI can take on negative values. We therefore transform these measures via the  $\zeta$ -transformation due to Cooper and Nakanishi (1983) before taking logs to linearize Equation (1).<sup>3</sup>

<sup>3</sup> Details of this transformation and the derivation of the dependent variables are available from the authors.

### Independent 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.<sup>4</sup> For business units that fall into this category, we set the pioneering variable ( $Pion_i$ ) to 1, for all other business units to 0.

The quantity variable ( $Q_{it}$ ) allows us to control for movement along the demand and average cost curves. Because there is no direct measure available, we create a quantity index measure by dividing the available revenue measure with the price measure. 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. These variables are described as  $X_{jit}$ ,  $j = 1 \dots 3$ , in Equations (1) to (3). The former set of variables contains a business unit's market position ( $MP_{it}$ ), the relative product quality ( $PQ_{it}$ ), and the log of the age of the business unit ( $\log AGE_{it}$ ), where the age is defined as years because market entry. The last variable is of particular interest because it controls for possible learning curve effects due to time in market rather than pioneering, per se. Market position ( $MP_{it}$ ) 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 1 and the minimum (worst possible market position) equals zero. Industry structure is captured by a summary measure of competitive environment ( $CE_{it}$ ) 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 competitive environment found in the PIMS database.

Finally, to help ensure identification in the simultaneous estimation of Equations (2) and (3), we add the following demand-side factors only to the inverse

<sup>4</sup> The actual PIMS measure is described more fully in Robinson and Fornell (1985).

**Table 1** Summary Statistics for Selected Variables<sup>1</sup>

	Consumer Goods (1109)				Industrial Goods (2788)			
	Pioneers (620)		Non-Pioneers (489)		Pioneers (1651)		Non-Pioneers (1137)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
ROI	25.40	−30/90	19.39	−30/90	26.26	−30/90	19.45	−30/90
ROS	8.84	−25/35	6.74	−25/35	10.73	−25/35	7.64	−25/35
Market share	28.80	1/70	17.82	1/70	30.03	1.9/70	22.07	1.9/70
Market position	0.98	0/4.52	0.47	0/4.50	1.05	0/4.52	0.61	0/4.52
Comp. environment <sup>2</sup>	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	27.84	−35/95	20.14	−35/95	28.25	−35/95	19.42	−35/95
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
Industry growth	2.95	−30/40	2.38	−30/50	3.35	−30/50	2.44	−30/50
% Sales from new products	8.96	0/70	9.43	0/70	6.53	0/70	5.36	0/70
Employee productivity	40.79	10/150	40.07	10/150	40.28	10/150	41.66	10/150
ΔGDP <sup>3</sup>	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 <sup>3</sup>	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 <sup>3</sup>	7.34	−0.2/11.6	7.48	−0.2/11.6	7.31	−0.2/11.6	7.51	−0.2/11.6
Product patent	0.17	0/1	0.15	0/1	0.27	0/1	0.13	0/1
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

<sup>1</sup>Number of observations is reported in parentheses in the column heads.

<sup>2</sup>Higher number indicates a lower degree of competitiveness.

<sup>3</sup>Data from US government sources; all other data from PIMS database.

demand function (2): industry growth ( $IG_{it}$ ), the percent of revenues from new products ( $NP_{it}$ ), change in GDP ( $GDP_t$ ), product R&D intensity ( $PDI_{it}$ ), and marketing intensity ( $MI_{it}$ ). Similarly, we add the following supply-side factors only to the average cost function (3): productivity of employees ( $EP_{it}$ ), the percent change in output per hour of the entire economy ( $OUT_t$ ), the percent change in unit labor cost ( $ULC_t$ ), process R&D intensity ( $PSI_{it}$ ), supply intensity ( $SI_{it}$ ), and production intensity ( $PI_{it}$ ).<sup>5</sup> The intensity variables are measured by the specific expenditure as a percent of revenues. For example, supply intensity ( $SI_{it}$ ) is the ratio of procurement costs to revenues of business unit  $i$  in year  $t$ . These intensity variables are also included in the profit Equation (1).

<sup>5</sup> We thank an anonymous reviewer for suggesting some of these variables for the purposes of identification. Data for the GDP, ULC, and OUT variables were obtained from various government sources through <http://www.economagic.com>.

All these identifying variables vary over time, and—with the exception of  $GDP_t$ ,  $ULC_t$ , and  $OUT_t$ —are all measured at the business unit level. Table 1 provides summary statistics of various variables.<sup>6</sup>

## 5. Estimation

Consistent with theoretical work, we consider the entry order potentially as endogenous. We therefore need an estimation procedure that controls for this possibility. Existing analyses that control for unobserved firm differences in resources and skills yield results that can only be considered unbiased by assumption. For example, the estimation strategy to measure firm resources and skills and include them in the entry performance equation (Murthi et al. 1996) must assume that *all* relevant firm skill and resource variables are included. Similarly, the instrumental

<sup>6</sup> All variables in nominal dollars are transformed into constant (real) dollar values by use of the CPI deflator.



variable approach by Moore et al. (1991) is based on an assumption that the instruments are uncorrelated with the unobserved effects. Because of their use of cross-sectional data, they are unable to test this assumption.

With time series/cross-sectional (panel) data, Hausman and Taylor (1981) provide an instrumental variable procedure (hereafter referred to as HT-IV estimation) 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 with a specification test.* This is important because a strict theoretical perspective implies that many conduct and structural factors are endogenous and thus not suited as instruments (Schmalensee 1989). With cross-sectional data the validity of instruments cannot be tested. Fortunately, panel data allows the researcher to circumvent these problems.

To illustrate this HT-IV estimation approach, consider Equation (1) and assume, for now, that included factors can only be correlated with fixed unobserved factors,  $\alpha_{1i}$ . The profit Equation (1) contains eight time-varying variables,  $X_{1it}$ , plus the time-fixed variable,  $Pion_i$ . Thus, for identification we need at least nine instruments. The mean differences,  $X_{1it} - \bar{X}_{1i}$ , where  $\bar{X}_{1i}$  is the mean over time for each business unit  $i$ , provide valid instruments for all eight time-varying variables,  $X_{1it}$ , because they are orthogonal to any time-fixed effect. Use of these instruments is identical to fixed-effect estimation. Thus, to estimate the fixed pioneering effect, we need at least one more instrument.

### Instruments

The HT-IV estimation procedure relies on the assumption that a subset of the time-varying variables in the model,  $X_{1it}$ , is independent of the fixed error term,  $\alpha_{1i}$ . For these variables, the business unit means,  $\bar{X}_{1i}$ , also become suitable instruments.<sup>7</sup> Of all the variables included in our models, the age of a business unit ( $\log AGE_{it}$ ) is the most likely candidate as

instrument due to our focus on mature and declining markets and surviving firms. Even though well-managed firms could be expected to survive longer, the average age of a business unit is likely uncorrelated with unobserved fixed factors,  $\alpha_{1i}$ , that affect profit given that the average age of a business unit in both samples is about 32 years (see Table 1). In other words, survival is no longer an issue for these businesses. Moreover, in a given market the pioneer is older than later entrants implying that the average age is correlated with pioneering. Industry structure variables provide a second group of possible instruments. For example, the competitive environment ( $CE_{it}$ ) is not only shaped by a firm's actions but also by competitors, customers, suppliers, and regulators. Similarly, the fraction of production costs relative to revenues ( $PI_{it}$ ) is often determined more by the economics of an industry and the availability of supply markets. However, we acknowledge the difficulty in identifying instruments via purely theoretical means and therefore test the sensitivity of our results to the use of particular instruments.

### Specification Test

The specification test for the HT-IV estimation procedure relies on the fact that consistent estimates,  $\hat{\beta}_1^{FE}$  for the time-varying variables,  $X_{1it}$ , are always available from fixed-effect estimation. This estimation does not yield an estimate  $\hat{\gamma}_1$  for the pioneering variable but it provides a benchmark for the HT-IV estimates,  $\hat{\beta}_1^{IV}$ . A large difference,  $\hat{\beta}_1^{IV} - \hat{\beta}_1^{FE}$ , relative to the respective standard errors, casts doubt about the assumption that the set of instruments is independent of the fixed error term and must thus be rejected. Thus, one further reason for including time-varying variables in an empirical model is to obtain benchmark estimates.

This HT-specification test requires overidentification, i.e., more instruments are needed than variables included in the model. The test yields a  $\chi^2$  statistic with the degrees of freedom provided by the number of overidentifying instruments. 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. Moreover, as part of our sensitivity analysis we examine whether the reported results are an artifact of the particular set of instruments.

<sup>7</sup> In subsequent work, Amemiya and MaCurdy (1986) show that under more restrictive assumptions, not just the business unit means but each observation of these variables can be used as instruments, yielding more efficient estimates (see also Breusch et al. 1989).

