New Product Introduction: Follower Firm Timing Behaviour

Dr. Scott G. Dacko
Associate Professor of Marketing and Strategic Management
Warwick Business School
The University of Warwick
Coventry CV4 7AL
England, United Kingdom
Phone: +44 (0)24 76 528 483; Fax: +44 (0)24 76 524 628
E-mail: S.G.Dacko@warwick.ac.uk

Professor Paul Stoneman
Emeritus Professor
Warwick Business School
The University of Warwick
Coventry CV4 7AL
England, United Kingdom
Phone: +44 (0)24 76 523 038; Fax: +44 (0)24 76 524 628
E-mail: Paul.Stoneman@warwick.ac.uk

Dr. Zafeira Kastrinaki
Assistant Professor
School of Management
University of Bath
Bath BA2 7AY
England, United Kingdom
Phone: +44 (0)1225 384117
E-mail: z.kastrinaki@bath.ac.uk

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Abstract

A multidisciplinary perspective is taken to the analysis of data upon the follower firm timing behaviour of 99 "non-pioneering" firms introducing low fat products into U.S. food markets, encompassing extant approaches in marketing, economic and managerial literatures. The payoffs to followers are considered to be related to demand growth, the extent of competition, early mover advantages, firm characteristics, and risk and entry cost reductions. The propensity of firms to react to these potential payoffs is considered as involving four sequential stages and determined by organisational characteristics. The findings suggest: (i) follower firms vary in the rate at which they ultimately move through each and all of the stages identified; (ii) there is evidence that firm characteristics, time and previous entry (although not simply) impact upon the speed of market entry by firms reflecting the various influences on payoffs identified; and (iii) speeds of reaction are related to firms' abilities to internalize external market developments.

Key words: new products, follower firm timing, competitive response time.

1. Introduction

Successful pioneering new product introductions by an innovating firm are typically accompanied by other firms subsequently starting to compete with the new product by launching similar product offerings. Our main purpose in this paper is to explore conceptually and empirically the timing of these subsequent actions and in particular to address what determines any lags in the process and why these lags may differ across firms. There is a substantial amount of existing literature on this topic to be found within several different disciplines, for example, Vakratsas, Rao, and Kalyanaram (2003) and Kalyanaram, Robinson, and Urban (1995) in marketing, Geroski (1995) and Gort and Klepper (1982) in economics, and Lieberman and Montgomery (2013) and Lilien and Yoon (1990) in management. These literatures variously label the process being analysed as involving either the timing of entry by firms to a new market (i.e. the market for the new product established by the pioneer) or alternatively the timing of follower new product launch. Although we prefer the latter description[1] this does not impact upon the essence of the analysis.

The approach taken here has four characteristics that individually and in combination cause it to depart from the existing literature. The first characteristic is that in seeking to understand and better explain the timing of the behaviours of follower firms we take a multidisciplinary approach drawing upon literatures from three different traditions encompassing marketing, economics and management. Although there is considerable existing research in each of these fields, (see, for example, Lee 2009) research which seeks to aggregate these and other perspectives is unusual and tends to be lacking. As a result there is a lesser-developed understanding of the extent that different perspectives may be competing or complementary. In order to pursue such a multidisciplinary approach, the prime

[1] The statement of Lieberman and Montgomery (2013, 317) that “after many decades of research we still have no clear and standard way of defining followers” is relevant here.

behavioural assumption that underlies our analysis is that the timing of followers depends upon the potential payoff to a firm from entry and the firm's individual propensity to respond to profitable market opportunities. We model potential payoffs and individual responses separately.

The second special characteristic of this work is that we further develop this simple conceptualization by allowing, following Zaltman and Wallendorf (1981), that firms that ultimately enter the market move through a staged process; namely, a four-stage process involving market attention, market interest, new product development (NPD) and finally product launch. Follower firm behaviour can then be considered relative to not just the total chronological time that elapses after pioneer product launch until a follower firm launches its own new product on the market, but also relative to the speed with which follower firms move through the non-overlapping four pre-launch stages (Tushman and Nadler 1978). Decomposing follower firm response time into different stages can be viewed as a potentially beneficial approach that is not exclusively linked to or constrained by any particular research perspective but has the advantage of providing insight into upstream actions of the firm which until now have not been explored.

The third characteristic is that we explicitly take in to account that, when an innovative new product is launched, not only potential suppliers but also potential buyers will change their behaviour, either switching or extending their purchasing patterns over time to include the new product. These changes occurring on the demand side over time will impact upon the potential payoffs to product launch and are thus are an important element to consider in modelling follower behaviour. A distinguishing characteristic of our approach to this matter is that it is based upon literature relating to the demand side component of the diffusion of new products over time.

The fourth and final innovative characteristic of this work is that a specially collected data set upon new low fat product introductions in the U.S. food market in the 1990s is used as the vehicle for the empirical part of the study. This is a unique and especially useful data set that has not previously been employed in this sort of analysis. Preliminary analysis of this data indicates, as one would expect from the extant literature, that follower firms vary considerably in their timing, for example, some followers companies are observed to have launched a competitor product in a matter of months while other firms took more than six years to do so.

The paper proceeds with further discussion of the conceptual background in the next section followed by sections considering: empirical methodology; sampling and data; estimation results and discussion; and then conclusions.

2. Conceptual Background

Our aim is conceptually and empirically to explore the timing of new product launches (or market entry) by firms following an initial product launch by a pioneer. We argue that one may consider that the timing of followers' responses reflect: (i) the payoff to following; and (ii) firms' individual response propensities[2] to profit opportunities. We consider the payoff and the propensity to respond separately, starting with the potential payoff.

2.1 The Potential Payoff

The potential payoffs are modelled to incorporate: demand side diffusion or growth as considered in marketing and economics; approaches in economics that suggest that the

[2] An alternative approach that is more common in the economics literature (see for example Ireland and Stoneman 1986) is to consider that firms have full information, are very competent information processors and seek value maximization. The date of product launch would then be determined by equality between the marginal costs of waiting and the marginal benefits of waiting. This approach would lead to the inclusion of a number of terms relating to future expectations of usage and costs as determinants of the probability of follower product launch. In the current context however we wish to place some emphasis upon differences between firms in their information collection and processing abilities and thus such a model is inappropriate. Moving away from this approach also means that we need no longer rigidly adhere to the value maximization paradigm which in turn will provide more freedom to be less rigorous in the modelling of expectation.

profitability of launching a new product will decrease as the number of other suppliers increases; approaches reflecting early mover advantages suggesting that the first imitators tend to earn higher rewards than later imitators (e.g. Golder and Tellis 1993); and firm heterogeneity and thus the possibility that firm characteristics will affect the payoff to the introduction of a follow-on product (e.g. Narasimhan and Zhang 2000).

Ceteris paribus, the gain or payoff[3] to be made from selling a product into a market will be higher if the demand for the product is greater (e.g. a higher price can be charged). There is a considerable literature in both economics and marketing that argues that new products are subject to a diffusion process on the demand side through which demand may be increasing over time. The literature on diffusion identifies a number of factors that may play a role in this diffusion process, for example Karshenas and Stoneman (1993) identify and test the empirical relevance of rank, epidemic, stock, and order effects. Of these, stock and order effects on the demand side (whereby greater ownership reduces the benefit to later buyers) are unlikely to be of particular relevance to consumer products, especially consumer products that, as here, are purchased repeatedly by buyers over time (see, for example, Stoneman and Battisti 2000 for a more explicit theoretical treatment of the diffusion of repeat purchase consumer goods). They are thus considered no further in this paper as drivers of product demand. Rank effects (buyers with different characteristics have different preferences and willingness to pay) will conceptually support a downward sloping demand curve (demand as a function of price) at any moment of time for any new product, and as such, are relevant here. The epidemic effect has a long tradition in both marketing and economics (Bass 1969; Mansfield 1969; Mahajan et al. 1990) and argues that, via emulation or information spreading

[3] The firm's payoff is of course an expected payoff rather than a known payoff. We have not however introduced formal modelling of expectations (see footnote 2). This is partly justified on the grounds that we have little guide as to how such expectations will be formed. However, more formally, our approach is consistent with literatures (see Ireland and Stoneman 1986) that assume that potential followers hold myopic expectations (i.e. that today is a good guide to what might be expected tomorrow).

