

## RESEARCH NOTES AND COMMENTARIES

# DETECTING THE RELATIONSHIP BETWEEN COMPETITIVE INTENSITY AND FIRM PRODUCT LINE LENGTH: EVIDENCE FROM THE WORLDWIDE MOBILE PHONE INDUSTRY<sup>1</sup>

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*The way firms lengthen or shorten their product line with respect to rivals is regarded as one of the possible strategies firms can pursue to respond to competition. This article builds and tests hypotheses to study the effect of different levels of competitive intensity on product line length. The empirical analysis of data on 3,527 handset models introduced by 66 mobile phone vendors from 1994 to 2010 shows a consistent inverse U-shaped relationship between competitive intensity and the firm's product line length. In this way, we pinpoint an interesting link between the product line extension literature and the competitive dynamics and competitive intensity perspectives. Copyright © 2013 John Wiley & Sons, Ltd.*

## INTRODUCTION

In the recent debate on temporary competitive advantage, management scholars suggest that 'nothing is sustainable forever' (D'Aveni, Dagnino, and Smith, 2010: 1373). They say competitive advantage is rare and declining in duration, especially in high velocity environments (Wiggins and Ruefli, 2002). In this vein, competitive intensity is regarded as one of the main factors threatening the firm's ability to sustain

a competitive advantage over time, often forcing firms to reshape their strategic postures in order to respond to competitor attacks (D'Aveni, 1994).

The way firms lengthen or shorten their product lines with respect to competitors has been described as one of the possible strategic actions firms can implement to cope with competitive intensity (Bayus and Putsis, 1999; Shugan, 1989). 'Product line' typically denotes a set of products that perform a similar function, are sold to the same customer groups, and are marketed through the same channels (Kekre and Srinivasan, 1990). For instance, the South Korean giant Samsung has several product lines, including mobile phones, photo cameras, video cameras, MP3 players, televisions, personal computers, air conditioners, and printing machines among others. 'Product line length' refers to the number of items/product

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variants in a product line (Bayus and Putsis, 1999; Draganska and Jain, 2005; Shankar, 2006). In 2008, for example, Samsung's mobile phone product line included more than 90 handset variants, so the firm's product line was more than 90 items in length. 'Product line extension' is the practice of increasing the number of products in the line by adding product variants (Kotler, 2000).

A first group of authors suggests that product line extension is an effective strategy to respond to competition. For example, by lengthening their product lines, firms can thwart competitive entry (Schmalensee, 1978), as well as alleviate price competition (Kadiyali, Naufel, and Chintagunta, 1999; Putsis, 1997). However, a second group of authors offers an opposing argument, warning that long product lines may lead to manufacturing and distribution diseconomies (Aaker and Joachimsthaler, 2000; Kumar, 2003) and threaten the value of a firm's brand in favor of competitors' products (John, Loken, and Joiner, 1998; Morrin, 1999). These opposing theoretical viewpoints suggest that the practice of lengthening product lines does not necessarily grant the firm a competitive advantage. Therefore, we ask whether firms should lengthen or shorten their product lines as competition increases.

The product line extension literature suggests that firms lengthen their product lines to use their underutilized capacities more efficiently, achieve quick increases in sales, and improve their overall competitive positions in the market by enhancing the market dominance of their brands (Draganska and Jain, 2005; Shankar, 2006). The competitive dynamics view, a potential complement to the preceding approach (Krider and Weinberg, 1998), emphasizes attacks and competitive moves and counter moves, competitive signaling, and multi-point competition (Chen, Su, and Tsai, 2007; Young *et al.*, 2000). Although competitive dynamics may help explain the rationale underlying product portfolio adjustment (Giachetti and Lampel, 2010), scholars from this stream of thought offer very limited arguments on the relationship between competition and the length of a firm's product line. This study takes a different view by linking the competitive dynamics and product line extension literatures, and it explores whether competitive responses to industry rivals in terms of product line extension are different when faced with different levels of competitive intensity over time.

The study investigates the competitive intensity-product line length relationship in the specific context of the mobile phone industry. Data on 3,527 handset models introduced by 66 mobile phone vendors from 1994 to 2010 show a consistent inverse U-shaped relationship between competitive intensity and the firm's product line length, with a positive slope at low and moderate levels of competitive intensity and a negative slope at high levels of competitive intensity.

