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Expanding into new product lines in response to COVID-19: The interplay between firm age and performance aspirations

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Expanding into new product lines in response to COVID-19:

The interplay between firm age and performance aspirations

Abstract

Unprecedented environmental shocks, like the outbreak of COVID-19, sometimes trigger firms to adjust to the new environment, by expanding quickly into new—relevant to the shock—product lines, as a means to capitalize on the booming demand of urgently needed supplies. This study examines the role of firm corporate liabilities, as the ones enclosed to firm age, in influencing the number of new product lines a firm introduces in response to the pandemic, and its reaction time to the shock. The way in which performance aspirations interfere in these managerial decisions is also examined. In testing hypotheses, we employ a novel multivariate matching approach, namely entropy balancing, which allows researchers to create balanced samples and accounts for the existence of non-random factors influencing the results. Using a sample of 973 manufacturers that introduced new product lines in response to COVID-19, our hypotheses, positively linking firm age to product line introductions, and negatively to response time to the environmental shock, are supported. Our results indicate that for firms with higher levels of performance above industry average, the positive influence of firm's age on the number of new product lines introduced is weaker than for firms with lower levels of performance above industry average.

Keywords: COVID-19 pandemic, firm age, performance aspirations, product line introductions, response time, entropy balancing

1. Introduction

The world has recently experienced an unprecedented environmental shock due to the outbreak of COVID-19 pandemic. Compared to short-term external changes, such environmental shocks are more challenging for firms because they combine greater environmental uncertainty and market unpredictability (Davis, Eisenhardt, & Bingham, 2009; Martin-Rios & Pasamar, 2018). Among many, a consensus is emerging that the environmental shock associated with the COVID-19 pandemic has provoked serious disruptions in supply chain, exposing the firms' vulnerabilities in demand fluctuations and lead times (Ivanov & Dolgui, 2021; Kumar & Sharma, 2021; Mazareanu, 2020). Further, the simultaneous restrictions for travel, non-essential business activities, and production—enforced by government officials around the globe—exacerbated these challenges and further derailed the already disrupted supply chain by altering demand dynamics and specifically, increasing demand for products that better suit the new environment (e.g., Knowles, Ettenson, Lynch, & Dollens, 2020; Wan & Yiu, 2009; Wenzel, Stanske, & Lieberman, 2020). For example, during the recent pandemic one could see a sharp shift in demand for emergency preparedness supplies, health care products, cleaning items, masks, and other medical equipment.

Researches have demonstrated that when an environmental shock significantly affects the demand dynamics and therefore, the firm's competitive position, it often triggers firms' strategic responses to adjust to the new environment (Bode, Wagner, Petersen, & Ellram, 2011; Chakrabarti, 2015; Rapaccinia, Saccani, Kowalkowski, Paiola, & Adrodegari, 2020). The greater the intensity and suddenness of the environmental shock, the more the firms need to promote extensive and prompt adjustments to survive (e.g., Cyert & March, 1963; Weitzel & Jonsson, 1989). Perhaps the most common way in which firms make these adjustments is by taking offensive approaches and expanding quickly into new product lines (Elsahn &

Siedlok, 2020; Sharma, 2000; Wenzel, Stanske, & Lieberman, 2020). Indeed, our data proffer evidence to suggest that approximately 5% of Portuguese companies operating in the manufacturing industry attempted to tackle the economic impact of COVID-19 by introducing some sort of new product lines (e.g., cleaning items, health care products, face coverings, etc.). On average, these companies have introduced 2.5 new product lines in 84 days from the announcement of the first coronavirus case in the country. Given that severe environmental shocks may have an immediate effect on the fit between the firm's current business and the external setting, expanding into new product lines in a timely manner can be an effective tool for faster firm recovery (e.g., Chesbrough, 2020; Hausman & Johnston, 2014). Let us take the example of LVMH, who pivoted from producing perfumes to making hand sanitizers or, H&M, the fast-fashion giant, who responded quickly to the coronavirus crisis by repurposing its manufacturing to produce medical equipment (Knowles, Ettenson, Lynch, & Dollens, 2020). Some firms, however, may find it difficult to introduce new product lines or to introduce them quickly following an environmental shock (Cooper & Schendel, 1976; Nelson & Winter, 1982; Tushman & Anderson, 1986). Due to their constrained resources and particularities regarding their risk-taking behaviour, some firms may make less rapid decisions and respond less effectively to the new environment than others (Carney, 2005; Kim & Vonortas, 2014; Sirmon & Hitt, 2003).

Researchers have demonstrated that the potential for firms to respond to the environment often depends on the firms' corporate liabilities, as the ones enclosed to firm age (Amburgey & Rao, 1996). Particularly, younger firms may lack established routines and experience to identify opportunities and properly respond to them (Kücher, Mayr, Mitter, Duller, & Feldbauer-Durstmüller, 2020). Empirical work also demonstrates that older firms may have an edge on industry-specific knowledge and accumulated goodwill with customers and/or suppliers (e.g., Barney, 1991; Cohen & Levinthal, 1990). On the other side of the

disciplinary divide, some scholars argue that young firms may exhibit more flexibility and speed in responding to the environment than old firms. This is because young firms suffer from less structural complexity and their routines are less rigid (Haveman, 1993).

Although older firms may have the knowledge, experience, and even resources, while young firms may have flexible routines, they may both decide not to respond to an environmental shock – or not to respond immediately. However, prior literature has emphasized that performance relative to aspirations can also interfere in current managerial decisions, preventing completely or delaying firms' response to the external environment (e.g., Lant & Hurley, 1999). Specifically, performance that is higher relative to aspirations tends to lock firms into existing businesses, making them reluctant to change (Cyert & March, 1963; Greve, 1998). Companies, for example, like Polaroid and Kodak, who made a fortune in film photography, fell into the “success trap” by exploiting only their historically successful business activities and failing to identify and expand in new domains. Illustrative examples like these may be suggestive of a link that exists between firm age and performance, which explains a firm's decisions on whether to expand in new product lines and when is the right time to do so, as a response to an environmental shock. Accordingly, it brings to the foreground the assumption often implied—but not yet tested in the product line extension literature—that high performance relative to aspirations motivates less risky firm behaviors and therefore, influences the way that age affects the time and number of new product line introductions (Kraatz & Zajac, 2001; Mishina, Pollock, & Porac, 2004). If this is true, performance relative to aspirations will moderate the relationship between firm age and product line extensions, as well as the relationship between firm age and the reaction time to an environmental shock through new product line additions.

Our goal is to investigate empirically this possibility. We use a unique sample of 973 manufacturers that introduced new product lines as a response to the COVID-19 pandemic.

To address the empirical challenge that older firms differ from younger firms across a range of different dimensions, we employ a novel multivariate matching approach, namely entropy balancing (e.g., Hainmueller, 2012; Hendricks, Howell, & Bingham, 2019). Our hypotheses linking firm age to number of new product line introductions and response time to environmental shocks are supported. Specifically, our models confirm the positive effect of firm age on the number of new product line introductions and the negative effect of firm age on the response time to environmental shocks. The results also indicate that for firms with higher levels of performance above industry average, the positive influence of firm's age on the number of new product line additions introduced when an environmental shock occurs is weaker than for firms with lower levels of performance above industry average.

In this paper, we build on and integrate disparate literatures on dynamic capabilities and behavioural theory of the firm to theorize and test a model that highlights the complex ways in which firm age and firm performance affect the pattern of product line introduction when severe environmental shocks occur. In doing so, we contribute to the research on corporate liabilities and extend our understanding of why and how firm age influences managerial decisions in highly complex and uncertain settings. Our study helps to clarify prior disagreements about the broader influence of firm age (e.g., Haveman, 1993, Sarangee & Echambadi, 2014). We also contribute to the burgeoning stream of product line extension research and extend researchers' limited understanding of the effects of firm performance. To our knowledge, our study represents the first empirical test of the moderating effects of firm performance relative to aspirations on the relationship between firm age and product line introduction. More broadly, our theory and model provide an appealing connection among corporate liability, firm performance, and product line extension literatures and, therefore, between the strategy and marketing realms. We also make a methodological contribution by

introducing a novel multivariate matching technique, namely entropy balancing, in the strategy and marketing literatures.

2. Theoretical background

2.1. Environmental shocks and dynamic capabilities theory

In conceptualizing environmental shocks, we refer to any sort of unexpected radical disruption emanating from outside the firm (i.e., Wenzel, Stanske, & Lieberman, 2020). We use the term “shock” rather than “crisis” or “recession”, as environmental shocks can create opportunities for firms, alongside challenges, and can affect every aspect of economic and social life. Examples of environmental shocks include shifts in political regimes, natural disasters, and/or pandemics. Although environmental shocks are heterogeneous, they share some common features. In particular, they tend to be sudden and trigger substantial environmental change (i.e., Marino, Lohrke, Hill, Weaver, & Tambunan, 2008; Meier & O’Toole, 2009; Meyer, Brooks, & Goes, 1990; Wright, Filatotchev, Hoskisson, & Peng, 2005). They can thus interfere with the firm’s ability to conduct business (Meyer, Brooks, & Goes, 1990). Indeed, one major implication of these shocks is that they can cause uncertainties regarding the firm’s current business and their fit with the new environment (e.g., Wan & Yiu, 2009).

