



## When do Entrepreneurs Benefit from Acting Like Scientists? A Field Experiment in the UK

Elena Novelli

Bayes Business School, [elena.novelli.1@city.ac.uk](mailto:elena.novelli.1@city.ac.uk)

Chiara Spina

INSEAD, [chiara.spina@insead.edu](mailto:chiara.spina@insead.edu)

This paper investigates *the role of a firm's degree of business development*—defined as the extent to which an entrepreneur has already crystallized the details of their firm strategy, making radical changes unlikely—in moderating the impact of a scientific approach to decision-making on performance. We explore this issue with a question-driven approach based on evidence from a field experiment with 261 UK entrepreneurs. Results show that treated firms at a higher degree of business development perform better than control firms, whereas firms at a lower degree of business development perform worse than control firms. We present qualitative and quantitative evidence to interpret this result. We elaborate on the implications for future research.

**Keywords:** Entrepreneurial Strategy; Experimentation; Field Experiment; Innovation; Value Creation

Electronic copy available at: <http://ssrn.com/abstract=3894831>

**Acknowledgments:** We gratefully acknowledge financial support from the Department for Business, Energy & Industrial Strategy (BEIS) of the UK Government through the BEIS Business Basics Grant, and support from the Innovation Growth Lab. This project was also made possible by support from The Business School (Formerly Cass), Bocconi University, and Oxford University. We thank scholars who provided comments on previous versions of this manuscript, particularly Alfonso Gambardella, Myriam Mariani, Teppo Felin, Arnaldo Camuffo, Ethan Mollick, and attendees from presentations at Warwick, ESADE, University of Bologna, EPFL, the Wharton Technology Conference, the Strategic Management Society Entrepreneurship and Strategy Seminar Series.

Working Paper is the author's intellectual property. It is intended as a means to promote research to interested readers. Its content should not be copied or hosted on any server without written permission from [publications.fb@insead.edu](mailto:publications.fb@insead.edu)

Find more INSEAD papers at <https://www.insead.edu/faculty-research/research>

Copyright © 2024 INSEAD

## 1. INTRODUCTION

Strategy elaboration is fundamentally about making choices (Porter, 1986; Ghemawat & Levinthal, 2008; Van Den Steen, 2018). A crucial question in this area thus concerns how the decision-making approach that firms use to make these choices impacts performance (Gans et al., 2019). This question is particularly relevant in entrepreneurial settings, where strategy makers face uncertainty in multiple domains, from technology (Folta, 1998; Gans & Stern, 2003; McGrath, 1997) to market preferences (Foss & Klein, 2012; Kirtley & O’Mahony, 2020; Sarasvathy, 2009), and the resolution of uncertainty is often endogenous to action (Agarwal et al., 2007; Moeen et al., 2020; Ott & Eisenhardt, 2020).

Recent research in this context highlights the relevance of a “scientific approach to decision making” (Agarwal et al., 2023a; Camuffo et al., 2020). This approach combines the formulation of a theory of the problem under investigation (Felin et al., 2020a and b) and the development of hypotheses that flow logically from that theory (Ehrig & Schmidt, 2022), followed by the systematic collection of evidence that can support or refute those hypotheses (Bloom et al., 2012; Ries, 2011) and its disciplined assessment (Murray & Tripsas, 2004). It is called “scientific” because it resembles the approach followed by scientists as they develop new knowledge (Zellweger & Zenger, 2021). It addresses uncertainty by starting with a *cognitive*-based approach to decision-making (i.e., formulating a theory about the problem faced, as in Bingham & Eisenhardt, 2011; Csaszar & Laureiro-Martinez, 2018; Felin & Zenger, 2017), which *guides* a subsequent *action*-based component (Ghosh et al., 2020; Kohavi & Thomke, 2017; Ott, Eisenhardt, & Bingham, 2017). Prior studies have suggested that a scientific approach to decision-making can be an effective way to tackle uncertainty (Agarwal et al., 2023a; Camuffo et al., 2020), but that the performance of this approach is contingent on the characteristics of the decision-making environment the firm is facing (Agarwal et al., 2023b). However, work in this area is still in its infancy (Zellweger & Zenger, 2021, 2022), and little evidence is available about the effectiveness of the scientific approach, especially when applied to different decisional contexts.

In this paper we address this issue by exploring the following research question: *What is the role of a firm’s degree of business development in moderating the impact of a scientific approach to decision-making on performance?* We define a firm’s *degree of business development* as the extent to which an entrepreneur has already crystallized the details of their firm’s strategy, making radical change

unlikely. This is opposed to the firm being still at the stage where an entrepreneur is defining key elements of their firm's strategy—a stage where radical change is still likely (Gans et al., 2019, Ghemawat & Levinthal, 2008; Leiblein et al., 2018; Siggelkow, 2002; Van Den Steen, 2018). The construct of degree of business development relates to the extent to which the entrepreneur perceives the process of strategy elaboration as complete.

The role of the degree of business development in moderating the relationship between the decision-making approach used by firms and performance has been thus far neglected by research. In fact, empirical evidence is mostly based on studies involving firms at a stage at which their strategy is likely well defined (Bloom & Van Reenen, 2010; Pillai et al., 2020; Yang et al., 2020) or that are just starting to elaborate their strategy (Bruhn et al., 2018; Camuffo et al., 2020). Thus, the generalizability of these prior findings is limited.

This paper addresses this gap with a question-driven abductive approach, which we use to infer the best possible explanation (King et al., 2021; Lipton, 2017; Pillai et al., 2020). To this end, we collected evidence via a 9-month randomized control trial (RCT) with 261 UK entrepreneurial firms attending a strategy training program. Both treated and control firms underwent a training course and were taught to use elements of cognitive-based decision-making (reasoning through strategy frameworks and tools) and action-based decision-making (using data-gathering and testing techniques), for a total of 21 hours of training spread across 7 sessions. Entrepreneurs in the control group were encouraged to apply each of these components to their businesses and supported in doing so, as is typical for any business training course. Those in the treatment group, instead, were taught to apply these concepts and tools using a scientific approach, combining cognitive- and action-based components. They were taught to use strategy frameworks to formally develop a theory of the business problem faced and hypotheses consistent with that theory, test those predictions, and systematically evaluate the results. We collected observations on the performance of firms participating in our program before the intervention and for 9 months following the beginning of the intervention.

We proceed by providing a general overview of what a scientific approach to decision-making is and of our research question. We then describe our empirical context and continue with the main analysis, which yields an intriguing result: Treated firms at a high degree of business development

perform better than control firms but treated firms at a low degree of business development perform worse than control firms. This result proves robust to several checks. We therefore conduct an abductive investigation and evaluate multiple interpretations of this result (King et al., 2021; Lipton, 2017; Pillai et al., 2020). We first consider the possibility that this result might be explained by an entrepreneur's confidence or experience. We provide empirical evidence that supports neither of these interpretations. We then consider the types of decisions that firms at a higher (vs. lower) degree of business development face and how this might affect the outcome of their decision-making process. Firms at a higher degree of business development, whose strategy is already well defined, face uncertainty and decisions that concern more peripheral aspects of their firm strategy. Firms at a lower degree of business development face uncertainty and decisions that concern more core aspects of their firm strategy (Siggelkow et al., 2002). A scientific approach to decision-making encourages both types of firms to articulate and question the theory underlying their strategy and validate it with tests. This enables the former (higher degree of business development) to gain insights into how to fine-tune an already defined strategy, with a relatively quick and positive effect on economic performance. However, it enables the latter (lower degree of business development) to understand that some core aspects of their value proposition need closer investigation. These insights might affect the firm strategic direction quite significantly and may eventually translate to higher firm performance, but in the short term might rather translate to increased uncertainty. The counterfactual are firms in the control group, who have not been encouraged to articulate, question, or validate the theory underlying their strategy. For control firms at a low degree of business development (those whose strategy has still not crystallized), this lack of a questioning attitude leads them to pursue opportunities as they emerge. Their speed in pursuing unvalidated opportunities might even lead to positive outcomes in the short term compared to treated (scientific) firms that delay action because they "stop to think." For control firms at a higher degree of business development, however, the lack of a questioning attitude encourages them to pursue business as usual, with limited performance improvements. We present qualitative illustrative evidence, based on twenty mini-cases, as well as quantitative evidence in line with this interpretation.

