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It's never too late (to enter)... till it is!
Firms' entry and exit in the digital audio player industry.

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Abstract

We study the determinants of firms' exit from product segments in a technologically dynamic industry to understand whether exit depends on entry timing, the pre-entry experience of entrants, and the presence of a dominant firm in the segment. Relying upon a detailed database of products from the digital audio player industry since its inception, we find that late entry in a product segment is beneficial for a firm's survival. Firms without prior experience in related markets have a higher hazard of exit from a product segment than those having previous experience. However, late entry into a product segment can mitigate this negative effect. We find also that the presence of a dominant firm in a product segment is generally associated with an increase in the hazard of exit for all the firms, but this effect is less evident for the firms that entered before the dominant firm. These results show that in industries with heterogeneous demand and several market segments, delaying entry into a specific segment may represent a successful strategy, especially for those firms that are relatively inexperienced. This strategy, however, can backfire if entry occurs 'too late', specifically after the dominant firm has entered the segment.

Keywords: firm exit; product segment; entry time; pre-entry experience; dominant firm.

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1. Introduction

The issue of the relationship between entry timing and firm exit has been on the agenda of researchers in innovation and strategy for a long period of time (see Markman et al., 2019; Zachary et al., 2015, for recent surveys). An extended body of empirical and theoretical literature in particular has focused on the advantage of early entry (i.e. ‘first mover advantage’) deriving from several sources (Fosfuri et al., 2013). Other contributions have instead focused on the conditions that may enhance or hamper the advantages from early entry in terms of both industry environment and firm resources and capabilities. Concerning the industry environment, Suarez and Lanzolla (2007) show that in industries characterized by a fast pace of technology and market evolution, late entry instead of early entry can be beneficial. Others have shown that in contexts where product innovation is paramount, innovators that enter late may enjoy a better performance than early movers (Afuah, 2004; Agarwal and Gort, 1996). Considering the role of firm resources and capabilities, Klepper (2001, 2002) and Klepper and Simons (2000) show that, in addition to early entry, the pre-entry experience of innovators can be a source of competitive advantage for both diversifiers and new firms. While these contributions have enhanced our understanding of the factors that moderate the effect of entry timing upon firm exit, other important aspects are still relatively under-researched and deserve further investigation (Markman et al., 2019; Zachary et al., 2015).

The first aspect concerns the focus of the analysis. Most of the literature has looked at the factors that moderate the effect of entry timing upon firm performance in industries with *homogeneous demand*. When demand is homogeneous and just one product version is commercialized and/or when the number of product segments is low, exit represents a failure, since it means that a company cannot cope with the strategic and operational challenges and surrenders to competitors. In industries with heterogeneous demand, however, many product segments (or niches) exist, and exit from a product segment may be driven by a variety of motivations, given cannibalization concerns and potential pre-emption motives (Carroll et al., 2010; Klepper and Thompson, 2006). Some recent contributions, particularly in the context of ‘platform industries’, have looked at the entry of firms in different niches (Ozalp and Kretschmer, 2019) by focusing on content or software development. In their analysis of the US

videogame industry, Ozalp and Kretschmer (2019) argue that firms' own experience in a specific market niche can substitute for external information, act as absorptive capacity, and facilitate learning, particularly in unpopulated niches defined on the basis of genre. Barlow et al. (2019), looking at new entrants in the field of smartphone apps, suggest that new entrants can use two important schemas to strategically categorize themselves to gain a competitive advantage when customers have heterogeneous preferences. In contrast to these contributions we look at entry and exit from product segments within a specific hardware-based industry that are defined on the basis of their technological characteristics and are, in this respect, very different.

The second aspect concerns the interaction between firms' resources and capabilities, the order of entry, and exit from a product segment (Afuah, 2004; Chesbrough, 2003; Ozalp and Kretschmer, 2019; Wen and Zhu, 2019). Bayus and Agarwal (2007), for instance, show that experienced entrants generally survive better than inexperienced firms within an industry. Furthermore, firms with previous experience in a niche are also better equipped to react to the emergence of 'trailblazers', i.e. products that capture wide attention (Lieberman and Asaba, 2006; Ozalp and Kretschmer, 2019). However, the initial advantage of experienced firms over inexperienced firms tends to diminish with entry time, thus suggesting that entry order might more than compensate for the effect of pre-entry experience (or lack thereof) on firm performance. No contribution has yet investigated whether this relationship still holds at the product-segment level.

Third, a further neglected aspect concerns the relationship between exit from a product segment and the presence of a dominant firm. To the extent that it restricts access to the potential customer base, because of network effects and/or brand popularity, the presence of a dominant firm in terms of market shares increases the likelihood of exit from a product segment (de Figueiredo and Kyle, 2006; de Figueiredo and Silverman, 2007). Another way in which the survival of new firms might be restricted is when dominance by the leader is accompanied by product innovations in terms of changes in the product design. Few works have looked at whether the presence of a dominant firm may limit the extent to which firms can benefit from being laggards (Suarez, 2004) and therefore increases the probability of exit from a product segment.

This paper focuses on entry into and exit from product segments within an industry and provides an opportunity to study the three aspects simultaneously in a context characterized by rapid technical change and product innovation. Specifically, we first focus on the effects of the interplay between entry order in new product segments and pre-entry experience on a firm's exit from a product segment. We then focus on how the presence of a dominant firm affects the exit of firms from a product segment.

Our analysis is carried out in the context of the digital audio player (DAP) industry. DAPs emerged in the market with the introduction of technologies for digital audio compression in the 1990s. Several product categories have been commercialized by two types of firms: experienced entrants and inexperienced entrants; however, none of these had been able to challenge the dominant firm in the market (i.e. Apple). Our dataset includes all the new DAPs commercialized by 24 players in the industry between 1999 and 2009 for a total of 869 products. For each new product, we have information on its date of market introduction, price, and technical characteristics. We use this information to define seven product segments and study the dynamics of entry and exit.

This study provides three sets of results. First, entering at later stages of the product life cycle reduces the hazard of exit from a product segment. This result is in line with the existing literature that has investigated the role of entry timing on firm's performance (Lieberman and Montgomery, 1998; Suarez and Lanzolla, 2007; Zachary et al., 2015). Our analysis contributes to the extant studies on entry time advantages or disadvantages by moving the focus from the industry to the level of (hardware) product segment. Although some recent studies have looked at the entry process into market niches (e.g. Barlow et al., 2019; Markman et al., 2019; Ozalp and Kretschmer, 2019), they have looked more into content/software market niches, and they have not explicitly investigated the effects of the timing of entry but have focused instead on the role of firms' prior experience, product similarity and interaction with complementors to explain firms' success. Furthermore, our finding that entering at later stages of the product life cycle reduces the hazard of exit from a product segment represents an innovative result and provides interesting strategic implications for firms competing in multi-segment markets.

Second, inexperienced entrants are more likely to exit from a product segment than experienced entrants. However, this disadvantage can be mitigated by entering relatively late into new product segments. The role of firm experience has been largely investigated in the literature, which has provided evidence for a positive relationship between individual experience and successful entry due to many factors ranging from the development of learning mechanisms and absorptive capacity (Cohen and Levinthal, 1990; Lieberman and Asaba, 2006) to the knowledge of customers' preferences. Our findings are, however, in line with empirical contributions suggesting that in hi-tech industries the presence of submarkets is conducive to sustained (late) entry by both experienced and less experienced firms (Klepper and Thompson, 2006). Furthermore, they confirm the idea that the combination of different contingencies challenges the support for 'first mover' or, in general, 'early entry' advantages and that entry needs to be considered as a 'process', not just an event (Franco et al., 2009; Markman et al., 2019; Markman and Waldron, 2014; Zachary et al., 2015).

Third, the presence of the dominant firm in a segment is associated with an increase in the hazard of exit for all the other firms, but this effect is stronger for those that entered after the dominant firm. Sensitivity analysis shows that these results are robust to changes in the baseline hazard and to alternative definitions of the market segments, as well as to changes in the timing of entry of the dominant firm. The works of Franco et al. (2009) and Bayus and Agarwal (2007) show that late entry can be detrimental as firms face stronger competition. We extend their work by focusing on the hazard of exit from different product segments (as opposed to exit from the industry) and by considering explicitly the role of a dominant firm in affecting the exit process.

The paper is structured as follows. Section 2 reviews the existing literature, develops a conceptual framework for analysing the relationship between entry timing, pre-entry experience, the presence of a dominant firm, and exit from product segments, and it advances testable hypotheses. Section 3 introduces the context of our analysis by discussing the main innovations and the evolution of the DAP industry, and presents our data, variables, and estimation strategy. Section 4 presents the results of the empirical analysis. Section 5 concludes.