Firms operating in environments where environmental shocks occur must often enter new, relevant to the shock business markets, as a means to respond to social or stakeholder pressure and, in turn, assure their survival and continuity (Chakrabarti, 2015; Ito, 1995). To put it differently, where uncertainties in a firm’s external environment are present, the firm may need to respond by introducing new product lines that are well suited to the new environment and the emerging needs. For example, as global auto sales plunged during the pandemic, many car manufacturers, including Rolls-Royce, Jaguar, Fiat, and Land Rover

responded to the social pressure resulted from the environmental shock by producing, among others, medical-grade face masks, gowns, and/or ventilators. *"In keeping with our altruistic nature, we have repurposed some of our teams to support the global effort to defend against COVID-19,"* Rolls-Royce's representatives said in a statement (National Business Aviation Association, 2020). In a similar spirit, Mike Manley, Fiat Chrysler CEO, wrote in a letter sent to employees that *"one of the group's plants in Asia would be converted to produce face masks for healthcare workers and would reach a target of one million masks per month in coming weeks"* (Reuters, 2020). An effective response to an environmental shock may also require that firms make timely adjustments in their business (e.g., Barr, Stimpert, & Huff, 1992). To survive, firms must be able to evaluate the new environment and identify well-suited businesses in a timely fashion (Teece, 2007). In fact, firms must reflect quickly on new ways of doing business and thus, introduce new product lines at an early stage (Kim & Bettis, 2014, Wenzel, Stanske, & Lieberman, 2020). Introducing new product lines at an early stage is necessary for building a strong market position and receiving all the benefits of learning in highly unpredictable and uncertain environments.

This general principal also underlies the dynamic capabilities theory (Eisenhardt & Martin, 2000; Pisano, 1994), which provides an underlying rationale for the introduction of new product lines that are well suited to the new environment and the speed of introduction. In particular, the spirit of dynamic capabilities theory is reflected in the importance assigned to the reconfiguration and transformation of firms ahead of competitors (Teece, Pisano, & Shuen, 1997). The proponents of this view argue that firms must respond to the environmental shock by maintaining sufficient alignment with the new environment and thus, reinvent themselves quickly by extending their product lines (Barker and Duhaime, 1997). Under this view, in order to reinvent themselves, firms must possess dynamic capabilities

defined as organizational and strategic routines by which managers alter their resources (Eisenhardt & Martin, 2000; Grant, 1996; Pisano, 1994). According to Zahra, Sapienza, & Davidsson (2006), however, these capabilities may differ in young versus mature firms, which often battle for market leadership.

While most scholars in the field acknowledge the importance of responding to environmental shocks quickly (e.g., Fredericks, 2005; Giunipero, Denslow, & Eltantawy, 2005), the role of firm's age in explaining the heterogeneity of capabilities possessed by different firms in this context is left undertheorized. In this study, we attempt to fill this gap by developing a more comprehensive picture of the influence of firm's age. We focus on this characteristic rather than other firm-level characteristics since firm capabilities are expected to undergo qualitative transformations within an aging firm and these transformations can be hardly overturned because age cannot be manipulated (Coad, Segarra, & Teruel, 2016). For example, one is not able to recommend a firm to stop aging or become 20 years older (Coad, 2018)¹. Age, therefore, can be a better proxy for the firm's capability base than other firm-level characteristics (Thornhill & Amit, 2003). Most importantly, age, can be particularly relevant in our setting (i.e., COVID-19 pandemic). While firms of the same size, for example, might have experienced different numbers of environmental shocks in the past, firms of the same age are expected to have survived the same number of environmental shocks and thus, to have the same experience in dealing with uncertainty. A focus on firm age, therefore, is particularly useful in isolating the influence of the firm's capabilities from other underlying mechanisms involved in the relationships examined.

We build, hence, on the dynamic capabilities theory to suggest that firm's age may influence both the number of new product lines that a firm is able to introduce, and the firm's

¹ In our analysis, we control for other firm-level characteristics (i.e., the number of employees; total sales; liquidity; working capital) to mitigate the possibility that our results are driven by their influence.

reaction time to an environmental shock through new product line additions. Firm's age is the prime indicator of how well the firm's resources and capabilities are aligned with the demands of the environment (Amit & Schoemaker, 1993; Thornhill & Amit, 2003). Further, as prior studies suggest, firm age is also associated with complex organizational and strategic routines (Gibson & Birkinshaw, 2004). These routines are often considered as higher-order metalevel capabilities that foster orientation toward exploration and thus, are closely linked to the firm's ability to explore new business opportunities (Gibson & Birkinshaw, 2004). Theoretically, young firms can possess similar capabilities and can develop a similar orientation. Because these lines of argument clearly lead to conflicting predictions about the relationship between firm's age and response to environmental shocks, we develop opposing hypotheses.

We further draw insights from the behavioral theory of the firm to develop hypotheses regarding the influence of firm performance relative to aspirations. The behavioral theory of the firm (Cyert & March, 1963) offers a framework better suited to modeling firms' decisions. According to this theory, firms set performance aspirations. Accordingly, failure to meet these aspirations can trigger "problemistic search" that leads firms to alter their programmed actions (Cyert & March, 1963; Greve 2003a). As we demonstrate the effects of firm's age interacts with performance relative to aspirations to influence both the firm's ability to introduce new product lines, and the firm's reaction time to an environmental shock through new product line additions. We organize our conceptual framework accordingly. First, we explicate alternative effects of firm age. We then offer predictions based on the two key sets of moderators: (1) performance that raises above the industry's average and (2) performance that falls below the industry's average. We use these two moderators as they signal the effectiveness of the firm's current lines of business relative to its aspirations (Cyert

& March, 1963; Greve, 1998; Thornhill & Amit, 2003). This process is illustrated in Figure 1.

[Insert Figure 1 about here]

2.2. *Firm age*

Firm age is typically seen as an easily observable characteristic that can influence business outcomes (Amit & Schoemaker 1993; Thornhill & Amit, 2003). This emphasis on age is a reflection of the perils of newness. As prior studies suggest, older firms have more organizational and strategic routines and greater access to resources in comparison to younger firms (Sorensen & Stuart, 2000). Younger firms, therefore, are more likely to face capability and resource constraints (Wiklund, Baker, & Shepherd, 2010). Specifically, younger firms may lack important capabilities and assets, such as name recognition, technological capabilities, and/or intangible resources needed to support the introduction of new product lines when an environmental shock occurs. Further, as older firms have more resources and capabilities available, they may also be better able to acquire new technologies and features that enable them to change their product development routines (Singh, Tucker, & House, 1986). Older firms, therefore, may possess dynamic capabilities that they can reconfigure and redeploy to create additional resources for the introduction of new product lines when an environmental shock occurs.

In the face of an environmental shock, lack of prior experience can further deteriorate the younger firms' ability to identify business opportunities more accurately in comparison to older firms (Kücher, Mayr, Mitter, Duller, & Feldbauer-Durstmüller, 2020). Following an environmental shock, the entire market will be in considerable flux and therefore, the environment will be highly uncertain (Kor & Misangyi, 2008). Because older firms have more experience and access to information, they might be better able to recognize and act on a range of business opportunities that arise in uncertain environments (Dimov, 2010;

Romanelli & Schoonhoven, 2001; Shepherd, Douglas, & Shanley, 2000; Ucbasaran, Westhead, & Wright, 2008). In fact, prior experience and access to novel information is needed for accumulating dynamic capabilities, which enable firms to explore the recognized opportunities (Laaksonen & Peltoniemi, 2018; Pandza & Thorpe, 2009). Older firms, therefore, are more likely to follow an exploration orientation where more product lines, suited to the emerging environment, are introduced to the market. In parallel, because older firms are endowed with increased resources, they can better support experimentation with a variety of product lines than younger firms can, in order to hedge their bets in the emergent phase of new and significantly uncertain business environment (Sarangee & Echambadi, 2014). This is in line with the dynamic capabilities theory, which emphasizes the importance of resources in experimentation (Teece, Pisano, & Shuen 1997). Accordingly, we hypothesize that:

Hypothesis 1a: Firm's age positively influences the number of new product line additions introduced when an environmental shock occurs.

A contradictory perspective, however, claims that younger firms are more willing to experiment with a variety of product lines as they have less structural complexity and therefore, less bureaucratization and formalization than older firms (Haveman, 1993). In addition, because younger firms have limited resources, they are more likely to react to an environmental shock by adding more resources and testing new alternative choices. Younger firms are less constrained by existing knowledge and thus, tend to experiment more than older firms. On the contrary, older firms may not engage in significant change due to committing themselves to existing courses of action (Hannan & Freeman, 1984). The pressures of inertia, therefore, may suppress the pressures of an environmental shock and may lead older firms to introduce less new product lines than younger firms. Accordingly, we offer a contradictory hypothesis that:

Hypothesis 1b: Firm's age negatively influences the number of new product line additions introduced when an environmental shock occurs.