This HT-specification test also provides a direct test for the exogeneity assumption of the entry order. By adding the pioneering variable to the set of instruments, it is treated as exogenous. If a set of instruments without the pioneering variable cannot be rejected, then large deviations from the benchmark estimates, *after the inclusion of the pioneering variable*, can be used as evidence against the exogeneity assumption of the order of market entry.

### Other Estimation Issues

So far, our discussion of the estimation has centered on the potentially biasing effect of omitted fixed factors,  $\alpha_{1i}$ . This is most relevant because pioneering is a fixed effect and thus can be correlated only with omitted fixed factors. However, controlling for omitted and potentially biasing time varying effects,  $\eta_{1it}$ , is also necessary because the HT-specification test is based on consistent estimates of time-varying effects. Thus, before applying the HT-IV estimation procedure, we need to remove the potentially biasing effects of contemporaneous shocks and serial correlation.<sup>8</sup>

Following Jacobson (1990), we first test and control for omitted contemporaneous factors. We do this with a standard IV procedure for all endogenous time-varying variables included in our three equations. We use instruments that are lagged two periods and therefore independent of contemporaneous omitted factors. Testing reveals that most variables in our models are correlated with contemporaneous factors, with the exception of Age of Business Unit, Industry Growth Rate and Change in GDP in the demand equation, and Age of Business Unit, Change in Labor Cost, and Change in Labor Output in the cost equation. These variables therefore act as exogenous demand and cost shifters to help identify the system of demand and cost equations. We keep the fitted values for the endogenous variables and proceed to control for omitted first-order autoregressive effects (i.e., dissipating returns) by  $\rho$ -differencing these data.

The overall result of all these statistical controls is an elaborate estimation procedure, which is summarized in Figure 1 and described in detail in

Appendix A. Although the resulting estimation procedure is highly calculation intensive, the cost of estimation is far outweighed by the benefit of being able to test whether the selected instruments in the HT-IV procedure are themselves free of the fixed effect. That is, all assumptions about instruments are tested. The HT-IV procedure has a secondary benefit. Measurement error in the quantity and pioneering variables could potentially lead to bias in their estimates, but IV estimation is a classic solution to such an errors-in-variables problem.<sup>9</sup>

## 6. Average Long-Term Implications of the Market Entry Order

### Endogeneity of Entry Order

The profit results of primary interest are presented in Table 2 and the demand and average cost results in Table 3. Complete estimation results are provided in Appendix B. Before we present the profit, demand, and average cost results, we examine the evidence regarding the exogeneity assumption of pioneering. The relevant results of the HT-specification tests are shown in Tables 2 and 3. While the particular set of instruments without the pioneering variable (endogenous specification) cannot be rejected, inclusion of this variable leads to a statistically significant test statistic (at the 0.2-level) in 7 out of eight models. Furthermore, in light of the additional results from the sensitivity analysis that examines the impact of choice of instruments and functional form (see Appendix C) and the analysis of conditional effects, we clearly reject the assumption that the entry-timing decision can be considered exogenous and conclude that *pioneering is endogenous*.

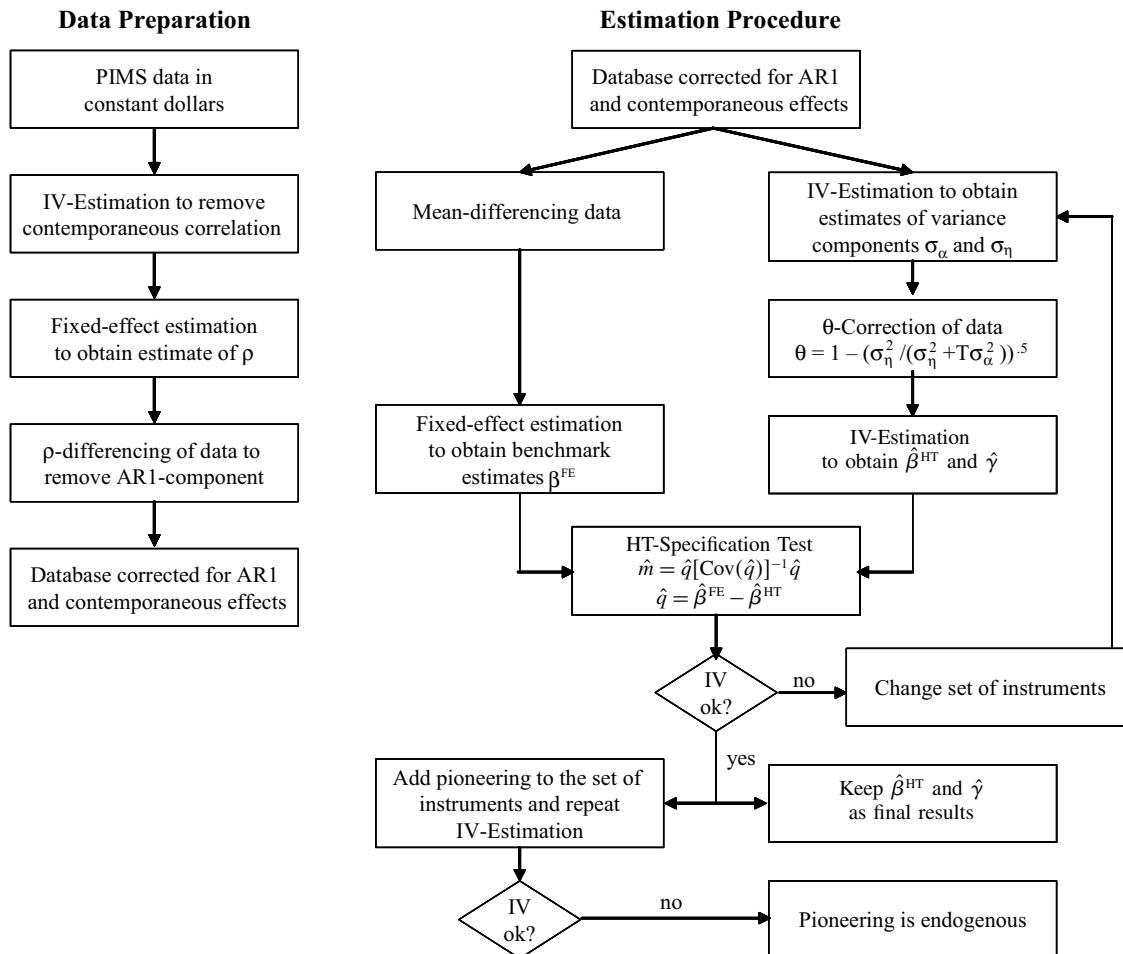
### Profit Effect

We now turn our attention to the estimates of the profit effect of pioneering reported in Table 2. The first two columns of Table 2 report the results for the con-

<sup>8</sup> We thank the reviewers for alerting us to this problem.

<sup>9</sup> The extension of the HT-IV estimation procedure to a system of simultaneous equations is discussed in Cornwall et al. (1992). We use 2SLS only to estimate the demand and average cost functions.

Figure 1



sumer goods sample. For both measures of profit, the estimated pioneering effect is negative and significant (net income:  $\hat{\gamma}_1 = -60.4$ ,  $p = 0.066$ ; ROI:  $\hat{\gamma}_1 = -56.1$ ,  $p = 0.036$ ). The results for our sample of business units in industrial markets show an even stronger pioneering disadvantage (see columns 3 and 4 in Table 2). The respective estimates of the pioneering effect on profit are  $\hat{\gamma}_1 = -133.7$  ( $p = 0.019$ ) for net income and  $\hat{\gamma}_1 = -96.9$  ( $p = 0.047$ ) for ROI.<sup>10</sup> In other words, for both samples of business units we find a *significant long-term pioneering disadvantage*.

<sup>10</sup> Significance levels for the effects of entry order in this section are based on two-tailed  $t$ -tests.

Estimates in Table 2 indicate the profit effects of pioneering under the assumption that entry order is exogenous. According to the HT-specification test results discussed earlier, these estimates cannot be considered consistent and unbiased. Thus, we do not discuss them in great detail except for noting that they would lead to greatly different conclusions. For example, all profit effects are positive and not statistically significant. Moreover, the demand and average cost results for industrial goods (see Table 3) imply that pioneering leads to a long-term demand disadvantage, but a long-term average cost advantage.

In the last row of Tables 2 and 3 we report the final instruments used in the HT-IV estimation procedure.