2. Conceptual framework and hypotheses

2.1. Entry timing and firm exit from a product segment

Prior research on innovation and industry evolution has emphasized that as an industry evolves through different phases the hazard of exit of firms is likely to change depending on their entry timing (Agarwal and Bayus, 2002; Agarwal and Gort, 1996). Generally, early entrants have a competitive advantage over latecomers in term of survival – the so-called first mover advantage, which depends upon three main features: leadership in innovation and/or technology; consumers' switching costs; and pre-emption of scarce assets such as factors of production, geographical location, and investment in plant and equipment (Lieberman and Montgomery, 1998; Robinson and Min, 2002). Delayed entry, on the other hand, is a risky strategy because of increasing competition and the emergence of entry barriers (Agarwal and Gort, 1996; Klepper, 1996; Lieberman and Montgomery, 1998; Robinson and Min, 2002). One feature of this literature on first mover advantage is that it has mainly studied industries with a homogeneous demand and measured firms' performance in terms of survival *in the industry*. But what about an industry with heterogeneous demand where many segments exist? Can we expect to observe benefits from late entry in this context? The extant literature suggests that we can.

Heterogeneous demand and submarkets generally shelter firms from competition (Klepper and Thompson, 2006). In addition to this, in an industry with heterogeneous demand, late entry or exit from one segment might be a conscious choice of a company willing to exploit the emergence of new technological opportunities that open up new and more profitable market segments, attracting customers. What happens to firms (in terms of entry into or exit from a segment) thus depends on managerial actions aimed at optimizing a firm's competitive advantage in that market (Carroll et al., 2010). Empirical research suggests that late entry is beneficial when there is technological and market uncertainty concerning the viability of a certain design for a new product generation (Golder and Tellis, 1993; Tellis and Golder, 1996) and the response of customers to a pioneer innovation. Late entrants face relatively less technological and demand uncertainty than pioneers. In industries with homogeneous products and demand, firms face a trade-off between early entry when barriers are low and the cost of

choosing a product design that might not become the dominant one. In contrast, when demand is heterogeneous the trade-off is less risky as barriers to entry are lower and late entrants face less uncertainty in terms of design as they tailor their products to the needs of a specific segment of customers.

Also, late entrants in a product segment have more time than pioneers to develop the necessary skills and capabilities to compete. In particular, companies can observe competitors' behaviour and derive clues about the profitability of a specific market segment (Ozalp and Kretschmer, 2019). Therefore, even if they do not have direct experience in a specific product segment, they can imitate the strategy of competitors, assuming that competitors' entry choices derive from superior market knowledge (Lieberman and Asaba, 2006; Ozalp and Kretschmer, 2019). When demand is heterogeneous, barriers to entry at the industry level might be lower than in an industry with a homogeneous product, but economies of scale within a specific segment might nevertheless exist (Bhaskarabhatla and Klepper, 2014). The presence of scale economies increase entry barriers as time passes. Therefore, if a firm manages to enter late, it must possess better knowledge, skills, and capabilities than the average and stay relatively longer in a specific segment. Scale economies also lead to cost reduction for firms already in the product segment, which makes them less likely to exit (de Figueiredo and Kyle, 2006).

Furthermore, late entry is also beneficial because of scope economies. At the birth of a new industry, demand is homogeneous, the number of existing segments is low, and there is often just one version of the product available. As the industry matures, more categories of users appear, and more segments emerge providing incentives for versioning and/or product differentiation in order to reduce competition. Within this context, both late entrants and incumbent firms benefit as versioning of existing products is accompanied by cost reduction (Giarratana and Fosfuri, 2007). Versioning can take the form of product dispersion, which has been found to decrease the hazard rate of products and extend the presence of a firm in a specific market segment (Requena-Silvente and Walker, 2009; Stavins, 1995). Or versioning might also take the form of product differentiation, as firms extend their product portfolio to adjacent segments (Barlow et al., 2019). While differentiation into existing product segments might have a negative effect, diversification into a completely new segment of products might actually

decrease the hazard of exit (Cottrell and Nault, 2004). In this context, Barlow et al. (2019) discuss the distinctiveness of a product – i.e. the extent to which it conforms to its category prototype or to a market category exemplar – as an important determinant of performance.

Finally, there are issues related to cannibalization. This is a form of intra-firm competition that refers to the negative effects that commercializing many products in the same and/or adjacent segments may have on each other (Carroll et al., 2010). Extant studies have shown that as the number of a firm's own products in the market increases, so does the likelihood of product withdrawal (Chisholm and Norman, 2006; Cottrell and Nault, 2004; Greenstein and Wade, 1998; Requena-Silvente and Walker, 2009; Ruebeck, 2002, 2005). Late entry might be used as a strategy to reduce cannibalization for both incumbents and new entrants. For incumbents, late entry into a new segment could avoid cannibalization of their successful products, therefore delaying exit from the segments in which they are currently active. For new entrants, late entry would avoid cannibalization of their successful products in an adjacent segment. Based on the above discussion we hypothesize the following:

Hypothesis 1: In a multi-segment industry, entering at later stages of the product life cycle reduces the hazard of exit from a product segment.

2.2. The effect of pre-entry experience on firm exit

The development of a new product and the consequent entry into a new market segment is an important strategic decision for firms (Sorenson, 2000; Sorenson et al., 2006). The economic incentives of entering new product segments lie in the possibility of gaining market shares, by offering entirely new goods that are not supplied by competitors or by better tailoring existing ones to customer needs. In order to avoid early exit from a specific segment, firms need to leverage specific capabilities (in terms of innovation and production) and complementary assets (Mitchell and Skrzypacz, 2015). In this respect, studies in industrial dynamics have linked these capabilities to the pre-entry experience and/or to the industry of origin of the entrants (Agarwal and Shah, 2014; Helfat and Lieberman, 2002; Holbrook et al., 2000). Indeed, very often in new industries inexperienced entrants and experienced incumbents coexist and it

is expected that these types of innovators will experience differences in their rates of exit (Klepper and Simons, 2000).

It is reasonable to argue that similar dynamics occur within product segments. Firms with experience from a related market are less likely to exit from a product segment, finding it easy to succeed, because they can exploit their technological, organizational, and market-related capabilities and develop knowledge-based complementary assets in order to compete in a new market and use this advantage to strengthen their intellectual property position (Chesbrough, 2003; He et al., 2006; Helfat and Lieberman, 2002; Klepper and Simons, 2000; Miller, 2006; Teece, 1986). As a consequence, firms with prior experience in related markets typically tend to enter more product segments and introduce more products (Ingram and Roberts, 1999). In addition to this, they are able to survive longer in a segment (Gang, 2018; Stavins, 1995) as they tend to enter product segments in which they can leverage their technological and production capabilities (Franco and Filson, 2006; Mitchell and Skrzypacz, 2015; Zachary et al., 2015) but which are sufficiently distant to avoid cannibalization of their focal business (de Figueiredo and Silverman, 2007).

On the other hand, inexperienced firms in a specific product domain possess fewer capabilities than experienced firms in market know-how (knowledge of the customers) (Buenstorf, 2007; Tripsas, 2008), technological know-how (knowledge of the technology and/or components) or a combination of both (Agarwal et al., 2004; Franco et al., 2009; Miller, 2006). These capabilities tend to be distinctive and very specific (Holbrook et al., 2000). This specificity, which is an asset, might also constrain their innovative capabilities strategies years after entry. Thus firms with no prior experience in a specific product domain usually tend to enter product segments with limited scope, to produce products targeted to customers with very specific needs (Klepper and Sleeper, 2005), to disperse their products less (Stavins, 1995), and, in general, to develop smaller product portfolios. Therefore, they face higher risks of exit compared to experienced firms, because of their lack of capabilities and knowledge of the specific market and technology of new product segments. On the basis of this discussion we therefore propose the following hypothesis:

Hypothesis 2a: Among product innovators in a multi-segment industry, inexperienced firms experience a higher hazard of exit from a product segment than experienced firms.

Another aspect highlighted by the literature is that the influence of pre-entry experience on the performance of innovative firms is moderated by the changing nature of the competition as an industry matures (Suarez and Lanzolla, 2007). When innovation in successive generations of improved and more complex products triggers entry opportunities into new segments, firms' competitive advantage crucially depends on the embracing of more advanced technologies and improved designs to address new customer needs.