(Escribano, Fosfuri, and Tribó 2009; Fabrizio 2009; Grimpe and Sofka 2009; Arbussà and Coenders 2007), where a major source of such information is the passive observation of others (Chandrasekaran and Tellis 2007), that the longer a new product has been on the market the greater will be the number of people aware of that product and/or its characteristics and thus the demand for it will increase over time. Overall, therefore, as a result of rank and epidemic effects on the demand side, one may reasonably expect that there exists a downward sloping demand curve for the new product that is shifting to the right over time and, ceteris paribus, as the elapsed time since the pioneer product was launched increases so the potential return from follower product launch will increase.

Reinforcing this positive impact of time through growth in demand one may also argue that: (i) based on the ideas of Mansfield (1969) that as the elapsed time since the pioneer product was launched or the number of followers increases (alternatives considered by Colombo and Mosconi 1995) so the risk and or uncertainty related to entry will decline, thereby increasing risk adjusted payoffs; and (ii) over time, either directly or by learning from other entrants, the cost of entry by a firm may decline because of further technological advances, or the firm may be enabled for a similar cost, to put a higher quality product on the market, thereby increasing potential payoff.

On the other hand one may argue that the payoff to entry, for a given market size, will decrease as the number of other following firms increases, for there will then be more suppliers on the market, competition will be tougher, and prices for the product and the possibility of monopoly gains will be lower as the market moves down the demand curve. This may be labelled a supply side stock effect. This would suggest that the payoff to the firm launching an imitative product in time *t* will be negatively related to the number of firms that have already followed to date. Additionally one may argue that a firm's position in the ordering of new product launches will impact upon the profit gain to be realized from entry. In a world in which there are first mover advantages or pre-emption effects (for an early discussion see Van der Werf and Mahon 1997; for a more recent discussion, see Suarez and Lanzolla 2007) a firm may, by being an early mover, have a potential advantage relative to a later mover in any game and thus higher payoffs. Lieberman and Montgomery (1988) (see also Huff and Robinson 1994) summarize the reasons for the existence of early mover advantages incorporating: proprietary learning effects, patents, pre-emption of input factors and locations, and development of buyer switching costs. Conversely, they also argue that early-mover disadvantages may result from free-rider problems, delayed resolution of uncertainty, shifts in technology or customer needs, and various types of organisational inertia. We argue that the essence of early mover advantages is that an early mover may have the potential to affect the decisions of later users. In an early study Lambkin (1988) shows that pioneers tend, on the average, to outperform later entrants but compared to early followers and late entrants have significantly different strategic profiles and performance levels. Schnaars (1994) on the other hand argues that being an imitator is the best route. In a much more recent study Lanzolla, Gomez, and Maicas (2010) show that in the European mobile telephony market over the period 1998 to 2007 first and second movers consistently outperformed later entrants. We label these early mover effects as a supply side order effect and the possibility of such early mover advantages reinforces the argument that the payoff to entry by a firm in time t will be negatively related to the number of firms that have already followed at that date.

The payoff to following may well also vary with the characteristics of the following firm (Narasimhan and Zhang 2000; Helfat and Lieberman 2002) which we label a supply side rank effect. Partly with an eye on the data availability two main characteristics are considered here—firm size and R&D spending. Firm size may be important as a reflection of general firm capabilities and the possibilities of scale and or scope economies that either increase the gross payoff to entry or reduce its cost. R&D spending will reflect technological capabilities and thus (lower) the costs of entry or (increase) the quality of the follow on product. We thus consider that both characteristics positively influence the extent that the firm is able to obtain benefits from being a follower. In addition one may argue that there may be a variety of other industry specific effects not elsewhere represented.

In total we may write that the potential payoff, as seen by firm i in industry j from entry following a pioneering product launch in that industry *t* periods after the date of that launch, $\Pi(i, j, t)$, will be: a positive function of *t* as a result of growth in demand, reductions in risk or launch costs; a negative function of the number of entrants in that industry to date, $N_j(t)$, via the supply side stock and order effects, although this effect may be counteracted if risk or launch costs decline as $N_j(t)$ increases; and firm and industry characteristics (supply side rank effects) given by the vector $x(i,t)$. We may thus write that $\Pi(i, j, t) = F(t, N_j(t), x(i,t))$.

2.2 Response Propensities

The individual response propensities of firms are modelled according to managerial approaches that acknowledge the facilitating (or alternatively hindering) influence of organisational characteristics on responses. Research on competitive reactions includes the view that follower firms perceive and act upon a range of signals from the market. In the light of a potential payoff to following a pioneering product launch such influences may ultimately shape the speed of a competitive reaction as well as its strength. For example, Hultink and Langerak (2002) posit, that such signals may arise from a pioneer's launch decision, characteristics of the pioneering entrant and market growth indications. Similarly, Fouskas and Drossos (2010) argue that the speed of competitive response is influenced by organisational perceptions of the competitive environment more specifically, arguing that managers decode cues of their competitive environment in terms of threats and opportunities and respond to them accordingly.

Such theoretical perspectives suggest that the speed with which firms will react to the profit opportunities offered by the possibility of following a pioneering new product will be largely determined by firm or organisational characteristics such that follower firms with superior abilities to perceive and act upon market and competitive signals may be more likely to respond more quickly to such signals relative to follower firms with lesser abilities. Such a perspective is consistent with a communication and information processing explanation of competitive response such as that suggested by Radner (1993) and Smith and Grimm (1991) as well as a more specific view that certain follower firm characteristics such as cognition, capabilities, and incentives are likely to facilitate a firm’s timely and effective response to technical change (Kaplan and Tripsas 2008). Given this theoretical perspective, a further review of the literature suggests several organisational and product characteristics that may either speed or slow a follower firm’s time of competitive response.

Research by Otero-Neira, Varela, and Garcia (2010) suggests that greater follower firm knowledge of rival firms beneficially supports interpreting market signals and is more likely to lead to a timely and effective competitive reaction. Yet, superior knowledge of competitors is but one element of the broader concept of market orientation (Kohli and Jaworski 1990) which further captures the extent that a follower firm is also listening to customers and striving to be internally responsive in terms of capabilities in commercialization (Lee 2009). As such, it is proposed in this research that follower firms with strong market orientations are likely candidates for shorter overall times of competitive response as a result of a consistently facilitating effect in the overall process of response.

Follower firms will vary in the extent that a new product that they ultimately develop is similar to (or different from) the firm's current, related products as well as those associated with new market developments. To the extent a follower firm's new product is ultimately more radical than incremental relative to its current products as well as those of a pioneer, the prevailing view in the competitive response literature is that a competitive response will likely be hindered as a result of it being more difficult for the follower firm to draw upon a sufficient experience and knowledge base to enable it to readily progress to the point of product launch with its more-radical new product (Chen, Smith and Grimm 1992; Debruyne et al., 2002). Thus product radicality matters.

Several studies examining competitive response suggest that, when follower firms are highly successful in managing related products that they currently offer in the market, such firms may potentially respond more slowly to pioneering new product-market developments than firms whose current products are less-successful. For example, MacMillan and McCaffery (1982) point to the inertia within a firm as a strategic barrier to an effective competitive response as a result of current strategic initiatives and the associated pre-commitment of management attention in the firm making a change in strategic direction prohibitively costly. Further, MacMillan and McCaffery (1984) refer to the term "commitment to existing profitable products" to denote the condition where a firm's strategic response may be slowed as a result of a situation where existing profitable products may be cannibalized. We thus consider that current product success matters.

The organisational literature suggests that certain characteristics of a follower firm's organisational structure may also influence the speed of its competitive response. For example, research by MacMillan (1982) on bureaucratization, Deshpande and Zaltman (1984) on firm's organisational formality, and Menon and Lukas (2004) on firm infrastructure and procedures suggests slower movement through the stages of competitive response as a result of high organisational formality stemming from its detrimental effects on the internal dissemination and use of information originating from outside the firm. Similarly, research by MacMillan (1982) and Zaltman and Wallendorf (1981) on complex organisational hierarchies and role specialties respectively suggests a potentially detrimental influence on the speed as well as the quality of information flow within an organisation which may be vital to developing a timely competitive response. We thus also consider measures of organisational formality and organisational complexity.