The remainder of this article is organized as follows: we next provide a review of the literature on the three main constructs we use to derive the hypotheses: product line extension/length, competitive dynamics, and competitive intensity. We then develop and illustrate two competing hypotheses on the competitive intensity-product line length relationship. After describing the empirical model, we present the empirical findings of our analysis. Finally, we gather the implications for research and practice and discuss the limitations and conclusion of the study.

## THEORETICAL BACKGROUND

### Reasons for product line extension

Researchers provide numerous insights on the issue of product line extension. Two main streams of literature offer contributions on this topic. The first stream includes studies that analyze the effects of a firm's product line extension on the positioning of its existing product models (Bordley, 2003; Kadiyali *et al.*, 1999; Nijssen, 1999; Putsis and Bayus, 2001). The second stream focuses on the factors that influence the optimal length of a firm's product line and the firm's decision to pursue further product line adjustments. Concerning the latter stream of literature, some authors show several 'market environment' factors—such as the heterogeneity of customer needs, the life cycle of market demand (Bayus and Putsis, 1999), the market structure (Shugan, 1989), and the barriers to entry in the industry (Brander and Eaton, 1984; Putsis, 1997; Schmalensee, 1978)—as having a significant impact. Other authors provide evidence for factors related to the firm's 'competitive position,' such as market share (Putsis and Bayus, 2001), as having a significant effect. Others

show a significant impact of factors 'internal' to the firm, such as the possible cannibalization among brands of the same product line (Wilson and Norton, 1989) and the cost associated with product line adjustments (Putsis, 1997). Finally, some researchers investigate the trade-offs among factors influencing product line adjustments and propose arguments about the optimal size of a product line (Putsis and Bayus, 2001).

### Competitive dynamics and product line strategies

Attacks and reactions among firms in an industry reflect competitive dynamics. These attack/reaction dynamics reveal a firm's search for higher profits and a stronger competitive position (MacMillan, McCaffrey, and Van Wijk, 1985). Authors suggest that the higher the level of competitive intensity in an industry, the more the firm is likely to feel its competitive position threatened by rivals (Porter, 1980). At the 'product line level,' when competition threatens the firm's competitive position, the firm may take no action or make product line adaptations.

However, only a firm that is aware of competitors can respond to its attacks by changing the length of its product line. This means that competitive moves have to generate signals that are noticeable to the firm (Chen, Smith, and Grimm, 1992; Smith and Grimm, 1991). The motivation that the firm has to respond to competitors' moves depends on the strategic importance of the products under attack and their contribution to the firm's profitability (Ferrier, 2001). Finally, the capabilities that the firm has to attack competitors' products or defend its product line depend on its resource endowments (Smith and Grimm, 1991). Authors suggest that individual awareness-motivation-capability components are manifested in a range of variables, including action visibility and firm size for awareness, multi-market contact for motivation, and execution constraints for capability (Chen *et al.*, 2007).

### Competitive intensity and product line strategies

Researchers have measured competitive intensity in several ways: with the markup that firms charge to consumers (Graddy, 1995); with relative profit

difference indicators (Boone, 2008); with the number of competitors (Porter, 1980); with the level of the barriers to entry (Caves, Fortunato, and Ghemawat, 1984; Porter, 1980); or with various industry concentration indexes (Caves *et al.*, 1984; Porter, 1980; Scherer and Ross, 1990; Wiggins and Ruefli, 2002).<sup>2</sup> Strategy authors show that competitive intensity may have a dramatic impact on a firm's profitability and usually triggers the quest for product differentiation (Porter, 1980).

The degree to which industries are subject to competition depends on various factors, such as production and marketing costs, the degree of product heterogeneity, consumer demand growth rate, and the complexity of consumers' needs (Kotler, 2000; Porter, 1980; Thomas and D'Aveni, 2009). Some authors argue that, over time, market opportunities may arise by increasing the standardization of consumers' needs, enabling firms to serve a larger number of consumer segments with relatively narrow product lines, thus avoiding product cannibalization problems (Mason and Milne, 1994). Others posit that, in certain industries, longer product lines provide firms with the opportunity to realize economies of scale and scope and to satisfy 'variety seeking' consumer behavior (Axaroglou, 2008). Other studies suggest that industries characterized by the presence of incumbents with very long product lines can be difficult to penetrate (Bayus and Putsis, 1999; Putsis and Bayus, 2001). In summary, depending on their structural differences, industries differ regarding their attractiveness and accessibility to competition. Building on the premise that firms operating in a certain product category are likely to be subject to different levels of competitive intensity over time, the objective of this study is to explore whether and how firms alter their levels of product line length when confronting different levels of competition.