**Table 2** Summary of Profit Results

	Consumer Goods		Industrial Goods	
	Net Income	ROI	Net Income	ROI
<i>Endogenous Pioneering</i>				
Parameter estimate <sup>1</sup>	-60.4 <sup>c</sup> (32.8)	-56.1 <sup>b</sup> (26.7)	-133.7 <sup>b</sup> (56.9)	-96.9 <sup>b</sup> (48.8)
Specification test <sup>2</sup>	$\hat{m} = 0.46$ (6) $p = 0.99$	$\hat{m} = 1.80$ (6) $p = 0.93$	$\hat{m} = 1.50$ (4) $p = 0.83$	$\hat{m} = 8.61$ (7) $p = 0.28$
<i>Exogenous Pioneering</i>				
Parameter estimate <sup>1</sup>	0.09 (4.50)	0.48 (6.24)	4.77 (4.55)	4.89 (4.72)
Specification test <sup>2</sup>	$\hat{m} = 8.76$ (7) $p = 0.27$	$\hat{m} = 11.1$ (7) $p = 0.13$	$\hat{m} = 14.8$ (5) $p = 0.011$	$\hat{m} = 11.5$ (6) $p = 0.073$
Instruments <sup>3</sup>	$\log AGE_{i,t}, CE_{i1/2},$ $PI_{i1/2}, RI_{i1/2}$	$\log AGE_{i,t}, CE_{i1/2},$ $PI_{i1/2}, RI_{i1/2}$	$\log AGE_{i,t}, \overline{CE}_i,$ $\overline{CEsq}_i, PI_{i1/2}$	$\log AGE_{i,t}, CE_{i1/2},$ $\overline{CEsq}_i, PI_{i1/2}$

<sup>a</sup>Significant at 0.01-level; <sup>b</sup>Significant at 0.05-level; <sup>c</sup>Significant at 0.1-level (based on two-tail *t*-tests).

<sup>1</sup>Standard errors are reported in parentheses.

<sup>2</sup>The test statistic,  $\hat{m}$ , is distributed  $\chi^2$ , with degrees of freedom as indicated in parentheses.

<sup>3</sup>Variables used as instruments for the pioneering variable are either the mean within a cross-section or of the first two observations as indicated by the 1/2 subscript. Pioneering was added for the exogenous specification.

dure. As expected the average age of a business unit,  $\log AGE_{i,t}$ , and variables related to industry structure provide suitable instruments to identify the pioneering effect.<sup>11</sup>

### Demand and Average Cost Effects

We now present the results for the underlying demand and supply effects of pioneering. The profit results together with the well-established demand-side pioneering advantage imply that pioneering should lead to an even stronger long-term cost disadvantage. The respective results are presented in Table 3. For both data samples the results replicate, within the framework of a formal demand model, the sustainable consumer-based (i.e., demand) advantage (columns 1 and 3). The estimates of this pioneering advantage are  $\hat{\gamma}_2 = 26.3$  ( $p = 0.010$ ) for the consumer goods sample and  $\hat{\gamma}_2 = 34.1$  ( $p = 0.031$ ) for the industrial goods sample. The respective estimates of the pioneering average cost disadvantage are  $\hat{\gamma}_3 = 39.9$  ( $p < 0.001$ ) for the consumer goods sample and  $\hat{\gamma}_3 = 50.6$  ( $p = 0.039$ ) for the industrial goods sample. Moreover, both average cost

estimates exceed the respective demand-side advantage by a significant margin.<sup>12</sup>

### Other Estimation Results

The estimates of all other variables included in our empirical models (see Appendix B) do not bear on our substantive interests. They are needed to provide instruments for the pioneering variable and benchmark estimates for the HT-specification test. Given the extensive statistical controls that trade efficiency for consistency in the estimation procedure, the relatively high number of insignificant estimates is unsurprising. However, we note that the overall models are significant and that other significant parameter estimates tend to have the expected sign. For example, our inverse demand function is downward sloping, time (i.e., experience) has a negative effect on average cost and a softer competitive environment leads to higher profits. Moreover, elimination of variables does

<sup>11</sup> In the industrial goods sample we found a significant nonlinear effect of the competitive environment ( $CE_{it}$ ). Thus, we also added a squared term ( $CEsq_{it}$ ) to the model and included its cross-section means as an instrument.

<sup>12</sup> Our specification of the inverse demand function and the average cost function only includes a shift parameter due to entry order. We also examine whether entry order affects demand and supply slope parameters (interaction with  $\log Q$ ). These results yield the same substantive conclusions—a demand advantage and cost disadvantage due to pioneering. We thank a reviewer for suggesting this analysis. Detailed results are available to interested readers.

**Table 3** Summary of Demand and Average Cost Results

	Consumer Goods		Industrial Goods	
	Demand	Average Cost	Demand	Average Cost
<i>Endogenous Pioneering</i>				
Parameter estimate <sup>1</sup>	26.3 <sup>a</sup> (10.2)	39.9 <sup>a</sup> (10.7)	34.1 <sup>b</sup> (15.9)	50.6 <sup>b</sup> (24.5)
Specification test <sup>2</sup>	$\hat{m} = 2.79$ (4) $\rho = 0.59$	$\hat{m} = 0.29$ (6) $\rho = 0.99$	$\hat{m} = 1.46$ (2) $\rho = 0.48$	$\hat{m} = 4.43$ (4) $\rho = 0.35$
<i>Exogenous Pioneering</i>				
Parameter estimate <sup>1</sup>	4.98 (3.06)	1.73 (2.87)	-7.67 <sup>a</sup> (2.68)	-10.0 <sup>a</sup> (2.35)
Specification test <sup>2</sup>	$\hat{m} = 17.0$ (5) $\rho = 0.005$	$\hat{m} = 155.9$ (7) $\rho < 0.001$	$\hat{m} = 7.24$ (3) $\rho = 0.064$	$\hat{m} = 14.7$ (5) $\rho = 0.012$
Instruments <sup>3</sup>	$\log AGE_{i,t}$ , CE <sub>i1/2</sub> , PDI <sub>i1/2</sub>	$\log AGE_{i,t}$ , CE <sub>i1/2</sub> , PI <sub>i1/2</sub>	$\log AGE_{i,t}$ , CE <sub>i1/2</sub>	$\log AGE_{i,t}$ , CE <sub>i1/2</sub> , PI <sub>i1/2</sub>

<sup>a</sup>Significant at 0.01-level; <sup>b</sup>Significant at 0.05-level; <sup>c</sup>Significant at 0.1-level (based on two-tail *t*-tests).

<sup>1</sup>Standard errors are reported in parentheses.

<sup>2</sup>The test statistic,  $\hat{m}$ , is distributed  $\chi^2$ , with degrees of freedom as indicated in parentheses.

<sup>3</sup>Variables used as instruments for the pioneering variable are either the mean within a cross-section or of the first two observations as indicated by the 1/2 subscript. Pioneering was added for the exogenous specification.

not change the effects of entry order (see results in Tables C2 and C3 in Appendix C). Similarly, the inclusion of all variables included in the inverse demand and average cost functions does not change the profit results.

Appendix B also reports the estimates of the AR(1) coefficient,  $\rho$ , which varies between 0.3 and 0.4 and is always highly significant in the net income and ROI equations. For the demand and average cost equations the estimates are much smaller and not significant in the inverse demand equation for industrial goods. The magnitude of these estimates is consistent with previous findings in similar studies (Boulding and Staelin 1993, 1995).

Finally, in Appendix C we present an extended analysis of the sensitivity of our profit results to different assumptions. Specifically, we examine the sensitivity of the results to (i) changes in the functional form of Equation (1), (ii) the exclusion of factors such as the market share position or the intensity variables, and (iii) changes in the set of instruments used in the HT-IV estimation. The results shown in Appendix C for the different sensitivity analyses provide strong evidence for the robustness of our findings about the average effect of entry order on business unit profit. Thus, we conclude that for the average consumer and industrial goods business unit in our sample (1) first-to-market leads to a long-term profit disadvantage

due to a long-term cost disadvantage, and (2) entry order is an endogenous decision.

## 7. Extended Analysis

### Time Path of Profit Effect

Empirical research on entry order effects focuses on long-term effects because presumably a pioneering firm can benefit from a short-term period of monopoly profits after entry. In our discussion of scenario one, we note the possibility that if knowledge of this initial advantage exists, differences in lifetime profit between entry strategies could be competed away. Thus, we next explore whether pioneering leads to an initial profit advantage that, to be consistent with the long-term profit results from the previous section, decreases over time.

To address this question, we use the exact same two profit equations as in §6 (see Appendix B) but now include an interaction of pioneering with time since entry ( $Pion_i X \log AGE_{it}$ ). The above conjecture implies that the coefficient for the main effect of pioneering, which indicates the magnitude of the entry timing effect at the time of market entry, should be positive. In contrast, the interaction term should be negative, allowing an early profit advantage to erode into the long-term profit disadvantage shown in the previous section. The results of these estimates are presented

**Table 4** Pioneering Effect at Time of Entry and Change over Time\*

Profit Measure	Consumer Goods			Industrial Goods		
	Pioneering Effect at Time of Entry	Change of Pioneering Effect Over Time	Duration of Pioneering Advantage	Pioneering Effect at Time of Entry	Change of Pioneering Effect Over Time	Duration of Pioneering Advantage
Net income	152.6 <sup>b</sup> (86.7)	-61.1 <sup>b</sup> (27.0)	12.2 years	216.9 <sup>b</sup> (125.9)	-86.3 <sup>a</sup> (34.8)	12.5 years
ROI	150.2 <sup>b</sup> (88.7)	-57.5 <sup>b</sup> (24.8)	13.6 years	185.8 <sup>c</sup> (140.3)	-72.0 <sup>b</sup> (35.5)	13.2 years

\*Estimation models are as shown in Appendix B with the Pion \* log AGE interaction term added. Standard errors are in parentheses.