Our study makes three main contributions. First, it contributes to strategy research on decision-making by providing evidence of the relationship between the use of a scientific approach to decision-

making and firm performance and how this relationship is moderated by the degree of business development. In doing so, it addresses an important conceptual shortcoming concerning the generalizability of prior empirical research that explored the use of more formal and deliberate decision-making approaches through samples of firms that did not necessarily display variety in their degree of business development (Bloom & Van Reenen, 2010; Bruhn et al., 2018; Camuffo et al., 2020; Yang et al., 2020). It also provides qualitative evidence that illustrates the specific way in which a scientific approach to decision-making affects entrepreneurial decisions.

Second, it contributes to research on entrepreneurial strategy by answering the call for empirical research on the performance implications of theory-based approaches to decision-making (Zellweger & Zenger, 2022). Our results show that a decision-making approach where the collection of evidence is combined with and guided by theory has implications for firms' outcomes that are different compared to when these elements are employed in isolation, further advocating for the importance of a theory-guided approach to decision-making (Agarwal et al., 2023a; Felin et al., 2020; Felin & Zenger, 2017).

Beyond its academic contribution, our study offers insight to policy makers and institutions looking to foster economic growth through programs that support innovation. Initiatives that offer training with a view to stimulating growth and productivity often yield limited results (Lerner, 2009; McKenzie, 2021). Awareness of how firms benefit from training programs could be a starting point for a more efficient admission process, and for the provision of targeted forms of support for firms depending on their degree of business development.

## 2. MOTIVATING OUR RESEARCH QUESTION

### 2.1 A scientific approach to decision-making

Prior literature emphasizes two different types of structured processes that firms can employ when making decisions in the face of uncertainty. A first stream emphasizes the benefits of a *cognitive- or theory-based approach* to decision-making. This approach is centered on the development of a theory (Felin & Zenger, 2009; Felin & Zenger, 2017; Zenger, 2015), or a mental representation of the problem faced (Csaszar & Laureiro-Martinez, 2018; Gary & Wood, 2011), as an important driver of business innovation, performance heterogeneity, and superior strategy. A second stream emphasizes, instead, the relevance of a more *evidence- or action-based approach* to decision-making, relying on acting and then

learning from that experience to guide subsequent action (Bingham & Eisenhardt, 2011; Leatherbee & Katila, 2020; McGrath, 2001). This category typically includes a variety of approaches to decision-making that range from the generation of feedback via trial and error to the controlled variation of activities via experimentation (Gans et al., 2019; McGrath, 1999; Murray & Tripsas, 2004; Ott et al., 2017; Pillai et al., 2020; Shepherd & Gruber, 2020)<sup>1</sup>.

Cognitive- and action-based approaches can be complementary and mutually reinforcing (Agarwal et al., 2023a; Gavetti & Levinthal, 2000; Ott, Eisenhardt, & Bingham, 2017). Eisenhardt and Bingham (2017, p. 247) underline the importance of combining “*thinking and doing*” and of a holistic approach to decision-making that involves both a cognitive understanding of the “*playing field*” and action/learning via experimentation. McDonald and Eisenhardt (2020) emphasize the benefits of testing the assumptions underlying the cognitive templates used by firms, such as business models. They suggest that combining cognition with action reduces the uncertainty faced by entrepreneurs regarding the most appropriate model to use and helps them ground models in realistic and relevant information, leading to quicker and faster learning. In the same spirit, Camuffo et al. (2020) emphasize how scientists’ rigor in the discovery process, which *simultaneously* involves a *cognitive* component (i.e., theory development and the formulation of hypotheses) and an *action-based* component (i.e., testing and evaluation of evidence), can be successfully applied to entrepreneurial decision-making. They call this the “scientific approach to decision-making,” and we use the same terminology in this paper. Each individual component of the scientific approach leads to superior performance, but there are synergies when using these different components sequentially (Agarwal et al., 2023a; Zellweger & Zenger, 2021).

A scientific approach to decision-making involves four key steps: (1) the development of a theory; (2) its articulation into hypotheses that logically flow from it; (3) the collection of evidence that can either support or refute the hypotheses; and (4) the disciplined assessment of the evidence collected. First, entrepreneurs who employ a scientific approach frame the problem they face using a theory—a cognitive representation of how their business generates value (Ehrig & Schmidt, 2022; Felin & Zenger,

---

<sup>1</sup> Several useful toolkits aimed at supporting practitioners in experimenting have emerged in this area. They focus on different aspects of the experimentation process such as how to identify new business ideas (Gruber & Tal, 2017), how to strategize after identifying the initial business idea (Osterwalder, Pigneur & Clark, 2010), and how to experiment while searching for the right product–market fit (Ries, 2011).

2017). This helps them understand more clearly what the key dimensions of the problem are and on what they should focus their attention (Camuffo et al., 2020; Felin et al., 2020a). Second, the articulation of their theory into clear, falsifiable, predictions (Felin & Zenger, 2016) helps entrepreneurs modularize the problem into smaller, decomposable, and more addressable blocks, which reduces the level of causal ambiguity (Felin et al., 2020b; Leatherbee & Katila, 2020) and helps them generate more innovative ideas via recombination and modular addition (Ott & Eisenhardt, 2020). Third, gathering feedback through rigorous tests provides valuable feedback that can help entrepreneurs distinguish between businesses with good and bad outcomes (Thomke, 2003; Murray & Tripsas, 2004; Bingham & Eisenhardt, 2011; Ries, 2011; Gruber et al., 2013; Gans et al., 2019; Pillai et al., 2020; Shepherd & Gruber, 2020). Fourth, the systematic and critical assessment of the evidence gathered helps compare the signals collected against an ideal threshold to find support for key hypotheses (Boulding et al., 1997; Keil & Mahring, 2010).

The use of a scientific approach combines the four elements described above in a synergistic way to help resolve the uncertainty associated with each choice faced by entrepreneurs (Packard et al., 2017), guiding them toward more informed decisions based on logical reasoning and systematic testing (Zellweger & Zenger, 2021). It essentially stimulates decision makers to articulate and question the theory underlying their strategy and validate it using tests and disciplined judgment. Without a scientific approach, entrepreneurs may lack focus in their thinking and actions and might make decisions that are purely based on gut feelings (Hodgkinson & Sadler-Smith, 2018; Forbes, 2005; Bennet & Chatterji, 2019). In the absence of a systematic approach, the process of decision-making is likely to produce untargeted variation with trial-and-error exploration (McBride & Wuebker, 2020).

## **2.2 A scientific approach for firms at different degrees of strategy elaboration**

Prior research on the effectiveness of a scientific approach for performance is limited. First, only a few studies (Agarwal et al., 2023a; Camuffo et al., 2020) have tested the performance implications of this approach (Zellweger & Zenger, 2022). Whereas prior conceptual research supports the idea that a scientific approach to decision-making—and theory-driven approaches in general—improves performance (Felin & Zenger, 2017; Zellweger & Zenger, 2021), more empirical evidence that shows

if and how these approaches work in practice is needed (Zellweger & Zenger, 2022). Second, and related to this first point, we still need to understand whether and how firm heterogeneity matters in determining the effectiveness of a scientific approach. This underscores the importance of an abductive exploration that can shed light on these relevant issues.