<sup>2</sup> The concentration indexes most commonly used in the extant literature are: the Herfindahl index (sum of the squared market shares  $S$  of the  $n$  rivals:  $H = \sum_{i=1}^n S_i^2$ ) and Entropy index (weighted sum of the market shares of the  $n$  rivals, the weight for each share being the logarithm of the inverse of the rival  $i$ 's share:  $E = \sum_{i=1}^n S_i \cdot \ln \frac{1}{S_i}$ ), that take into account both the number and the market share of industry rivals; and the firm concentration ratio, that sums up the market share of the  $m$  largest rivals (with  $m < n$ ).

## DEFINING THE HYPOTHESES: THE EFFECT OF COMPETITIVE INTENSITY ON THE FIRM'S PRODUCT LINE LENGTH

### Linear relationship

The firm can respond to competitors' attacks by using product line strategies in a number of ways: (1) reallocating resources to threatened products within the line; (2) lengthening the product line through introducing new models to provide more choice to consumers; (3) narrowing the product line and focusing its marketing resources on a limited number of models; or (4) divesting and leaving the field open to competitors (Bayus and Putsis, 1999; Draganska and Jain, 2005; Shankar, 2006).

Incumbents usually invest resources to build their product lines and tend to protect their investments over time. Competitive dynamics scholars suggest that incumbents are likely to defend their profitability and market shares from direct attacks of other incumbents or potential new entrants (Ferrier *et al.*, 2002). Market entries represent a credible threat to incumbents and as competitors' attacks become more intense, incumbent capabilities weaken. As competition increases, consumers can choose among a wider number of brands, thereby making the firm's products less attractive in terms of profitability (Shankar, 2006). In this scenario, incumbents are likely to lengthen their product lines by engaging in long-term investments promising new product variants, effectively offering consumers more alternatives (Axaroglou, 2008; Krider and Weinberg, 1998; Shankar, 2006). In fact, product lines comprising a larger number of models can enable a firm to achieve greater power compared with the other industry members and can deter the introduction of new models from rivals (Bordley, 2003). A reduction of the product line length would make incumbents dependent on the (fewer) core product variants that are under attack. This suggests firms should not make use of this option. In essence, as competitive intensity increases, firms tend to lengthen their product lines. This logic leads to the following hypothesis:

*Hypothesis 1 (H1): There is a positive relationship between competitive intensity and the firm's product line length.*

### Curvilinear relationship

Although the argument we presented suggests that firms are likely to invest in several product variants in order to effectively respond to increasing competitive pressures, some authors argue that very long product lines may also lead to a number of coordination problems. The first problem is self-cannibalization (Axaroglou, 2008), a phenomenon whereby a new product introduced by a firm competes with and reduces the sales of the firm's existing products. This is a clear negative effect of the new product. Second, very long product lines may require huge investments for firms to efficiently coordinate product promotion and distribution (Aaker and Joachimsthaler, 2000). In favor of the latter argument, empirical studies emphasize the greater manufacturing and distribution economies and relative advertising and administration efficiencies of portfolios comprising a smaller number of models (Bayus and Putsis 1999; Kumar, 2003). Therefore, as competitive intensity increases, up to which point are firms likely to lengthen their product lines? Next, an alternative argument with respect to the one developed in Hypothesis 1 is proposed.

In particular, it is argued that while product lines including many product variants are manageable in a relatively easy fashion if competitive intensity is from low to moderate, when numerous new entrants challenge the products of incumbents and then competitive intensity reaches relatively high levels, firms with very long product lines may encounter line coordination difficulties. At high levels of competition, incumbents might attempt to check the new competition by leveraging scope economies, exploiting synergies between product segments, applying price pressure, or erasing entry barriers (Shankar, 2006). However, although these strategies are normally useful and effective in responding to competitive threats, that may not always be the case. In a scenario of high competitive intensity, if the firm has a very long product line, successful implementation may be difficult. This may occur since the highly competitive environment is likely to exacerbate the product line coordination complexity (Draganska and Jain, 2005). As competitive dynamics scholars have suggested, in structurally complex firms, such as those involved in the production and commercialization of several product variants (Krider and Weinberg, 1998), coordination complexities of



the various activities within the organization are likely to retard the decision-making speed (Jones, 2003), constraining the firm's ability to respond effectively to competitive challenges (Smith and Grimm, 1991). Thus, how will the firm adapt its product line length when the industry is subject to high levels of competitive intensity?