<sup>a</sup>Significant at 0.01-level; <sup>b</sup>Significant at 0.05-level; <sup>c</sup>Significant at 0.1-level (based on one-tail *t*-tests).

in Table 4. As seen in this table, for both samples and profit measures the two pioneering terms exhibit these expected signs.<sup>13</sup> In addition, seven of these eight estimates (2 estimates × 2 data samples × 2 profit measures) are significant at the 0.05-level or better; the remaining estimate is significant at the 0.1-level.

Given these estimates, the profit advantage due to pioneering appears to last for about 12 to 14 years, before becoming a profit disadvantage (see columns 3 and 6 of Table 4), depending on which sample and which profit measure is used. For our two samples, this initial profit advantage applies to 12% and 6% of the observations for consumer goods and industrial goods, respectively. With these parameter estimates we can calculate the hypothetical discount rate that would equilibrate the lifetime profit streams accruing to either a pioneering or following strategy. A discount rate of approximately 6%, for both the consumer and industrial goods samples, brings the differential in lifetime profits between the two market entry strategies to zero. We note, however, that this hypothetical discount rate is based on parameter estimates with underlying standard errors and should therefore be viewed with caution.

#### Conditional Long-Term Effects of Pioneering

Finally, we explore three conditions where we expect, a priori, to observe long-term profit effects of market entry order that differ from the “average” effects reported in §6. First, we explore the moderating effects of consumer learning. Consumer learning and preference formation provide important

and well-tested arguments in favor of a demand-side pioneering advantage (Carpenter and Nakamoto 1989, Kardes and Kalyanaram 1992). In particular, Carpenter and Nakamoto (1989) show that when product quality is ambiguous to customers the order of entry affects preferences in a way that favors pioneers. Clearly, markets differ to the extent customers are willing and able to learn, and therefore able to resolve quality ambiguities. Thus, pioneering should be more advantageous in markets where customers are unable and/or unmotivated to learn about alternatives after initial trial of the first-mover’s product.

We operationalize the motivation/learning construct by creating a “likelihood of customer learning” index. This index is based on three underlying components available in the PIMS data: frequency of purchase, purchase amount, and fraction of total purchases that the product represents. Our belief is that more frequent purchases lead to more learning opportunities (ability), while higher purchase amounts and greater importance of the product (as captured by its percentage of the customer’s spending budget) lead to greater motivation to learn. The index is created such that lower values indicate little ability/motivation to learn and high values indicate high ability/motivation. Thus, we expect to find a positive main effect of pioneering (i.e., when ability/motivation to learn is low) and a negative interaction effect between pioneering and likelihood of customer learning.

Second, we explore the moderating role of dominance in market share position. We conjecture that a stronger market position provides more leverage (i.e., market power) for the pioneering business unit, and

<sup>13</sup> Detailed estimation results are available from the authors. Due to the existence of prior predictions, significance levels for the effects of entry order in this section are based on one-tail *t*-tests.

**Table 5** Moderating Factors of Long-Term Profit Effects of Pioneering<sup>a</sup>

Factor <sup>1</sup>	Consumer Goods		Industrial Goods	
	Net Income	ROI	Net Income	ROI
"Main effect"	253.6 <sup>b</sup> (124.0)	235.6 <sup>b</sup> (114.2)	258.6 <sup>b</sup> (154.2)	273.7 <sup>b</sup> (128.3)
Customer learning	−28.0 <sup>b</sup> (13.3)	−29.9 <sup>b</sup> (14.4)	−26.6 <sup>c</sup> (19.9)	−22.8 <sup>b</sup> (14.8)
"Weak" market position	−35.6 <sup>b</sup> (16.1)	−26.7 <sup>b</sup> (15.5)	−18.0 <sup>b</sup> (11.6)	−3.61 (12.8)
No product patent	−142.8 <sup>c</sup> (94.3)	−139.1 <sup>c</sup> (92.6) + + +		
No process patent			−245.4 <sup>b</sup> (125.2)	−271.7 <sup>b</sup> (147.8)

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

<sup>b</sup>Significant at 0.01-level; <sup>c</sup>Significant at 0.05-level; <sup>d</sup>Significant at 0.1-level (based on one-tail *t*-tests).

<sup>1</sup>Estimation models are shown as in Appendix B with three respective interaction terms added. Also added are the customer learning and the respective patent variable. The various factors were coded such that a zero value corresponded to the conditions for which we hypothesized a pioneering advantage. The "weak" market position variable was defined as 4.52—market position; the patent variables were coded such that a zero value indicated the presence of a patent. Thus, the "main effect" provides the effect of pioneering when all factors simultaneously indicate a favorable environment.

conversely, a bigger hurdle to overcome for followers. To examine this conjecture we recode the  $MP_{it}$  variable so that higher values indicate a weaker market position. Consequently, we expect a positive main effect of pioneering (i.e., when market position is strong) and a negative interaction between pioneering and market share position.

Finally, we explore the moderating roles of product and process patents. Patent protection can be thought of as a major incentive for firms to enter a market first. Conversely, Lieberman and Montgomery (1988) point out that the decision to pioneer leads to higher costs and thus lower profits when the firm does not benefit from a market protection mechanism like patents. This is a testable conjecture. Specifically, we expect continued patent protection to shield pioneers from the long-term profit disadvantage for the average business. We thus predict a positive main effect of pioneering, which represents the effect of pioneering with patent protection, and a negative effect of the interaction of pioneering and no patent protection. Also, we explore the role of product and process patents separately in the event that one form of patent protection provides stronger benefits relative to the other.

To test these three moderating predictions we use the same model as in §6 and add 5 variables—three pioneering interaction terms and the consumer learning and patent variables. Because we estimate the interaction effects simultaneously, the estimate of the main effect of pioneering should be strongly positive as it indicates the differential effect when all three

moderating conditions are most favorable to a pioneer. Conversely, we should observe negative effects for all three pioneering interaction terms. We present estimation results for both samples and profit measures in Table 5.<sup>14</sup>

We begin by noting the estimated main effect of pioneering. As predicted, this effect is strongly positive and significant for both the consumer and industrial goods samples and for both the net income and ROI profit measures. Thus, under conditions of low customer learning, strong market position, and patent protection, we observe a strong long-term pioneering profit advantage. Consistent with our predictions (and the average results), all interaction effects are negative. All four estimates of the moderating effect of customer learning are significant, which indicates that pioneers do better in markets where customers have a lower ability/motivation to learn. The moderating effect of market position is also significantly negative for both the consumer and industrial goods samples, though the estimate fails to reach significance in the ROI equation for industrial goods. Therefore, as predicted by a market power argument, the effect of pioneering on profit performance is better when market position is strong.

Finally, we examine the moderating effects of process and product patents separately. Of interest, we

<sup>14</sup>Our estimation procedure controls for omitted variables bias which enables us to estimate each interaction independently. Such a procedure yields the same results.

find a significant moderating effect of product patents in our consumer goods sample, but not our industrial goods sample. Conversely, we find a significant moderating effect of process patents in our industrial goods sample but not our consumer goods sample. These results suggest a more favorable effect of pioneering on profit performance under conditions of product and process patent protection, respectively, for consumer and industrial goods firms.

## 8. Discussion

By empirically examining at the business unit level the profit implications and the exogeneity assumption of the entry order, this study addresses two key gaps in the literature (Lieberman and Montgomery 1998). In doing so, it makes a number of substantive contributions and a methodological contribution. 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, i.e., the entry order, is itself fixed over time*. This is important because strategic actions tend to be fixed over the typical research horizon. Important examples in marketing include the use of CRM or the degree of market orientation.

Contrary to common expectations, our results show that, on average, *first-to-market leads to a long-term profit disadvantage relative to later entrants*. We replicate, in an economic framework, the well-established consumer-based *long-term demand advantage*, and show that first-to-market leads to an *even larger long-term average cost disadvantage*. These results hold for a sample of business units selling consumer goods as well as for a sample of business units selling industrial goods. The statistical evidence against the exogeneity assumption is very strong and indicates that the *entry timing decision must be considered endogenous*. Failure to do so can lead to vastly different conclusions. An extensive sensitivity analysis indicates that these findings are robust to various assumptions, including the particular choice of instruments.

In the extended analysis we provide evidence of two kinds of pioneering profit advantage. First, we show that for both data samples pioneering leads to an *initial profit advantage that erodes over time*. The advantage

lasts for about 12 to 14 years. Second, we show that the likelihood of customer learning, the market share position of a business, and patent protection—product patents for consumer goods and process patents for industrial goods—moderate the long-term profit effect of entry order. The moderating effects tend to be stronger for the consumer goods sample, where *limited customer learning, a strong market share position, or patent protection can eliminate the long-term profit disadvantage and even lead to a sustainable pioneering profit advantage*. Future research should focus on identifying other conditions and specific firm resources that moderate the effect of market entry order.