Closely related to issues of a firm's response to an environment shock is the time it takes for the firm to respond to the given shock through new product line additions (i.e., reaction time). Such a time might also be a function of firm age. As we observed earlier, younger firms are more likely to face the constraint of limited resources in comparison to older firms (Wiklund, Baker, & Shepherd, 2010). In addition, younger firms may lack experience and therefore, relevant knowledge about what they can do or should do (Jovanovic, 1982; Lippman & Rumelt, 1982). These limitations can lead younger firms to perceive the decision to introduce new product lines as particularly risky, and in turn, extend the time it takes them to react to the environmental shock.

In the face of an environmental shock, advantages related to firm age can be further exacerbated. As prior studies suggest, environmental shocks place a premium on firms and push them to rethink and expand their business to fit the new environmental context (Putsis & Bayus, 2001, Wenzel, Stanske, & Lieberman, 2020). Through their abundant resources, and access to external contacts and information, older firms can quickly identify new business opportunities, and therefore, develop, and commercialize new product lines in a timely fashion. In contrast, younger firms are less ideally positioned to respond quickly to environmental shocks, as they lack resources and superior information for assessing the viability of alternative business options (Dimov, 2010; Shepherd, Douglas, & Shanley, 2000; Ucbasaran, Westhead, & Wright, 2008). Therefore we hypothesize that:

Hypothesis 2a: Firm's age negatively influences the reaction time to an environmental shock through new product line additions.

A plausible counterargument, however, would suggest that since older firms suffer from inertial pressures, their response to environmental shocks might be neither adequate nor timely (Coad, Segarra, & Teruel, 2016; Hambrick & D'Aveni, 1988; Le Mens, Hannan, & Pólos, 2015). Because older firms have more rigid structures and routines, they are more likely to experience competency traps that prohibit them from exploring new opportunities that arise from environmental shocks on time (Leonard-Barton, 1992). Younger firms, conversely, have less inertial pressures, which offer them more flexibility. They can thus respond to product line opportunities more readily than older firms (Hannan & Freeman, 1984). Therefore, we offer again a contradictory hypothesis suggesting that:

Hypothesis 2b: Firm's age positively influences the reaction time to an environmental shock through new product line additions.

2.3. Firm performance relative to aspirations as a boundary condition

We also aimed to push the boundaries of our phenomenon by examining a closely related contextual and managerially relevant moderator, namely firm performance relative to aspirations. In the behavioral view, firms use an aspiration level, which is "*the smallest outcome that would be deemed satisfactory by the decision maker*" (Schneider, 1992: 1053) to their evaluate performance. Previous research has suggested that evaluating the firm's current performance against the industry average can provide an indication as to whether there is (mis)alignment between what a firm can do and what the environment requires (Amit & Schoemaker, 1993; Thornhill & Amit, 2003). It is possible that such a (mis)alignment can strengthen or weaken the influence of age. Specifically, we posit that a firm's performance can serve as either a facilitator or an inhibitor when it lags behind or exceeds the industry average (e.g., Cyert & March, 1963; Greve, 1998; Thornhill & Amit, 2003). Therefore, to

assess the influence of firm performance relative to aspirations, we consider two key performance benchmarks: performance above the industry average and performance below the industry average.

Performance above the industry average: A performance that exceeds the industry average demonstrates that the firm's resources and capabilities are well aligned with the environment (Amit & Schoemaker 1993; Thornhill & Amit, 2003). Theoretical and empirical studies have supported the contention that firms who enjoy such alignment may be disinclined to change (Cyert & March, 1963; Greve, 1998). As Greve (1998) suggests, the likelihood of change or risky behaviour drops rapidly for firms that enjoy performance that exceeds the industry average. Accordingly, a sizable body of empirical work has shown that there is a link between strong performance compared to the industry average and persistence with current businesses (e.g., Fiegenbaum & Thomas, 1995; Hu, Blettner, & Bettis, 2011; Massini, Lewin, & Greve, 2005). Such a performance may lock firms into previously successful businesses, because it increases their confidence with respect to potential organizational outcomes (Lant & Hurley, 1999, Lant, Milliken, & Batra, 1992, Levinthal & March, 1993; Milliken & Lant, 1991). Importantly, firms are likely to be considerably more confident in their abilities and less likely to expand in new product lines (Levinthal & March, 1993). Another implication of such an inertia may also be that firms will be slower and less motivated to respond to an environmental shock as their current performance might lead them to exaggerate their chances of survival and success in a changing environment (Levinthal & March, 1993).

In summary, we expect an increase of performance above the industry average to weaken the positive impact (or strengthen the negative impact) of firm age on the number of new product line additions introduced when an environmental shock occurs. Additionally, we expect that an increase of performance above the industry average to weaken the negative effect (or strengthen the positive effect) of age on the reaction time to an environmental

shock through new product line additions. These weakening and/or strengthening effects might arise because forces of inertia should not only reduce the firm's flexibility regardless of its age, but also its ability to sense, experiment or react to the changes in the environment in a timely fashion. Therefore, firms that enjoy performance above the industry average are expected to pay less attention to the overall environment dynamics (Daft & Weick, 1984).

More formally, we hypothesize that:

Hypothesis 3a: As firm performance raises above the industry's average, the positive influence of firm's age on the number of new product line additions introduced when an environmental shock occurs becomes weaker.

Hypothesis 3b: As firm performance raises above the industry's average, the negative influence of firm's age on the number of new product line additions introduced when an environmental shock occurs becomes stronger.

Hypothesis 3c: As firm performance raises above the industry's average, the negative influence of firm's age on the reaction time to an environmental shock through new product line additions becomes weaker.

Hypothesis 3d: As firm performance raises above the industry's average, the positive influence of firm's age on the reaction time to an environmental shock through new product line additions becomes stronger.

Performance below the industry average: Whereas firms that perform above the industry average may be locked into previously successful businesses, firms performing below the industry average may be highly inclined to change (Cyert & March, 1963; Greve, 2003a). In contrast to performance above the industry average, performance below the industry average demonstrates that the firm's resources and capabilities are misaligned with the environment (Amit & Schoemaker, 1993; Thornhill & Amit, 2003). Such a misalignment is indicative of

serious problems facing the firm (Greve, 2003a, 2003b) and thus, it may be directly associated with exploration of alternative business opportunities (Cyert & March, 1963). As March (1991) suggests firms who score below the industry average in terms of performance may choose to undergo rounds of exploratory search, which can be significantly risky (Voss, Sirdeshmukh, & Voss, 2008). In summary, with greater opportunities for experimentation, we expect firms regardless of their age to respond to performance below the industry average by introducing more product lines that are suited to the new environment and by reacting more quickly (in less time) to an environmental shock through new product line additions. More formally, we hypothesize that:

Hypothesis 4a: As firm performance falls below the industry's average, the positive influence of firm's age on the number of new product line additions introduced when an environmental shock occurs becomes stronger.

Hypothesis 4b: As firm performance falls below the industry's average, the negative influence of firm's age on the number of new product line additions introduced when an environmental shock occurs becomes weaker.

Hypothesis 4c: As firm performance falls below the industry's average, the negative influence of firm's age on the reaction time to an environmental shock through new product line additions becomes stronger.

Hypothesis 4d: As firm performance falls below the industry's average, the positive influence of firm's age on the reaction time to an environmental shock through new product line additions becomes weaker.

3. Methodology

3.1. Empirical setting

The COVID-19 outbreak was chosen as the empirical setting for our study. The first case of COVID-19 was reported in late 2019 in Wuhan, China, but as soon as March 2020 there were cases confirmed in several other countries and regions. With over 285 million confirmed cases and 5.4 million deaths worldwide (World Health Organization, 2021; Worldometers, 2021), COVID-19 is seen as a major environmental shock. In fact, COVID-19 has curtailed large areas of business activities over the months, as measures on the part of governments were implemented to limit the spread of the virus. In addition, demand stagnation has been seen in many industries. Many firms resources, therefore, were left un-deployed and firms have endured significant revenue losses from the pandemic (Bagchi, Chatterjee, Ghosh, & Dandapat, 2020).

Notwithstanding the challenges experienced by firms, there were also several opportunities emerging from the pandemic. For example, opportunities have appeared in increased market demand for certain products, such as personal protection equipment, medicinal equipment, and other medical devices. To better recover from the environmental shock, many firms transformed drastically their operations to allocate their un-deployed resources and to manufacture urgently these products. Giorgio Armani, Burberry, Gucci and Prada, for instance, altered their designer clothing factories to produce masks, gloves, and nonsurgical gowns. Similarly, automotive giants like Ford, Tesla, Suzuki, etc. shifted their production from cars to ventilators and hospital beds (Bagchi, Chatterjee, Ghosh, & Dandapat, 2020). Thus, flexibility and expansion in new businesses where product demand became stronger played a crucial role in buffering firms from the adverse effects of the pandemic. As a result, using COVID-19 as our focal empirical setting allows us to test our theory and hypotheses concerning the patterns of new product line introductions in response to environmental shocks.