As time goes by, the disadvantages of inexperienced firms fade away, as they have had time to observe competitors, learn from their experience, and develop the necessary knowledge-based and market capabilities to survive in the product segment. The literature explicitly discusses the potential benefits that imitators derive from the observation of early entrants' behaviour concerning the technology and the design of the products (Lieberman and Asaba, 2006; Ozalp and Kretschmer, 2019; Semadeni and Anderson, 2010). Established business relationships with component providers will no longer be a unique advantage for firms with prior experience in a product domain. Furthermore, technological components become cheaper over time, reducing the barriers to adoption and generating benefits that are marginally greater for inexperienced firms than for experienced ones. Within this context, the broad capabilities which constituted the source of competitive advantage for experienced firms may even become a source of rigidity and inertia (Ingram and Roberts, 1999). In other words, the existing technological and market legacy of experienced firms may prevent them from successfully competing in a segment (Afuah, 2004; Carroll and Swaminathan, 2000; Christensen, 1997). In addition to this, as their product portfolio grows, fear of cannibalization will prevent experienced firms from further expanding their product line (Khessina and Carroll, 2008). Therefore, they either reduce their rate of new product introduction or withdraw their presence from the segment. Inexperienced firms, in contrast, typically have a more distinctive set of capabilities and a narrower product portfolio, which make them more flexible and swift in responding to new opportunities (Franco et al., 2009). Unlike experienced firms, inexperienced firms are generally mono-product and derive their own identity from the unique

market segment they enter. Therefore, their product design must constantly be updated to reflect this identity. This creates pressure on them to offer technologically advanced products and increase the speed of product turnaround (Khessina and Carroll, 2008). All in all, the initial competitive advantage of experienced firms over inexperienced entrants diminishes with entry time (Bayus and Agarwal, 2007; Klepper, 1997, 2002; Markman and Waldron, 2014; Tegarden et al., 2000; Zachary et al., 2015). We therefore propose the following hypothesis:

Hypothesis 2b: Among product innovators in a multi-segment industry, the disadvantage of being inexperienced is mitigated by late entry into the product segment.

2.3. The presence of the dominant firm and its effects on exit from a product segment

A further factor that affects the exit rate of firms from product segments is the presence of a dominant firm. Dominant firms, generally those with greater market shares, have more resources to extend their product lines (Bayus and Putsis, 1999) and promote their products (Connor, 1981) and tend to have a more heterogeneous installed base of customers (de Figueiredo and Silverman, 2007). In addition to this, they generally have a strong brand, which leads to more frequent introduction of new products (de Figueiredo and Kyle, 2006) and less withdrawal of existing ones (de Figueiredo and Kyle, 2006; Greenstein and Wade, 1998; Ruebeck, 2002). Lastly, they typically have a strong market reputation, which helps them to stay in the market longer (Stavins, 1995). The presence of a dominant firm changes the competing landscape in a product segment and is likely to affect the hazard rate of rival firms for several reasons.

First, a dominant firm tends to enter a segment with technologically superior products and/or to extend to the new segment a design that has been already successful in an adjacent segment. The extant literature has well documented that the emergence of a ‘dominant design’ for a specific product affects market shares (Suarez, 2004; Tushman and Anderson, 1986) and the exit rate of firms (Baum et al., 1995; Christensen et al., 1998; Suárez and Utterback, 1995; Tegarden et al., 2000). In particular, once specific product features are recognized and assumed to be dominant in the eyes of innovators and early imitators, the industry becomes more concentrated, and the worst performing firms are driven out of the

market (Henderson and Clark, 1990). In high-tech industries innovative product designs aimed at solving some problems with previous generations often result in the emergence of a dominant firm (Christensen and Rosenbloom, 1995). Therefore, while innovative companies can benefit from the existence of an established design, other firms might suffer from this and might decide to exit the segment or even the industry.

Second, a heterogeneous installed base of customers allows the dominant firm to leverage them and the related switching costs and extend its leadership to other segments. In industries with network effects, such as the one analysed in this paper, the utility from adoption increases in the number of other adopters that purchase the same good (Farrell and Saloner, 1985). From a competitive standpoint, the outcome is that in the case of competition between incompatible new products, multiple equilibria emerge naturally, and one or few firms ultimately dominate the market (Katz and Shapiro, 1985). Incompatibility is a source of switching costs that are related to initial investments that customers make in adapting to the firm's product and to supplier-specific learning (Lieberman and Montgomery, 1998).

Third, thanks to strong brand and market reputation, the dominant firm leverages its past customers' loyalty to attract new customers to a new product segment. With imperfect information on product quality, customers tend to stick to the brand they first chose. There are short-term and long-term effects of brand popularity. In the short run, popularity enhances customers' confidence and reduces risks related to purchasing decisions (Aaker, 1991), and it can help customers to process a large quantity of information about products and brands (Kim and Chung, 1997), through perceived quality, awareness, and positive associations. In the long run, if brand popularity provides intangible value to customers, they enhance their brand loyalty and transfer its good image to new ones through word-of-mouth, which will affect the future sales of the brand.

As a consequence of the above-mentioned reasons, the presence of a dominant firm in a product segment makes it hard for competitors to survive in that segment. Therefore, we hypothesize the following:

Hypothesis 3a: In a multi-segment industry, the presence of the dominant firm in a product segment increases the hazard of exit of all firms in that segment.

As argued in prior sections, late entry can be beneficial for competing in industries with heterogeneous products and multiple product segments. However, this strategy might turn out to be risky when entry in a product segment occurs after the dominant firm. The presence of a dominant firm in a product segment reduces the market space and the demand for competing products, therefore increasing the likelihood of rival firms to exit the segment. In particular, if a firm enters a segment where a dominant firm already exists, it will find it hard to attract customers from the leader because over time switching costs increase and brand reputation effects get stronger.

Wang and Shaver (2014) and Wen and Zhu (2019) show that the entry, or the threat of entry, of a dominant firm creates a competitive pressure which forces other smaller firms in the market to reposition themselves as an attempt to differentiate from the market leader. Wang et al. (2010) show that in product segments with rapid product innovation and strong network effects, cross-generation incompatibility harms but within-generation incompatibility favours the pioneer's advantage. Consequently, dominant firms are likely to enjoy a competitive advantage and keep their leadership if a new product is cross-generation compatible but within-generation incompatible. Also, the literature has shown that not only do dominant brands have more customers, but also that these customers are very loyal (Ehrenberg et al., 1990). Once brand loyalty is established, it positively influences market share. The most popular brand gets more positive evaluations from consumers, which in turn produces larger shares in the long run within the segment and at the industry level (Kim and Chung, 1997; Raj, 1985; Scherer and Ross, 1990). In the light of this discussion, we hypothesize the following:

Hypothesis 3b: Among product innovators in a multi-segment industry, firms entering after the dominant firm experience a higher hazard of exit from a product segment than firms entering before the dominant firm.

3. Data and methods

3.1. Research setting: product innovation and competition in the DAPs market

The history of DAPs began in the late 1990s with the introduction of technologies for digital audio compression (i.e. audio codecs). These compression technologies reduced the size of digital audio tracks without significantly compromising their quality, allowing them to be stored and treated as simple data files. This led to the introduction of portable devices (DAPs) able to store and reproduce digitally compressed audio files. One particular audio codec – the MP3 format – gained increasing popularity, becoming a *de facto* standard for home audio encoding (Holmes, 2006) and providing the generic name for the entire category of DAPs, which are often called MP3 players.

The early MP3 players available were introduced in 1998 and came with a 32MB flash memory, which significantly limited the amount of music they could store (about 10–12 MP3 songs). Shortly after, new DAPs equipped with a hard drive memory (a 2.5in laptop hard disk) were launched. Thanks to a 4.8GB hard drive, these players allowed storage of more than 1,000 songs.

The amount and type of memory used to store music is one of the most important features of DAPs, which can be accordingly divided into three product families: flash, hard drive (HD), and Microdrive players. Flash players are generally small and lightweight, but with limited storage space. Hard drive players have higher storage capacities, but they are generally bigger and heavier. Microdrive players are somewhere in between the previous two, but they became technologically obsolete relatively rapidly (when flash memories overcame Microdrives' storage capacity), and therefore they have been used for only a limited period of time.

Over time, DAPs have undergone significant innovations which have made them smaller, lighter, powered by rechargeable and more powerful batteries, and equipped with several additional features (such as FM radio player or voice recorder) (Camerani et al., 2015). An important innovation that played

a key role in DAPs' success was the increase in storage space.¹ Product innovation also entailed changes in another key technical feature of DAPs: their display. Thanks to the display of the player, users could browse their music library, select which songs to play, create playlists, and see the song title, artist name, and other information.

DAPs enjoyed a tremendous success during the 2000s; however, at the end of the decade, their decline had already started. This is mainly due to the introduction of a new line of products – smartphones – that merged into a single product many consumer devices such as DAPs, photo and video cameras, mobile phones, and portable gaming consoles.

During their decade of commercial success several competitors have entered the DAP market. Nonetheless, competition in the DAP industry has been influenced by the presence of one dominant firm, Apple, which entered the DAPs market in October 2001 with the introduction of its first iPod. The iPod was a product innovation aimed at providing a response to the problems that early DAPs were suffering from. Apple's iPod was a highly innovative product; it was small, compact, user-friendly, and had an appealing design (Kahney, 2005).² Alongside Apple, many competitors entered into the DAP business launching new products though few of them seriously attempted to weaken Apple's supremacy. Among these firms, we can distinguish two types of entrants: *experienced entrants* and *inexperienced entrants*. We base this distinction on the pre-entry experience of the firm, specifically on whether these firms were active in a related market, the portable music player, prior to their entry into DAPs.