How do these empirical findings compare to the two scenarios developed in §2? Our findings support all six of the predicted effects of pioneering in scenario 1: null effect on lifetime profitability, initial profit advantage, long-term profit disadvantage, long-term demand advantage, average cost disadvantage, and endogenous entry order. We acknowledge that the effect on lifetime profitability is difficult to test. However, our time path results suggest that a discount rate of about 6% equalizes the initial profit advantage and the long-term profit disadvantage of pioneering. While we have no information about actual cost of capital for the business units in our sample, the average value for the prime rate during the relevant time in our sample of firms (1920–2000) is 6.02%. Although a crude measure, this number is roughly compatible with, on average, zero lifetime profits for pioneers. Clearly, future research is needed to more accurately address the question of differences in lifetime profits due to entry order. Another area of future research concerns the question how different conditions moderate the effect of time. For example, is there a three-way interaction between time in market, patent protection, and pioneering?

Conversely, two of the three predictions of scenario 2—long-term profit advantage and exogenous entry order—are clearly rejected. Thus, we reject the hypothesis that innovation, and therefore market entry, is driven by luck. “Luck” suggests that entry is random, and therefore rents to entry are not competed away. Surely, luck plays a role in innovation but apparently not a dominant one. Moreover, the conjecture that pioneering leads to higher profits to com-



pensate for the higher risk associated with this market entry strategy is not supported.

What are the managerial implications of our findings? First, the presence of a long-term profit disadvantage does not mean that a pioneering strategy is strictly unprofitable. It means that in the long run, entering a market later is, on average, more profitable than pioneering. Thus, it would be incorrect to predicate an entry strategy on the sustainability of profits by being first to market. In this regard, it would be interesting to know what exactly managers expect when they pursue a strategy of being first-to-market.

Second, the worries of firms like Procter & Gamble that have not created new markets in a long time and instead rely on the profits from existing “pioneering” brands in well-established markets could be justified (Jarvis 2000). The initial profit advantage that appears to last little over a decade suggests that firms may be better off pursuing a strategy that continuously creates new markets.

Third, pioneering firms may be able to benefit by paying closer attention to later entrants and in particular to their organization and processes, which yield lower average costs. In this regard, more theoretical and empirical work is needed to understand the relationship between entry order and costs beyond average cost.

While the sensitivity analyses indicate that the direction of our findings is robust to various assumptions, our analysis is nevertheless subject to different limitations. In particular, our analysis is limited to PIMS data. This dataset, although aging, is still the largest and most complete dataset available to examine the effect of strategic actions of firm performance. However, we hope to see replication (or disconfirmation) of our findings using data that differ along a variety of dimensions. For example, it would be interesting to use data that include firms operating in the “new economy.” In this setting, first-to-market is supposedly an important strategic principle because of network effects and the ability to impose standards. However, the recent high-tech crash and the dominance of Microsoft, who is a follower in its most profitable businesses, provide at least anecdotal evidence that our results may extend to the new economy.

PIMS data are also limited in that they contain only surviving business units. If pioneers and followers have different survival rates, our results are biased in favor of a pioneering advantage because pioneers presumably have a relatively lower survival rate. In addition, as shown in Table 1, our datasets contain more pioneers than followers. It is of concern if managers systematically misclassify business units. In particular, if managers misclassify followers as pioneers based on successful market outcomes, this too would bias our results in favor of a pioneering advantage. Because we find a pioneering disadvantage, these potential biases make our findings more conservative.

In sum then, while we believe our empirical findings provide new insights, many unanswered questions remain for future research. Still, we believe our empirical findings cast doubt on the basic strategic principle of “first mover advantage.” When managers articulate and evaluate an entry timing strategy, we urge that consideration be given to precisely why and how the strategy will provide a sustainable advantage.

### Appendix A: Estimation Procedure

With time series/cross-sectional data a researcher typically has the choice between random-effect and fixed-effect estimation. Random-effect estimation leads to inconsistent estimates when the regressors are not independent of unobserved fixed effects. Fixed-effect estimation leads to consistent estimates but has two other disadvantages. First, it does not yield any estimates for coefficients of time-fixed variables. Second, the removal of all between-firm variance reduces efficiency. The instrumental variable approach developed by Hausman and Taylor (1981), HT-IV, corrects both problems. The estimation procedure requires the assumption that a subset of time varying variables,  $X_{jit}$ , is uncorrelated with the fixed, unobserved factor,  $\alpha_{ji}$ . By using the variation across firms and over time separately, such variables provide two instruments—the difference from the mean within a cross-section and the means of the cross-section. Use of the former instrument is equivalent to fixed-effect estimation (i.e., mean differencing the data).

Because fixed-effect estimation always yields consistent estimates for the coefficients of all time-varying variables, i.e.,  $\beta_j$  and  $\delta_j$ , these estimates serve as a benchmark to test the independence assumption for the chosen subset of  $X_{jit}$ . For the fixed-effect estimates to be a consistent benchmark, however, contemporaneous and autocorrelated effects must be removed from the empirical error term. Thus, our estimation procedure consists of two parts (see Figure 1). In the first part, we use IV-estimation with lagged variables as instruments and  $\rho$ -differencing to create a dataset that leaves only unobserved fixed effects as an issue. In the second part, we use the HT-IV estimation approach to obtain consistent estimates of all parameters, including the pioneering variable.

We next explain the different steps of our multistage estimation procedure in detail for the inverse demand Equation (2), but the same procedure is applied to all other equations. We start by including our empirical measure for price,  $P'_{it} \equiv P_{it}/P_{Bt}$ , and taking logs to linearize Equation (2). This results in the following model:

$$\log P'_{it} = \beta_{02} + \delta_2 \cdot \log Q'_{it} + X_{2it}\beta_2 + \gamma_2 \cdot \text{Pion}_i + \varepsilon'_{2it}, \quad (\text{A1})$$

where

$$\begin{aligned} \varepsilon'_{2it} &= \alpha'_{2i} + \eta_{2it}, \quad \alpha'_{2i} = \alpha_{2i} + \gamma_{Di} \cdot \text{Pion}_i - (1 + \delta_2) \log P_{Bi} - \delta_2 K_i, \\ \text{and } \eta_{2it} &= \rho_2 \eta_{2it-1} + \omega_{2it}. \end{aligned} \quad (\text{A1a})$$

The fixed error term,  $\alpha'_{2i}$ , contains the original firm-specific unobserved factor,  $\alpha_{2i}$ , the nuisance terms from creating the price variable and the quantity variable, i.e.,  $\log P_{Bi}$  and  $K_i$ , and the firm-specific effect of pioneering,  $\gamma_{Di} \cdot \text{Pion}_i$ .

First, we remove contemporaneous and first-order autoregressive effects from the empirical error term. Following Erickson and Jacobson (1992) we use instruments for all time varying variables where instruments are of a higher order lag than any contemporaneous (time varying) error appearing in the empirical error term. Specifically, we use variables lagged two periods. The fitted values of all endogenous time-varying variables are used in the next step.

Through a serial correlation adjustment, the autocorrelation effect,  $\eta_{2it-1}$ , is removed, leaving only the contemporaneous shock,  $\omega_{it}$ , and all fixed effects,  $\alpha'_{2i}(1 - \rho)$ :

$$\begin{aligned} \log P'_{it} &= \rho_2 \log \hat{P}'_{it-1} + \beta_{02}(1 - \rho_2) + \delta_2 \cdot \log \hat{Q}'_{it} \\ &\quad - \delta_2 \rho_2 \log \hat{Q}'_{it-1} + \hat{X}_{2it}\beta_2 - \hat{X}_{2it-1}\rho_2\beta_2 \\ &\quad + \gamma_2 \cdot \text{Pion}_i(1 - \rho_2) + \alpha'_{2i}(1 - \rho_2) + \omega_{2it}. \end{aligned} \quad (\text{A2})$$

The fixed effect could be removed by taking first differences, which, of course, also removes  $\text{Pion}_i$  from estimation. However, using fixed-effect estimation for Equation (A2) yields a consistent estimate of  $\rho_2$ .

After estimating  $\rho_2$ , we remove the serial correlation using the  $\rho$ -differencing procedure. This yields a dataset with variables that are corrected for *contemporaneous* and *serial correlation*, i.e.,  $\Delta \log P'_{it} = \log P'_{it} - \hat{\rho}_2 \log P'_{it-1}$ ,  $\Delta \log \hat{Q}'_{it} = \log \hat{Q}'_{it} - \hat{\rho}_2 \log \hat{Q}'_{it-1}$ , and  $\Delta \hat{X}_{2it} = \hat{X}_{2it} - \hat{\rho}_2 \hat{X}_{2it-1}$ .