The literature on organisational competences and resources in an NPD context also suggests potentially important influences on the timeliness of a follower firm's competitive response. In particular, research by McGrath, MacMillan, and Venkataram (1995) on NPD competence, which captures the extent that individuals in the firm are competent in problem solving and that the firm understands the risks involved in successfully developing new products, suggests a facilitating effect on the processes culminating in a timely new product introduction. Yet, while NPD competence is viewed consistently in the literature as beneficial in this regard, research on the role of NPD resources suggests both a facilitating and a hindering influence. For example, Debruyne, Frambach, and Moenaert (2010) argue that resources possess a dual, and opposing, role in influencing competitive reaction to new products: on the one hand, resources enhance decision makers' belief that they are able to react effectively to competitive attacks; on the other hand, the presence of resources makes them less motivated to react where the latter explanation given is the liability-of-wealth effect. Given such views, it is therefore possible that NPD resources may exhibit varying influences in follower firm's processes of developing a timely competitive response.

There may well be other external influences beyond the above on follower firm timing. For example, characteristics of particular industries or product markets, such as the number of industry players within it, may also act to shape the nature of competitive response within an industry (Fouskas and Drossos 2010). It may well therefore be the case that the industry specific effects that have already been discussed as reflecting payoffs may also pick up some reaction effects. We define Y(i, j, *t*) as the vector of the various factors impacting upon response times for firm i in industry j, *t* periods after pioneering product launch in that industry.

2.3 Stages of Response

Following Zaltman and Wallendorf (1981) we allow that the process by which firms introduce a new product in to a market involves movement through a time intensive process that has four stages involving market attraction, market attention, market interest and new product development (NPD) as below:

Stage 1: period to market attention, the attraction period;

Stage 2: period from market attention to market research initiation, the market attention period;

Stage 3: period from market research initiation to NPD initiation, the market interest period;

Stage 4: period from NPD initiation to follower product launch, the NPD period.

When the pioneer in an industry launches its new product on to the market, other firms in that industry may be at any stage in the product launch process. Thus a firm may be either: unaware that products of the new type may be sold on to the market (in stage 1); in the market attention period; in the market interest period; or in the NPD period. We thus allow that firms may have initiated the process of follow-on product launch prior to the pioneer's launch date and may at that date in fact be several stages into that process.

This staged approach has two particular advantages. First, in modeling the overall timing of new product launch by the follower firm relative to the launch data of the pioneer, we may test the hypothesis that the follower will (ceteris paribus) be quicker if at the pioneer's launch date it is further in to the new product launch process. Thus a firm that at the date of pioneer product launch has passed through the third stage will be a quicker follower than one that has only passed through the second stage, but it, in turn, will be quicker than one that has only passed through the first stage. The slowest will be a firm that has not even passed through the first stage. To pursue this we define three dummy variables that measure the stage that the follower firm is in at the launch date of the pioneer in its industry: D1 which takes a value of 1 if the firm has passed through the first stage (and no further) at that date and zero otherwise; D2 which takes a value of 1 if the firm has passed through the second stage (and no further) at that date and zero otherwise; and D3 which takes a value of 1 if the firm has passed through the third stage (and no further) at that date and zero otherwise. These dummy variables are then considered as potential determinants of overall follower timing.

The staged approach also enables one separately to analyze the speed with which follower firms move through the different stages (Tushman and Nadler 1978) in addition to overall follower timing. To pursue this we allow that the variables that we have considered above as impacting upon the overall timing of the following firm, potentially can impact on the timing of each of the stages identified. Thus, for example, the length of each of the stages detailed above can be individually related to (at least a subset of) the different organisational characteristics examined. However, different organisational characteristics are likely to have varying degrees of influence or importance at different stages of the follower firm's development of its competitive response. For example, the literature suggests a facilitating role of market orientation on both the time in which the follower's attention is attracted to the new market developments and the time taken for NPD (i.e. reducing the duration of each), but its potential influence on the duration of in-between stages is not something the literature has explicitly examined. In addition, it is also possible that some organisational characteristics may have a facilitating role at one stage but a hindering role at another. Research by Debruyne, Frambach, and Moenaert (2010) on the enabling and inhibiting roles of organisational resources on competitive reactions provides theoretical and empirical support for such a view in relation to the effects of NPD resources on the pre-launch stage durations of follower firms, although such research has been operationalized by means of marketing simulation only. In this context, then, it is deemed beneficial to examine such possible influences on stage durations in greater detail.

The staged approach also permits us to consider whether the timing of the upstream actions of a follower firm may be influenced by the time taken by that firm to move through previous stages. One would at least expect that a firm that initiates a stage at later date would complete that stage at a later date. We define, relative to the industry pioneer launch date, τ_{1i} as the date when firm i completed the first stage (initiated the second), τ_{2i} as the date when firm i completed the second stage (initiated the third), τ_{3i} as the date when firm i completed the third stage (initiated the fourth) and τ_{4i} as the date of completion of the fourth stage (which is also the date of follower product launch). These variables, being defined with respect to the pioneer launch date, may take negative values.

In Table 1 we summarize the arguments above by listing and labelling the various explanatory variables discussed and the expected impact of each upon the time taken by firms to follow the pioneering launch of a new product, both overall and by stage.

-- Insert Table 1 about here --

3. Empirical Methodology

Following Karshenas and Stoneman (1993) and other research in the field of new technology adoption and new product launch timing, this paper employs hazard rate analysis to operationalize the conceptual framework and test the relevance of the various factors identified above as determinants of the behaviour of follower firms. One of the strengths of this approach is that it allows firms to develop, to be dynamic entities, not just random draws of characteristics at any point in time, recognizing that observations on a firm come from the same firm, and placing these observations in the correct chronological order.

Our empirical strategy is primarily concerned with exploring the impacts of different explanators e.g. time and prior usage rather than trying to attribute any measured impacts to particular forces such as demand growth, or supply side stock and order effects. This is primarily because we do not believe that we can empirically separate out these different forces. One particular reason why is because the extent of entry by firms increases with time and thus there will be difficulties in empirically separating out the impact of time and the impact of the extent of accumulated entry.

As argued above, follower firm behaviour can be examined relative to not just the total chronological time that elapses until follower firms place their own new product on the market but also the speed with which follower firms move through the non-overlapping four pre-product launch stages (Tushman and Nadler 1978). Hazard functions are defined for both the whole process between the pioneering firms' successful new product introduction and the follower firms' introduction of their own new product, and for each of the four stages of that process (although for data reasons we can only estimate three[4]).

[4] As explained below in section 3.3 data limitations prevented the estimation of the hazard model for completion of the first stage.

For the overall process the hazard is the probability that a firm i (in industry j), after a period of time *t* since the successful new product introduction by the pioneering firm in that industry, will introduce its own new product, conditional on not having done so prior to that time. Clearly *t* takes a value of zero at the date of the pioneer's product introduction. For each stage (1- 4), the dependent variable of the hazard function is the probability that a firm i, after periods of time t_1, $t_{2,}$ $t_{3,}$ and $t_{4,}$ respectively, since the successful new product introduction by the pioneering firm in that industry, will complete that stage, conditional on not having completed prior to that time The modelling is undertaken such that these variables are allowed to only take positive values.[5]

Generally the hazard $h_i(t)$, is defined as:

$$h_i\left(t\right) = \lim_{dt \to 0} \frac{\Pr\left(t \le T_i < t + dt / T_i \ge t\right)}{dt} \qquad (1)$$

The hazard function may take several different forms. Non-parametric analysis is informative about the pattern of duration dependence and may suggest appropriate functional forms for parametric analysis and for the specification of more complicated models (Kiefer 1988). Thus before estimating a parametric model, we investigate the duration data using a non-parametric empirical hazard function for the overall process by using the Nelson (1972) and Aalen (1978) estimator. This provides graphic summaries of the analysis times of firms in the sample without making any assumptions regarding the underlying distribution of analysis times and how covariates serve to change followers' experiences. The procedure produces a smoothed hazard estimate of the follower product launch and is shown in Figure 1.

-- Insert Figure 1 about here --

[5] As explained and discussed below, some of the follower firms completed stages 1, 2 or 3 before the pioneers' launch. This has appropriately been explicitly taken into account when estimating the hazard functions for each stage.

The non-parametric analysis indicates that a hazard model allowing for a hazard rate to rise over time is the most appropriate.[6] We chose the Weibull proportional continuous time hazard function[7] as being both simple and able to capture this positive time dependency. The Weibull hazard (2) has two parameters, a scale parameter and a shape parameter. The scale parameter is the exponentiated linear predictor and is modelled using the covariate vector $X_i(t)$ which will incorporate the determinants of the payoff as discussed above, i.e. $\tau_{1i}, \ldots \tau_{4i}$, N($t$), and x(i,$t$), and the vector of firm characteristics impacting upon the response propensity Y(i,t) where β is a vector of unknown parameters.

$$h_t(t) = h_o(t)\exp\left[X_i(t)'\beta\right] \qquad (2)$$

The shape parameter is given by p which is incorporated in the underlying or baseline hazard at time t, given as $h_0(t) = p\,\mathrm{t}^{(p-1)}$ and if p>1 then the hazard rises monotonically with t while if p<1 the hazard falls monotonically with t. The instantaneous risk of completion of a stage at time t, conditional on no prior completion, is the product of the baseline (or underlying risk at time t) and an exponential function of these independent variables.