DAPs can be considered a major breakthrough in music reproduction technology; however, they are not an isolated product: they have precursors and followers. In particular, portable music players such as cassettes, CDs and MiniDiscs pre-dated DAPs. These products were available to customers from the end of the 1970s, and several firms accumulated significant technological know-how and expertise in

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¹ This need for more storage space is linked to another innovation that accompanied the history of DAPs: the proliferation of file-sharing technologies that allowed users to exchange and accumulate a large number of songs in MP3 format (Camerani et al., 2016).

² A key element of success for the iPod was its design and ease of use, facilitated by the adoption of a touch-sensitive scroll wheel as user interface. Alongside these elements, another factor that contributed to iPod's success was its seamless integration with the iTunes software, which allowed users to manage their music library and load songs into their iPod. After introducing the first iPod, Apple engaged in sustained product innovation and periodically launched new improved versions of its DAP which were embedding the newest available technologies (e.g. more capable storage media, colour display, touch screen interface, etc.), as well as new variants with a different product design.

manufacturing them. Some of these companies, building upon their proprietary assets or leveraging their existing product's reputation, expanded their product mix of music players (e.g. portable CD players) by adding a new product line and started producing DAPs. We define these firms as *experienced entrants*. Meanwhile, other firms that ultimately started manufacturing DAPs had no prior experience in the industries or technologies that preceded the advent of DAPs, or they had no experience at all, i.e. they were newly established start-ups. We define these firms as *inexperienced entrants*.

Experienced entrants include companies, such as Sony and Philips, which had innovated in the portable music player markets for decades.³ However, they failed to transfer their leadership to the emerging DAPs industry. Although they launched new products, with technical characteristics and price which were not too dissimilar from Apple's, they never achieved comparable success.

Inexperienced entrants are a heterogeneous group of firms with no prior experience with portable music devices. For instance, this is the case of Creative and Microsoft. Creative is a Singapore company established in 1981, which became very successful in the production of sound systems, speakers, and computer sound cards. With their HD-based player Nomad, and more lately with the Muvo and Zen series, Creative has been one of the early entrants into the DAP market. However, despite its early entry, Creative never managed to fully capitalize on its audio components' technological know-how and to threaten Apple's leadership. Microsoft entered the DAP market relatively late, in 2006, trying to challenge Apple by launching the Zune, an integrated solution that, like the iPod/iTunes, combined hardware and software (the Zune software). In addition, Microsoft could count on some previous expertise with digital audio, i.e. a proprietary audio codec (WMA, Windows Media Audio), and on a large customer base using Windows Media Player, and more general Microsoft operating systems. In spite of these potential advantages, Microsoft Zune never managed to undermine Apple leadership.

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³ Both firms contributed to the definition of standards for music storage. Philips introduced the compact audio cassette in 1963, and Sony and Philips jointly released the so-called Red Book defining the compact disc standards. They also launched some of the most popular portable music players (e.g. Sony's Walkman and Discman).

3.2. Data

To test our hypotheses, we employed information on the number of new products launched and on the pre-entry experience of the firms active in the DAP market, and detailed information about entry and exit from the product segments. We collected this information for a large sample of products commercialized between 1999 and 2009. The operational definition of digital audio players that guided our data collection considered a DAP as a portable electronic device able to store and play MP3 files and digital audio files using non-removable erasable digital media (Holmes, 2006). For this reason, devices such as MiniDisc or MP3-CD players, although they are compatible with some types of digital audio formats, have been excluded from the analysis and considered precursors of DAPs. Similarly, smartphones capable of playing digital music have also been excluded and considered successors of DAPs.

The main source of data has been CNET.com, an authoritative and reliable website that publishes articles, news, and reviews of technological products and consumer electronics. Since 1999 this website has been reviewing a large number of DAP models, reporting detailed information about their price and technical characteristics. CNET can be considered a comprehensive source of data about electronic products, their technical specifications, and reviews, and has been used as a data source for several studies on consumer products (see, for example, Chen and Xie, 2008; Dan, 2019; Li and Hitt, 2010). Notwithstanding this, in order to ensure data consistency and accuracy of timing of product launch, and to reduce the number of missing product characteristics, in addition to CNET, we employed other data sources, such as alternative buyers' guide websites (e.g. PCMagazine.com), manufacturers' websites, official product user manuals, press releases, and Wikipedia. Also, for each product at least two different sources have been compared (typically CNET and the product user manual).

At the time of data collection, CNET listed around 80 DAPs manufacturers. For some manufacturers, the information about the products was incomplete, unsystematic, and difficult to integrate from other sources (e.g. manufacture website, or user manual). We thus excluded them from our sample. Other manufacturers listed by CNET actually turned out to make products such as MP3 radio alarm clocks,

MP3 car radios, and digital photo frames playing MP3 files. These types of products are able to reproduce MP3 files but cannot be considered portable digital players and therefore are outside the scope of this study and excluded from the sample. Finally, more than 50% of the listed manufacturers launched only one or two products in the period 1999–2009. For these manufacturers it was extremely difficult to find enough evidence about the product launch date to ensure the reliability of the product information data. We also excluded them from the sample. The final data set contains 869 new products commercialized by 24 manufacturers in seven product segments in the period 1999–2009 for a total of 299 firm–segment–year observations. It includes all the DAPs released by the producers with at least four products that qualified as DAPs, launched in the period 1999–2009 and for which we could find reliable information from at least two sources. This should ensure an adequate representativeness of the sample and a high reliability of the information collected.

Table 1 reports the number of new products launched by the firms in our sample. These are all new models, which may display new features, or may simply be improved versions of existing products.⁴

[Insert Table 1 about here]

As mentioned before, within our sample we can distinguish between experienced entrants and inexperienced entrants. Table 2 reports the number of new products by firm category.

[Insert Table 2 about here]

Concerning the definition of product segments, the extant literature proposes several ways of defining a segment depending on whether we look at the industry level, the product category, the product form, its technology, a specific model, or a specific brand (Bayus, 1998). For our analysis, we chose the technology level and more specifically we identify a product segment using the two key characteristics whose development has defined the performance of DAPs over time: storage medium (flash, HD, and Microdrive) and screen type (no screen, black and white, colour, touch screen). On the basis of the

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⁴ Products with exactly the same technical characteristics of existing ones but offered in different colours do not count as separate products.

intersection between these two characteristics we thus identify seven product segments (No screen, Flash b/w, Flash colour, HD b/w, HD colour, Microdrive, Touch screen). They are summarized in Table 3.

[Insert Table 3 about here]

The last relevant information for our analysis is the timing of product innovation. We identify product innovation with the year of launch of a specific product. A firm's entry into a product segment therefore coincides with the date it has launched its first product into that focal segment.

3.3. Variables

We used our data to create the following variables.

3.3.1. Dependent variable

Our dependent variable is the hazard of exit from a DAP product segment. We measure exit in terms of a firm ceasing to introduce new products in a specific segment. According to this definition, 44.8% of our observations can be considered as exits before 2009. This definition of exit from a product segment does not necessarily coincide with one firm's exit from the industry and it is consistent with the definition used in other analyses of industries characterized by rapid growth (Fontana and Greenstein, 2019; Greenstein and Wade, 1998).

3.3.2. Independent variables

Entry timing

We expect entry timing into a specific segment to be an important determinant of the hazard of exit (Bayus and Agarwal, 2007; Fontana and Malerba, 2010; Fontana and Nesta, 2009; Franco et al., 2009). As mentioned before, a firm enters a specific segment when it introduces its first product in that focal segment. The level of detail of our data allows us to account for entry timing difference across generations of DAPs. *Entry time in segment i* is defined as the year in which a firm enters segment i less the year we register the launch of the earliest product in segment i in our database.

Pre-entry experience

Pre-entry experience has been widely analysed as a predictor for firm survival. This experience has been captured in different ways. Several studies have considered the difference between de novo and diversifying entrants (e.g. Bayus and Agarwal, 2007; Franco et al., 2009), while others have looked at prior experience in a certain industry before a new submarket was created (e.g. Fontana and Nesta, 2009; Gang, 2018). We followed the latter approach, and in order to identify firms with pre-entry experience, we analysed the activity of firms in our sample prior to their entry into the DAP market and in particular whether these firms were active in a related market, the portable music player, before entering into the DAP market. The majority of the firms in our sample (15 firms, 62.5%) were active in a related market: the portable music player (e.g. CD players). These firms possess both the technological know-how (i.e. knowledge about the technology) and the market know-how (i.e. knowledge about the customers) to compete in the industry. We define these firms as *experienced entrants*. The rest of the firms in our sample (9 firms, 37.5%) either did not have any prior experience in a related market or were young start-ups. We define these firms as *inexperienced entrants*. We then created a dummy variable - *Inexperienced* - which equals to one if the firm has not been previously active in the portable music player market and zero otherwise.