3.2. Data and sample

As explained earlier, amid the COVID-19 pandemic, many firms in different countries, including Portugal, begun to redeploy their resources and production lines to meet the booming demand for medical devices and personal protective equipment. In response to this, the Portuguese Government issued new regulations, namely the Decree-Law no. 14-E / 2020, that established an exceptional and transitional regime for the manufacture, import, placement, and availability in the national market of these products. Following the European guidelines, the Government created a task force that established the technical requirements for each type of product, and designated independent entities to test and certify the new products (National Health Department, CITEVE and CTCP). In the first semester of the pandemic in Portuguese ground, 1,311 private firms proposed new products to get such certification and thus, ensure that their products meet the essential requirements. Data on the firms' name, product developed, and date of certification were obtained by the official list, namely Certification Entities' Database/List, provided by these entities. Furthermore, we were able to obtain secondary data for these firms from the financial database SABI, the Iberian Balance Sheet Analysis System, provided by INFORMA D&B and Bureau Van Dijk. This database has general information and annual financial data of Portuguese firms. After excluding for missing data, we ended up with a sample of 973 Portuguese firms.

3.2.1. Dependent variables

To compute our main dependent variables, we obtained data from the Certification Entities' Database/List. These data are unique in elucidating the product line activity of the firms during the COVID-19 crisis (i.e., since March of 2020 when the first COVID-19 case was recorded in Portugal) and the timing of these new line introductions. In the following, we describe the computation of the dependent variables used in this study.

New product line additions. To compute this variable, we used information about the new product lines firms added in response to the COVID-19 crisis. We coded the variable as a count variable to reflect the varying degree to which a firm may engage in new product line additions as form of altering or extending its businesses.

Reaction time through new product additions. To measure the reaction time, we used a count variable, which reflects the number of days between the country's announcement of the first coronavirus case and the introduction of the first new product line that a firm has added in response to the COVID-19 crisis.

3.2.2. Independent variables

Firm age. To compute firm age, we used the total number of years since the founding of the firm.

Firm performance relative to aspirations. We assessed firm performance with an objective financial indicator, that is, the return on assets (ROA). ROA is calculated as the ratio of total income to assets (e.g., Tang, Hull, & Rothenberg, 2012). The measure indicates the short-term future financial efficiency of the firm and therefore, is widely monitored by managers and commonly used by researchers (e.g., Feng, Morgan, & Rego, 2015; Lehmann & Reibstein, 2006). Following, we measured firm performance relative to the industry's average by calculating the average performance of firms that belong to the same industry group (Audia & Greve, 2006). To identify these firms, we used the firms' SIC codes (Mishina, Dykes, Block, & Pollock, 2010). The average performance of firm's i competitors at time t is given by the following equation:

$$\text{Industry average performance} = \sum_{j \neq i} \text{Performance}_{jt} / N$$

where, $Performance_{jt}$ is the performance in terms of the ROA of competitor j at time t and N is the total number of the firm's i competitors.

We then estimated the two moderating variables of the study by employing a spline function (e.g., Audia & Greve, 2006). Specifically, we constructed two separate variables for *Performance above industry average* and *Performance below industry average* (e.g., Harris & Bromiley, 2007; Mishina, Dykes, Block, & Pollock, 2010). We measured performance above industry average by subtracting the measurement of *Industry average performance* from ROA_{it} . We further measured performance below industry average by subtracting ROA_{it} from *Industry average performance*. To assist the interpretation of our models, we used the absolute values of both measures. Also, we replaced all negative values with zero, while leaving all other values unaffected (positive values and zero) (see e.g., Kuusela, Keil, & Maula, 2017).

3.2.3. Control variables

In our models, we control for various firm characteristics measured in 2019 (i.e., prior to the 2020 announcement of the first coronavirus case in Portugal). We obtained these measures from the financial database SABI and the Certification Entities' Database/List. We used the number of employees (*No of Employees*) and total sales (*Total Sales*) as indicators of firm size (Riahi-Belkaoui & Pavlik, 1991; Smith, Guthrie, & Chen, 1989). We used firm liquidity (*Liquidity*) to control for firm wealth (Thomsen & Pedersen, 2000). Cash flow (*Cash Flow*) was used to account for the firm's short-term sources of finance (Walker & Petty, 1978; Deakins, Logan, & Steele, 2001). We used working capital (*Working Capital*) to control for the availability of funds and thus, the firm's ability to meet current operations (Eljelly, 2004). Further, we controlled for the number of product lines that the firm had prior to the COVID-19 crisis (*Prior Assortment Width*) and the depth of the firm's assortment (*Assortment*

Depth), measured as the average variety of individual product groups within the firm's product lines. Finally, industry effects were captured by using industry codes (SIC codes) and a dummy variable, which takes the value 1 if the firm is a manufacturing firm and 0 otherwise.

4. Estimation approach

4.1. Model framework: Poisson and negative binomial regression

Both dependent variables of our study (i.e., number of new product line additions and reaction time) are observed counts, and thus take on only non-negative integer values (i.e., 0, 1, 2, 3, and so on). Although count variables are often treated as continuous within the linear regression framework, this approach can result in inefficient and biased estimates (Trivedi, 1997). Count data models have been introduced to deal explicitly with the characteristics of non-negative, integer-valued random variables (Long & Long, 1997). Specifically, the Poisson model is widely used in past literature for the analysis of events, such as patenting behavior, product innovation, discoveries, etc. (Trivedi, 1997). The Poisson process describes the frequency of an event per period of time and assumes that the parameter, λ , for each case i is given by

$$\lambda_i = \exp(X_i' \beta), \quad (1)$$

where, λ is a function of a vector of regressors, and is also the expected value of any Poisson random variable of the i th entity at time t ; X_i is a vector of i th entity's characteristics and other explanatory variables; β is a conformable matrix of unknown parameters to be estimated. Rare events, such as discoveries or accidents, are assumed to occur according to a Poisson process. The parameter λ is known as the rate of occurrences, since it is the expected number of times that an event has occurred per unit of time, and λ can also be thought of as the mean or expected count (Long & Freese, 2001).

The exponential functional form in (1) ensures a non-negative λ for all values of X and β . This specification is attractive because it is consistent with the integer nature of rare events data and, in particular, one may often observe non-occurrences of events at any given time. Thus, the basic Poisson model captures the discrete and non-negative nature of the dependent variable and allows one to draw inference on the probability of the occurrences of an event. The basic Poisson probability specification is given as (Long & Freese, 2001):

$$\Pr(y | \lambda) = \frac{e^{-\lambda} \lambda^y}{y!}, \text{ for } y = 1, 2, 3, \dots, \infty, \quad (2)$$

where, y is a random variable indicating the number of times an event has occurred. The following assumptions are made about the Poisson distribution (Long & Freese, 2001): (i) λ is the mean of the distribution and as λ increases, the mass of the distribution shifts to the right; (ii) λ is also the variance, and thus, $var(y) = \lambda$, which is known as equi-dispersion; (iii) as λ increases, the probability of a zero count decreases, and for many count variables, there are more observed zeros than predicted by the Poisson distribution; (iv) as λ increases, the Poisson distribution approximates a normal distribution.

The Poisson model can be estimated by the maximum likelihood method. One property of the Poisson regression model is that the variance of the data is equal to the conditional mean. If this property does not hold, the situation is analogous to heteroscedasticity in ordinary least squares models. In such case, the coefficient estimates are consistent, but inefficient. In real data, many count variables have a variance greater than the mean, which is called over-dispersion. The presence of over-dispersion may suggest that the use of the negative binomial distribution is more appropriate than the Poisson (Long & Long, 1997). The negative binomial regression model is an extension or modification of the Poisson regression model that allows the variance of the process to differ from the mean. The mean λ_i , is re-specified as

$$\lambda_i = \exp(X_i\beta)\exp(\varepsilon_i) = \lambda_i\exp(\varepsilon_i) = \lambda_i\delta_i, \quad (3)$$

where, $\exp(\varepsilon_i)$ has a gamma distribution with mean 1.0 and variance α . ε is a random error that is assumed to be uncorrelated with X , and it can be considered either as the combined effects of unobserved variables that have been omitted from the model or as another source of pure randomness. The negative binomial probability distribution is given as:

$$\Pr(y_i | X_i) = \frac{\Gamma(y_i + v_i)}{y_i! \Gamma(v_i)} \left(\frac{v_i}{v_i + \lambda_i} \right)^{v_i} \left(\frac{\lambda_i}{v_i + \lambda_i} \right)^{y_i}, \quad (4)$$

where, $v_i = \alpha^{-1}$. Compared with the Poisson model, the negative binomial probability distribution model has an additional estimable parameter α , such that $\text{Var}(y_i) = E(y_i)\{1 + \alpha E(y_i)\}$. This is a natural form of over-dispersion and the over-dispersion rate, i.e. $\text{Var}(y_i)/E(y_i) = 1 + \alpha E(y_i)$. The α is known as the dispersion parameter since an increasing α increases the conditional variance of y . The model can be estimated by the standard maximum likelihood method. If α is not statistically different from zero, then the simple Poisson model is more appropriate.

Our analysis showed that the variance of both our dependent variables (i.e., number of new product line additions and reaction time) is greater than the mean value, which is a symptom of over-dispersion due to unobserved heterogeneity. We, therefore, estimated two negative binomial regression models, which account for greater than Poisson variation and correct for problems relating to unobserved heterogeneity (e.g., Almeida & Phene, 2004; Arregle, Beamish, & Hébert, 2009). Further, negative binomial regression models account for omitted variable biases (Cameron & Trivedi, 1986; Hausman, Hall, & Griliches, 1984).