With this dataset we now proceed to the second part of our estimation procedure. First, we use a fixed-effect estimation to obtain the benchmark estimates of  $\delta_2$  and  $\beta_2$ , namely  $\hat{\delta}_2^{\text{FE}}$  and  $\hat{\beta}_2^{\text{FE}}$ , that are needed for the HT-specification test. More specifically, we estimate

$$\begin{aligned} \Delta \log P'_{it} - \Delta \log P'_{it-1} &= \delta_2 (\Delta \log \hat{Q}'_{it} - \Delta \log \hat{Q}'_{it-1}) \\ &\quad + (\Delta \hat{X}_{2it} - \Delta \hat{X}_{2it-1})\beta_2 + \omega_{2it} - \omega_{2it-1}. \end{aligned} \quad (\text{A3})$$

Then, we use two-stage least squares estimation to estimate

$$\begin{aligned} \Delta \log P'_{it} &= \beta_{02}(1 - \hat{\rho}_2) + \delta_2 \Delta \log \hat{Q}'_{it} + \Delta \hat{X}_{2it}\beta_2 \\ &\quad + \gamma_2 \text{Pion}_i(1 - \hat{\rho}_2) + \alpha'_{2i}(1 - \hat{\rho}_2) + \omega_{2it}, \end{aligned} \quad (\text{A4})$$

with the mean differences  $\Delta \log \hat{Q}'_{it} - \Delta \log \hat{Q}'_{i.}$  and  $\Delta \hat{X}_{2it} - \Delta \hat{X}'_{2i.}$  as instruments for the time-varying variables and a subset of the cross-section means,  $\Delta \hat{X}'_{2i.}$ , as instruments for  $\text{Pion}_i$ . We need only

one such variable for the equation to be just identified. However, to run the HT-specification test, the number of such instruments must be greater than the number of time-fixed variables, i.e., we need at least two instruments. We always start with the mean age of the business unit ( $\overline{\log \text{AGE}_i}$ ) as a first instrument to which we add the production intensity ( $\overline{\text{PI}_i}$ ) and the R&D intensity ( $\overline{\text{RI}_i}$ ). A specification test when estimating  $\rho_2$  indicated that these variables are generally uncorrelated with the fixed error term  $\alpha'_{2i}$ .

Third, this estimation does not yet yield the final estimates because we need to first correct the error covariance matrix, which is not of the form  $\sigma^2 I$ . This step is used to obtain consistent estimates of the variance components,  $\sigma_{\alpha'_{2i}}^2$  and  $\sigma_{\omega_{2i}}^2$ , respectively. They are used to calculate the correction factor,  $\hat{\theta} = 1 - \sqrt{\hat{\sigma}_{\omega_{2i}}^2 / (\hat{\sigma}_{\omega_{2i}}^2 + \bar{T} \hat{\sigma}_{\alpha'_{2i}}^2)}$ , for the error covariance matrix.  $\bar{T}$  is the average number of observations per firm. After  $\theta$ -transforming the data, we arrive at the final empirical equation:

$$\begin{aligned} \Delta \log P'_{it} - \hat{\theta} \Delta \log P'_{i.} &= \beta_{02}(1 - \hat{\rho}_2) \cdot (1 - \hat{\theta}) \\ &\quad + \delta_2 (\Delta \log \hat{Q}'_{it} - \hat{\theta} \Delta \log \hat{Q}'_{i.}) \\ &\quad + (\Delta \hat{X}_{2it} - \hat{\theta} \Delta \hat{X}_{2i.})\beta_2 \\ &\quad + \gamma_2 \text{Pion}_i(1 - \hat{\rho}_2) \cdot (1 - \hat{\theta}) \\ &\quad + \alpha'_{2i}(1 - \hat{\rho}_2) \cdot (1 - \hat{\theta}) + \omega_{2it} - \hat{\theta} \omega_{2i.}. \end{aligned} \quad (\text{A5})$$

Fourth, we estimate (A5) using two-stage least squares with the same set of instruments used in step 2. This yields estimates  $\hat{\delta}_2^{\text{HT}}$ ,  $\hat{\beta}_2^{\text{HT}}$ , and  $\hat{\gamma}_2^{\text{HT}}$ .

Fifth, the estimates obtained with the HT-IV estimation procedure,  $\hat{\delta}_2^{\text{HT}}$  and  $\hat{\beta}_2^{\text{HT}}$ , can now be compared to  $\hat{\delta}_2^{\text{FE}}$  and  $\hat{\beta}_2^{\text{FE}}$  from (A3). We know that the latter estimates are consistent but potentially less efficient. A large difference  $\hat{q} = (\hat{\delta}_2^{\text{FE}} \hat{\beta}_2^{\text{FE}})' - (\hat{\delta}_2^{\text{HT}} \hat{\beta}_2^{\text{HT}})'$  indicates that the HT-IV estimates are not consistent, which invalidates the selection of instruments for pioneering. The test statistic under the null hypothesis that the instruments are valid,  $\hat{m} = \hat{q}' [\text{cov}(\hat{q})]^{-1} \hat{q}$ , is distributed  $\chi_d^2$  with  $d = k_1 - 1$  degrees of freedom, where  $[\ ]^{-1}$  indicates the generalized inverse and  $k_1$  is the number of instruments used for pioneering. If the test statistic,  $\hat{m}$ , exceeds the critical value, steps 2 to 5 are repeated with a set of instruments that excludes one of the initial variables. The final set of instruments is reported with the estimation results. As shown by Amemiya and MaCurdy (1986) and Breusch et al. (1989), it is also possible to include each observation and not only the means of the cross-sections as instruments, i.e.,  $\Delta \hat{X}'_{2i1}$ ,  $\Delta \hat{X}'_{2i2}$ , etc. We generally use this result to expand the pool of possible instruments and increase the efficiency of the estimates. Because we do not have the same number of observations for each business unit, we consider only the first two observations as potential instruments.

After we obtained a  $\chi^2$ -test statistic,  $\hat{m}$ , that was not rejected at the 0.20-level, we systematically exclude one or more variables from this set of instruments to analyze whether these variables could consistently pass the HT-specification test. In addition, we add variables other than the three variables mentioned above to test their suitability as instrument. Only the competitive environment variables ( $\text{CE}_{it}$ ) emerged as another candidate. Other variables were always rejected, often with a high level of statistical significance.

Sixth, after having obtained efficient and consistent estimates for Equation (A5), the pioneering variable,  $Pion_i$ , is added to the list of instruments and steps 2 to 5 of the HT-IV estimation procedure are repeated one more time. This final iteration yields

parameter estimates with pioneering treated as exogenous and, more importantly, a direct test of the exogeneity assumption. If the HT-specification test rejects this set of instruments, pioneering cannot be considered exogenous.

## Appendix B

	Estimation Results for Profit Effects			
	Consumer Goods		Industrial Goods	
	Net Income Equation	ROI Equation	Net Income Equation	ROI Equation
Constant	-18.3 <sup>c</sup> <i>10.2</i>	-38.7 <sup>b</sup> <i>16.5</i>	-24.2 <sup>a</sup> <i>7.14</i>	-29.8 <sup>a</sup> <i>7.99</i>
Market	7.28	6.89	-4.75	-6.95
Position (MP)	<i>5.15</i>	<i>4.98</i>	<i>4.46</i>	<i>4.37</i>
Competitive	5.35 <sup>b</sup>	6.83 <sup>b</sup>	16.3 <sup>b</sup>	21.8 <sup>a</sup>
environment (CE)	<i>2.29</i>	<i>3.09</i>	<i>8.26</i>	<i>7.69</i>
CE-squared			-1.15 <sup>c</sup> <i>0.67</i>	-1.66 <sup>b</sup> <i>0.72</i>
Product	-0.13	-0.04	0.12	0.09
quality (PQ)	<i>0.14</i>	<i>0.17</i>	<i>0.12</i>	<i>0.12</i>
log(Age of	10.5	9.75	26.8 <sup>b</sup>	17.7 <sup>c</sup>
business Unit)	<i>9.0</i>	<i>7.55</i>	<i>11.9</i>	<i>10.5</i>
Supply	0.69 <sup>c</sup>	0.61 <sup>c</sup>	0.69 <sup>a</sup>	0.63 <sup>a</sup>
intensity (SI)	<i>0.39</i>	<i>0.34</i>	<i>0.21</i>	<i>0.20</i>
Production	0.34	0.73 <sup>b</sup>	0.47 <sup>b</sup>	0.57 <sup>a</sup>
intensity (PI)	<i>0.34</i>	<i>0.33</i>	<i>0.21</i>	<i>0.19</i>
R&D	-0.92	-0.53	2.36 <sup>b</sup>	2.26 <sup>b</sup>
intensity (RI)	<i>1.90</i>	<i>1.82</i>	<i>1.14</i>	<i>1.13</i>
Marketing	-0.27	-0.08	0.62	0.64
intensity (MI)	<i>0.68</i>	<i>0.66</i>	<i>0.65</i>	<i>0.64</i>
Pioneering effect	-60.4 <sup>c</sup> <i>32.8</i>	-56.1 <sup>b</sup> <i>26.7</i>	-133.7 <sup>b</sup> <i>56.9</i>	-96.9 <sup>b</sup> <i>48.8</i>
Autoregressive	0.36 <sup>a</sup>	0.29 <sup>a</sup>	0.33 <sup>a</sup>	0.37 <sup>a</sup>
coefficient ( $\rho$ )	<i>0.05</i>	<i>0.05</i>	<i>0.03</i>	<i>0.03</i>
Observations	1109	1109	2788	2788
F-Test <sup>1</sup>	1.79 (0.084)	1.95 (0.058)	5.12 ( $p < 0.001$ )	5.22 ( $p < 0.001$ )
Instruments <sup>2</sup>	log AGE, CE <sub>1</sub> , CE <sub>2</sub> , PI <sub>1</sub> , PI <sub>2</sub> , RI <sub>1</sub> , RI <sub>2</sub>	log AGE, CE <sub>1</sub> , CE <sub>2</sub> , PI <sub>1</sub> , PI <sub>2</sub> , RI <sub>1</sub> , RI <sub>2</sub>	log AGE, CE, PI <sub>1</sub> , PI <sub>2</sub> , CEsq	log AGE, CE <sub>1</sub> , CE <sub>2</sub> , PI <sub>1</sub> , PI <sub>2</sub> , CEsq
HT-specification test <sup>3</sup>				
Endogenous	0.46 (6)	1.80 (6)	1.50 (4)	4.75 (5)
Specification	$p = 0.99$	$p = 0.94$	$p = 0.83$	$p = 0.45$
Exogenous	8.76 (7)	11.1 (7)	14.8 (5)	11.5 (6)
Specification	$p = 0.27$	$p = 0.13$	$p = 0.01$	$p = 0.07$