Presence of a dominant firm and its effect on the hazard of exit

One of the aims of our analysis is to understand whether and how the presence of a dominant firm has influenced the hazard of exit from a product segment. We identify Apple as the dominant firm and we account for whether the overall hazard of exit may depend on the presence of Apple in a certain segment, and whether entry of another manufacturer in a specific DAP segment has occurred before or after its entry. This choice is motivated by the role played by Apple in setting the dominant design of DAPs, with the launch of its first generation iPod in 2001, and especially after 2003 when Apple added support to Windows-based PCs and introduced the iTunes Music Store, which allowed customers to (legally) download MP3 files. To study the effects of the presence of the dominant firm on the hazard of exit from DAPs segments we computed two variables. The first is *Presence of dominant firm in segment i*,

a dummy taking value one in each period after the entry of the dominant firm in a specific segment, and zero before the entry. The second variable is *Entry after dominant*, which is a dummy equal to one if the firm has entered segment i after the dominant firm, and zero otherwise.

3.3.3. Controls

As controls we include a series of variables accounting for tenure in the segment, segment structure, and the characteristics of the specific product market segment. First, we include *Firm age in segment i* , a variable that captures firm's tenure as measured by the time elapsed since entry occurred in a specific segment i . Previous studies have highlighted a non-linear relationship between industry tenure and the hazard of exit (Bayus and Agarwal, 2007; Fontana and Nesta, 2009). *Firm age in segment i sq* captures this non-linearity. Second, to control for the structure of the segment, we use two variables based on product density (Bayus and Agarwal, 2007; Christensen et al., 1998; Franco et al., 2009). On the one hand, the presence of many products in a segment increases the hazard of exit by crowding the product space and increasing competition. On the other hand, an initial increase in the number of products commercialized in a specific segment also signals product viability, contributes to a reduction in uncertainty, and should translate into a general decline in the hazard. *Density of segment i at $t-1$* measures the number of products available in segment i in the year prior to firm's entry. *Density of segment i at $t-1$ sq* captures the existence of a potential non-linear effect. Finally, we account for product segments' specific characteristics. Each product segment identifies a specific generation of DAPs with specific characteristics catering for specific customer bases. Firms may be active in several segments, leading to the possibility of increasing competition from close or distant substitutes (Greenstein and Wade, 1998). Moreover, the speed of product life cycle is likely to differ across different DAP generations. As a result, products may become obsolete at different rates, therefore conditioning the hazard of exit from that specific segment (Stavins, 1995). A list of segment dummies is included in each regression to capture the impact of segment specific characteristics on the hazard of exit.

3.4. Empirical approach

Like some other studies (e.g. Bayus and Agarwal, 2007; Fontana and Malerba, 2010; Franco et al., 2009), given that in our dataset information on entry and exit from each market segment is available on a yearly basis, we employ discrete time duration models to estimate the hazard of exit from a specific market segment i . We assume there are firms $j = 1, \dots, N$ entering market segment i at time t . The hazard of exit for firm j in segment i at time t can be assumed to take the following form:

$$\theta_{jit} = \theta_{i0}(t) \cdot X'_{ji}\beta \quad (1)$$

where $\theta_{i0}(t)$ is the baseline hazard function for segment i and X'_{ji} is a series of firm and segment based variables. It can be shown (Jenkins, 2005) that the discrete time formulation of the hazard of exit from segment i for firm j in time interval t is given by a complementary log-logistic function:

$$h_{jit}(X_{ji}) = 1 - \exp \left[-\exp \left(\beta X'_{ji} + \theta(t) \right) \right] \quad (2)$$

4. Results

Our dataset contains all the products commercialized by the 24 selected manufacturers in the period 1999–2009. Table 4 reports, for each segment, the number and share of products, the year of introduction of the first product, the year of entry for the pioneer firm (first entrant) and the year of entry of the dominant firm (Apple). Figure 1 shows the pattern of product innovation, entry and exit by year in each segment, also highlighting when Apple entered in the segment.

[Insert Table 4 and Figure 1 about here]

Table 4 and Figure 1 highlight that product launch in different segments has occurred according to different patterns. Flash b/w is the most crowded segment, with at least one product launched in each time period. Microdrive DAPs had only a very limited lifespan, and touch screen DAPs have been

introduced only in relatively recent periods. If we look at Apple, we note that despite being the dominant firm, Apple has never been the first mover except in one case (Microdrive), thus letting other firms pioneer the segment. However, if we analyse the patterns of firm exit after Apple's entry, we observe an interesting regularity. With the exception of the No screen players segment, exit of firms from each segment always begins with the entry of Apple. In other words, in the year immediately following the one in which Apple introduces its first product in a certain segment, several competitors decide to exit. Also, it is no coincidence that the only segment in which exit does not seem to follow any specific pattern (which is also the most populated one in terms of number of firms and number of products) is the one in which Apple never entered (Flash b/w). Overall these preliminary observations are consistent with some of our hypotheses, and in particular to those related to the role of the dominant firm. In the remainder of this section we will perform duration models to estimate the hazard of exit from a specific market segment i in order to test whether our hypotheses find empirical validation in our data.

Table 5 shows the summary statistics and correlation matrix of our variables. We note that the correlation coefficients are within acceptable limits. In addition, to assess the presence of multicollinearity, we computed variance inflation factor (VIF) scores for our predictors, which do not indicate the presence of severe multicollinearity.

[Insert Table 5 about here]

Table 6 reports the results of our complementary log-logistic (cloglog) estimations where the explanatory variables are introduced in sequence.

[Insert Table 6 about here]

In Model 1 we consider the effect on the hazard of exit of our control variables together with entry time. The coefficient of *Entry time in segment i* is negative and significant, suggesting that the later a firm enters a specific segment i , the lower its hazard of exit from that segment. This result is robust to the inclusion of additional variables in the subsequent models and confirms Hypothesis 1. Additionally, both our coefficients for the density controls are significant with a positive linear effect and a negative

quadratic effect, suggesting that the DAPs industry has been characterized by the presence of increasing competition at the segment level. The coefficient estimates of firm age and firm age squared are negative but never significant. This evidence indicates that the hazard of exit is independent from the age of the firm in the segment itself. Both results suggest that competition at the segment level may be very hard, especially at early stages after the opening up of a new segment when uncertainty about customers' preferences for a specific design is high. Within this context, delaying entry may be seen as a good strategy.⁵

In Model 2 we add the dummy for pre-entry experience. The coefficient of *Inexperienced* is significant and positive indicating that inexperienced entrants have a higher hazard of exit than experienced firms, which is in line with Hypothesis 2a. To test whether the initial disadvantage of inexperienced firms can be overcome, in Model 3 we look at pre-entry experience interacting with entry time. The coefficient of *Inexperienced x Entry time in segment i* is negative and significant, supporting Hypothesis 2b, according to which, among firms entering at later stages of the product life cycle inexperienced entrants have a lower hazard rate than experienced entrants. Interestingly the coefficient of *Inexperienced* is still positive and significant. Altogether these results suggest that inexperienced entrants have an initial disadvantage compared to experienced entrants. However, the disadvantage decreases the later they enter into a specific product segment. In Figure 2a we plot the predicted hazard of exit for experienced and inexperienced entrants over time.⁶ It can be seen that, while the predicted hazard of exit declines over time for both, *experienced* firms always enjoy a higher chance of survival than *inexperienced* ones.

[Insert Figure 2 about here]

The previous results suggest the presence of a late mover advantage for the firms in our sample, as firms entering late enjoy a relatively lower hazard of exit. This advantage is particularly beneficial for inexperienced entrants, as it allows them to close the relative gap in experience with respect to experienced entrants. These benefits notwithstanding, late entry can also be risky, as it may expose new

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⁵ We re-run our specifications using *firm age in the industry* rather than *firm age in the segment* as control variable. The main results remain substantially unchanged. Results from these additional regressions are available upon request from the authors.

⁶ The predicted hazards are calculated at the means of the other covariates.

firms to strong competition, particularly when they enter after the dominant firm. We check for this possibility in Models 4 and 5.