4.2. Entropy balancing: A novel approach for sample adjustment

In testing our hypotheses, we address the empirical challenge that older firms differ from younger firms across several different dimensions, which may drive our results. To assess this challenge, we built a binary treatment variable that identifies old firms per the commonly used definition—specifically, those that are more than 10 years old. A great deal of prior

studies use this year of age as cut-off point to categorize a firm as either young or old. Specifically, young firms are considered as those that are at least one year old, but not more than 10 years old. Consequently, old firms are considered as those that are more than 10 years old (e.g., Eisenhardt & Schoonhoven, 1996; Fernhaber & Patel, 2012; Yli-Renko, Autio, & Sapienza, 2001).

In line with our expectation, and as indicated in Table 1, the descriptive statistics for our study sample suggest that older firms, in comparison to younger, are generally larger (in terms of number of employees), with higher performance, sales, liquidity, working capital, and cash flow. Also, they tend to have a wider range of product lines. Relevant t-tests on these variables confirm that older firms are not comparable to younger firms (i.e., p-values < 0.10).

[Insert Table 1 about here]

We assert that this could be a potential source of selection bias, in that, non-random factors exist, which both correlate with firm age, as well as the number of new product lines introduced and the reaction time. To address this potential concern we pre-balance the sample based on the firm's age. More precisely, we employ entropy balancing—a recently developed, novel multivariate matching approach—to account for these differences between older and younger firms that may influence our results (Hainmueller, 2012).

In essence, entropy balancing creates a “synthetic” control group based on weighting each observation so that treatment (i.e., younger firms in our study) and control group (older firms) are as similar as possible, based on a predefined set of covariates and their moments (Abadie, Diamond, & Hainmueller, 2010). Entropy balancing directly addresses the covariate imbalance between our two groups of firms by reweighting observations in the sample of older firms (control group) such that the distributional moments of the matching variables for

the reweighted sample are indistinguishable from the moments of the distributions of these variables for the sample of younger firms (treatment group).

By achieving covariate balance, entropy balancing can be used to either reduce model dependence (i.e., substantial variations in the causal effect depending on different model specifications and assumptions), when subsequently estimating treatment effects in observational survey data, or to simply achieve sample adjustment. In practice, entropy balancing employs a maximum-entropy reweighting scheme to create a set of weights such that the reference and reweighted non-random samples satisfy a large set of balance constraints. The weighting procedure calculates weights to be as similar as possible (in entropy terms) to base weights, optimising the twin goals of improved balance in covariate distribution and maximum retention of information (the latter is enhanced by the entropy approach's ability to vary weights smoothly across units). Balance can be introduced on the first (mean), second (variance), and, potentially, third (skewness) moments of the covariate distributions, and the procedure can be set to iterate repeatedly until the variance of the weights cannot be reduced further without undermining the balance constraints.

We accomplished entropy balancing by solving a straightforward optimization problem. Specifically, weights are selected to minimize the entropy distance metric:

$$\min_{w_1} H(w) = \sum_{\{i|D=0\}} w_i \log(w_i/q_i) \quad (5)$$

where w_i is the weight selected for each non-random sample units. $D_i \in \{1,0\}$ is a binary indicator coded as 1 if unit i is drawn from the reference sample or 0 if it is drawn from the non-random sample. $q_i = 1/n_0$ and is a base weight. The selection of weights is subject to the balance constraints defined as: $\sum_{\{i|D=0\}} w_i c_{ri}(X_i) = m_i$ with $r \in \{1, \dots, R\}$; the normalizing constraints defined as: $\sum_{\{i|D=0\}} w_i = 1$; the non-negativity constraints defined as: $w_i \geq 0$ for all i such that $D = 0$. X is a matrix that contains the data of J exogenous pre-treatment covariates with X_{ij} denoting the values of the j th covariate characteristic for unit i . Last,

$c_{ri}(X_i) = m_i$ describes a set of R balance constraints imposed on the covariate moments of the reweighted non-random sample group.

5. Results

Table 2 presents the correlation matrix of our study. All correlation coefficients are relatively low. To examine whether multicollinearity poses a statistical concern, we compute the variance inflation factors in our equations. None of the variance inflation factors was greater than the maximum threshold of 10 (Gujarati, 2003). Specifically, the VIF scores in all equations ranged from a minimum of 2.03 to a maximum of 2.95, indicating that multicollinearity was not a problem. The overall fit of our models is assessed by the log likelihood value and Chi-square.

[Insert Table 2 about here]

Tables 3 and 4 present the results of the negative binomial models with entropy balancing, using the two different dependent variables of the study. In each case, we first estimated a baseline model including only the control variables. Next, we added the direct term (i.e., *Firm Age*). In the last three models, we added the interaction terms to the variables included in the previous model. Specifically, Models 1 and 6 contain all the controls, Models 2 and 7 contain both controls and the direct effect, Models 3 and 8 contain the first interaction term (i.e., *Firm Age*Performance above industry average*), Models 4 and 9 contain the second interaction term (i.e., *Firm Age*Performance below industry average*), and Models 5 and 10 contain both interaction terms (i.e., *Firm Age*Performance above industry average*; *Firm Age*Performance below industry average*).

Hypotheses 1a (1b) proposed that firm's age has a positive (negative) effect on the number of new product line additions introduced when an environmental shock occurs. The

results of Model 2 show that coefficient of *Firm Age* is both positive and significant ($\beta = 0.009$, $p < 0.05$), so Hypothesis 1a (1b) is supported (rejected). Model 3 tests Hypotheses 3a and 3b by adding the coefficient for the interaction term between firm age and performance above industry average. The coefficient for the interaction term was negative and significant ($\beta = -0.215$, $p < 0.1$). Therefore, we find support for Hypothesis 3a, positing that as firm performance raises above the industry's average, the positive influence of firm's age on the number of new product line additions introduced when an environmental shock occurs becomes weaker. To understand the nature of this significant interaction, we plotted the results in Figure 2 (e.g., Aiken & West, 1991). Figure 2 indicates that at higher levels of performance above industry average, the positive influence of firm's age on the number of new product line additions introduced when an environmental shock occurs is weaker than it is at lower levels of performance above industry average. This result provides further support for Hypothesis 3a and reject convincingly Hypothesis 3b.

[Insert Figure 2 about here]

Following, we test hypothesis 4a (4b), suggesting that as firm performance falls below the industry's average, the positive (negative) influence of firm's age on the number of new product line additions introduced when an environmental shock occurs becomes stronger (weaker). We thus expect the interaction between firm age and performance below industry average to be positive and statistically significant. In Model 4, the interaction term is positive but insignificant ($\beta = 0.094$, $p > 0.1$) and thus, we find no support for this hypothesis. Qualitatively similar interaction effects are obtained in Model 5.

[Insert Table 3 about here]

In Hypotheses 2a (2b), we predicted that firm's age will negatively (positively) influence the reaction time to an environmental shock through new product line additions. In model 7, the effect of firm's age on the reaction time through product line additions was negative and significant ($\beta = -0.003$, $p < 0.05$), supporting (rejecting) Hypothesis 2a (2b). Models 8 examined Hypothesis 3c (3d), suggesting that as firm performance raises above the industry's average, the negative (positive) influence of firm's age on the reaction time to an environmental shock through new product line additions becomes weaker (stronger). As we see in Model 8, the interaction term between firm age and performance above industry average is positive and insignificant ($\beta = 0.032$, $p > 0.01$). Thus, H3c (H3d) is rejected. In Model 9, we included the interaction term between firm age and performance below industry average. The coefficient of the interaction term is positive and insignificant ($\beta = 0.049$, $p > 0.01$). These results reject Hypothesis 4c (4d), predicting that as firm performance falls below the industry's average, the negative (positive) influence of firm's age on the reaction time to an environmental shock through new product line additions becomes stronger (weaker). In Model 10, the results for both moderation effects remained qualitatively similar.

[Insert Table 4 about here]

Last, we rerun our negative binomial models without pre-balancing our sample as a robustness test. This is to ensure that our estimations are not influenced by the application of the entropy-balancing procedure. As shown in Tables 5 and 6, our results remain virtually unchanged, suggesting that our main insights are not driven by the method.

[Insert Table 5 about here]

[Insert Table 6 about here]

6. Discussion

The recent outbreak of COVID-19 pandemic has increased its pressure on firms to introduce new, relevant to the pandemic, product lines that suit better the environment (e.g., Chesbrough, 2020; Hausman & Johnston, 2014; Knowles, Ettenson, Lynch, & Dollens, 2020). While some firms are able to respond to this pressure, others may find it difficult to introduce new product lines or to introduce them quickly to the market (Levinthal & March, 1993; Wenzel, Stanske, & Lieberman, 2020). This study investigates the factors that influence both the number of new product line additions that firms introduce when an environmental shock occurs and the reaction time to an environmental shock through these new product line additions. By focusing on firm age and its interaction with performance aspirations, we substantiate our claim that a firm's performance that raises above (falls below) the industry's average, weakens (strengthens) the positive effect of firm's age on the number of new product line additions introduced when an environmental shock occurs, as well as the negative effect of firm's age on the reaction time that a firm needs to respond to an environmental shock through these new product line additions.