\*Standard errors are in italics.

<sup>a</sup>Significant at 0.01-level; <sup>b</sup>Significant at 0.05-level; <sup>c</sup>Significant at 0.10-level (based on two-tail  $t$ -test).

<sup>1</sup>Because the typical measures of fit do not apply for 2-stage least squares, the  $F$ -test statistic for the benchmark fixed-effect estimation is reported as an indication of model significance ( $p$ -value in parentheses).

<sup>2</sup>In the HT-IV 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 (see Appendix A for a detailed estimation description). In the exogenous specification, the pioneering variable is itself added to the list of variables.

<sup>3</sup> $\chi^2$ -value of HT-specification test with degrees of freedom given in parentheses.

Estimation Results for Demand and Average Cost Effects*					
	Demand Equation			Average Cost Equation	
	Consumer Goods	Industrial Goods		Consumer Goods	Industrial Goods
Constant	11.7 <sup>a</sup> 0.88	13.8 <sup>a</sup> 1.67	Constant	8.62 <sup>a</sup> 1.33	4.82 <sup>a</sup> 1.53
log(Quantity)	-2.55 <sup>b</sup> 1.27	-11.3 <sup>a</sup> 1.34	log(Quantity)	0.02 1.70	-7.59 <sup>a</sup> 1.49
Market position (MP)	1.32 0.88	4.14 <sup>a</sup> 1.50	Market position (MP)	-5.94 <sup>a</sup> 1.21	5.31 <sup>a</sup> 1.65
Competitive environ. (CE)	-4.11 <sup>a</sup> 1.04	6.42 <sup>a</sup> 0.98	Competitive environ. (CE)	-0.43 1.22	2.19 <sup>b</sup> 1.04
Product quality (PQ)	-0.05 0.03	0.03 0.04	Product quality (PQ)	-0.06 <sup>c</sup> 0.04	-0.06 <sup>c</sup> 0.04
log(Age of business unit) <sup>4</sup>	-5.87 <sup>a</sup> 2.08	-2.52 3.58	log(Age of business unit) <sup>4</sup>	-8.09 <sup>a</sup> 2.66	-7.40 <sup>c</sup> 4.50
			Supply intensity (SI)	0.01 0.10	0.22 <sup>b</sup> 0.09
			Production intensity (PI)	-0.21 <sup>b</sup> 0.11	0.14 0.09
Product R&D intensity (PDI)	-0.08 0.65	-0.86 0.48	Process R&D intensity (PSI)	-0.23 1.29	-3.69 <sup>a</sup> 1.06
Marketing intensity (MI)	-0.05 0.13	-0.34 0.23			
% Industry growth rate <sup>4</sup>	0.58 <sup>a</sup> 0.15	0.22 <sup>b</sup> 0.11	Employee productivity	0.04 0.05	-0.29 <sup>a</sup> 0.04
% Sales of new product	-0.02 0.05	0.06 0.08	% Change in labor cost <sup>4</sup>	0.31 <sup>b</sup> 0.13	0.31 <sup>b</sup> 0.13
% Change in GDP <sup>4</sup>	0.16 <sup>b</sup> 0.07	0.16 <sup>c</sup> 0.09	% Change in labor output <sup>4</sup>	-0.60 <sup>a</sup> 0.18	-0.59 <sup>a</sup> 0.18
Pioneering effect	26.3 <sup>a</sup> 10.2	34.1 <sup>b</sup> 15.9		39.9 <sup>a</sup> 10.7	50.6 <sup>b</sup> 24.5
Autoregressive coefficient ( $\rho$ )	0.06 <sup>c</sup> 0.04	0.04 0.04		0.08 <sup>c</sup> 0.04	0.10 <sup>a</sup> 0.03
Observations	1109	2788		1109	2788
F-Test <sup>1</sup>	5.70 ( $p < 0.001$ )	12.6 ( $p < 0.001$ )		7.61 ( $p < 0.001$ )	12.6 ( $p < 0.001$ )
Instruments <sup>2</sup>	log AGE, CE <sub>1</sub> , CE <sub>2</sub> , PDI <sub>1</sub> , PDI <sub>2</sub>	log AGE, CE <sub>1</sub> , CE <sub>2</sub>		log AGE, CE <sub>1</sub> , CE <sub>2</sub> , PI <sub>1</sub> , PI <sub>2</sub>	log AGE, CE <sub>1</sub> , CE <sub>2</sub> , PI <sub>1</sub> , PI <sub>2</sub>
HT-specification test <sup>3</sup>					
Endogenous	2.79 (4)	1.46 (2)		0.29 (4)	4.43 (4)
Specification	$p = 0.59$	$p = 0.48$		$p = 0.99$	$p = 0.35$
Exogenous	17.0 (5)	7.24 (3)		155.9 (5)	14.7 (5)
Specification	$p = 0.005$	$p = 0.064$		$p < 0.001$	$p = 0.012$

<sup>4</sup>Indicated variables were exogenous with respect to unobserved contemporaneous effects; all other variables were endogenous.

### Appendix C: Sensitivity Analysis of Profit Results

We examine the sensitivity of our results with respect to three different kinds of assumptions. First, we examine the sensitivity of our results to the functional form assumption of Equation (1). Specifically, we estimate a linear model and a multiplicative model. This provides eight additional estimates of the effects of pioneering on profit (2 measures of profit  $\times$  2 data samples  $\times$  2 new functional

forms). All eight additional estimates exhibit the same sign as the effects reported in Table 2 and 7 are significant at the 0.1-level or higher.

Of particular interest are the results of a linear specification, which we report in Table C1. These results help us examine whether the findings from our nonlinear models are an artifact of aggregation bias. Specifically, our business unit level data are based on a linear aggregation of measures from products and product

**Table C1 Summary of Results for Linear Specifications**

Equation	Consumer Goods		Industrial Goods	
	Pioneering Effect <sup>1</sup>	Exogeneity Test Results <sup>2</sup>	Pioneering Effect <sup>1</sup>	Exogeneity Test Results <sup>2</sup>
Net income	−6.43 <sup>b</sup> (2.51)	18.9 (4) $p < 0.001$	−5.79 <sup>c</sup> (3.06)	14.8 (5) $p = 0.011$
ROI	−3.78 <sup>c</sup> (2.03)	12.7 (3) $p = 0.005$	−4.24 <sup>b</sup> (1.94)	20.4 (4) $p < 0.001$

<sup>a</sup>Significant at 0.01-level; <sup>b</sup>Significant at 0.05-level; <sup>c</sup>Significant at 0.1-level (based on two-tail  $t$ -tests).

<sup>1</sup>Standard errors are in parentheses.

<sup>2</sup>The test statistic,  $\hat{m}$ , is distributed  $\chi^2$ , with degrees of freedom as indicated in parentheses.