One particular variant of this model is to allow that the shape parameter (or baseline hazard) is purely related to time. However, as stated above, it is conceptually possible that the number of followers to date may also have a similar impact. Thus, instead of imposing the restriction that the shape parameter is purely related to time we allow it to also differ with the number of imitators in the industry to date. We thus allow time to have a different effect for different numbers of imitators. This specification is more general for it allows the effect of

[6] Non-parametric analysis of stages response (Models 2, 3, and 4) leads to the same conclusions. Results are available upon request.
[7] For more details on hazard models see Greene (2012, ch. 19).

$N_j(t)$ on the shape parameter to take a zero value without such a value being imposed. It also potentially allows the impact of $N_j(t)$ on the overall hazard to change in sign as the number of followers increases. We operationalize this by assuming that ln(*p*) is a linear function of the accumulated number of followers to date i.e. $\ln\left(p\right) = \alpha_o + \alpha_1 N_j\left(t\right)$. We parameterize in terms of ln(*p*) instead of *p* itself because *p* is constrained to be positive, whereas a linear predictor takes on any values (see Cleves et al., 2004). Our specification therefore allows $N_j(t)$ to have an effect not only on the scale of hazard but also on the shape of the hazard.

4. Sample and Data

4.1 Product Market

The market studied is four product categories (industries) in the U.S. food sector (salad dressings, crackers, cookies, and ice creams) where non-pioneering food product manufacturers followed pioneers' with launches of their own low-fat/fat-free products. This market was selected because it is technically well defined and has a suitably long history. To be considered a low-fat product for the study the product has to meet the requirements of National Label Education Act (NLEA) of 1990 which made it a legal marketing requirement for manufacturer's food products to use a new label which was designed to give consumers nutrition information to enable them to make more educated purchasing decisions. Thus although there may have been other products on the market before the pioneers' launch dates used in this study which tended toward low-fat properties (and which were not specifically marketed as "low-fat" products) they would not have subsequently met the 1990 NLEA requirement for being truly low-fat and as such are not considered here to predate the pioneers.

The new product introductions of pioneering firms occurred at approximately the same point in time in each sector (December 1989 and February 1990), are clearly identifiable and were immediately successful, thereby making an appropriate basis for the identification of all subsequent follower firms and their associated behaviours. Follower product launches began in 1990, and continued through 1997. There is a sufficiently large number (e.g., 100) of competitive firms in the market to make quantitative analyses reliable (Sudman 1976). As further background, throughout the period examined, the market for low-fat/fat free foods and beverages in the U.S. experienced continuing growth, with the overall category expanding around 20% annually and showing over 2000 new low-fat/fat free product introductions and over $20 billion in U.S. sales in 1997 (with similar growth continuing in subsequent years) (Dacko 2000). By the end of the period examined, approximately 200 firms (of which approximately 1/3 were cookie, 1/3 were salad dressing, 1/6 were ice cream and 1/6 were cracker firms) competed via a low-fat/fat free salad dressing, cookie, cracker or ice cream offering (Dacko 1999; 2000).

4.2 Sample and Data Collection

A combination of database data, telephone surveys, and mail surveys was used to identify the follower firms in these markets and to collect data for the independent and dependent variables examined in the study. Data purchased from a marketing intelligence firm in 1997 was used to establish the time of follower product launch to the nearest calendar month for all firms that launched new low-fat products in the four product categories of interest. Of the 172 firms identified from the database as potentially reachable for the study, in-depth 30-minute telephone interviews and 12-page surveys were sought to be completed with key informants within all firms. Key informants chosen were those who had the greatest knowledge of the introduction of the firm’s new product and the firm’s organisation and included marketing managers, marketing directors, and marketing VPs.

An overall study participation rate of 64% was achieved with 117 telephone interviews conducted with key informants at 110 different firms during the 1997 calendar year. After screening the responses for conformance to the study's requirement that the follower firms' new products were internally developed by the firm, the final sample of eligible product introductions into the low-fat food product market for the first time consisted of 99 initial new product introductions by 96 follower firms (three firms were large enough to have had low-fat food products introduced in different categories by different areas of the firm, and are here treated as independent observations) that had entered the low-fat food product market for the first time with their own product. For these firms, the average number of employees was 643 with a median of 88. The effective sample available for estimation purposes however is less than 99 due to missing values for some explanatory variables (see below).

The data collection method used means that all the firms analysed as followers did in fact launch a new product and in fact completed all the stages in that process. Thus the sample has no right censoring. However, as we have no firms in our sample that did not follow (and we do not see how it would have been practical to identify such firms and their process through the stages), one may best describe our findings as relating to the speed of follower timing by firms that actually follow. One cannot impute any findings from our results relating to what determines whether firms actually follow. Our data collection method also means that we do not observe any firms that might have existed at the date of pioneer introduction but exited the market before launching a follow-up product. Six of the firms that launched a follow-up product were established after the date of pioneer introduction. For such firms we consider in the hazard analysis below that the date of establishment is the date of the onset of risk (rather than using the date of pioneer launch).

4.3 Timing Measurement

The time until follower product launch measured for all firms was established from the database. In aggregate, the mean duration between the pioneer's launch and the followers' launch of a new product is 45.8 months, with a standard deviation of 23.4 months which indicates considerable dispersion. The timing (relative to the date of launch by the industry pioneer) of stage completions was established by asking key informants. In all cases where key informants indicated they were willing and able to provide a chronological record of their firm's pre-launch stages, such values were recorded to the nearest calendar month. In Table 2 we provide indicative statistics of overall timing and durations of stage completions for each of the four sub-markets. It should be noted however that in this Table, although for stages 2, 3 and 4 duration is measured from completion of the prior stage, for stage 1 duration is measured from pioneer launch date. This is because it has not been practical to reliably measure the date from which stage 1 activities began. This also means that we cannot estimate hazard functions for stage 1.

-- Insert Table 2 about here --

We note that the data illustrates that the actions of many follower firms' temporally precede actual pioneering product launch. Of the 99 follower launches observed, at the date of the pioneer launch in their industry, in 24 cases attention had already been attracted (completed stage 1), of which 15 firms had also completed stage 2, of which 13 firms had already completed stage 3 (although of course none had completed stage 4). In this sense, while our approach adopts "time zero" as the point when a pioneer launches its product for purposes of recording the timing of follower firm actions, the data itself accommodates the realistic and observed tendency for some firms to act prior to the time of actual pioneering launch. We thus do not suggest that the timing and duration of all upstream follower firm actions is completely dependent upon, or stems from, the pioneer's actual product launch. The followers' reactions may have earlier origins. However, for the estimation of the overall hazard function these data provide reliable estimates of timing and also enable measurement of stage completions (i.e. D1 – D3) at the date of pioneer introduction.

The data also provide reliable estimates of the date of prior stage completion for the estimates of stage completion hazards. It should however be noted that because some of the follower firms completed stages 1, 2 or 3 before the pioneers' launch, some of the prior stage completion dates may be negative when the pioneer introduction date is taken as time zero. Our estimates of the hazard functions for completion of stages 2, 3 (but of course not stage 4) exclude those firms for whom completion of that stage took place prior to the pioneering product launch, both for estimation reasons and because our main interest in this study is to explore the behaviour of follower firms, and, as such, we are thus only interested in firms' actions after the date of pioneering product launch.[8]

4.4 Explanatory Variables

Consistent with the modelling approach of Gort and Klepper (1982), the cumulative number of previous followers was calculated for a given firm in a given industry/market at a given point in time as the total number of other firms who have already placed a product on that market at that date (up to an overall maximum of 98). Measures for each of the organisational constructs discussed above were established using a series of questions developed in prior research. Specifically, the questionnaire included: (i) five questions assessing market orientation (Narver, Jacobson, and Slater 1993); (ii) four questions assessing new product radicality (MacMillan, McCaffery, and Van Wijk 1985); (iii) five questions assessing current or related product success (Bowman and Gatignon 1995; Smith

[8] Although activity prior to pioneer launch may be of some interest in itself, explaining such activity is not really within our remit.

and Grimm 1991); (iv) four questions each assessing organisational formalization (Deshpande 1982) and organisational complexity (MacMillan and McCaffery 1982); (v) four questions assessing NPD competence (McGrath, MacMillan, and Venkataram 1995); and (vi) five questions assessing NPD resources (Smith and Grimm 1991). Other questions about company size and R&D provided data on these two variables. R&D was measured by a variable indicating whether the firms was spending on NPD a lot less or a lot more than its competitors, whereas firm size was measured by the number of employees.