6.1. Theoretical contributions

Our findings advance current approaches to the explanation of product line introductions in several ways. The influence of firm age points to the importance of resources and capabilities in uncertain environments (Aldrich & Auster, 1986; Bode, Wagner, Petersen, & Ellram, 2011; Chakrabarti, 2015). These are the foundation for a firm's ability to respond to external shocks and as such, they can expand perceived opportunities for entering new business lines in a timely fashion (Singh, Tucker, & House, 1986; Thornhill & Amit, 2003). Such an interpretation would be consistent with Levitt and March's (1988) observation that capability increases with age. Our study reveals that although this assumption holds in some cases, in

many other cases it does not. What emerges from our findings is a highly contingent view of the influence of firm age that ensue from the performance of the firm. Specifically, our results demonstrate that performance aspirations can dictate the firm's risk-taking activity (e.g., Kitching, Smallbone, Xheneti, & Kasperova, 2011), weakening the relationship between firm age and the number of new product line additions introduced when an environmental shock occurs. For example, a performance that exceeds the industry average indicates alignment of the firm's resources and capabilities with the environment in which the firm operates (Thornhill & Amit, 2003). Firms who experience such an alignment are less likely to employ risky behaviour and change their status quo, in fear of failure (see e.g., Greve, 1998). These findings indicate that the effects of firm age are real, but we need to account for contingencies that are likely to weaken these effects. Indeed, the role that firm performance play has been all but ignored in existing literature. Our study fills this gap and further suggests that other systematic differences in how new product introductions as a function of firm age should be explored.

The findings of the moderating effect of performance relative to aspirations may also have implications for liability of newness research. Prior studies in the field have taken for granted the view that mature firms are more able to respond to uncertain environments (e.g., Hmieleski, Carr, & Baron, 2015; Leifer, O'Connor, & Rice 2001; Mohan- Neill, 1995). Different performance benchmarks, however, may have distinct impacts on the extent to which these firms are able to respond effectively (Audia & Greve, 2006; Mishina, Dykes, Block, & Pollock, 2010). Future research on liability of newness might fruitfully examine how other behavioural aspects, in addition to performance aspirations examined in this study, influence firm risk-taking in periods of uncertainty through their interplay with firm age.

From the perspective of the broader literature on corporate liabilities, the findings of our study help resolve some of the previous contradictory findings. At the heart of this

literature, there are two contradictory beliefs about the role of firm age. On the one hand, flexibility concerning the management of resources as a means to adapt to an uncertain environment is purported to increase with firm age (e.g., Singh, Tucker, & House, 1986; Romanelli & Schoonhoven, 2001; Sarangee & Echambadi, 2014). On the other hand, it is often believed that this same flexibility decreases, as firms grow older (e.g., Hambrick & D'Aveni, 1988; Hannan & Freeman, 1984; Haveman, 1993). Our study indicates that the conflicting findings in the literature can be attributed to systematic differences that firms exhibit in their performance. For example, firm age is associated with less flexibility when the firm is performing better than its industry peers are. But when these circumstances were reversed (i.e., the firm is performing less than its industry peers), the influence of firm age could become highly positive.

Finally, our study contributes to the strategic management literature by trying to understand under what conditions firms can survive severe environmental shocks. As discussed, under negative environmental conditions triggered by such a shock, if companies wish to maintain their competitive position and stay relevant, they must introduce new product lines in a timely manner (e.g., Chesbrough, 2020; Hausman & Johnston, 2014; Knowles, Ettenson, Lynch, & Dollens, 2020). A focus on firm age is especially informative in this setting as resource availability and prior experience play a more vital role in the firms' ability to introduce new product lines. As prior studies suggest environmental shocks pose a greater threat to smaller firms rather than larger firms whose competitive edge is based on economies of scale and scope (Dass, 2000; Porter, 1980). In fact, the primary concern for smaller firms during an environmental shock is survival and to achieve this, they need to undergo cost-cutting at the risk of reducing their ability to adapt adequately to the new environment and therefore, their ability to introduce new product lines (Kitching, Smallbone, Xheneti, & Kasperova, 2011).

6.2. Practical contributions

These findings should encourage managers and policy makers to consider the broader implications of age. Understanding the influence of age on the firm's ability to respond to environmental shocks is important for the design and implementation of firm strategies and support schemes provided to businesses at a subnational level. In designing these strategies and schemes, managers and governments have to recognise that certain businesses (i.e., those that are relatively young) are more vulnerable to environmental shocks than others (i.e., those that are relatively mature) and thus, less able to respond to environmental shocks effectively. They should offer, therefore, tailored support based on their individual needs. For example, young businesses may need more financial support available from a range of internal and external sources as well as more access to networking opportunities that enable them to leverage new knowledge and other complementary resources (Aldrich & Auster, 1986; Bode, Wagner, Petersen, & Ellram, 2011; Chakrabarti, 2015).

Managers and policy makers should also anticipate that even mature firms may delay their response or decrease their response rate to environmental shocks, if their performance exceeds the industry average (Audia & Greve, 2006; Mishina, Dykes, Block, & Pollock, 2010). They must thus provide firms with incentives to increase total risk and thus, encourage the exploration of alternative growth opportunities. Our research reaffirms that managers and policy makers, along with age, should weight up the importance of performance aspirations when designing and implementing policies and strategies.

Our findings also imply that to limit the adverse impact of environmental shocks and generate additional resources, young firms may need to compete with the more affluent mature firms and to collaborate with the less affluent mature firms simultaneously (Lavie,

2006). Because the affluent mature firms tend to be more rigid when facing radical uncertainty, a window of opportunity for younger firms to create value by extending their business into wider areas of scope can emerge. Once this opportunity arises, collaboration with less affluent mature firms may also become relevant. These firms are rather flexible, but may still be willing to collaborate with younger firms with the aim to access complementary resources (Chetty & Wilson, 2003). In essence, it is quite possible that young firms can enjoy a great degree of assistance from these collaborations through coproduction activities and the sharing of available resources. They can thus compete more effectively with the more affluent mature firms in highly uncertain environments.

We also showed that a performance which exceeds the industry average may hinder the positive reaction of a mature firm to the environmental shock by introducing new product lines. Hesitation to react to the environmental shock, in fear of changing their status quo, may inevitably pose a serious threat to high performing, mature firms that exceed their performance aspirations. Managers must realise that when the environment is so unpredictable, the sustainable competitive advantage may not come from being static and focusing on what they know already, but from developing new organizational capabilities that foster rapid adaptation to the new environmental conditions. Firms that thrive during an environmental shock are the ones that use some form of experimentation to develop and test new products and services tailored to the emerging needs. To be able to do this, however, managers must be quick to read and act on signals of change, think beyond their own boundaries, and ultimately work closely with their customers and suppliers. When the environmental shocks occurs, firms may depend on building these new capabilities, as a means to maintain or even improve their performance relative to aspirations and stay ahead of their competitors.

6.3. Methodological contributions

We also make a methodological contribution by introducing a novel multivariate matching technique, namely entropy balancing, in the strategy and marketing literatures. Although a range of matching methods are often used in observational studies in strategy and marketing, one major issue is that most of these methods do not directly focus on producing covariate balance. In the most widely used methods, researchers check manually until they can achieve a satisfactory balancing solution (Hainmueller, 2012). The aim is that the estimated propensity score should stochastically balance the covariates. To achieve this, however, researchers should find the correct model specification and need relatively large samples (Hainmueller, 2012). As low balance levels tend to prevail, prior studies often accomplish the exact opposite of their intended goal (Hendricks, Howell, & Bingham, 2019).

In contrast to other commonly used matching methods, entropy balancing involves a reweighting scheme that directly incorporates covariate balance into the weight function that is applied to the sample units. The distributional moments of the matching variables for the reweighted sample of control firms are indistinguishable from the moments of the distributions of these variables for the sample of treatment firms. By achieving covariate balance, entropy balancing can reduce model dependency (Hainmueller, 2012). Our study demonstrates the utility of the entropy balancing technique empirically and provides a working example on how this technique can be used to answer prevalent research questions in the strategy and marketing literatures.

6.4. Limitations and directions for future studies

Despite the interesting results, this study has some limitations. First, we used data from 973 Portuguese firms that obtained certification to introduce new product lines in response to the

COVID-19 pandemic and were listed in the Certification Entities' Database/List. This may reduce the representativeness in terms of other regions, specific sectors, or types of companies. Future studies should include a wider range of companies in European regions. Also, we do not have similar data regarding non-EU countries, such as the United States of America, Japan, or emerging economies, such as China and India. Someone would naturally wonder: what if these countries are not reacting like the European countries vis-à-vis the current pandemic? What if their firms are not introducing new product lines in response to the crisis? Second, our data are cross-sectional and therefore do not capture the dynamic nature of the pandemic. Time series data would be able to provide much better information on the effects of the crisis, and the next studies will certainly shed light on this. Further research must be carried out when more accurate data is available. To gain better insights, it would be also particularly useful if one can compare the patterns of new product line introduction during and before the pandemic. In fact, if firms adopt similar rates of new product line introduction and similar timeframes under normal circumstances, then the importance of our empirical setting (i.e., COVID-19 pandemic) can be undermined. In our study, we do not test for this issue due to insufficient data. Also, given that our chosen empirical setting is very dynamic, with the COVID-19 pandemic still ongoing, future studies should consider the duration of the environmental shock and most importantly the duration of its effects. These suggestions will make it possible to investigate more in depth the dynamics of new product line additions and responsiveness over time.