If high levels of competitive intensity threaten the present competitive position of the firm's products, the firm is likely to sacrifice peripheral product variants to reduce coordination complexity and increase internal consistency (Draganska and Jain, 2005). In essence, high levels of competitive intensity will lead managers to redirect resources away from peripheral products toward core product models within the line, thereby reducing the product line length in favor of increasing product line coherence. This refocusing strategy should allow the firm to concentrate its resources on a limited number of product models so as to more easily safeguard their competitive positions in the context of high competitive intensity. These arguments lead to the following hypothesis:

*Hypothesis 2 (H2): Competitive intensity relates positively to a firm's product line length across the low to moderate range of competitive intensity and relates negatively to a firm's product line length across the moderate to high range of competitive intensity.*

## METHODS

### Dynamic model

This study assesses whether and how firms adjust their product line lengths in the face of competitive intensity. In other words, the analysis investigates whether a firm's product line length depends on the level of competitive intensity in the industry. A key argument of competitive dynamics research is that the time to competitive response will depend on the initial action's typology. In fact, empirical studies in the competitive dynamics literature show that certain actions elicit faster responses than others (Chen *et al.*, 1992; Smith and Grimm, 1991). To test the competitive intensity-product line length hypotheses, we have applied a longitudinal research design, relating the level of competition intensity tackled by the firm in a certain time  $t$  to the level of the firm's product line length

in a subsequent time period  $t + 1$ , where  $t$  is equal to one year. This choice seems consistent since various studies in the competitive dynamics literature have shown that in high-tech industries, certain actions, such as 'new product introduction,' elicit a response time of approximately 12 months (Giachetti and Lampel, 2010; Smith, Grimm, and Gannon, 1992). Moreover, such one-year lags have been used in several empirical studies to test the amount of time it takes a competitor to respond to changing competitive intensity (Bowen and Wiersema, 2005).

### Sample

We tested H1 and H2 in the context of the worldwide mobile phone industry. Data on 3,527 handset models introduced by 66 mobile phone vendors from 1994 to 2010 were collected from the special interest Web pages for mobile telephony (<http://www.gsmarena.com> and <http://mobile.softpedia.com>) widely regarded as key industry references (Giachetti and Marchi, 2010).

The 66 mobile phone vendors in the sample operate at the international level; domestic operators have been excluded on purpose. Given their global presence, it is unlikely that the entrance of a mobile phone vendor in the industry would go unnoticed by incumbents. For these reasons, the analysis assumes that: (1) competition dynamics are highly visible (Smith and Grimm, 1991); and (2) the entrance of a new firm in the industry is generally perceived as a potential threat by the other mobile phone vendors.

We believe our setting to be particularly suitable for testing the proposed hypotheses because our time window (1994 to 2010) covers most of the mobile phone industry's life cycle, characterized by massive changes in technologies, demand, and competitive intensity.

Data about handsets and industry dynamics were triangulated in a series of interviews with mobile phone marketing and product managers who played leading roles in their firms in the time period under scrutiny. The firms whose managers agreed to be interviewed include, but are not limited to, Sony-Ericsson, LG, Samsung, Motorola, and NEC. Together with individual in-depth interviews, we also organized a couple of expert panels with industry specialists to discuss the reliability of the indicators used in the model.

## Measures

In line with the aim of providing a dynamic longitudinal analysis of competitive intensity and product line extension responses, all the independent and control variables were computed at time  $t$ , while the dependent variable product line length was computed at time  $t + 1$  (Bowen and Wiersema, 2005).

### Dependent variable

**Product line length.** The firm's product line length was measured with the natural logarithm of the number of models belonging to the firm's product line. In this study, the time unit is the year  $t$ , so following the procedure of Giachetti and Lampel (2010), it was assumed that each handset is introduced at the beginning of the year  $t$  and remains in the firm product line only over that year  $t$ . In other words, we assumed that the life cycle of each handset begins on the first day of the year and lasts one year.<sup>3</sup>