Analyses prior to hypothesis testing included conducting correlational, reliability, and exploratory factor analyses for each of the constructs in the study and examining the potential influence of other variables such as brand type on time of follower firm response. As a result of these analyses, one item each was removed from the scale items measuring new product radicality, related product success, and organisational formalization, and two items each were removed from the scale items measuring organisational complexity and NPD resources. Table 3 provides details of how the organisational constructs were generated. Further, a correlation analysis has found that there are no highly correlated variables (hence, the correlation matrix is not shown) and an examination of relevant diagnostics to check for possible multicollinearity has indicated it is not an issue in the analysis.

-- Insert Table 3 about here --

5. Estimation, Results and Discussion

We start with 99 firms with respect to which we measure accumulated entry in time *t*. All 99 firms eventually complete stage 4 and launch. At time zero there are 24 firms that have finished stage 1, 15 that have finished stage 2 and 13 that have finished stage 3. We do not estimate a stage 1 hazard. In estimating stage 2 and stage 3 hazards we exclude those who have finished the stage prior to time zero, i.e. 15 and 13 respectively. As a result of missing data on the organisational variables and/or missing data on the timing of pre-launch stages for some firms, however, the sizes of the estimating samples are reduced. In particular, the data collected invariably included missing data for multiple cases where the respondents were asked to provide information on organisational variables and/or timing variables required by particular models and where respondents did not provide such information. The final estimating samples were 76 for the overall and stage 4 completion hazards, 72 for stage 2 completion and 75 for stage 3 completion. These are all of an adequate size to ensure robust estimates.

The hazard models are estimated using Maximum Likelihood. Table 4 presents results relating to overall hazard of follower firm product launch (Model 1). In this Table we have included estimates of the elasticity of the hazard (evaluated at the sample mean) with respect to those variables that are significant at 5% or 1%. Two versions are presented, one (Model 1b) that incorporates explanatory variables capturing the stage that the follower firm is in at the launch date of the pioneer in its industry and one (Model 1a) that does not, in an attempt to examine the sensitivity of the results. Both models seem to perform well in terms of explanatory power.

-- Insert Table 4 about here --

The estimates of the baseline (or shape of the) hazard in both models show a positive and significant impact of the number of cumulative followers as well as a statistically significant constant effect. The parameter, *p*, is always greater than one which indicates that the baseline hazard has a positive duration dependence, indicating empirical support for the argument that there are positive impacts on follower product launch from time (given $N_j(t)$). This, as we have argued may reflect demand growth as time since pioneer launch increases (with possible further impacts from uncertainty reductions and reduced costs of product launch). Our results also show that the impact of time on the baseline hazard increases with the number of existing followers, $N_j(t)$.

The cumulative number of adopters also appears as an explanatory factor for the scale of the hazard as well as the shape of the hazard. In both models 1a and 1b this variable carries a negative coefficient and is significant. This implies, in contrast to the positive impact upon the baseline hazard, that a greater number of prior users reduces the hazard of follower product launch. This is consistent with increased competition and early mover advantage (supply side stock and order effects) jointly acting in a negative manner. The estimates indicate that these effects are quantitatively large: an incremental increase in the number of cumulative followers will, in this way, decrease the hazard of follower product launch by 35% or 46 % depending on the model.

Given the counteracting negative and positive effects of accumulated entry on the hazard it is of interest to explore the overall impact of the cumulative number of adopters as more firms follow the pioneer. We may derive from the hazard function that

$$dlnh_i(t)/dN_j(t) = \alpha_1 + \alpha_1 exp(\alpha_0 + \alpha_1 N_j(t))lnt + \beta_N \quad (3)$$

where β_N is the coefficient upon $N_j(t)$ in the vector of explanatory variables $X'(t)\beta$. We may then deduce that for given t, the elasticity of $h_i(t)$ with respect to $N_j(t)$ is negative if $N_j(t) < N^*(t)$ and positive if $N_j(t) > N^*(t)$, where $N^*(t)$ is given by

$$N^*(t) = [ln(-\beta_N - \alpha_1) - ln\alpha_1 - \alpha_0 - ln(lnt)]/\alpha_1 \quad (4)$$

Using the parameters from the estimates of model 1a and 1b we calculate and plot the values of $N^*(t)$ for Models 1a and 1b in Figure 2.

-- Insert Figure 2 about here --

In essence if, at time t, $N_j(t)$ lies below the plotted curve then, overall, the impact of an increase in $N_j(t)$ on the hazard rate is negative and if above then positive.

One may calculate the values of t and the number of firms at which the impact of an increase in $N_j(t)$ on the hazard rate changes from negative to positive for each industry. For model 1a the switch month (number) is 39 (10 of 33 firms) for salad dressings, 44 (9 of 14) for crackers, 38 (10 of 31) for cookies and 44 (9 of 21) for ice cream; for model 1b the switch date (number) is 48 (13 of 33 firms) for salad dressings, 58 (11 of 14) for crackers, 42 (14 of 31) for cookies and 44 (12 of 54) for ice cream. Clearly for each industry the impact of accumulated entry overall is negative when accumulated entry is low i.e. in the early period of the entry process; in the later period, the effect of accumulated entry on the baseline hazard dominates the effect on the scale and as a result further usage increases the overall hazard of entry.[9]

Of the two supply side rank effects included, firm size is not significant, but R&D is, as expected, positive and significant in Model 1a, where an incremental increase in a firm's self-perceived R&D spending compared to its competitors is observed to increase the hazard rate of follower entry by 22% (at each time of follower entry). None of the industry dummies are significant.

In Model 1a we find that a number of the organisational/managerial variables are also significant. Thus market orientation (positively), new product radicality (negatively) and

[9] We have also estimated models in which the baseline hazard is a function of time alone and not accumulated usage. The current model is more general and exhibits greater explanatory power, and is thus preferred. The estimates of the alternative model are similar to those presented here except that the coefficient upon $N_j(t)$, as a scale effect, is positive (and significant) implying that the hazard rate always increases as $N_j(t)$ increases. The negative then positive impact we have estimated above is much richer.

organisational formality (negatively) carry significant coefficients. These effects are of the signs that were expected a priori, and have quantitatively significant impacts on the hazard, with elasticities of 32%, -13% and -14% respectively.

Model 1b includes three extra explanatory variables compared to 1a that reflect the stage that the following firm has reached at the date of pioneering product launch. Of these, the two dummies reflecting “completed stage 2” and “completed stage 3” carry significant and positive coefficients, the latter being greater than the former. These results indicate that the further into the process is the follower at the date of pioneering product launch the greater is the hazard of that follower launching a follow on product at any time *t*. This is exactly as one would expect and as we have argued. In particular, a firm that at the date of pioneer product launch has passed through stage 2 (and no further) or stage 3 (and no further) has an associated hazard rate of product launch which is 22% or 53%, respectively, higher than firms that have not. However, in these estimates, market orientation, new product radicality and organisational formality are no longer significant, although NPD competence becomes significant with the expected sign. It is our view that the organisational variables that we have modelled will have significantly impacted upon the stage in the process reached by the follower at the date of pioneering product launch, and as such the organisational variables and the stage state dummy variables may be alternative ways of capturing the same effects.

In addition to these results upon overall follower timing we have also estimated three other models: Model 2 referring to time to stage 2 completion (stage 3 initiation) i.e. initiating market research; Model 3 referring to time to stage 3 completion (stage 4 initiation) i.e. completing market research and initiating NPD; and Model 4 referring to time to stage 4 completion (i.e. completing NPD and follower launch[10]). The results are presented in Table 5. In each case we present results for models a and b, the latter includes time of entry to the stage as an explanatory variable whereas the former does not.[11]

-- Insert Table 5 about here --

The results generally give support to the hypothesis of a baseline hazard that increases with elapsed model time. The constant in the expression for the shape parameter (p) is significantly different from zero and in all the models (taking the impact of $N_j(t)$ into account) the shape parameter, p, is always greater than unity, suggesting a positive time dependency.[12] However, the effect of this time dependency does differ by stage. Thus once again, as found with the overall hazard, for each stage there are significantly positive time effects.