Further, due to lack of relevant information, our study does not consider the differences in the resource allocation and therefore, for the level of commitment necessary for the development of each product line. Indeed, there is the possibility that different product lines necessitate unequal resource allocation to ensure their development and timely introduction to the market. Future studies would benefit from recalculating the dependent

variables used in this study (i.e., new product line additions; reaction time through new product additions) by incorporating weighting, which accounts for this issue.

Moreover the data considered here provide information on firms that have already introduced new product lines during the pandemic, but do not consider what influences firms' decision whether to introduce new product lines in response to an environmental shock or not. Future analysis must also consider the timeframe and the intensity of the pandemic in different regions, and account for the interaction between our dependent variables and firm characteristics. It is possible also that some of the new product line introductions observed in this study are driven by the focal firm's ability to access complementary resources and knowledge from external partners. Future research should attempt to capture if the moderating effect of networking opportunities and collaboration is significant. Collectively, these limitations open the door for future research that focuses on the role of specific moderators in influencing the relationships between firm characteristics and new product line additions during environmental shocks.

Declaration of Interests

None.

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Table 1. Descriptive statistics by firm age classification with and without entropy balanced matching

Before entropy balanced matching

	Treatment Group (younger firms)			Control Group (older firms)		
	Mean	Variance	Skewness	Mean	Variance	Skewness
No of Employees	18.720	1728	7.808	85.740	856.290	13.290
Liquidity	2.085	8.264	5.331	2.347	14.120	18.530
Working Capital	0.031	0.018	10.170	0.204	0.539	12.060
Cash Flow	0.008	0.001	1.636	0.098	0.388	15.020
Total Sales	4.976	7.925	-0.640	7.010	7	-1.129
Prior Assortment Width	1.945	1.646	1.909	2.116	1.851	1.434

After entropy balanced matching

	Treatment Group (younger firms)			Control Group (older firms)		
	Mean	Variance	Skewness	Mean	Variance	Skewness
No of Employees	18.720	1728	7.808	18.720	416.400	2.754
Liquidity	2.085	8.264	5.331	2.085	2.635	6.412
Working Capital	0.031	0.018	10.170	0.031	0.004	4.928
Cash Flow	0.008	0.001	1.636	0.008	0.001	3.166
Total Sales	4.976	7.925	-0.640	4.976	8.791	-0.732
Prior Assortment Width	1.945	1.646	1.909	1.945	1.686	1.782

Table 2. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Assortment Width												
(2) Product Time Introduction	-0.296***											
(3) Firm Age	0.077**	-0.056*										
(4) Performance above industry average	-0.019	-0.068**	0.001									
(5) Performance below industry average	0.029	-0.022	-0.016	0.130***								
(6) No of Employees	0.044	-0.086***	0.187***	0.040	0.009							
(7) Liquidity	-0.033	0.010	0.055*	0.046	0.023	-0.043						
(8) Working Capital	0.038	-0.111***	0.201***	0.053	-0.008	0.583***	0.004					
(9) Cash Flow	-0.003	-0.096***	0.157***	0.038	0.010	0.812***	-0.018	0.609***				
(10) Total Sales	0.111***	-0.128***	0.408***	0.036	-0.055*	0.305***	-0.002	0.311***	0.224***			
(11) Prior Assortment Width	0.012	0.003	0.025	0.131***	0.040	0.020	0.006	0.019	0.052*	0.147***		
(12) Manufacturing Firm	0.045	-0.018	0.033	-0.266***	-0.015	0.061*	-0.043	0.052*	0.041	0.082**	-0.286***	
(13) Assortment Depth	-0.036	0.003	0.004	-0.073**	0.007	0.002	0.004	-0.007	-0.015	0.049	-0.032	0.019

*** p<0.01, ** p<0.05, * p<0.1

Table 3. Analysis of the product line additions: negative binomial model with E-Balance

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
No of Employees	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
Liquidity	-0.016 (0.011)	-0.019* (0.012)	-0.017 (0.012)	-0.019* (0.012)	-0.018 (0.012)
Working Capital	0.276 (0.283)	0.271 (0.266)	0.265 (0.272)	0.327 (0.277)	0.327 (0.297)
Cash Flow	-0.521** (0.219)	-0.714*** (0.265)	-0.883 (1.008)	-0.776*** (0.294)	-1.035 (1.096)
Total Sales	0.020 (0.020)	0.018 (0.020)	0.013 (0.021)	0.018 (0.020)	0.014 (0.021)
Prior Assortment Width	0.006 (0.030)	0.006 (0.030)	0.014 (0.032)	0.005 (0.030)	0.013 (0.032)
Manufacturing Firm (dummy)	0.102 (0.121)	0.088 (0.122)	0.136 (0.131)	0.101 (0.124)	0.147 (0.132)
Assortment Depth	-0.086*** (0.017)	-0.092*** (0.016)	-0.095*** (0.017)	-0.092*** (0.016)	-0.096*** (0.017)
Firm Age		0.009** (0.004)	0.015** (0.006)	0.009** (0.004)	0.015** (0.006)
Performance above industry average			4.538* (2.662)		4.391 (2.785)
Firm Age*Performance above industry average			-0.215* (0.125)		-0.227* (0.130)
Performance below industry average				3.309 (4.338)	1.501 (4.887)
Firm Age*Performance below industry average				0.094 (0.195)	0.212 (0.247)
Constant	0.780*** (0.211)	0.690*** (0.200)	0.581*** (0.212)	0.677*** (0.200)	0.564*** (0.213)
Industry effects	Included	Included	Included	Included	Included
No. of observations	957	957	893	957	893
Log-likelihood	-977.02681	-973.72983	-901.71467	-973.1786	-901.11981
Chi-squared	58.02	73.35	65.75	67.49	63.65

Standard errors are in parenthesis: *** p<0.01, ** p<0.05, * p<0.1

Table 4. Analysis of reaction time through product line additions: negative binomial model with E-Balance

	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)
No of Employees	0.000 (0.000)	0.000* (0.000)	0.000* (0.000)	0.000* (0.000)	0.000* (0.000)
Liquidity	0.001 (0.005)	0.001 (0.005)	0.002 (0.005)	0.001 (0.005)	0.002 (0.005)
Working Capital	0.134 (0.109)	0.134 (0.105)	0.202* (0.113)	0.115 (0.105)	0.202 (0.131)
Cash Flow	-0.681*** (0.246)	-0.639*** (0.236)	-1.102** (0.494)	-0.629*** (0.233)	-1.103** (0.540)
Total Sales	-0.018** (0.007)	-0.017** (0.007)	-0.018** (0.008)	-0.017** (0.007)	-0.018** (0.008)
Prior Assortment Width	0.016 (0.013)	0.015 (0.013)	0.017 (0.013)	0.015 (0.013)	0.017 (0.013)
Manufacturing Firm	-0.010 (0.063)	-0.006 (0.063)	-0.038 (0.068)	-0.009 (0.063)	-0.038 (0.069)
Assortment Depth	0.009 (0.008)	0.010 (0.008)	0.007 (0.008)	0.010 (0.008)	0.007 (0.008)
Firm Age		-0.003** (0.001)	-0.003** (0.002)	-0.002** (0.001)	-0.003** (0.002)
Performance above industry average			-2.072* (1.089)		-2.074* (1.112)
Firm Age*Performance above industry average			0.032 (0.040)		0.031 (0.041)
Performance below industry average				-1.527 (3.255)	-0.004 (3.608)
Firm Age*Performance below industry average				0.049 (0.121)	0.008 (0.133)
Constant	4.526*** (0.099)	4.550*** (0.100)	4.616*** (0.108)	4.549*** (0.100)	4.615*** (0.108)
Industry effects	Included (0.136)	Included (0.078)	Included (0.081)	Included (0.078)	Included (0.081)
No. of observations	954	954	890	954	890
Log-likelihood	-2481.6591	-2480.3501	-2260.8366	-2480.2239	-2260.8312
Chi-squared	16.80	21.30	34.79	21.84	35.10

Standard errors are in parenthesis: *** p<0.01, ** p<0.05, * p<0.1

Table 5. Analysis of the product line additions: negative binomial model without E-Balance