We note that, in the process of strategy elaboration, a firm makes decisions regarding a variety of dimensions, such as target market, product features, marketing, procurement, sale channels, and so on (Ghemawat & Levinthal, 2008; Porter, 1986). These choices, which are made over time as a series of “partial-commitment(s)” (Gans et al., 2019, p.737), determine the configuration of the organization (Siggelkow, 2002). Firms typically start with the elaboration of the more macro elements of their strategy and subsequently move to the elaboration of more peripheral elements to pursue fit and consistency (Eisenhardt & Brown, 1999; Ghemawat and Levinthal 2008; Moeen & Agarwal, 2017; Siggelkow, 2002). For example, Siggelkow (2002) examines how Vanguard started the elaboration of its strategy with the definition of core elements such as its policy to engage in candid communication with its clients. Over time, the firm developed activities that reinforced these core elements, such as clearly written annual reports, letters to shareholders warning them that the high performance of certain funds was unlikely to continue, and “Plain Talk” brochures that explained fundamental issues of investing. Firms’ early choices, those that are more “strategic” or “core”<sup>2</sup>, tend to have strong interdependencies with subsequent ones, so that radical change becomes increasingly less likely (Rios, 2021; Van Den Steen, 2018), with a corresponding reduction in organizational plasticity (Gavetti & Rivkin, 2007; Rios, 2021).

In this study, we incorporate this important insight from prior literature and ask whether the impact of a scientific decision-making approach on performance is moderated by the *degree of business development of the firm*. We define the degree of business development as the extent to which an entrepreneur has already crystallized the details of their firm’s strategy, making radical changes unlikely, as opposed to being still at a stage where the key elements of their strategy are in the process of being

---

<sup>2</sup> What constitutes a core element versus what constitutes a peripheral one varies for different firms: “The same elements are not equally central for all firms” (Siggelkow, 2002, p.126). However, there is consensus in the literature on the properties of core elements: (1) a high interdependency with other current organizational elements and (2) a large influence on future organizational elements (Siggelkow, 2002). This is also consistent with Van Den Steen’s (2018) definition of strategic choices.



defined and radical changes are still likely. The degree of business development ultimately reflects entrepreneurs' subjective assessment regarding whether their firm strategy is still open to radical changes in direction as opposed to being already crystallized.

As a clarifying example, imagine two companies providing fitness coaching for busy individuals. The first company, Coach Guru, is still early in the definition of its strategy, and some of its core choices are still undecided, so radical changes are still possible. The entrepreneur is unclear whether the service should be offered as a "gym van" driven to the customer's house or office, via personal trainers visiting the customer's home, or through small fitness units in neighborhoods with no gym. The second company, Coach Pod, already has quite a defined strategy. The entrepreneur has made key choices such as that the company will focus on delivering fitness services in small containers located in various residential locations so that individuals can exercise indoors in easy-to-access "portable gyms." In this paper we ask: What happens when these two companies adopt a scientific approach?

Prior research suggests that different decision-making approaches can be more or less appropriate for firms at different stages of their journey or operating in different environments (Agarwal et al., 2023b; Ghemawat & Levinthal, 2008; Siggelkow, 2002). Yet we have very limited research that studies this issue directly, not only in relationship to a scientific approach to decision-making but also more generally in association with decision-making approaches that are more rigorous and deliberate, and that can thus help decision makers move beyond making decisions based on gut feelings. Much of the research in this area tends to focus exclusively on firms that are either large and established (and therefore likely to have a high degree of business development) or still unestablished (and therefore likely to be still in the process of defining their strategy).<sup>3</sup>

For example, Bloom and Van Reenen (2007) found that the use of standard management practices is associated with higher performance. Yet the sample they investigated consisted of firms that, on average, were 54 years old and had 2,064 employees. Yang et al. (2020) found an association between the use of highly formalized, rigorous, cognition-based, and deliberate processes and firms' growth in employment. However, their sample consisted of firms that, on average were 50 years old and had 2,088

---

<sup>3</sup> The degree of business development may be correlated with the age of the firm or the size of the firm, but it is not necessarily so, in that some firms might reach high levels of strategy definition when they are still young or small.

employees. These types of firms are likely to already have a well-defined strategy. Other studies have shown that approaches to learning that rely on structure and codification are associated with superior performance in the context of acquisition integration for large and experienced acquirers such as BOC, Boeing, Cisco, Dow, Eastman Chemical, GE Commercial Finance, Home Depot, IBM, Stanley Works, and Xerox (Heimeriks et al., 2012; Zollo & Winter, 2004).

The evidence on firms that might be at a lower degree of business development is more limited and mixed. In conducting an RCT with start-ups, Camuffo et al. (2020) found that treated entrepreneurs using a scientific approach were more likely to pivot to alternative ideas and terminate their projects early, but the effect on firm performance showed a higher degree of variability. With regards to testing, Koning et al. (2022) found that A/B testing benefited performance slightly more for early-stage startups, but on specific metrics such as page views and new product features.

When observing the impact of rigorous and deliberate decision-making approaches on the performance of these different types of firms, it is important to be aware of the characteristics of the samples used and the consequent limitations to the generalizability of results. This calls for an exploration of the extent to which the degree of business development moderates the relationship between the use of a scientific approach and performance.

### **3. THE EMPIRICAL CONTEXT**

#### **3.1 The RCT: Setting and data-collection process**

To investigate how the degree of business development moderates the impact of a scientific approach to decision-making on firm performance, we conducted an RCT. We embedded the field experiment in a business-support program designed and run by the authors in London, UK, from mid-February 2019 to November 2019. The treatment was administered through a training program, as similar interventions have been shown to affect outcomes for entrepreneurs (Anderson et al., 2018; Camuffo et al., 2020). We targeted entrepreneurial firms with less than 10 employees, as our empirical design required that the subjects receiving the treatment be key decision makers, a condition more accurately met in the

context of micro-businesses, where all employees tend to be involved in the management of the firm. We recruited firms with an ad-hoc marketing campaign using online media (such as social media, blogs, and online communities) and offline channels (flyers). We did not impose any restrictions in terms of industry; firms admitted to the program operated in a wide range of sectors, from software to retail. Our setting enabled the recruitment of firms with different degrees of business development, a feature that set the program apart from other studies where only more developed (Campos et al., 2018; Chatterji et al., 2018; Guzman & Stern, 2016) or less developed businesses participated (Camuffo et al., 2020; Karlan et al., 2015).

The program involved an initial formal training period of 7 sessions (21 hours in total), which started in mid-February 2019 and finished in April 2019. Participants were divided into a treatment and a control group, and the sessions were used to administer the intervention. The training in both groups exposed participants to elements of both cognitive-based decision-making, such as strategy frameworks and tools (for instance, the Business Model Canvas or Balance Scorecard), and action-based decision-making (such as multiple data collection and testing techniques, including surveys, qualitative interviews, and A/B testing to adapt to different entrepreneurial contexts). However, while the control group was not explicitly encouraged to combine the two approaches, the treatment group was encouraged to do so, employing a scientific approach to decision-making. Specifically, the treatment group was encouraged to use the strategy frameworks presented in class to develop a theory of the problem they were facing and derive hypotheses from it and was later encouraged to use the data-gathering and analysis techniques learned in class to test those hypotheses.