In Model 4 we add the variable *Presence of dominant firm in segment i*. The coefficient estimate of this variable is positive and highly significant. This indicates that after the entry of the dominant firm the hazard of exit of all the firms in a specific segment increases, which corroborates Hypothesis 3a. In Model 5 we test whether the effect of the presence of the dominant firm on the hazard of exit is the same for firms entering before or after the dominant firm itself.⁷ To do so we interact the variable *Presence of dominant firm in segment i* with the variable *Entry after dominant*. Results show that in the case of entry before the dominant firm (*Entry after dominant* = 0), the coefficient of *Presence of dominant firm in segment i* loses significance, while the coefficient of the same variable is still positive and significant in the case of entry after the dominant firm. This result is in line with Hypothesis 3b. Taken together, both results indicate that entry by the dominant firm in a segment has an asymmetric effect on competitors according to their time of entry. Despite increasing the hazard of exit of all firms in that same segment, its effect is particularly detrimental for those who enter after the dominant firm. In Figure 2b we again plot the predicted hazard of exit for the firms that entered after the dominant firm, which is constantly higher than for the firms that entered before.

All in all, the results from the empirical analysis have highlighted the following. First, for the firms in our sample there is a late mover advantage, as innovators entering a product segment relatively late enjoy a relatively lower hazard rate than early entrants. This advantage is particularly beneficial for inexperienced firms, as it allows them time to close the relative gap in technological and market know-how with respect to experienced entrants. This evidence suggests that firms may compensate for their relatively lack of experience by entering late, which is consistent with the results of Franco et al. (2009), who found that the benefits of timing of entry in high-tech industries with multiple product generations is contingent upon the possession of both technological and market know-how. Second, the presence of a dominant firm in a certain segment increases the hazard of exit for all the other firms. This effect is

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⁷ We are here abstracting from the possibility that other firms adjust their own entry (times) due to Apple's early or late entry. We will consider this possibility in Section 4.1.

particularly significant for firms that enter after the dominant one. These results show that delaying entry may represent a successful strategy, especially for those firms which are inexperienced. This strategy is limited, however, by the entry of the dominant firm, which increases the hazard of exit from the segment, especially for firms that delay entry too long and enter after the dominant firm. In other words, entry by the dominant firm represents a ‘watershed’ in the evolution of the product segment and of the industry in the sense of limiting the possibility for new entrants to compensate for their lack of experience by entering late.

4.1. Robustness checks and further exploratory results

To check the robustness of our results we carry out the following additional analyses. First, we re-estimate Model 5 by changing the specification of the baseline hazard function. Second, we change the shape of the link function. Results are reported in Table 7.

[Insert Table 7 about here]

In Model 6 the hazard function is a polynomial of order 3. Coefficient estimates are unchanged. In Model 7 we report the results for the non-parametric specification in which a full vector of entry year time dummies is introduced. Again, results do not change. In Model 8 a Logit model instead of a cloglog function is estimated. Both the sign and the magnitude of the estimates are stable.

We then explore further our data and relax some of the assumptions made in our original estimation to check the extent to which our results are sensitive to these assumptions. Specifically, we start by redefining the market segments. In our analysis a market segment is defined on the basis of the combination of two technical characteristics of DAPs – memory type and screen type. It might be argued that this definition is overly detailed, providing little value, and potentially affecting the results. To exclude this possibility, we test what happens when the market segments are defined by either memory type or screen type only. The results are reported in Table 8.

[Insert Table 8 about here]

Models 9–13 consider the case in which only three segments can be defined on the basis of memory type. Coefficient estimates are mostly unchanged when compared to results in Table 5. The main difference is that the estimated coefficient of the interaction *Presence of dominant firm in segment i X Entry after dominant = 0* is now significant but its coefficient is much lower than the one of *Presence of dominant firm in segment i X Entry after dominant = 1*. This result is still consistent with Hypothesis 3b. Models 14–18 consider the case in which three segments defined on the basis of screen type (b/w or no screen, colour screen, and touch) exist.⁸ Again, results substantially mimic those of Table 5, the only difference being the coefficient estimate of the interaction term *Inexperienced X Entry time in segment i* in Model 16, which was weakly significant in our original estimation and is no longer significant.⁹ As results are substantially unchanged when redefining the segments, we take this evidence as a confirmation that our results do not depend on the identification of the segments. Still, we deem the classification in seven segments preferable, as it captures more closely the different designs available in the market.

We then focus on our analysis of the effect of the presence of the dominant firm on the hazard of exit from the segments (Hypotheses 3a and 3b). Our main results clearly suggest that late entry in a segment is beneficial for firms provided that it occurs before the dominant firm itself enters the segment. In this sense, they indicate the presence of a window of opportunity for new entrants in a segment. This window of opportunity coincides with the period between the start of the segment and the time of entry in that segment by the dominant firm. To further highlight the importance of this result we explore what happens if the window of opportunity changes as a consequence of changes in the timing of entry of the dominant firm. We consider four different scenarios – the dominant firm’s entry takes place two years before what has been observed in reality, one year before, one year later, two years later – and re-estimate Models 4 and 5 from Table 6 for each of these scenarios. Results of this exploration are reported in Table 9.

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⁸ A further analysis with four segments in which b/w and no screen are treated as separate segments could not be carried out owing to a low number of observations and reduced variance in the outcomes.

⁹ This result is probably the consequence of the reduction in the number of observations (firms X segments X years) that occurs when redefining the number of segments.

[Insert Table 9 about here]

Results show that when entry by the dominant firm is anticipated by one or two years (Models 19–20 and Models 21–22 respectively), the adverse effect of the presence of the dominant firm on the hazard of exit of the other entrants intensifies, suggesting that a narrowing of the window of opportunity is detrimental for competitors. Conversely, if entry by the dominant firm is delayed the opposite results are found. When entry is postponed by one year (Models 23–24), the adverse effect on the hazard of exit is no longer significant. When entry is postponed by two years the effect is reversed, as the presence of the dominant firm in the segment lowers the hazard for all the entrants (Model 25). This beneficial effect is significant for those entering before or as the same time as the dominant firm (Model 26), as indicated by the negative *Presence of dominant firm in segment i $\times$ Entry after dominant = 0*. It no longer affects significantly the hazard of those firms entering after the dominant one. In all these cases, the late mover advantage still holds as suggested by the negative and significant coefficient of the variable *entry time*.

Finally, we explore whether a potential endogeneity issue may bias our results. This potential issue is related to the fact that the entry of the dominant firm in a certain segment affects the exit of all firms in the subsequent periods *because* it discourages the relatively inexperienced firms from entering, thus affecting the future patterns of market entry and potentially biasing our results. To deal with this issue, we checked whether inexperienced producers are less likely to enter after the entry of Apple. To do so, for each segment, we calculated the share of inexperienced firms that entered after Apple and we compared it with the average share of inexperienced firms in the sample. The results of this exercise did not highlight any systematic pattern. In fact, if we exclude one segment in which Apple did not enter, we see relatively less inexperienced firms after the entry of the dominant firms in three segments, while in other three segments we see about the same or a higher proportion of inexperienced firms. This seems to indicate that our analysis does not suffer from this type of endogeneity issue.

All in all, these additional results confirm and further qualify our main evidence. They confirm our main evidence because they indicate the presence of the window of opportunity whose ‘narrowing’ and

‘widening’ affect the hazard of exit of new entrants in the market segments. They further qualify our evidence because they seem to suggest that the benefits of widening the window are significant only when entry by the dominant is postponed by a rather long period of time (i.e. two years) which provides an, albeit indirect, indication that, even in the absence of the dominant firm, entry in a new segment is not easy because firms need some time to adjust to the new segment.

5. Discussion and conclusions

We have investigated the influence of entry timing on the hazard of exit of firms from product segments in the market for DAPs. In doing so, we have compared inexperienced entrants with experienced companies, and we have investigated whether the presence of a dominant firm may affect the hazard of exit at the product segment level.

Our study contributes to several streams in the literature. First, our analysis contributes to the literature on entry time advantages or disadvantages (Suarez and Lanzolla, 2007) by moving the focus from the industry to the level of product segment. In particular, our finding that entering at later stages of the product life cycle reduces the hazard of exit for a product suggests that competition at the segment level may be very hard, especially at early stages when uncertainty about customers’ preference for a specific design is high. Within this context, delaying entry may be seen as a good strategy to improve a firm’s chances of providing a better, more competitive product. Our results align with the existing contributions on the role of entry timing in firm’s performance (Lieberman and Montgomery, 1998; Suarez and Lanzolla, 2007; Zachary et al., 2015). They also connect the literature on the role of entry timing in firms’ performance with some recent studies investigating entry into market niches (e.g., Barlow et al., 2019; Markman et al., 2019; Ozalp and Kretschmer, 2019), which have analysed different settings (content/software markets) and have not considered explicitly the effects of the timing of entry on firms’ exit. In this respect, they also extend prior works by moving the context of analysis from the whole ‘ecosystems’ (i.e. software and hardware) to the (hardware) product segments. Our finding that entering at later stages of the product life cycle reduces the hazard of exit from a product segment represents an

innovative result and provides interesting strategic implications for firms competing in multi-segment markets.