The number of cumulative followers is also estimated to have a significant negative effect on the scale of the hazard of stage 2 and stage 4 completion but not on stage 3. Given that for Stage 3 the number of cumulative followers is estimated to not have a significant effect on the scale of the hazard its only impact is via the shape parameter and that is estimated to be positive. For stages 2 and 4 the number of cumulative followers is estimated to have a positive impact on the shape and a negative impact on the scale. We calculate that for model

[10] In these estimates we have allowed the onset or risk of stage completion to start at the date of pioneering product launch in the industry. We have thought however that as one cannot complete a stage before starting a stage that there may be some advantage in left truncating the stage estimates, so that the risk only accumulates from the date at which the firm started the stage. This in fact made little difference to the results. Moreover the inclusion of the stage start dates as regressors may have a similar effect.

[11] Estimates of the restricted version of Models 2-4 in which p is a constant, as in the case of Model 1, provide less explanatory power but similar results other than that $N_j(t)$ carries a significant and positive sign and in Model 3a p has a value which is slightly less than one indicating a negative duration dependence. However for Model 3a after the first follower, time will impact positively on the hazard via increases in accumulated usage over time. Given their greater generality and explanatory power we consider the reported results above to be superior.

[12] The only exception to that is Model 3a, where the constant in the shape parameter is not significant and the shape parameter depends only on cumulative followers. In this model, we need to have at least one follower to get $p>1$.

2a by period 40 the impact of cumulative followers on the hazard has switched from negative to positive in all sectors and for model 4a this has happened by period 50, i.e. overall the number of cumulative followers initially has a negative effect and then a positive effect for stage 2 and stage 4 completion (as with the overall hazard).

The significant impact of the R&D variable on stage 4 completion indicates that rank effects receive at least some significant support. For example, an incremental increase in a firm's self-perceived R&D spending compared to its competitors is observed to increase the hazard rate of stage 4 completion by 26% (Model 4a) or 29% (Model 4b) (at each time).

In general the organisational variables appear to have limited impact upon stage hazard rates. Market orientation impacts positively on the hazard in Models 2a 3a and 4a (with large elasticities of 33%, 40% and 35% respectively) and also in Model 4b where the elasticity is much smaller. New product radicality has a negative impact in Models 4a and 4b (with an elasticity of about -15%). Organisational formality carries a significant and expected negative sign in Models 3b and 4a with elasticities of -20% and -12%, respectively.

The model b estimates indicate that the time taken by a follower to move through previous stages plays a significant role to the hazard rate of stage 2, stage 3 and stage 4 completion. In particular, if duration of the market attraction period increases by one month the hazard rate of stage 2 completion at each time *t* decreases by 4%. If the duration of the market attention period increases by one month, the hazard rate of the subsequent stage 3 completion at each time *t* decreases by 9%. Also, if the duration of the market interest period increases by one month the hazard rate of stage 4 completion at each time *t* decreases by 7%. That means, not surprisingly, that a follower that initiates stage 2, or stage 3 or stage 4 at a later date completes that stage at a later date.

However comparing model a and model b estimates, it seems that incorporation of the timing of preceding actions as explanatory variables into the empirical models of stage 2 and stage 3 (and to some degree, stage 4) completion affects the estimates of the impact of organisational characteristics of the firm, which tend to become insignificant. This further implies that such characteristics may be reflected in follower's upstream actions. Multiple industry characteristics affect the hazard rate of stage 2 and 3 completion only when upstream actions of the follower are not taken into consideration. This is consistent with research by Hultink and Langerak (2002), for example, who argue that industry characteristics convey signals to incumbents which are influential to the speed of competitive reaction, and thus industry effects may be captured by earlier stage completion speeds.

Implications associated with these stage-level findings on organisational characteristics include that there are unequal influences of variables across the different stages of activity preceding a follower's product launch. For example, new product radicality is found to have a significant hindering influence on the later two stages of follower firm activity but not the earlier two stages, thereby suggesting that its detrimental influence should receive greater managerial attention and/or scrutiny as the follower firm's market entry efforts become increasingly committed. On the other hand, other characteristics such as NPD resources are found to have a significant facilitating influence on an early stage of follower firm activity (stage 2) but not the later stages, suggesting barriers to be acknowledged and overcome to a greater extent by managers in the firm's early efforts to evaluate an appropriate and timely competitive response. The results also show that the effect of organisational characteristics is influenced by the followers' upstream actions. Also, the time taken by a firm to move through previous stages affects the timing of the firm in completing a subsequent stage of competitive response. If a firm initiates a stage at a later date it will complete that stage at a later date. Furthermore, the results show that a follower will (ceteris paribus) be quicker if at the pioneer's launch date it is further in to the new product launch process.

6. Conclusions

This study adopts a multidisciplinary perspective on follower firm product launch timing and relates that timing to the potential payoff from following and potential followers' individual response propensities. The analysis investigates both overall timing and the timing of stages in follower firm activity and incorporates elements from marketing, economic and managerial approaches, the latter specifically encompassing internal firm characteristics and activities prior to new product launch. This multidisciplinary perspective is one which extant follower firm entry timing studies have neither previously captured nor analyzed. One major contribution is therefore in highlighting the value of an integrated theoretical perspective on explanations of follower firm timing. We find that such a multidisciplinary provides a much broader explanation of follower firm timing behaviour than any single perspective alone. Incorporated in the approach are impacts arising from demand growth over time, increased competition and early mover advantages as the number of followers increases, reductions in risk and or reduced costs as time or the number of followers increases, differences in payoff to firms according to their characteristics (size and R&D) and the greater or lesser abilities of potential followers to internalize external market developments and ultimately respond with a new product. The empirical analysis uses a specially collected data upon the timing behaviour of 99 "non-pioneering" or following firms introducing low fat products into U.S. food markets.

Preliminary analysis indicates that in aggregate, the mean duration between the pioneer's launch and the followers' launch of a new product is 45.8 months, with a standard deviation of 23.4 months which indicates considerable dispersion. We show however that many follower firms start (and sometimes complete) the early stages of the following process prior to pioneer product launch. In other words the following process is not necessarily initiated by the pioneer launch. Not surprisingly, those who start the process prior to pioneer launch also follow more quickly. More generally we are also able to explore the influence of the timing of preceding actions on the subsequent actions of the following firm.

The empirical analysis is based upon the estimation of hazard functions. Preliminary analysis indicates that hazard functions incorporating a time variant baseline hazard are most appropriate. We find clear evidence that (ceteris paribus) as time proceeds the probability that a follower, conditional on not having previously followed, will launch a new product in time *t*, increases. This is consistent with but not necessarily proof that demand side growth matters. We have argued however that it is difficult to separate out the effects of time and accumulated entry, and our results indicate that the latter has a negative impact on the hazard in the early part of the process and a positive impact in the later part of the process. This would be consistent with (but it cannot be proved) that in the early part of the process the negative impact of accumulated usage via increased competition and early mover advantage outweighs positive impacts via the baseline hazard (e.g. demand growth) uncertainty reduction and/or reduced entry costs, whereas in the later part of the process this ordering is reversed.

In terms of specific organisational and product characteristic influences, the results relating to organisational characteristics are consistent with prior work. With respect to organisational formality in particular, we believe that the results provide empirical support for a hindering effect on overall follower firm entry timing and believe that one contribution of this study is the empirical validation of the prior theoretical work. In terms of the role of the strategic factor of market orientation, the results support the view that a strong market orientation is not only beneficial in facilitating an overall competitive response but, importantly, beneficial in facilitating speedy completion of multiple early actions of the follower firm as a result of the firm's strong efforts to listen to customers and keep an eye on competitors. The result of the study also highlight the importance of a number of other influences suggested in the competitive response literature, namely, the hindering influence of product radicality and a beneficial influence of NPD resources at least in part. For each, there is at least partial empirical support in terms of significant coefficients for one or more stages of follower response. Finally, the results of this study confirm the facilitating role of NPD competence in line with existing literature (McGrath, MacMillan, and Venkataram 1995).