The difference in the two approaches can be seen in how treated and control groups were taught to use the same tools. For instance, one of the training sessions in both treatment and control groups was focused on the “Business Model Canvas.” Both sets of entrepreneurs were taught to apply the tool to their business and discuss it with their peers, but only those in the treatment group were explicitly taught to reflect on the extent to which the different elements of the business model connected to each other in a cohesive theory and were subsequently asked to explicitly formulate that theory and break it down into separate hypotheses. Later in the program, entrepreneurs in both groups were taught about the importance of making decisions based on collected evidence and were exposed to multiple evidence-

gathering techniques (e.g., surveys, A/B testing, qualitative interviews). Entrepreneurs in the control group were free to apply those techniques based on their intuition, whereas entrepreneurs in the treatment group were explicitly encouraged to use these techniques to test the hypotheses developed in the previous sessions and reflect on how the evidence collected compared to their initial theory. We also designed a series of in-class activities and post-class assignments to encourage entrepreneurs to use the tools and techniques described in class. Consistent with our experimental design, entrepreneurs in both treatment and control groups were given the same number and types of in-class activities and post-class assignments. There were, however, differences in that the activities and assignments for the treatment group specifically focused on applying a scientific approach to decision-making, while the control group was not exposed to this approach. We provide an example of the differences in the training and in-class activities between treatment and control groups in Section 2 of the Appendix (Figures A1 and A2). This was an important feature of our training, which was highly engaging and experiential, involving hands-on activities and feedback from the instructors. To achieve this goal, we assigned entrepreneurs in both groups to smaller subgroups that were randomly matched with six experienced instructors who were recruited and trained for this study. The experiment was designed such that each instructor taught groups of entrepreneurs in both the treatment and control groups, allowing us to account for instructor-related differences in our regressions through fixed effects. All instructors received identical training material from the research team and underwent multiple “train-the-trainer” sessions to ensure they would deliver the content of the program in line with our research design.

Several measures were taken to ensure the internal validity of our results. We addressed contamination by teaching treated and control groups on different days of the week (Wednesday vs. Thursday) or different time slots of the same day (Saturday morning vs. afternoon), preventing them from meeting and discussing key elements of the treatment. We also kept communication about the program separate and discrete for the two groups.

We required all applicants to complete an extensive survey and participate in a 30-minute call with a member of the data collection team that aimed to collect baseline information on their business and their approach to decision-making prior to the intervention. We then used this information to

randomly assign firms to either the treatment or control group using statistical software (STATA); 139 firms were assigned to the treatment group and 135 firms to the control group.

*Data collection and operationalization.* The intervention ran between February and April 2019, but we monitored firms' performance and decision-making until the end of November 2019. Due to funding availability, we could only gather data over this relatively short time window, and we take this aspect into consideration when discussing our results. In addition to the pre-intervention survey and interview, we collected eight data points through telephone interviews that focused on each firm's decision-making, key changes it had made in terms of strategy, and its performance. The first telephone interview post-intervention took place about 8 weeks after the training program had begun. We then collected data once a month until the end of our data-gathering period. In conducting these calls, we created a pre-defined protocol that included open- and close-ended questions, an approach in line with Bloom and Van Reenen's (2010) and Camuffo et al.'s (2020). We used open-ended questions to monitor entrepreneurs' decision-making process and let key themes emerge from narratives and close-ended questions to elicit self-reported performance information. The open-ended questions substantially reduce concerns that respondents might answer in a way that complies with the research design, particularly since entrepreneurs were not aware their answers were scored against a pre-defined grid. The performance data provided were self-reported by the entrepreneurs, but we conducted cross-reference checks with external sources for 100 firms (for which we found correspondence between the information provided by the entrepreneurs and public records in 92.5% of the cases, with small discrepancies in other cases) and consistency checks across interview rounds. The final sample included 261 firms, as we excluded data provided by four participants who gave inconsistent information about their business and nine participants who were not willing to share data. Table 1 compares the baseline characteristics of the treated and control groups for the final sample of 261 firms.

*Add Table 1 about here*

To check that the treatment produced the intended result, we measured the level of adoption of the scientific approach based on the content of the telephone interviews. *Scientific Intensity* is a time-varying score (ranging from zero to five) that captures the level of adoption of the scientific approach.

To calculate this score, we followed the data collection method used by Camuffo et al. (2020). A team of research assistants analyzed and coded each interview's content according to a pre-defined coding scheme and collected measures on the extent to which entrepreneurs used theory (measured with four variables), hypotheses (measured with four variables), tests (measured with four variables), and evaluations (measured with four variables). To adequately capture the multiple dimensions of each component, we identified sub-components that measure the key aspects that define theory, hypotheses, tests, and evaluation. We provide details on each of the sub-components of the approach in Table A1a in the Appendix. For each subcomponent, research assistants provided a score from 0 to 5, where a low score (say 0 or 1) indicates that the entrepreneur does not at all employ or employs to a very limited extent that specific aspect in his/her decision-making process; a high score (such as 5) reflects that the entrepreneur adopts a specific aspect extensively. We then aggregated all variables by taking the average of the sub-components to compute an overall scientific intensity score. The rationale for this choice is that the scientific approach is a holistic approach and entrepreneurs should use it in its entirety (Lazear, 2004; Zellweger & Zenger, 2021).

In Table A1b, we compare the level of scientific intensity of the treatment and control groups at the time of each interview. Results show that there was no clear difference between the two groups at the baseline. The level of scientific intensity was clearly higher for treated firms in subsequent interviews up until Interview 4, although it diminished in size and precision over time.

### 3.2 Methodology and variable operationalization

*Methodology.* To explore the *impact of the treatment on firm performance*, we employed a classic *difference-in-difference* specification. We estimated it by fitting the following model:

$$\text{Performance}_{it} = \beta_0 + \beta_1 T_i + \beta_2 P_i + \beta_3 T_i P_i + \beta_4 DBD_i + \varepsilon_{it}$$

where  $T_i$  denotes the treatment and is equal to 1 for firms that were allocated to the treatment group and 0 for firms that were allocated to the control group, and  $P_i$  denotes the time-period post training, with  $P_i = 0$  before the training program took place and  $P_i = 1$  after the training program (at the end of the observation period).  $DBD_i$  is a variable that measures the degree of business development at the

baseline. In this model the difference-in-difference estimand is the coefficient of the interaction term ( $\beta_3$ ). It corresponds to the difference in performance before and after the training for treated firms vs. control firms.

To explore *the moderating effect of the degree of business development*, we employed a *triple difference specification* and analyzed how the difference in performance between treated and control firms is shaped by the *Degree of business development*, measured at the baseline. We fit the following model:

$$\text{Performance}_{it} = \beta_0 + \beta_1 T_i + \beta_2 DBD_i + \beta_3 T_i DBD_i + \beta_4 Post_i + \beta_5 T_i Post_i + \beta_6 P_i DBD_i + \beta_7 T_i Post_i DBD_i + \varepsilon_{it}$$

The coefficient of interest is  $\beta_7$ , the coefficient on the triple interaction term (Wooldridge, 2007). In all regressions, we clustered the standard errors at the firm level.

#### *Variable operationalization.*

*Dependent variable: Performance.* Our paper investigates the impact of a scientific approach to decision-making on performance. We measured performance using *Revenue*, measured as the log of (1+) the cumulative revenue generated from the beginning of the program up until the last period in thousand pounds sterling. To do so we used data collected by our research assistants during the interviews with entrepreneurs.

*Independent variables.* Our first independent variable is *Treatment*, a dummy variable equal to 1 for firms in the treatment group and 0 for those in the control group. Our second independent variable is *Post*, a dummy variable equal to 0 at the baseline and 1 after the training program and until the end of our observation period. Finally, we included the degree of business development in the analysis. We asked entrepreneurs to provide us with an estimate of the probability of making a radical change to their business (on a scale from 0% to 100%). For clarity of interpretation, we constructed a variable that we call *Degree of business development* that we calculated as the difference between 100 and the probability of making a radical change (provided by the entrepreneur). This is a proxy of the extent to which an entrepreneur has already crystallized the details of their firm's strategy when he or she is exposed to the scientific approach. We expected that entrepreneurs with a *lower* degree of business development, who

were still making decisions on their core elements and whose firms are still plastic, would report a *lower* probability of *not* changing their business. We expected that entrepreneurs with a more defined strategy, who were just fine-tuning the peripheral elements of that strategy, would indicate that the probability of not making changes to their business was higher. Among the advantages of this measure, one is that it is comparable across firms irrespective of the nature of the context or industry in which a firm is operating. The measure also reflects the continuous nature of the construct.