### Independent variable

**Competitive intensity.** Usually strategy authors measure competitive intensity by considering the number of competitors or concentration ratios (Porter, 1980; Scherer and Ross, 1990). The higher the number of competitors and the lower the level of concentration, the higher the intensity of competition in the industry (Porter, 1980). In particular, authors assume that, on the one hand, in an industry with a high number of competitors, the firm's products are more likely to be under attack; on the other hand, a high level of industry concentration is likely to lead to 'collusion,' i.e., when rivals cooperate for their mutual benefit (the few large firms in a concentrated industry are not likely to fight aggressively against each other, but instead are more likely to find agreements to fix prices and quantities). In this study,

information on the number of firms competing in the global landscape was collected from the special interest Web sites <http://www.gsmarena.com> and <http://mobile.softpedia.com>, and information on mobile phone vendors' market shares in terms of units sold was collected from Gartner Dataquest. Therefore, to measure competitive intensity, we first developed two indicators: one was a count of the number of firms ( $nfirms$ ) and the other was the cumulative global market shares of the four largest mobile phone vendors in terms of units sold ( $concentration$ ). Second, following the procedures of Sanders and Carpenter (1998), we integrated the two measures into a composite measure of competitive intensity. In so doing, we divided the number of firms and the concentration ratio, respectively, by the maximum number of firms and the minimum level of concentration in the sample, so as to obtain two ratios. In this way, for both ratios, the closer the value is to 1, the more intense the competition. Third, we computed the averages of the two ratios as in Equation 1, so that the final measure of competitive intensity took values ranging from 0 to 1, with 1 representing the highest level of competitive intensity in the sample.

$$compint_t = \frac{\left[ \frac{nfirms_t / \max(nfirms)}{+ \{1/[concentration_t / \min(concentration)]\}} \right]}{2} \quad (1)$$

According to Equation 1, competitive intensity increases the higher the number of firms in the industry and the lower the concentration level.<sup>4</sup>

### Control variables

**Degree of technological convergence in the firm's product line.** Convergence in products occurs when previously unrelated products are bundled together to form a new integrated class of products. The current trend among mobile phone vendors to integrate nearly all types of portable technologies (e.g., camera, digital music player) provides a case in point. Over the past two decades, the function of the mobile phone market has expanded

<sup>3</sup> Most of the handsets are not sold to the final consumers by the mobile phone vendors, but by the handset retailers, such as the telecommunication companies' retail chains (e.g., Vodafone or Orange) and the independent phone retailers (e.g., Carphone Warehouse). 'One year' is usually the standard period of time, starting with the introduction of the product by the mobile phone vendor and ending with the moment in which it no longer supplies the product to retailers, irrespective of whether the retailers, after this one-year period, keep on selling the product to the final consumers.

<sup>4</sup> It is noteworthy that in this study it was not possible to compute the Herfindahl or the Entropy concentration indexes because they require data on the market shares of all industry members, whereas in our sample only market shares of the largest rivals were available.

outside its traditional arena of providing pure telephone capabilities to include an ever-growing number of features and applications. The decision to incorporate technologies from other product categories in new models can have a dramatic impact on a firm's product portfolio strategy (Giachetti and Marchi, 2010). The 'degree of technological convergence in the firm's product line' was measured by the average number of technologies from other product categories in the firm's product line at time  $t$  (Equation 2):

$$TC_{i,t} = \frac{\sum_{p=1}^m N_{p,t}}{m} \quad (2)$$

where  $N$  is the number of technologies from other categories incorporated in the handset model  $p$ , introduced in the market by firm  $i$  at time  $t$  and  $m$  is the number of handset models introduced by the firm at time  $t$ . Over the period analyzed, we identified 10 technologies from other product categories: text messaging capabilities (from the personal computer industry); games (from the video game industry); voice recorders (from the digital voice recorder industry); Internet access (from the personal computer industry); touchscreens (from the computer-assisted learning terminal industry); radios (from the digital radio industry); MP3 players (from the MP3 player industry); advanced operating systems (from the personal computer industry); and photo cameras and video cameras (from the digital camera industry).<sup>5</sup>

*Firm age.* Extant research suggests that younger firms usually enter the market with relatively narrow product lines and eventually lengthen them over time once they have acquired adequate resources (Kotler, 2000). 'Firm age' was measured by the natural logarithm of the total number of years since the firm started operating in the mobile phone industry.

*Corporate group size.* Since mobile phone vendors are mainly business units or diversified multinationals, usually financial data capturing 'size' at

the mobile phone business unit level are not available. So we controlled for corporate size by using the natural logarithm of the firm's corporate group revenues. Data on the corporate group's revenues were collected from COMPUSTAT Global, Orbis Dataset (Buerau van Dijk) and corporate group's annual reports.