In addition to these findings as to the drivers of follower firms' timing (or alternatively the timing of entry to new markets) per se, our findings have implications for the overall intertemporal pattern of new technology diffusion. It is now generally recognized that it is the interaction of supply side and demand side factors that determine the intertemporal pattern of usage of new technology (see, for example, Stoneman and Battisti 2010). The demand side has been quite well studied (Geroski 2000). The supply side has been less studied. On the supply side the main issues relate to the pricing of new products (or technologies), their improvements over time and the quantities that firms produce. Such variables will be particularly affected by the number of suppliers at a point in time[13] and also the rate at which new firms enter the markets.[14] It is to the understanding of this supply side that our work contributes and indicates that, via various effects, changes in the number of suppliers at a point in time will be determined by time itself, the number of previous entrants, and firm

[13] One might also note that even if the new product is imported the number of importers may well change over time producing similar effects.

[14] In fact the rate of entry is so crucial that the pattern of entry i.e. the change in the number of suppliers over time, might even be labeled 'diffusion on the supply side'.

characteristics that affect payoffs and reaction speeds. Clearly one might expect differences across different products as potential entrants differ. Also, some of the effects might be considered exogenous e.g. time itself encourages more firms in to the industry, while others will be endogenous i.e. increased usage encourages further usage and there will differences across industries. The overall diffusion pattern that will result from the interaction of these demand and supply factors may thus also be partly exogenously driven and partly endogenously driven and differ across products and industries as they differ in the characteristics of potential entrants (and of course potential buyers). An obvious policy observation is thus that, should it be deemed desirable to speed up the diffusion process, policies may be directed at either the supply side (number of suppliers) or the demand side (number of buyers) but, because supply and demand interact, there is no guarantee that demand side policies will not be counteracted by supply side reaction or vice versa.

Figure 1. Smoothed hazard function of overall timing of follower product launch.

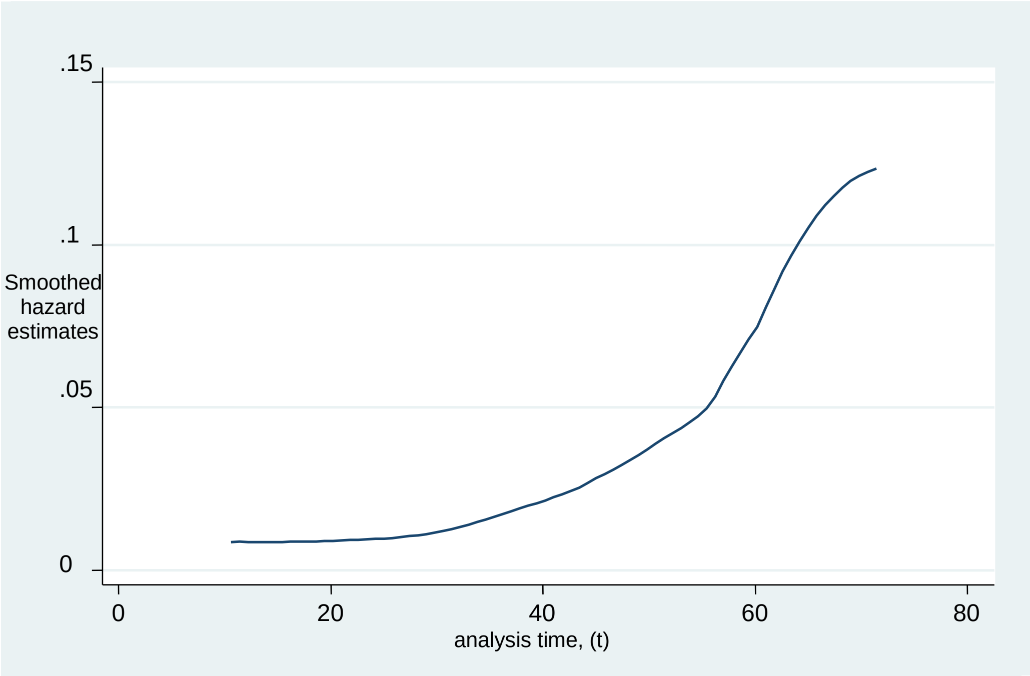

Figure 2. Critical values of $N_j(t)$ against analysis time

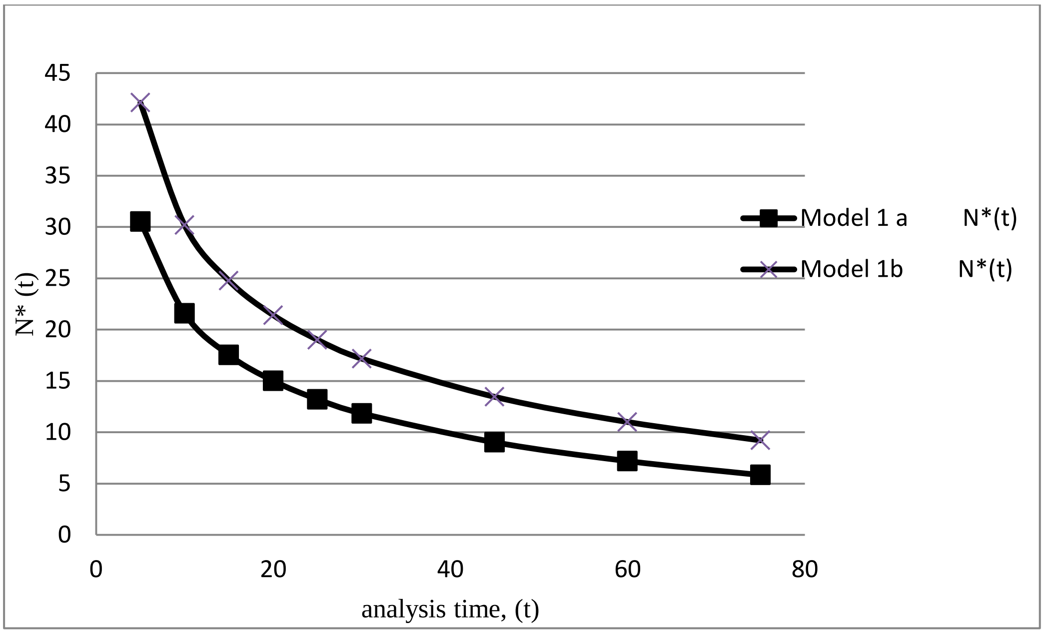

Table 1. Explanatory variables and expected impact on follower firm timing

Effect (indicator)	Variable Label	Expected Sign (sooner +, later -)
Time since industry pioneer launch	t_j	+
Number of imitators to time *t*	$N_j(t)$	-
R&D (relatively high or low R&D)	R_i	+
Firm Size (number of employees)	S_i	+
Market orientation (see Table 3)	Y_{1i}	+
New product radicality (see Table 3)	Y_{2i}	-
Related product success (see Table 3)	Y_{3i}	-
Organisational formalization (see Table 3)	Y_{4i}	-
Organisational complexity (see Table 3)	Y_{5i}	-
NPD competence (see Table 3)	Y_{6i}	+
NPD resources (see Table 3)	Y_{7i}	+/-
Industry effects		unspecified
Overall timing		
Completed first stage at pioneer launch date	$D1_i$	+
Completed second stage at pioneer launch date	$D2_i$	+
Completed third stage at pioneer launch date	$D3_i$	+
Stage timing		
Timing of completion of stage 1	τ_{1i}	-
Timing of completion of stage 2	τ_{2i}	-
Timing of completion of stage 3	τ_{3i}	-

Notes: i refers to firm, j to the industry in which the firm is located.

Table 2. Mean (standard deviation) of follower timing and stage durations (months)

Industry Sub-Sample	**Time to Follower Launch**	**Duration Stage 1**	**Duration Stage 2**	**Duration Stage 3**	**Duration Stage 4**
Salad Dressing Mfrs. (n=33)	49.8 (24.6)	17.6 (19.9)	17.9 (18.3)	7.7 (8.5)	8.7 (6.0)
Cracker Mfrs. (n=14)	36.5 (23.4)	-4.2 (26.1)	14.5 (32.6)	12.2 (17.7)	11.2 (5.3)
Cookie Mfrs. (n=31)	46.1 (21.4)	10.2 (16.5)	15.8 (19.5)	7.1 (8.4)	10.8 (8.4)
Ice Cream Mfrs. (n=21)	45.2 (24.0)	-0.9 (19.2)	17.1 (23.6)	8.8 (10.7)	14.7 (13.8)
All firms	45.8 (23.6)	9.4 (20.9)	16.6 (21.5)	8.3 (10.6)	10.9 (8.9)

Note: Time to follower launch and the duration of stage 1 measured from pioneer launch date. Durations of stages 2, 3 and 4 measured from completion of prior stage.