Table 2 displays summary statistics and pairwise correlations.

*Add Table 2 about here*

## 4 MAIN RESULTS

### 4.1 Firm performance: Firm Revenue

We start by examining the impact of our intervention on firm size in Table 3, where we report the results of our analyses that investigate the impact of the treatment on firm revenue and the moderating role of the *Degree of business development*. Column 1 reports the results of the difference-in-difference specification. The impact of our intervention on performance can be assessed by looking at the interaction between *Treatment* and *Post*. This corresponds to what happens, on average, to treated firms after the treatment, compared to control firms. Results show that, on average, the intervention did not have a clear impact on performance as measured by firm revenue ( $B = -0.1197$ ,  $p = 0.4596$ ). Results from the triple difference specification, reported in Column 2, paint a very interesting picture. They show that the effect of our intervention varies when we look at firms at different degrees of business development. For firms whose degree of business development was equal to 0 when they started the program (firms that at the time of enrolment in our program reported that their probability of making a radical change was 100%), being exposed to our intervention had a negative impact on revenue ( $B = -1.1558$ ,  $p = 0.0029$ ). However, the coefficient of the triple interaction shows that the impact of our intervention increased with the degree of business development of the firm at the baseline ( $B = 0.0184$ ,  $p=0.0020$ ). We refer to the mean and the standard deviation of the degree of business development to comment on the economic significance of this effect. Treated firms that were at the average degree of business development (56.0115) when they started the program experienced revenues that, at the end of the



program, were 13% lower compared to those of firms in the control group. However, treated firms that were one standard deviation (27.4184) above the mean in their degree of business development at the beginning of the program reported revenues that, at the end of the program, were 38% higher than the control group.

*Add Table 3 about here*

To help clarify the effect, in Figure 1 we provide a graphical representation of how the predicted values of the performance variable (Log 1 + Revenue) vary in the four groups of interest—(1) Treatment Pre Training, (2) Control Pre Training, (3) Treatment Post Training, and (4) Control Post Training—as a function of the firm *Degree of business development* before the training. The coefficients  $\beta_0$ ,  $\beta_1$ ,  $\beta_4$ , and  $\beta_5$  all shift the intercept term, estimating the mean of the outcome variable among our four groups: Control Pre Training ( $\beta_0$ ), Treatment Pre Training ( $\beta_0 + \beta_1$ ), Control Post Training ( $\beta_0 + \beta_4$ ), and Treatment Post Training ( $\beta_0 + \beta_1 + \beta_4 + \beta_5$ ). The coefficients  $\beta_2$ ,  $\beta_3$ ,  $\beta_6$ , and  $\beta_7$  are all slope shifters, capturing how the *Degree of business development* differentially affects the four groups. Looking at the coefficients, the impact of the degree of business development for control firms after the training (vs. before the training) is given by  $\beta_6$ , the overall impact of the degree of business development for treated firms after the treatment is  $\beta_6 + \beta_7$ , and the differential effect of the degree of business development for treated firms after the training is given by  $\beta_7$ , which therefore constitutes our focus.

*Add Figure 1 about here*

Figure 1 clearly shows that after the treatment, the performance of treated firms is lower than that of the control group for firms at a *lower degree of business development*.<sup>4</sup> For firms at a *higher degree of business development* the performance of treated firms is higher than that of the control group.

## 4.2 Robustness checks

We ran a series of checks to test the robustness of this effect.

### *Outliers*

---

<sup>4</sup> This Figure was inspired by Starr, Balasubramanian, and Sakakibara's (2018) graphical representation.

We checked if the results might have been driven by the presence of outliers in our sample by replicating the analysis after 99% winsorization. We report these results in Table A2 in the Appendix; they are consistent with those reported in Table 3.

#### *Alternative measure of strategy elaboration*

The previous analysis suggests that firms with more developed strategies will benefit more from the intervention. We tested the robustness of results by using an alternative proxy for the degree of business development: the annual revenue of each firm in the year before it started the program (log of 1 +, in thousands of GBP). This measure has been used by prior research on firm evolution as a measure of the development of the firm (Churchill & Lewis, 1983; Davidsson, 2004; Greiner, 1972). Results are reported in Table A3 in the Appendix and are in line with those reported in the main analysis.

#### *Attrition*

Not all the firms in our sample continued to participate in the interviews for the full duration of the study (see Table A4a for the distribution of attrition over time). Notoriously, attrition is more the norm than the exception in field experiments (Gerber & Green, 2012). To address this issue, we designed the program so that the training was followed by a series of monthly events focused on relevant themes for entrepreneurs delivered in the same way for treated and control firms but on separate days. Participation in these events was conditional on firms' continued engagement with the program and data collection. Nevertheless, some firms dropped out before the last interview round. Entrepreneurs that were not available for interviews indicated that their incentive to participate in interviews was lower after the training was over. To verify that attrition did not affect our results, we followed the best practice outlined by Gerber and Green (2012). First, we checked there was no clear difference between treated and control groups in terms of early withdrawal from the program. In Table A4b in the Appendix, we estimate early withdrawal from the program as a function of the intervention, which we show has no relevant impact. Second, we addressed attrition by inputting the missing values of those who left the study. We followed Gerber and Green (2012) and used different case scenarios. As a starting point, the main analyses presented in Table 3 made the conservative assumption that the performance of firms

that left the program remained the same as when they left the program. This assumption is consistent with previous studies that have used similar data (Camuffo et al., 2020). We then replicated the analyses by assuming that the performance of firms who left the program grew at the average rate of growth for firms in the sample. We present these analyses in Table A4c in the Appendix, Column (1). Finally, we replicated these analyses using an unbalanced panel and retaining firms in the sample only up until the time at which they left the program. We included interview dummies to control for the fact that different firms left the program at different points in time. Results are reported in Column (2) and are overall consistent with those presented in the main analyses, supporting the idea that our results are robust despite attrition.

## 5 INTERPRETING THE RESULTS

Our analyses in Table 3 suggest that the *Degree of business development* moderates the relationship between a scientific approach to decision-making and performance. We found that treated firms perform worse than control firms when they are at a lower degree of business development, whereas they perform better than control firms when they are at a high level of business development. Why is this so? Following our abductive approach, in this section we aim to provide an interpretation of the results. We identify some possible explanations for the observed patterns and present additional analyses that offer insights in support of or in contrast to those explanations. Table 4 provides a conceptual schema of the main results and evidence in support of the abductive interpretation.

*Add Table 4 about here*

### 5.1 Confidence and experience: Excluding alternative explanations

We measured the degree of business development by asking firms (at the baseline) to assess the probability of making a radical change to their business (and taking the complement of it). The intuition behind this measure is that entrepreneurs with a crystallized strategy are unlikely to report that they will make a radical change to that business.

However, we considered the possibility that results in Table 3 might rather be driven by the confidence of the entrepreneur in their project (Bennett & Chatterji, 2019; Chen et al., 2020; Hayward

et al., 2010). We also considered the experience of the entrepreneur as an alternative explanation, since research has extensively emphasized the importance of prior experience for firm survival (Agarwal & Shah, 2014; Klepper & Sleeper, 2005) and performance (Agarwal et al., 2016; Azoulay et al., 2020; Gruber et al., 2013; Shah et al., 2019).

We investigated these alternative explanations in a series of triple differences analyses that we report in Table 5, where we studied performance as a function of the interactions between the intervention and (a) the level of confidence of the entrepreneur at the baseline (measured as their agreement on a 1–5 scale with statements related to confidence, as displayed in Table 1) (Column 1) and (b) prior work experience of the team at baseline (measured as the average number of years of work experience in any role of all individuals working in the firm) (Column 2). Results show that these alternative explanations do not account for the results from our main analyses: The interaction terms do not show any clear impact of confidence nor of experience in driving the results, suggesting that these are not likely interpretations of our finding.