Also, our results indicate that when controlling for pre-entry experience, among firms entering at later stages of the product life cycle inexperienced entrants have a lower hazard rate than experienced entrants. Therefore, although inexperienced entrants might have an initial disadvantage, the disadvantage decreases the later they enter specific segments of the DAPs industry. This is in line with the existing empirical contributions suggesting that in hi-tech industries the presence of submarkets is conducive to sustained (late) entry by both experienced and less experienced firms (Klepper and Thompson, 2006). Furthermore, this finding complements existing studies on entry into different market niches that discuss how imitators might benefit from the observation of leaders' behaviours in terms of technological and product design choices in uncertain contexts. While the literature generally supports the idea that individual experience can even replace the external information concerning the number of products within a market niche (Ozalp and Kretschmer, 2019; Simon and Lieberman, 2010), we provide an innovative result by considering the interaction between entry timing and pre-entry experience – two of the most relevant determinants of (successful) entry strategies (Markman et al., 2019; Zachary et al., 2015) – and showing their effect on firms' exit from a segment.

Finally, our work also relates to the strategies that late entrants may adopt in order to compete successfully. In particular, our findings that late entry can also be risky, because it may expose new entrants to strong competition particularly after the entry of the dominant firm, builds upon and extends prior work by Franco et al. (2009) and Bayus and Agarwal (2007). We do so by looking specifically at entry into and exit from product segments instead of investigating entry/exit within an industry context and by considering the role of a dominant firm on the hazard of exit for different entry timing. Some recent literature on platforms (Cennamo, 2018; Wen and Zhu, 2019) has studied this role in the specific context of a platform leader entry into its complementary product market, showing that the 'threat' of potential entry by the leader may significantly hurt the providers of complementary product. We enrich these studies by showing that the effect of entry by a dominant firm is not limited to the case of platform

markets but can also be observed in those cases in which other firms are direct competitors in specific product segments.

These contributions notwithstanding, our work has some important limitations, which indicate avenues for future research. First, our findings are based upon a study of a single industry within a particular time span. Future research could investigate the generalizability of our findings to other industries. Second, our industry has been characterized by the presence of an undisputed dominant firm (Apple). Though this study is not about the sources of Apple's leadership in the DAP industry, it is nevertheless true that the dynamics observed in the DAP industry are very much related to the product innovation strategy of this dominant firm in this market but also in related markets (i.e. mobile phones and tablets). Future research should unravel these aspects. Finally, in our analysis we capture firm negative performance in term of exit from a DAP segment. However, exit from one segment might well be an indicator of good performance if it is associated with the redeployment of resources towards a new segment. Again further research should also look at cases of 'proactive exits' from obsolescing segments.

Two broad managerial implications can be drawn from our study. The first implication is for managers of more inexperienced firms which, in high-tech sectors characterized by fast technical change and the development of multiple generations of products, can overcome their lack of competencies by choosing to enter late into specific product segments of the industry. This implication is particularly important because it highlights that promoting and sustaining product variety might be a source of competitive advantage. The second implication refers to the effect that the presence of a dominant firm has on the strategic choices of competitors. The case of DAPs has shown that the window of opportunity for successfully entering and surviving in a segment is narrow, particularly when the leader has built its leadership by leveraging network and brand effect. In this context, refining the strategy of new product development by adapting to the challenges posed by the dominant firm in terms of design might give firms the opportunity of being competitive in the market above and beyond their timing of entry.

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Tables

Table 1: Number of new products by firm

	Number of new products	Percentage
APPLE	58	6.7%
ARCHOS	51	5.9%
BUSLINK	14	1.6%
COBY	34	3.9%
COWON	60	6.9%
CREATIVE	88	10.1%
DIGITALWAY	7	0.8%
HAIER	6	0.7%
ICETECH USA	6	0.7%
INSIGNIA	9	1.0%
IRIVER	65	7.5%
MICROSOFT	8	0.9%
NEXTAR	29	3.3%
OREGON SCIENTIFIC	14	1.6%
PANASONIC	15	1.7%
PHILIPS	63	7.2%
RCA (THOMSON CE)	30	3.5%
SAMSUNG	70	8.1%
SANDISK	34	3.9%
SONY	88	10.1%
TOSHIBA	9	1.0%
TREKSTOR	96	11.0%
ULTRA PRODUCTS	8	0.9%
WOLVERINE DATA	7	0.8%
Total	869	100%

Table 2: Number of new products by entrant category

	Number of new products	Percentage
Experienced	585	67.3%
Inexperienced	284	32.7%
Total	869	100.0%

Table 3: Definition of product segments

		Storage medium		
		Flash	Hard Disk	Microdrive
Screen type	None	No screen	/	/
	Black and white	Flash b/w	HD b/w	Microdrive
	Colour	Flash colour	HD colour	
	Touch	Touch screen		/

Table 4: Number of products, entry firm and time by segment

Segment	Number of products	Percentage	First entrant	Year of introduction	Apple entry
Flash b/w	342	39%	CREATIVE	1999	-
HD b/w	45	5%	ARCHOS	2000	2001
HD colour	86	10%	ARCHOS	2002	2004
No screen	52	6%	COBY	2001	2004
Flash colour	261	30%	IRIVER	2004	2005
Microdrive	32	4%	APPLE	2004	2004
Touch screen	51	6%	ARCHOS	2005	2007
	869	100%			

Table 5: Descriptive statistics and correlations

	Mean	S.D.	1	2	3	4	5	6	7	8	9
1 Exit	0.448	0.498	1								
2 Firm age in segment i	2.107	1.703	0.066	1							
3 Firm age in segment i sq	7.331	13.432	0.017	0.949***	1						
4 Density of segment i at t-1	12.134	17.514	-0.127**	-0.17***	-0.167***	1					
5 Density of segment i at t-1 sq	452.950	1089.080	-0.135**	-0.103*	-0.108*	0.946***	1				
6 Entry time in segment i	3.572	2.556	-0.408***	-0.409***	-0.324***	0.255***	0.213***	1			
7 Inexperienced	0.331	0.471	-0.034	-0.17***	-0.171***	0.107*	0.124**	0.143**	1		
8 Presence of dominant firm	0.609	0.489	-0.132**	-0.405***	-0.358***	-0.036	-0.071	0.196***	0.215***	1	
9 Entry before dominant	0.632	0.483	-0.149***	0.179***	0.199***	-0.024	0.033	0.323***	0.05	-0.342***	1

Table 6: Complementary log-logistic regressions for the hazard of exit

	(1)	(2)	(3)	(4)	(5)
Entry time in segment i	-0.651*** [0.064]	-0.685*** [0.068]	-0.610*** [0.067]	-0.723*** [0.072]	-0.679*** [0.083]
Inexperienced		0.583** [0.233]	1.427*** [0.542]	0.429* [0.242]	0.397 [0.242]
Inexperienced X Entry time in segment i			-0.277* [0.163]		
Presence of dominant firm in segment i				0.902*** [0.346]	
Presence of dominant firm in segment i X Entry after dominant = 0					0.547 [0.423]
Presence of dominant firm in segment i X Entry after dominant = 1					1.041*** [0.377]
Firm age in segment i	-0.212 [0.206]	-0.214 [0.204]	-0.245 [0.202]	-0.219 [0.210]	-0.196 [0.206]
Firm age in segment i sq	-0.002 [0.025]	-0.001 [0.025]	0.003 [0.025]	-0.003 [0.025]	-0.004 [0.025]
Density of segment i at t-1	0.120*** [0.027]	0.128*** [0.028]	0.128*** [0.028]	0.120*** [0.031]	0.108*** [0.032]
Density of segment i at t-1 sq	-0.001*** [0.000]	-0.002*** [0.000]	-0.002*** [0.000]	-0.002*** [0.000]	-0.001*** [0.000]
Constant	1.646*** [0.491]	1.629*** [0.486]	1.500*** [0.485]	1.800*** [0.515]	1.711*** [0.512]
Number of firms X segment X years	299	299	299	299	299
Number of firms X segment	168	168	168	168	168
Number of Exits	134	134	134	134	134
Log likelihood	-126.7	-124.3	-122.3	-121.7	-121.1
Chi-square	131.1	124.6	118.6	129	140.8
Prob Chi2	0	0	0	0	0

Standard errors adjusted for clustering on firm in brackets * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression contains a full vector of dummies for entry in segment i

Table 7: Complementary log-logistic regressions for the hazard of exit. Checking the robustness to alternative baseline hazard functions