Table 3. Organisational explanatory variables and their bases.

Market Orientation (alpha = .776) How often … (never – very frequently) …salespeople in firm shared information about competitor's strategies …firm's management monitored its orientation and commitment to serving current and future customer needs …firm's business strategies were driven by effort to give their customers products and services of greater value …firm's top management regularly discussed competitor firm's strategies and strengths How well managers in firm understood how all employees could produce products and services that were valued by firm's customers (not very well – extremely well)
Product Radicality (alpha = .701) How different pioneering product was compared to firm's products (very similar – very different) How different formulation of product introduced was compared to that of firm's other products (" – ") How different manufacturing process of product introduced was compared to that of firm's other products (" – ")
Related Product Success (alpha = .661) Importance of product market to firm's management (extremely unimportant – extremely important) Concern over product introduction taking away sales from firm's other products (no concern – great concern) Profitability of firm's product brand (extremely unprofitable – extremely profitable) Profitability of firm's products overall (extremely unprofitable – extremely profitable)
Organisational Formality (alpha = .761) How often was it stressed in firm that employees go through proper channels to get tasks done (never – always) How would describe the degree of formality and bureaucracy in the way firm was running (very low – very high) Extent the firm had strict operating procedures that employees were encouraged to follow to do their jobs (" – ")
Organisational Complexity (inter-item correlation = .856) How many levels the firm had from lowest ranking employee to highest ranking employee (Answer then divided by the number of full time employees in firm in 1990.) How many levels the firm had from the typical marketing employee to firm's highest ranking employee (Answer then divided by the number of full time employees in firm in 1990.)
NPD Competence (alpha = .875) How confident NPD teams understood risks in developing new products (not at all – extremely confident) How competent NPD teams were in solving problems effectively & efficiently (not at all – extremely competent) How well NPD teams understood customer needs to be satisfied (poorly – extremely well) How often it has been that NPD projects have had all the key skills for smooth implementation (never – always)
NPD Resources (alpha = .853) How would characterize the R&D and engineering resources that were available (scarce – abundant) How would characterize the manufacturing resources that were available (" – ") How would characterize the marketing resources that were available (" – ")

Table 4. Model 1: overall timing of follower product launch, hazard rate coefficient estimates, associated p-values and elasticities.

	Model 1: Overall timing of follower product launch	
Explanatory Variables	**Model 1a**	**Model 1b**
Constant	-6.77 (0.00***)	-13.89 (0.00***)
Cumulative Followers (N_j)	-0.43 (0.00***) -35%	-0.62 (0.00***) -46%
R & D (R)	0.20 (0.03**) 22%	-0.05 (0.58)
Firm Size (S)	0.00 (0.92)	0.00 (0.18)
Market Orientation (Y1)	0.28 (0.00***) 32%	0.08 (0.36)
New Product Radicality (Y2)	-0.14 (0.04**) -13%	-0.08 (0.26)
Related Product Success (Y3)	0.04 (0.56)	0.05 (0.53)
Org'l Formality (Y4)	-0.15 (0.05**) -14%	0.02 (0.83)
Org'l Complexity (Y5)	-0.10 (0.16)	0.04 (0.58)
NPD Competence (Y6)	-0.04 (0.68)	0.17 (0.04**) 19%
NPD Resources (Y7)	-0.02 (0.77)	0.03 (0.72)
Industry (Crackers)	0.62 (0.20)	0.19 (0.72)
Industry (Cookies)	0.22 (0.51)	0.15 (0.65)
Industry (Ice Cream)	-0.02 (0.96)	-0.49 (0.24)
Completed stage 1 at pioneer launch, D1		-0.01 (0.98)
Completed stage 2 at pioneer launch, D2		0.20 (0.00***) 22%
Completed stage 3, at pioneer launch, D3		0.43 (0.00***) 53%
Ln(p)		
Cumulative Followers (N_j)	0.04 (0.00***)	0.03 (0.00***)
Constant	0.58 (0.00***)	1.24 (0.00***)
Pseudo R-sq	50%	79%
No. of firms	76	76
Number of obs	3360	3360

Values in parentheses refer to p-values; *, **, *** indicating significance at 10%, 5%, and 1% levels respectively

Table 5. Stage hazard rate coefficient estimates, associated p-values and elasticities (percent)

Explanatory Variables	Model 2: Hazard rate of stage 2 completion, (market research initiation) Model 2a	Model 2b	Model 3: Hazard rate of stage 3completion (NPD) initiation Model 3a	Model 3b	Model 4: Hazard rate to stage 4completion (follower product launch) Model 4a	Model 4b
Constant	-8.62 (0.00***)	-8.02 (0.00***)	-7.52 (0.00***)	-3.18 (0.01***)	-6.44 (0.00***)	-6.49 (0.00***)
Cumulative Followers (N_j)	-0.54 (0.02**) -42%	-0.78 (0.01***) -54%	-0.18 (0.20)	-0.17 (0.21)	-0.59 (0.00***) -45%	-0.56 (0.00***) -43%
R & D (R)	-0.05 (0.57)	-0.17 (0.13)	-0.02 (0.79)	0.02 (0.82)	0.23 (0.01***) 26%	0.26 (0.00***) 29%
Firm Size (S)	0.00 (0.80)	0.00 (0.29)	0.00 (0.70)	0.00 (0.55)	0.00 (0.97)	0.00 (0.91)
Market Orientation (Y1)	0.29 (0.00***) 33%	0.16 (0.21)	0.34 (0.00***) 40%	0.12 (0.25)	0.30 (0.00***) 35%	0.16 (0.10*) 17%
New Product Radicality (Y2)	-0.02 (0.73)	-0.01 (0.88)	-0.03 (0.69)	-0.05 (0.48)	-0.17 (0.02**) -16%	-0.15 (0.03**) -14%
Related Product Success (Y3)	0.09 (0.27)	0.11 (0.31)	0.09 (0.20)	0.01 (0.93)	0.05 (0.50)	0.03 (0.68)
Org'l Formality (Y4)	0.06 (0.45)	0.12 (0.18)	-0.10 (0.19)	-0.23 (0.01***) -20%	-0.13 (0.10*) -12%	-0.12 (0.11)
Org'l Complexity (Y5)	-0.05 (0.58)	-0.04 (0.72)	-0.02 (0.83)	0.05 (0.61)	-0.12 (0.12)	-0.15 (0.04**) -14%
NPD Competence (Y6)	-0.09 (0.26)	-0.08 (0.54)	-0.01 (0.89)	0.00 (1.00)	-0.06 (0.47)	-0.11 (0.21)
NPD Resources (Y7)	0.15 (0.07*) 16%	0.19 (0.12)	0.02 (0.80)	-0.06 (0.54)	-0.01 (0.90)	-0.01 (0.92)
Industry (Crackers)	0.10 (0.05**) 11%	0.99 (0.17)	0.13 (0.01***) 14%	0.08 (0.09*) 8%	0.04 (0.94)	-0.40 (0.37)
Industry (Cookies)	0.09 (0.03**) 9%	0.73 (0.13)	0.07 (0.04**) 7%	0.07 (0.84)	-0.03 (0.94)	-0.48 (0.18)
Industry (Ice Cream)	0.11 (0.02**) 11%	0.33 (0.61)	0.09 (0.02**) 9%	0.10 (0.82)	-0.50 (0.16)	-0.76 (0.03**) -53%
Time of market attraction (completed stage 1) τ_{1i}.		-0.04 (0.00***) -4%				
Time of initiating market research (completed stage 2) τ_{2i}.				-0.09 (0.00***) -9%		
Time of initiating NPD (completed stage 3) τ_{3i}.						-0.07 (0.00***) -7%
Ln(p)						
Cumulative Followers (N_j)	0.05 (0.00***)	0.05 (0.00***)	0.04 (0.00***)	0.03 (0.00***)	0.04 (0.00***)	0.003 (0.00***)
Constant	0.59 (0.00***)	0.74 (0.00***)	0.23 (0.25)	0.51(0.00***)	0.67 (0.00***)	1.11 (0.00***)
Pseudo R-sq	39%	66%	39%	69%	51%	61%
No. of firms	72	72	75	75	76	76
Number of obs	2083	1645	2548	2548	873	873*

Values in parentheses refer to p-values; *, **, *** indicating significance at 10%, 5%, and 1% levels respectively

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