*Intensity of smartphones introduction.* The diffusion of smartphone devices in the mid-2000s has given birth to a new generation of handsets, potentially affecting the mobile phone vendors' product line strategies. The development of smartphones usually requires higher research and development (R&D) investments than ordinary handsets and, thus, firms deciding to invest heavily in these product models might have to abandon the idea of using product line extension as a competitive practice. After performing an extensive content analysis of special interest magazines for mobile telephony over the time window (1994 to 2010) analyzed, we decided to use the 'advanced operating system' as the demarcation criteria to distinguish between 'smartphones' and ordinary phones.<sup>6</sup> The firm's intensity of smartphones introduction was measured as the percentage of smartphones in the firm's product line in a certain time  $t$ .

*Product diffusion in the market.* Empirical evidence suggests that product diffusion in a market affects the product portfolio strategies of the firm (Bayus and Putsis, 1999; Putsis and Bayus, 2001). In this article, product diffusion in a market was measured by the number of mobile handsets per 100 inhabitants (i.e., penetration rate) at year  $t$ , at the global level. We collected data on the worldwide mobile phone penetration by using the International Telecommunication Union.

*Market leader product line length.* Empirical studies have found that the leader may trigger either similar or dissimilar actions by the other industry members (Lieberman and Asaba, 2006; Smith *et al.*, 1992). Therefore, we controlled for the potential influence of the market leader's product line strategy, measured as the natural logarithm of the number of models belonging to the

<sup>5</sup> A technology here is defined as a software or hardware that allows the phone to provide a new functionality.

<sup>6</sup> The operating systems we consider as 'advanced' in the time period analyzed are as follows: Android OS, BlackBerry OS, Linux, Mac OS, Microsoft Windows Mobile, Palm OS, and Symbian.

leader's product line at the year  $t$ , on the product line strategy of the firm (i.e., our dependent variable computed at time  $t + 1$ ). A positive (negative) relationship between the market leader's product line strategy and our dependent variable would be an indication that firms attempt to respond to the leader's decisions of lengthening or shortening its product line with similar (dissimilar) actions. The market leader was defined as the firm with the greatest market share (Smith *et al.*, 1992) in terms of units sold. Over the time period analyzed (1994 to 2010), we identified two market leaders: Motorola from 1994 to 1997 and Nokia from 1998 to 2010.

**Firm effect.** Dummy variables for each of the sample mobile phone vendors were used to control for firm identity (Stock and Watson, 2007). Table 1 presents the variables' descriptive statistics.

## RESULTS

Hausman's specification test confirmed the presence of fixed effects in the unbalanced panel. The model was estimated by a fixed-effects regression using STATA. We computed the variance inflation factors (VIFs) to determine whether there was multicollinearity in the analyses. None of the VIF scores approached 10, the commonly accepted threshold indicating a potential problem (Chatterjee and Hadi, 2006); the average VIF was, in fact, 3.53. The results suggested that multicollinearity was not a concern in our model. The sample contained 346 observations over 17 years, yielding an unbalanced time series cross-sectional panel.<sup>7</sup> Table 2 presents the results of the regression analysis.

Model 1 (Table 2) is an examination of the effects of the control variables on product line length. Model 2 adds competitive intensity as an independent variable to test the linear relationship predicted in Hypothesis 1, while Model 3 adds competitive intensity squared to test the inverse U-shaped relationship predicted in Hypothesis 2.

In Model 2, the coefficient of competitive intensity is positive and significant ( $\beta = 3.070$ ,

$p < 0.001$ ). Model 3 includes a statistically significant and positive relationship between competitive intensity and product line length ( $\beta = 16.422$ ,  $p < 0.01$ ) and a statistically significant and negative relationship between competitive intensity squared and product line length ( $\beta = -8.497$ ,  $p < 0.05$ ). The latter relationship suggests a curvilinear relationship, and these two relationships combined denote a potential inverted U-shaped relationship between competitive intensity and product line length. As Table 2 shows, the F-test associated with Model 3 (curvilinear model) is significantly higher than in Model 2 (linear model) ( $\Delta F$ : 3.93,  $p < 0.05$ ), suggesting that the explanatory power of the model increased significantly when the squared term of competitive intensity entered into the equation. This indicates that the curvilinear model fits the data better than the linear model, thus supporting Hypothesis 2 and not Hypothesis 1.<sup>8</sup>