	Model (11)	Model (12)	Model (13)	Model (14)	Model (15)
No of Employees	0.001** (0.000)	0.001** (0.000)	0.001** (0.000)	0.001** (0.000)	0.001** (0.000)
Liquidity	-0.016 (0.011)	-0.023** (0.011)	-0.021* (0.011)	-0.024** (0.011)	-0.022** (0.011)
Working Capital	0.024 (0.079)	-0.013 (0.075)	-0.007 (0.087)	-0.012 (0.077)	-0.003 (0.089)
Cash Flow	-0.340*** (0.122)	-0.289*** (0.111)	-0.249* (0.129)	-0.288*** (0.110)	-0.249** (0.126)
Total Sales	0.041*** (0.015)	0.027* (0.016)	0.022 (0.017)	0.028* (0.016)	0.024 (0.017)
Prior Assortment Width	0.004 (0.024)	0.003 (0.024)	0.012 (0.025)	0.001 (0.024)	0.010 (0.025)
Manufacturing Firm (dummy)	0.025 (0.100)	0.027 (0.103)	0.069 (0.106)	0.033 (0.104)	0.078 (0.107)
Assortment Depth	-0.061*** (0.017)	-0.061*** (0.017)	-0.067*** (0.017)	-0.062*** (0.017)	-0.069*** (0.017)
Firm Age		0.008*** (0.003)	0.012*** (0.004)	0.008*** (0.003)	0.012*** (0.004)
Performance above industry average			3.173 (2.326)		3.195 (2.380)
Firm Age*Performance above industry average			-0.162* (0.090)		-0.175* (0.093)
Performance below industry average				0.550 (4.076)	-0.596 (4.238)
Firm Age*Performance below industry average				0.129 (0.125)	0.186 (0.137)
Constant	0.829*** (0.178)	0.755*** (0.180)	0.654*** (0.189)	0.744*** (0.180)	0.634*** (0.190)
Industry effects	Included (0.088)	Included (0.087)	Included (0.088)	Included (0.086)	Included (0.088)
No. of observations	973	973	909	973	909
Log-likelihood	-1983.9696	-1977.5516	-1860.6472	-1975.9304	-1858.5472
Chi-squared	40.49	55.58	61.13	60.57	66.74

Standard errors are in parenthesis: *** p<0.01, ** p<0.05, * p<0.1

Table 6. Analysis of reaction time through product line additions: negative binomial model without E-Balance

	Model (16)	Model (17)	Model (18)	Model (19)	Model (20)
No of Employees	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Liquidity	0.003 (0.005)	0.004 (0.005)	0.004 (0.005)	0.004 (0.005)	0.004 (0.005)
Working Capital	-0.048 (0.030)	-0.040 (0.031)	-0.043* (0.026)	-0.041 (0.031)	-0.043* (0.026)
Cash Flow	-0.092 (0.064)	-0.100 (0.071)	-0.032 (0.089)	-0.098 (0.071)	-0.029 (0.089)
Total Sales	-0.015*** (0.005)	-0.011* (0.006)	-0.014** (0.006)	-0.011* (0.006)	-0.014** (0.006)
Prior Assortment Width	0.006 (0.010)	0.006 (0.010)	0.008 (0.010)	0.006 (0.010)	0.008 (0.010)
Manufacturing Firm (dummy)	-0.013 (0.043)	-0.016 (0.043)	-0.035 (0.045)	-0.018 (0.043)	-0.037 (0.045)
Assortment Depth	0.004 (0.007)	0.005 (0.007)	0.003 (0.007)	0.005 (0.007)	0.003 (0.007)
Firm Age		-0.002** (0.001)	-0.003** (0.001)	-0.002** (0.001)	-0.003** (0.001)
Performance above industry average			-1.340 (0.899)		-1.139 (0.913)
Firm Age*Performance above industry average			0.013 (0.036)		0.007 (0.037)
Performance below industry average				-3.565 (2.199)	-2.974 (2.251)
Firm Age*Performance below industry average				0.097 (0.064)	0.081 (0.066)
Constant	4.520*** (0.070)	4.546*** (0.071)	4.604*** (0.077)	4.543*** (0.071)	4.598*** (0.076)
Industry effects	Included (0.088)	Included (0.058)	Included (0.060)	Included (0.058)	Included (0.060)
No. of observations	970	970	906	970	906
Log-likelihood	-4701.4637	-4698.3579	-4362.6759	-4697.1336	-4361.8121
Chi-squared	28.66	31.81	39.31	35.35	41.30

Standard errors are in parenthesis: *** p<0.01, ** p<0.05, * p<0.1

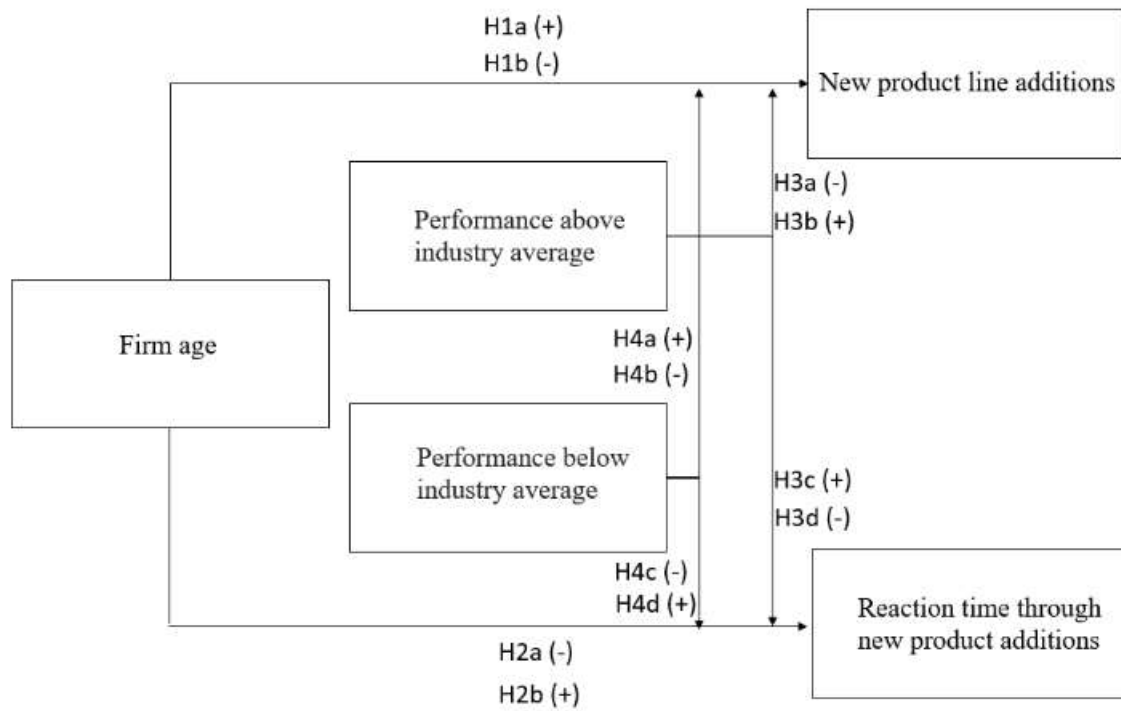


Figure 1. Conceptual model

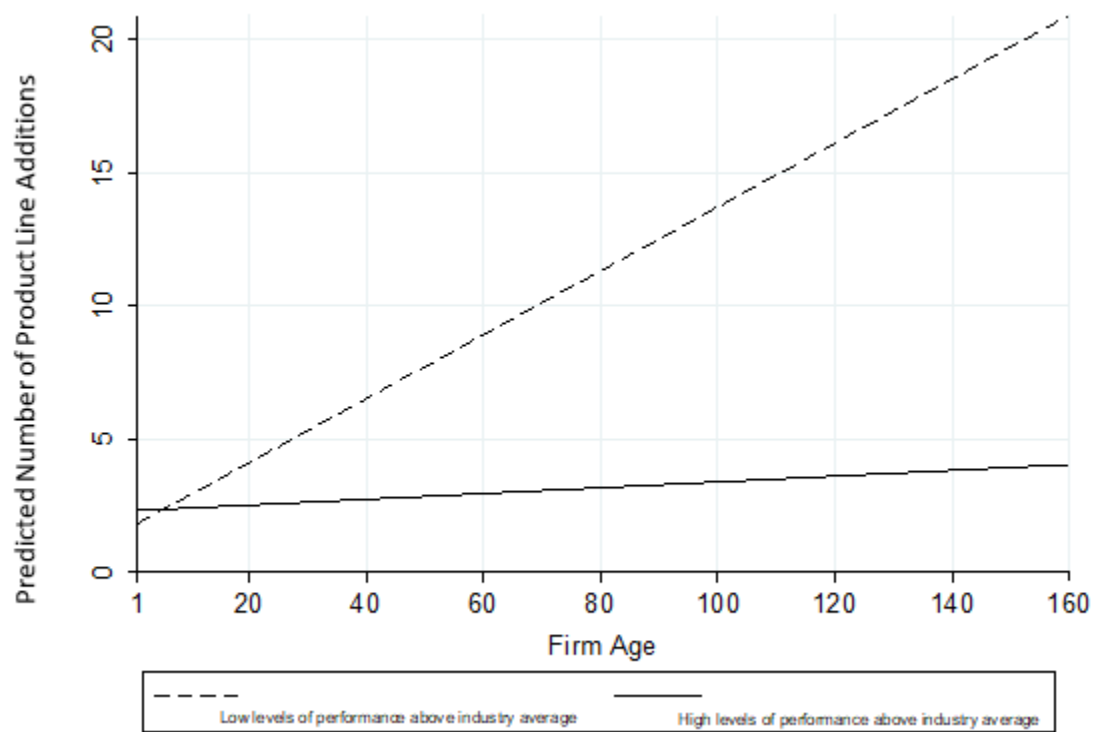


Figure 2. Interaction effect of firm's age with performance above the industry average on the number of product line additions.