*Add Table 5 about here*

## **5.2 Choice commitments and uncertainty resolution**

The work of Gans and colleagues (2019) suggests a possible alternative explanation for the main results reported in Table 3 and Figure 1 that treated firms at a high degree of business development have higher performance than control firms, while treated firms at a low degree of business development have lower performance than control firms. These authors suggest that during the process of strategy definition, entrepreneurs make a series of “partial-commitment choices” (Gans, Stern, & Wu, 2019, p.737) and this affects the nature of the search process they conduct and its performance implications. Early in the process of strategy definition, when the amount of strategic commitment is limited, feedback from the early search phases has an “inducement effect,” leading to further search (as opposed to commitment) and to an increase in uncertainty because the entrepreneur is still collecting information about “*the environment in which search is being undertaken*” and the “*value distribution*” the idea is coming from (Gans et al., 2019, p. 737).

A scientific approach implies that firms articulate, question, and validate the theory underlying their business, and produces in this way feedback that can affect the firm strategy. But firms at different degrees of business development are different in terms of their “choice commitments” and this will affect the way in which they will incorporate that feedback, and its performance implications in the way discussed by Gans and colleagues (2019).

The questioning attitude elicited by the scientific approach and the feedback derived from it induce entrepreneurs with firms at a lower degree of business development to question core aspects of their firm strategy. While this might help them improve their firm trajectory, it may not immediately translate to positive firm performance. It may rather lead to more uncertainty and the need for further search. This implies that in the short term treated firms at a lower degree of business development might even perform worse than control firms. In comparison, control firms, who do not use a scientific approach, lack a questioning attitude. When their strategy is still undefined, they pursue opportunities as they emerge with little hesitation, in a trial-and-error approach. This approach might lead to positive outcomes in the short term, but because these choices are not validated it is unclear whether they will lead to positive outcomes in the longer term. Because control entrepreneurs do not question their own choices (or do so to a lesser extent), they *do not know what they do not know*. The degree of uncertainty that they associate with their business therefore remains invariant.

The situation for firms at a high degree of business development is different. These firms’ strategies are less likely to go through radical changes, but some more peripheral choices still require fine-tuning, and the questioning attitude induced by the scientific approach helps achieve this. Because these choices are more peripheral, and the key elements of the strategy are already in place, the “scope” of uncertainty is narrower, and uncertainty is therefore more straightforward to address. Feedback that derived from the application of a scientific approach can be implemented quickly, with a positive impact on performance. In comparison, the lack of a scientific “questioning” attitude induces entrepreneurs in the control group with an already crystallized strategy to pursue “business as usual” with no improvements to their trajectory. We present qualitative illustrative evidence and quantitative evidence that supports this interpretation.

### 5.2.1 Qualitative analysis: Illustrative cases

To explore this possible interpretation of our findings we conducted a qualitative exploration of our data. Among all the audio interviews conducted by research assistants with entrepreneurs, we selected a sample of baseline interviews, final interviews, and interviews where the entrepreneurs mentioned an important change to the business model. We used our variables *Treatment* and the median of the *Degree of business development* to identify four groups: (1) Treatment – Low Degree of business development; (2) Treatment – High Degree of business development; (3) Control – High Degree of business development; and (4) Control – Low Degree of business development. We then went through the interviews in each of these categories, focusing on the qualitative questions where the focal entrepreneur was talking about their business proposition and decision-making process to abstract from the narratives key themes regarding (1) the way in which entrepreneurs made decisions and (2) the outcome of those decisions. We identified five illustrative cases in each category, for a total of twenty illustrative cases that support the above interpretation, presented in Table 6 and illustrated in the following sections.

*Add Table 6 about here*

#### 5.2.1.1. Treatment – Low Degree of business development: Key themes

We found illustrative evidence that the treatment induced firms in this category to articulate, question, and validate their theory and assumptions and that this process helped them to learn that some aspects of their original ideas needed to be revised. The early feedback was useful, but it increased uncertainty for the entrepreneur. For example, an entrepreneur in this category reported:

*“So before coming into the (program), we had a very clear vision of which problem we were solving. But as we’ve gone through and sort of, you know, rigorously tested our hypothesis and our ideas, we’re a little bit less clear on which points, which pain we’re sort of reducing for our users. So that’s the thing we’re trying to ensure and struggling a little bit to get clarity on.”*  
(Table 6, case 1, Interview 1)

This process tends to trigger novel search processes, which will require time to be completed, but that are meant to set the entrepreneur on a better trajectory in the future.

*“So, for the next one year we are not going to do anything, so I just need to reforecast, re-plan, and get my new target audience and just work out on my marketing strategies. We both came*

*for the (program), just realized that there were quite a little bit that I actually needed to improve on in understanding the market properly.” (...) “I think right now we’re just sort of everywhere. So, it’s really finding out exactly who the main target audience will be. So, we’ve sort of stepped back, it is needed to improve ourselves and then to come out better.” (Table 6, case 2, Interview 8)*

#### 5.2.1.2. Control – Low Degree of business development: Key themes

Similar to entrepreneurs in the previous category, entrepreneurs in this category joined the program with strategies that were at a lower stage of development. But instead of articulating and questioning their theory, and using this process to guide their tests, they tended to pursue opportunities that emerged with little hesitation. For example, an entrepreneur in this category said:

*“The existing competitors are all shifting towards offering consulting and development of blockchain solutions. So it means that at the moment this is what was the market and this is where we should go.” (...) “We have to change the idea of the kind of team that we are building because we need a programmer, so that would be the first change, and yes, the image of the project also changes, and as you said, we’re looking for different kinds of clients. We already hired a developer.” (Table 6, case 6, Interview 3)*

Not questioning their theory and assumptions made entrepreneurs in this category quicker to implement solutions, which generated some revenue in the short term. But these solutions were not necessarily “thought through,” so there was no guarantee that they would perform well in the long run.

#### 5.2.1.3. Treatment – High Degree of business development: Key themes

Entrepreneurs in this category joined the program with more defined strategies. They still articulated, questioned, and validated their theories, but their search process focused on specific aspects of their strategy as opposed to macro aspects. For example, one entrepreneur in this category said:

*“We hope that will confirm whether our understanding of the problem is correct (...) basically, we’ve defined the problem is to retain the talent, and second, to re-skill their people within the organization, but now we have to double confirm whether our solutions would be perceived by the end consumer as something that can actually help them feel future proof.” (Table 6, Case 6, Interview 5)*

Because entrepreneurs in this category applied the scientific approach to a more crystallized strategy, they used the approach to refine some specific aspects (such as product promotion or entry strategy) rather than addressing macro questions about the product or service. For example, an entrepreneur said:

*“Through the program, I changed much the strategy of promotion of the company, not as much the service itself. So my biggest testing and one thing that came out of the program was I tested*

*whether if I promoted the same service to the same people but using my achievements to promote the service people would be more willing to buy it. That has proven right, and this was a big take away.” (Table 6, Case 11, Interview 2)*

The scope of their analysis and test was narrow so, as soon as results were available, they could be quickly implemented, with positive results for performance. Another entrepreneur provided an example of this dynamic:

*“So we had the children go through the different levels and then we asked them at different points throughout what was easy, difficult (...) and then afterwards we asked them to go through the pack and then got their feedback on that so it was very qualitative.” (...) “So we found that kids really like to take what they learned in the digital and apply it in the physical and they like to use their hands. Anything to kind of add a tactile component is really good.” (...) “It was an assumption and that just kind of confirmed it.” (...) “I think that it helped us to implement more tactile activities in our learning pack.” (...) “We gained about 30 (new customers).” (Table 6, Case 12, Interview 7)*