## DISCUSSION AND CONCLUSION

### Theoretical implications

The existing literature offers logical but opposing arguments regarding the use of product line extension as an effective competitive instrument. Although some researchers suggest that long product lines can enable a firm to achieve greater market power in relation to competitors and can deter the entry of new product models from rivals, others find that the practice of lengthening the product line may lead to a number of diseconomies and inefficiencies (Aaker and Joachimsthaler, 2000; Draganska and Jain, 2005; Kumar, 2003). In light of the advantages and drawbacks of product line extension, the extant product line extension literature does not provide a clear-cut explanation of the reasons why firms lengthen or shorten their product lines when industry rivals threatens their competitive positions or how the length of a firm's product line changes at different levels of competitive intensity over time.

<sup>7</sup> Our panel is unbalanced since most of the firms walked into the industry after 1994, others shut down their operations before 2010, other vendors decided to enter the market again after having been out for one or more years, and others had life cycles of just a few years.

<sup>8</sup> As other authors investigating the effect of competitive intensity dynamics on firms' strategies (Hutzschenreuter and Gröne, 2009) did, we conducted a robustness analysis using a no-year lag, as well as two- and three-year lag dependent variables. Although coefficients and significance levels of the competitive intensity variables varied slightly, effect directions and significance remained consistent with the results shown.



Table 1. Descriptive statistics

Variable	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8
1 Product line length	1.651	1.122	0	4.844	1							
2 Competitive intensity	0.750	0.141	0.515	0.920	0.228 <sup>†</sup>	1						
3 Technological convergence	5.503	2.565	0.7	10	0.146 <sup>†</sup>	0.650 <sup>†</sup>	1					
4 Firm age	1.309	0.890	0	3.295	0.450 <sup>†</sup>	−0.067	0.045	1				
5 Corporate group size	15.234	2.959	3.891	18.891	0.230 <sup>†</sup>	−0.099 <sup>†</sup>	0.006	0.371 <sup>†</sup>	1			
6 Intensity of smart-phones introduction	0.302	0.415	0	1	−0.175 <sup>†</sup>	0.250 <sup>†</sup>	0.624 <sup>†</sup>	−0.083	0.006	1		
7 Product diffusion in the market	24.917	21.411	1	68.2	0.183 <sup>†</sup>	0.792 <sup>†</sup>	0.826 <sup>†</sup>	0.105 <sup>†</sup>	−0.014	0.368 <sup>†</sup>	1	
8 Market leader product line length	2.413	1.161	0	3.850	0.219 <sup>†</sup>	0.849 <sup>†</sup>	0.784 <sup>†</sup>	0.002	−0.076 <sup>†</sup>	0.324 <sup>†</sup>	0.865 <sup>†</sup>	1

Notes:  $n = 346$ Significance: <sup>†</sup>  $p < 0.10$ 

Moreover, the competitive dynamics perspective, a potential complement of product line extension literature (Chen *et al.*, 2007; Young *et al.*, 2000), while relevant for understanding the rationale of product portfolio adjustment (Giachetti and Lampel, 2010), has heretofore offered very limited arguments to shed light on the relationship between competition and the length of a firm's product line.

Aiming to complement the product line extension literature (Draganska and Jain, 2005; Kekre and Srinivasan, 1990; Shankar, 2006) with the competitive dynamics perspective (Chen *et al.*, 2007; Young *et al.*, 2000), this study has focused on the attack intensity and the firm's competitive responses to provide insights into whether competition affects product line extension decisions. Two alternative hypotheses were developed on the competitive intensity-product line extension relationship: linear versus inverted U-shaped curvilinear relationship. The results provide support for the latter (curvilinear) relationship. Low and moderate levels of competitive intensity relate positively to product line length, but high levels of competitive intensity are likely to encourage firms to reduce the lengths of their product lines in favor of better product line coherence.

This inverse U-shaped relationship between competitive intensity and product line length

provides a new perspective on the competitive intensity-product line length relationship. In particular, our findings that competitive responses in terms of product line extension are different when faced with different levels of competitive intensity over time provide an appealing connection between competitive dynamics and product line extension literatures and, therefore, between the strategy and marketing realms.