**Table C2 Consumer Goods Sample: Sensitivity of Pioneering Effects**

Instruments <sup>1</sup>	log AGE, CE <sub>1/2</sub> , PI <sub>1/2</sub> , RI <sub>1/2</sub>	log AGE, CE, PI, RI	CE <sub>1/2</sub> , PI <sub>1/2</sub> , RI <sub>1/2</sub>	log AGE, PI <sub>1/2</sub> , RI <sub>1/2</sub>	log AGE, CE <sub>1/2</sub> , RI <sub>1/2</sub>	log AGE, CE <sub>1/2</sub>	log AGE	log AGE, CE <sub>1/2</sub> <sup>††</sup>	log AGE, CE, PI <sub>1/2</sub> , RI <sub>1/2</sub> <sup>†††</sup>
<i>Net income</i>									
Pion. effect <sup>2</sup>	−60.4 <sup>b</sup> (30.8)	−58.5 <sup>c</sup> (36.1)	−57.6 (35.7)	−78.9 (53.5)	−58.5 <sup>c</sup> (35.2)	−59.8 <sup>c</sup> (35.7)	−83.8 (96.5)	−58.9 <sup>c</sup> (35.6)	−69.1 <sup>c</sup> (39.8)
Spec. test <sup>3</sup>	8.76 (7)	9.90 (4)	3.95 (6)	5.41 (5)	7.91 (5)	7.99 (3)	2.13 (1)	8.81 (3)	80.7 (6)
	0.27	0.04	0.68	0.37	0.16	0.05	0.14	0.03	<0.001
<i>ROI</i>									
Pion. effect <sup>2</sup>	−56.1 <sup>b</sup> (26.7)	−53.9 <sup>c</sup> (31.7)	−56.0 <sup>c</sup> (32.8)	−58.8 <sup>c</sup> (31.3)	−51.3 (34.8)	−49.5 (34.1)	−97.7 (71.2)	−60.6 <sup>c</sup> (33.5)	−76.7 <sup>c</sup> (39.7)
Spec. test <sup>3</sup>	11.1 (7)	9.24 (4)	3.79 (6)	8.87 (5)	6.17 (5)	6.01 (3)	3.43 (1)	7.45 (3)	38.2 (7)
	0.13	0.06	0.71	0.11	0.29	0.11	0.06	0.06	<0.001

<sup>†</sup>The squared term for competitive environment (CESq) is excluded from this model.

<sup>††</sup>All the intensity variables are excluded from this model (SI, PI, RI, and MI).

<sup>†††</sup>Market share position variable is excluded from this model (MP).

<sup>a</sup>Significant at 0.01-level; <sup>b</sup>Significant at 0.05-level; <sup>c</sup>Significant at 0.1-level (based on two-tail  $t$ -tests).

<sup>1</sup>To simplify the notation, we eliminated the  $i$  subscript and the bar to indicate use of the business unit mean. The subscript 1/2 again indicates that the first two observations for each business unit were used as instruments.

<sup>2</sup>Standard errors are in parentheses.

<sup>3</sup>The first value is the  $\chi^2$ -test statistic for the exogenous treatment of pioneering with degrees of freedom in parentheses. The second value indicates the  $p$ -value for the test statistic.

lines. As shown by Christen et al. (1997), this can lead to aggregation bias in a nonlinear model specification. Importantly, the results from a linear specification do not suffer from such an aggregation bias. As shown in Table C1, the linear results replicate our nonlinear profit findings, both in terms of sign and significance.

A second critical element of our empirical analysis is the selection of instruments. To examine how sensitive the obtained findings are to the choice of instruments in the HT-IV procedure, we systematically exclude instruments from the final set and repeat the estimation.<sup>15</sup> A summary of the results is provided in Table C2 for our consumer goods sample and in Table C3 for our industrial goods sample. These tables report the estimated pioneering effect for our two different profit equations when entry is considered endogenous in estimation, along with the  $\chi^2$ -statistic of the HT-specification test for the assumption that entry order is exogenous. The reported

results provide an indication of the range of estimates for the pioneering effect found in this sensitivity analysis. Importantly, all testable subsets of instruments passed the HT-specification test at a 0.20-level of significance, i.e., could be considered exogenous for purposes of identifying the pioneering effect.

To facilitate the interpretation of these results, we repeat in column 1 of Tables C2 and C3 the results from Tables 2. Column 2 shows the results with the same instruments. However, rather than using the first two observations of each business unit, as previously done following Amemiya and MaCurdy (1986), only the business unit means are used, as originally proposed by Hausman and Taylor (1981). The estimates tend to stay very close to the original estimates but, as expected, are typically less efficient. The estimates of the two profit effects for industrial goods deviate somewhat more, but actually show an even higher pioneering disadvantage. The next few columns show the results with various instruments excluded. Again, as expected, the estimates tend to be less efficient.

<sup>15</sup> We thank a reviewer for making this suggestion.

**Table C3 Industrial Goods Sample: Sensitivity of Pioneering Effects**

Instruments <sup>1</sup>	log AGE, CE, CE, CEsq, PI <sub>1/2</sub>	log AGE, CE, CEsq, PI	CE <sub>1/2</sub> , CEsq, PI <sub>1/2</sub>	log AGE, PI <sub>1/2</sub>	log AGE, CE, CEsq	log AGE, CE, PI <sup>†</sup>	log AGE	log AGE, CE <sub>1/2</sub> , CEsq <sup>††</sup>	log AGE, CE, CEsq <sup>†††</sup> , PI <sub>1/2</sub>
<i>Net income</i>									
Pion. effect <sup>2</sup>	-133.7 <sup>b</sup> (56.9)	-135.4 <sup>b</sup> (57.2)	-94.0 <sup>c</sup> (53.7)	-187.5 <sup>b</sup> (89.4)	-122.5 <sup>b</sup> (58.1)	-128.8 <sup>b</sup> (56.0)	-182.4 <sup>c</sup> (111.2)	-94.1 <sup>b</sup> (4.3)	-144.3 <sup>a</sup> (55.0)
Spec. test <sup>3</sup>	14.8 (5)	15.5 (4)	8.08 (5)	12.6 (3)	12.4 (3)	14.9 (3)	10.5 (1)	13.1 (4)	17.4 (5)
	0.011	0.004	0.15	0.006	0.006	0.002	0.001	0.011	0.004
<i>ROI</i>									
Pion. effect <sup>2</sup>	-96.9 <sup>b</sup> (48.8)	-118.7 <sup>b</sup> (57.4)	-80.0 <sup>c</sup> (50.4)	-155.4 <sup>c</sup> (91.2)	-98.8 <sup>c</sup> (57.4)	-100.4 <sup>c</sup> (54.8)	-143.5 (90.4)	-107.5 <sup>c</sup> (57.6)	-113.2 <sup>c</sup> (49.7)
Spec. test <sup>3</sup>	11.5 (6)	12.0 (4)	8.42 (4)	10.4 (3)	7.61 (3)	11.8 (3)	6.96 (1)	8.08 (3)	13.0 (6)
	0.073	0.018	0.077	0.016	0.055	0.008	0.008	0.044	0.044

<sup>†</sup>The squared term for competitive environment (CEsq) is excluded from this model.

<sup>††</sup>All the intensity variables are excluded from this model (SI, PI, RI, and MI).

<sup>†††</sup>Market share position variable is excluded from this model (MP).

<sup>a</sup>Significant at 0.01-level; <sup>b</sup>Significant at 0.05-level; <sup>c</sup>Significant at 0.1-level (based on two-tail *t*-tests).

<sup>1</sup>To simplify the notation, we eliminated the *i* subscript and the bar to indicate use of the business unit mean. The subscript 1/2 again indicates that the first two observations for each business unit were used as instruments.

<sup>2</sup>Standard errors are in parentheses.

<sup>3</sup>The first value is the  $\chi^2$ -test statistic for the exogenous treatment of pioneering with degrees of freedom in parentheses. The second value indicates the *p*-value for the test statistic.

In column 7 of both tables we report the results when only the average age of the business unit ( $\log AGE_{it}$ ) is used as an instrument. All estimates exhibit the same negative sign, although efficiency with only one instrument is greatly reduced.

Finally, we also exclude variables from the model to examine the sensitivity of our results to the inclusion of (some) variables. Since our estimation procedure controls for all kinds of omitted variables, such a change should not materially affect the results. The last two columns of both tables report, respectively, the results when market position and the four intensity variables (supply, production, R&D, and marketing) are excluded. Again we replicate the direction of the pioneering effect across our two samples and two profit equations.<sup>16</sup>

In all, we report estimates for 9 different sets of instruments and model specifications in Tables C2 and C3. Overall, these results are remarkably consistent in three different ways. First, of the 36 estimates (32 of which are new) of the pioneering effect (9 sets of instrument or model specifications  $\times$  2 data samples  $\times$  2 profit equations), all 36 show the same negative sign. Second, despite loss of efficiency in some estimates due to eliminating potential instruments, based on two-tailed tests, 29 of the 36 estimates are significant at the 0.10-level or better. Third, these estimates show that in 31 of the 36 models we reject the hypothesis of exogenous entry order at the 0.20-level or better.<sup>17</sup>

<sup>16</sup> A change in model specification also requires a new estimate of the first-order autoregressive coefficient,  $\rho$ . These estimates deviate little from the estimates reported in Appendix B.

<sup>17</sup> We also conducted a similar sensitivity analysis for the demand and average cost effects. The support provided by this analysis for the robustness of our findings is equally strong.

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