#### 5.2.1.4. Control – High Degree of business development: Key themes

Similar to entrepreneurs in the previous category, entrepreneurs in this category also joined the program with more developed strategies. Yet the theory underlying their business was never properly articulated or questioned, and the quality of the test they performed was very limited, which limited their ability to improve in comparison to the treatment group. One entrepreneur in this category said:

*“I also did a bit more handholding, mentoring or one-to-one, something like that.” (...) “I did do a test with a lady, (...) I have a list of pain points, what they want, like their sleepless nights, freedom of time, because success is not just money in the bank, being able to go to your child’s show or something like that.” (...) “Those are the questions I think they need, but it might be very different from what actually they need, so that would be just in the test, I think.” (Table 6, Case 19, Interview 2)*

Entrepreneurs in this category tended not to question their value proposition throughout the program:

*“(The idea was about) the number of people who had heard about Bitcoin, who wanted to understand themselves what all the fuss was about but they were not computer educated so they needed someone who understood the way the computer-educated side came from, that wanted to understand it in a more conversational point of view.” (...) “I was already in close contact with these people anyway because that was my previous business was in financial markets.” (Table 6, Case 16, Interview 7)*

Asked about whether they gathered any evidence to verify that their understanding of the problem was correct, and their value proposition valuable, they responded:

*“No, because we already knew what the product was.” (Table 6, Case 16, Interview 7)*

#### 5.2.2 Quantitative analysis: Value expectations and (un)certainty about the value distribution



The qualitative illustrative analysis presented in the previous section suggested that the questioning attitude stimulated by the scientific approach to decision-making led entrepreneurs at a lower degree of business development to identify core aspects about their value propositions that they still did not fully understand. So, for these entrepreneurs, uncertainty on the key elements of their strategy increases as a result of using the scientific approach (at least in the short term). However, the analysis also shows that the same attitude helped entrepreneurs at a higher degree of business development to fine-tune their strategy. Because the “scope” of uncertainty is narrower for these entrepreneurs (it only concerns peripheral choices whereas the key elements of the strategy are already in place), uncertainty is relatively straightforward to resolve. We explored if this is supported by quantitative evidence through additional analysis.

During the entire observation period of the study, we asked entrepreneurs about the expectation of the value of their own business over time. Specifically, we asked them about the likelihood that their turnover would increase or decrease certain amounts over the subsequent three months.<sup>5</sup> We used these data to measure two aspects: (1) the entrepreneurs’ estimation of the value of their business, which we measured by taking the (log transformed) net likelihood of turnover increase (i.e., if the difference between aggregate likelihood of turnover increased and the likelihood of turnover decreased), and (2) the entrepreneurs’ uncertainty about the value distribution of their business proposition, which we measured by calculating the Herfindahl index of the distribution of the likelihood estimates expressed by entrepreneurs across the different options (decrease GBP0–30,000; decrease GBP30,000–100,000; decrease more than GBP100,000; increase GBP0–30,000; increase GBP30,000–100,000; increase more than GBP100,000). The intuition behind the use of the Herfindahl index is that a more concentrated likelihood reflects a higher degree of certainty about the prospects of the venture.

Results, reported in Table 7, show that the treatment does not affect the value of entrepreneurial expectations, but it does affect the level of certainty about the value distribution of their business proposition. Specifically, the effect of the treatment on certainty was negative for firms whose degree

---

<sup>5</sup> Precisely, our survey asked: “Looking at the next three months, how likely it is that your turnover will increase (decrease) by GBP 0–GBP 30,000 (GBP 30,000–100,000; more than GBP 100,000), where 0 is extremely unlikely, 5 is neither likely nor unlikely and 10 is extremely likely.”

of business development was 0 ( $B = -0.0648, p = 0.0388$ ), but its impact on certainty increased alongside the degree of business development ( $B = 0.0023, p = 0.0439$ ). Figures 2a and 2b provide a graphical representation of this result. These results further support the abductive interpretation presented in Section 5.2.

*Add Table 7 about here*

## **6 DISCUSSION AND CONCLUSIONS**

Is it beneficial for entrepreneurs to use a scientific approach to decision-making? And, if so, when is it beneficial to use this approach? Recent research indicates that a scientific approach leads to improved learning (Camuffo et al., 2020; Zellweger & Zenger, 2021), but there is limited and mixed empirical evidence on the effect of this approach on performance (Zellweger & Zenger, 2022), and, in particular, on whether the degree of business development moderates the relationship between the use of a scientific approach and performance. We addressed this issue with a question-driven approach. We conducted an RCT with 261 entrepreneurial firms in the UK to evaluate the impact of a scientific approach on performance and its differential effect on different types of firms. With the RCT, we created a business support program and taught treated firms a scientific approach to decision-making, while control firms received comparable training without a scientific approach. We collected detailed observations on performance and key business choices at baseline and after the training. Our sample is unique as it includes different types of firms with various degrees of strategy elaboration.

Our main result shows that treated firms at a high degree of business development have higher performance than control firms but treated firms with a low degree of business development have lower performance than control firms. We explored these results abductively. We excluded the alternative explanations that the experience or confidence of the entrepreneur explained the results. We found, instead, qualitative and quantitative support for our intuition that this result is related to the type of decisions faced by firms at a higher degree of business development, which concern fine-tuning their strategy, and those faced by firms at a lower degree of business development, which concern more core, strategic choices. The scientific approach induced firms in both categories (i.e., lower and higher degrees of business development) to articulate, question, and validate their theory, but with different

effects. It led the former to go back to the drawing board, with a consequent increase in uncertainty and a need for further search; it led the latter to find more precise answers to their narrower questions, reducing uncertainty. The same types of firms in the control group tended not to articulate, question, and validate their strategy. As a result, those control firms at a lower degree of business development, whose strategy was still not crystallized, were faster in pursuing ideas as they emerged, although these ideas were not vetted, so there is no guarantee that they will work in the long term. Meanwhile, those control firms at a higher degree of business development tended to continue “business as usual,” with limited improvement.

Our study makes several contributions to research in strategy and entrepreneurship. First, our results provide insight on the performance implications of the use of a scientific approach to decision-making, and, more broadly, on the use of decision-making approaches that combine cognitive-based and action-based components. The growing literature on entrepreneurial strategy (Gans et al., 2019; Zellweger & Zenger, 2021) has advanced (mostly through theoretical work) that theory-based or scientific-like experimentation improves performance. Preliminary evidence from qualitative studies (McDonald & Eisenhardt, 2020) supports this idea. Our results provide an important empirical test of these recent concepts through an RCT that allows us to identify cause-effect relationships between a scientific approach and performance. We found that only firms with a higher degree of business development experienced superior performance compared to our control when exposed to the scientific approach, at least within the time window we considered. This finding is important from a theoretical standpoint because it provides quantitative and qualitative insights that concern not only the implications of a scientific approach but also the way in which a scientific approach operates in practice. This study is also important from a methodological standpoint. Prior studies on decision-making have focused on either firms with a higher (Bloom & Van Reenen, 2007; Yang et al., 2020; Zollo & Winter, 2004) or lower degree of business development (Camuffo et al., 2020) in isolation. Our paper shows how some of the nuances associated with the use of a particular approach to decision-making emerge only when looking at a more heterogeneous sample.

Second, this study contributes to the strategy literature on search (Gavetti & Levinthal, 2000; Gavetti & Rivkin, 2007; Levinthal, 2017). We advance that the use of a scientific approach supports a

search process that combines cognitive and experiential search: it begins with a process of theory and hypothesis development, which facilitates the creation of a map of action-outcome linkages and the assessment of options “off-line”; it is then followed by the collection of evidence and its disciplined assessment, which resonates with the idea of experiential search (Lippman & McCall, 1976; Levitt & March, 1981). Research on search has emphasized the existence of synergies between cognitive and experiential approaches, with the theory seeding the search process in promising regions of the landscape and preventing it from taking root in less attractive ones (Gavetti & Levinthal, 2000; Gavetti & Rivkin, 2007; Levinthal, 2017). Our quantitative and qualitative results shed light on how a search process that combines cognitive and experiential search applies in an entrepreneurial setting and how it leads to different search paths for firms with higher vs. lower degrees of business development, with important consequences in terms of uncertainty resolution.