### Managerial implications

This study also offers various implications to product and marketing managers and business-level executives. In light of the observed relationships, managers can use competitive intensity to develop projections on the product line lengths of their rivals and plan strategic responses accordingly. In fact, our findings suggest that firms attempt to pursue 'optimal' product line length levels as competitive intensity varies over time. Across the low to moderate range of competitive intensity, managers should expect that competitors increase the lengths of their product lines to offer consumers more product variety and to secure product line returns. In addition, as competitive intensity increases, the introduction of new models within the product line may enable firms to efficiently utilize their

Table 2. Model estimation: fixed-effects regression

<i>Dependent variable: product line length</i>	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>
<b>Competitive intensity</b>	—	3.070*** (4.41)	16.422** (2.42)
<b>Competitive intensity squared</b>	—	—	−8.497* (−1.99)
<b>Technological convergence</b>	0.114* (2.25)	0.068 (1.35)	0.055 (1.09)
<b>Firm age</b>	0.077 (0.63)	0.046 (0.39)	0.060 (0.50)
<b>Corporate group size</b>	0.524*** (6.69)	0.492*** (6.45)	0.486*** (6.41)
<b>Intensity of smartphones introduction</b>	−0.521* (−2.26)	−0.320 (−1.41)	−0.270 (−1.19)
<b>Product diffusion in the market</b>	−0.004 (−0.64)	0.001 (0.24)	−0.001 (−0.01)
<b>Market leader product line length</b>	0.388*** (4.14)	0.130 (1.21)	0.148 (1.38)
<b>Constant</b>	−8.388*** (−5.96)	−9.611*** (−6.91)	−14.594*** (−5.09)
<b>Firm dummies (fixed-effects)</b>	<i>Included</i>	<i>included</i>	<i>included</i>
<b>R-sq</b>	0.680	0.702	0.706
<b>F</b>	8.23***	8.94***	8.96*
<b>ΔF</b>	—	19.48***	3.93*

Notes:  $n = 346$ Significance: \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ ; †  $p < 0.10$ ; t-statistic in parentheses

increased expert capacities and to generate scope and scale economies, potentially leading to a competitive advantage. In this stage, managers should have an adequate resource endowment prepared to advertise and distribute the increasing number of new product models. By contrast, across the moderate to high range of competitive intensity level, managers should expect competitors to refocus their product lines, redirecting resources (e.g., advertising campaigns, trade marketing, and R&D investments) away from peripheral models toward core products, thereby reducing the product line length in favor of increasing product line coherence. This kind of coherence may be required when competitive intensity is high in order to avoid spreading resources across an excessively wide number of models within the line.

### Limitations and suggestions for future research

As frequently occurs, the limitations of this study suggest opportunities for future research in the fields of strategy and marketing. First, in our analysis, the variables controlling for the vendor's propensity to outsource activities to specialists

are missing. In fact, mobile phone vendors can outsource a number of activities to third parties. Some of them are suppliers of components (such as chips, software, operating systems, etc.), some assemble electronic components and devices on behalf of their vendors, and others are independent contractors that develop prototype handsets and trade them to mobile phone vendors who, in turn, market them under their brand names. We are aware that the efforts required to lengthen or shorten the product line may significantly change depending on the firm's level of vertical integration (Rothaermel, Hitt, and Jobe, 2006). Future research on the competitive intensity-product line length relationship could control for the firm's level of upward or downward vertical integration or explore its moderating forces.

Second, it is important to note that this article investigates how firms respond to competitive intensity by shaping their product line length, but does not provide evidence on the performance implications of product line extension strategies. In fact, no measure of performance is used in this study. Future research could explore if firms

following the inverse U-shaped curve are really those that obtain higher performance outcomes. If this were the case, it would mean that the firm's ability to sustain its competitive advantage significantly depends on the way it shapes the length of its product line as competitive pressures evolve over time. In this light, relevant implications for the body of the strategic management literature that focuses on temporary competitive advantage would be developed (D'Aveni *et al.*, 2010).

Finally, since this analysis has focused on the mobile phone industry, industry-specific variables were missing and, in turn, the patterns observed cannot be easily generalized to other industries. Further research could analyze the competitive intensity-product line length relationship in other product categories in order to grasp in what other instances the patterns observed can be confirmed. In this vein, strategy inquiry could take into account marketing scholars' suggestions that different specific marketing mix tools are required for managing the types of firm's products, generally depending if they are 'intermediate' versus 'final' products, 'durable' as opposed to 'nondurable' products or 'technology-based' rather than 'non-technology-based' products (Kotler, 2000).

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