	(5)	(6)	(7)	(8)
Entry time in segment i	-0.679*** [0.083]	-0.679*** [0.083]	-0.677*** [0.084]	-0.967*** [0.134]
Inexperienced	0.397 [0.242]	0.399* [0.241]	0.397 [0.241]	0.462* [0.380]
Presence of dominant firm in segment i X Entry after dominant = 0	0.547 [0.423]	0.531 [0.428]	0.501 [0.435]	1.075 [0.738]
Presence of dominant firm in segment i X Entry after dominant = 1	1.041*** [0.377]	1.041*** [0.377]	1.045*** [0.375]	1.870*** [0.658]
Firm age in segment i	-0.196 [0.206]	-0.346 [0.527]		-0.464 [0.338]
Firm age in segment i sq	-0.004 [0.025]	-0.039 [0.137]		-0.001 [0.036]
Firm age in segment i ³		0.003 [0.010]		
Density of segment i at t-1	0.108*** [0.032]	0.108*** [0.032]	0.107*** [0.031]	0.113*** [0.039]
Density of segment i at t-1 sq	-0.001*** [0.000]	-0.001*** [0.000]	-0.001*** [0.000]	-0.001*** [0.001]
Constant	1.711*** [0.512]	1.836*** [0.660]	1.601*** [0.396]	4.044*** [1.175]
Full vector of entry year time dummies			included	
Number of firms X segment X years	299	299	299	299
Number of firms X segment	168	168	168	168
Number of Exits	134	134	134	134
Log likelihood	-121.1	-121.1	-121	-121.3
Chi-square	140.8	140.5	129.4	121.2
Prob Chi2	0	0	0	0

Standard errors adjusted for clustering on firm in brackets * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression contains a full vector of dummies for entry in segment i

Table 8: Complementary log-logistic regressions for the hazard of exit. Exploring the robustness to alternative definitions of product segments

	Three segments based on memory type (Flash, HD, Microdrive)					Three segments based on screen type (b/w or no screen, colour screen, touch)				
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Entry time in segment <i>i</i>	-0.508*** [0.109]	-0.514*** [0.116]	-0.429*** [0.106]	-0.719*** [0.143]	-0.617*** [0.174]	-0.239* [0.122]	-0.278** [0.122]	-0.224 [0.153]	-0.296** [0.128]	-0.294** [0.141]
Inexperienced		0.121 [0.306]	1.503*** [0.574]	-0.218 [0.393]	-0.143 [0.473]		0.541* [0.282]	0.766 [0.537]	0.472* [0.284]	0.475* [0.283]
Inexperienced X Entry time in segment <i>i</i>			-0.435** [0.177]					-0.077 [0.147]		
Presence of dominant firm in segment <i>i</i>				1.829*** [0.470]					1.554*** [0.512]	
Presence of dominant firm in segment <i>i</i> X Entry after dominant = 0					1.359** [0.587]					1.539*** [0.567]
Presence of dominant firm in segment <i>i</i> X Entry after dominant = 1					2.269*** [0.474]					1.561*** [0.535]
Firm age in segment <i>i</i>	-0.057 [0.323]	-0.059 [0.325]	-0.076 [0.316]	-0.417 [0.327]	-0.387 [0.320]	-0.171 [0.251]	-0.173 [0.250]	-0.182 [0.250]	-0.309 [0.257]	-0.308 [0.257]
Firm age in segment <i>i</i> sq	-0.026 [0.041]	-0.026 [0.041]	-0.027 [0.039]	-0.008 [0.041]	-0.003 [0.039]	-0.007 [0.032]	-0.006 [0.032]	-0.004 [0.032]	0.004 [0.031]	0.004 [0.031]
Density of segment <i>i</i> at t-1	0.162** [0.075]	0.163** [0.078]	0.167** [0.072]	0.142 [0.089]	0.126 [0.103]	0.065** [0.030]	0.073** [0.031]	0.070** [0.030]	0.047 [0.032]	0.046 [0.039]
Density of segment <i>i</i> at t-1 sq	-0.002* [0.001]	-0.002 [0.001]	-0.002* [0.001]	-0.001 [0.001]	-0.001 [0.001]	-0.001*** [0.000]	-0.001*** [0.000]	-0.001*** [0.000]	-0.001** [0.000]	-0.001* [0.000]
Constant	-0.793 [0.753]	-0.805 [0.778]	-1.100 [0.774]	-0.133 [0.672]	-0.076 [0.687]	-0.041 [0.540]	-0.251 [0.576]	-0.363 [0.655]	-1.044 [0.720]	-1.045 [0.719]
Number of firms X segment X years	184	184	184	184	184	192	192	192	192	192
Number of firms X segment	72	72	72	72	72	72	72	72	72	72
Number of Exits	69	69	69	69	69	72	72	72	72	72
Log likelihood	-77.94	-77.87	-74.51	-68.75	-67.62	-105.7	-104.1	-103.9	-98.36	-98.36
Chi-square	57.88	57.07	61.18	83.15	103.6	30.95	33.51	34.37	47.89	48.78
Prob Chi2	0	0	0	0	0	0	0	0	0	0

Standard errors adjusted for clustering on firm in brackets * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression contains a full vector of dummies for entry in segment *i*

Table 9: Complementary log-logistic regressions for the hazard of exit. Exploring the robustness to alternative timing of entry of the dominant firm

	Original results		Dominant firm's entry: -1 year		Dominant firm's entry: -2 years		Dominant firm's entry: +1 year		Dominant firm's entry: +2 years	
	(4)	(5)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Entry time in segment <i>i</i>	-0.723*** [0.072]	-0.679*** [0.083]	-0.732*** [0.070]	-0.652*** [0.088]	-0.725*** [0.068]	-0.621*** [0.087]	-0.693*** [0.074]	-0.660*** [0.095]	-0.624*** [0.076]	-0.568*** [0.081]
Inexperienced	0.429* [0.242]	0.397 [0.242]	0.348 [0.250]	0.293 [0.262]	0.315 [0.252]	0.113 [0.271]	0.567** [0.238]	0.606*** [0.234]	0.662*** [0.247]	0.635*** [0.244]
Presence of dominant firm in segment <i>i</i>	0.902*** [0.346]		1.388*** [0.341]		1.617*** [0.372]		0.132 [0.356]		-0.729* [0.396]	
Presence of dominant firm in segment <i>i</i> X Entry after dominant = 0		0.547 [0.423]		0.546 [0.423]		0.547 [0.456]		-0.008 [0.415]		-1.029** [0.454]
Presence of dominant firm in segment <i>i</i> X Entry after dominant = 1		1.041*** [0.377]		1.684*** [0.372]		1.924*** [0.384]		0.352 [0.530]		-0.156 [0.533]
Firm age in segment <i>i</i>	-0.219 [0.210]	-0.196 [0.206]	-0.218 [0.213]	-0.166 [0.212]	-0.214 [0.215]	-0.180 [0.210]	-0.224 [0.206]	-0.189 [0.208]	-0.136 [0.205]	-0.076 [0.208]
Firm age in segment <i>i</i> sq	-0.003 [0.025]	-0.004 [0.025]	-0.003 [0.026]	-0.007 [0.025]	-0.003 [0.026]	-0.005 [0.025]	-0.001 [0.025]	-0.004 [0.025]	-0.007 [0.025]	-0.014 [0.026]
Density of segment <i>i</i> at t-1	0.120*** [0.031]	0.108*** [0.032]	0.121*** [0.031]	0.099*** [0.033]	0.122*** [0.031]	0.099*** [0.031]	0.126*** [0.030]	0.111*** [0.041]	0.135*** [0.026]	0.121*** [0.028]
Density of segment <i>i</i> at t-1 sq	-0.002*** [0.000]	-0.001*** [0.000]	-0.001*** [0.000]	-0.001** [0.000]	-0.002*** [0.000]	-0.001*** [0.000]	-0.002*** [0.000]	-0.001*** [0.001]	-0.002*** [0.000]	-0.002*** [0.000]
Constant	1.800*** [0.515]	1.711*** [0.512]	1.826*** [0.521]	1.638*** [0.521]	1.798*** [0.521]	1.606*** [0.512]	1.682*** [0.522]	1.626*** [0.524]	1.264*** [0.505]	1.141** [0.504]
Number of firms X segment X years	299	299	299	299	299	299	299	299	299	299
Number of firms X segment	168	168	168	168	168	168	168	168	168	168
Number of Exits	134	134	134	134	134	134	134	134	134	134
Log likelihood	-121.7	-121.1	-119.1	115.8	-118.2	-114	-124.2	-124	-122.2	-121
Chi-square	129	140.8	143.6	231.1	147.7	228.1	127	136.6	133.4	136.1
Prob Chi2	0	0	0	0	0	0	0	0	0	0

Standard errors adjusted for clustering on firm in brackets * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression contains a full vector of dummies for entry in segment *i*

Figures

Figure 1: Pattern of product innovation, firm entry and exit by year and market segment

Figure 2: Predicted hazards of exit for key explanatory variables