Relatedly, prior research in this area has advanced a relevant tension between organization rationality and plasticity (Rios, 2021; Gavetti & Levinthal, 2005), suggesting that firms tend to naturally shift to more rational, less experiential search mechanisms later in their evolution, when they often lack the plasticity necessary to harvest the fruit of rationality (Gavetti & Rivkin, 2005). Our results suggest the intriguing possibility, which should be tested by future research, that inducing firms to employ a scientific approach is a way to nudge them toward more rational search processes even earlier in their journey, when they are more plastic and therefore more absorptive to them.

Finally, our paper contributes to research on strategic entrepreneurship that advocates for the importance of testing and purposeful experimentation for firm performance (Bingham & Eisenhardt, 2011; Gruber & Tal, 2017; Murray & Tripsas, 2004; Shepherd & Gruber, 2020; Thomke, 2003). In line with these studies, our results support the view that experimentation (and the collection of evidence more generally), particularly combined with theory and hypothesis development, can be useful. However, they also highlight that the way in which entrepreneurs are taught to use these tools plays a fundamental role in determining performance. Entrepreneurs in our control group were presented tools individually, as is typical in many Master’s or MBA programs, either as part of the same module or as part of multiple modules. Our treated entrepreneurs, instead, were taught how to use these tools in

combination, using cognitive frameworks to develop a theory and hypotheses and using evidence-gathering techniques to test and evaluate their theory and hypotheses.

In making these considerations, we also acknowledge the limitations of this study, which point to opportunities for future research. First and foremost, it would be important for future research to replicate our analyses in a longer time window to support the intuition that firms with a lower degree of business development (not only those with a higher degree) can also benefit from the approach in terms of revenue in the long run. In fact, our qualitative findings suggest the intriguing possibility that the longer-term performance effects might be even greater for firms at a lower degree of business development because a scientific approach to decision-making gives these firms a chance to fix errors and invest in the right direction, even if this positive effect is not visible in the short term.<sup>6</sup>

Second, our study is focused on firms with fewer than ten employees. This is an advantage in that it allowed us to ensure that the treatment was administered to the individuals directly involved in the firm's decision-making. However, the open question as to whether the treatment would produce the same effect with larger firms limits the generalizability of our findings. We see this as an opportunity for future research.

Third, our results have shown that the effect of our 21-hour intervention on the way in which entrepreneurs made decisions lasted only for a few months. Subsequently, the decision-making processes of treated firms and control firms became comparable. We interpret this result as raising some important points. The fact that we observed an impact of the treatment on performance and other outcomes despite the impact of our treatment on decisions being short lived speaks to the effectiveness of the scientific approach to decision-making. Also, we note that, as all firms progress in their journey, their decision-making processes naturally tend to become more systematic. In addition, and very importantly, we note that the scope of our intervention was not sufficient to deliver a long-lived effect on the way in which entrepreneurs make decisions. Understanding how long and how intense an intervention should be for it to continue to shape the way in which entrepreneurs make decisions in the long run is an important question for future research.

---

<sup>6</sup> We are grateful to one of the reviewers for making this valuable suggestion.

Fourth, future research could examine additional factors that might contribute—in conjunction with a scientific approach to decision-making—to better performance. For instance, resources might play an important role in shaping performance outcomes and might afford entrepreneurs with more opportunities to experiment scientifically.

In line with our abductive approach, we assembled a set of analyses that explored the phenomenon, identified a “promising explanatory conjecture,” and put together plausible evidence in line with those explanations. In keeping with an abductive approach, readers are encouraged to form their own interpretation of this important phenomenon. In this respect, we believe that our study’s finding set the stage for future research. Other scholars can build on this work to develop theory, pre-register hypotheses, and conduct hypothesis testing so that a cumulative knowledge base may be developed.

A final contribution is to offer insights to policymakers. Encouraging entrepreneurship has been a major means to spur economic growth (Bennett & Chatterji, 2019; Decker et al., 2014; Lerner, 2009; McKenzie, 2021). Bennett and Chatterji’s (2019) nationally representative survey of the pre-entry activities conducted by potential entrepreneurs in the US found that fewer than half of those who consider starting a business take the lowest-cost steps, such as searching the Internet for potential competitors or speaking with a friend, a phenomenon they attribute to the psychological costs associated with learning the true promise of an idea. They conclude that one way to increase the quality and quantity of entrepreneurial ventures would be to lower the cost of experimentation at the very *beginning* of the entrepreneurial process. Our results show that an intervention intended to encourage systematic experimentation to support decision-making was differently helpful for firms were different degrees of business development. These results, therefore, underline the importance of understanding the ideal time window as well as the most effective performance dimensions by which programs targeted at less developed firms should be evaluated to appreciate their effectiveness. Given the importance of this topic for the economy, we consider this a promising path for future research.

## REFERENCES

- Agarwal, R., Audretsch, D., & Sarkar, M. B. (2007). The process of creative construction: knowledge spillovers, entrepreneurship, and economic growth. *Strategic Entrepreneurship Journal*, 1(3–4), 263–286.
- Agarwal, R., Campbell, B. A., Franco, A. M., & Ganco, M. (2016). What do I take with me? The mediating effect of spin-out team size and tenure on the founder–firm performance relationship. *Academy of Management Journal*, 59(3), 1060–1087.
- Agarwal, R., Bacco, F., Camuffo, A., Coali, A., Gambardella, A., Msangi, H., Sonka, S. T., Temu, A., Waized, B., & Wormald, A. (2023a). Does a theory-of-value add value? Evidence from a randomized control trial with tanzanian entrepreneurs. Bocconi University Management Research Paper, Available at SSRN: <https://ssrn.com/abstract=4412041> or <http://dx.doi.org/10.2139/ssrn.4412041>
- Agarwal, R., Camuffo, A., Gambardella, A. Sonka, S., & Valentine, J. (2023b). Evaluating common approaches to entrepreneurial learning and their fits within entrepreneurial Environments [Conference presentation]. <https://www.strategicmanagement.net/home/conferences/sms-conferences>
- Agarwal, A., Gans, J. S., & Stern, S. (2021). Enabling entrepreneurial choice. *Management Science*.
- Alexy, O., Poetz, K., Puranam, P., & Reitzig, M. (2021). Adaptation or persistence? Emergence and revision of organization designs in new ventures. *Organization Science*, 32(6), 1439–1472.
- Ambos, T. C., & Birkinshaw, J. (2007). How do new ventures evolve? The process of charter change in technology ventures. *Academy of Management Proceedings* 2007(1), 1–6.
- Anderson, S. J., Chandy, R., & Zia, B. (2018). Pathways to profits: The impact of marketing vs. finance skills on business performance. *Management Science*, 64(12), 5559–5583.
- Arenius, P., & Minniti, M. (2005). Perceptual variables and nascent entrepreneurship. *Small Business Economics*, 24(3), 233–247.
- Azoulay, P., Jones, B. F., Kim, J. D., & Miranda, J. (2020). Age and high-growth entrepreneurship. *American Economic Review: Insights*, 2(1), 65–82.
- Bennett, V., & Chatterji, A. (2019). The entrepreneurial process: Evidence from a nationally representative survey. *Strategic Management Journal*.
- Bingham, C., & Eisenhardt, K. (2011). Rational heuristics: The ‘simple rules’ that strategists learn from process experience. *Strategic Management Journal*, 32(13), 1437–1464.
- Blank, S. (2013). Why the lean startup changes everything, *Harvard Business Review*. <https://hbr.org/2013/05/why-the-lean-start-up-changes-everything>
- Bloom, N., Sadun, R., & Van Reenen, J. (2012). The organization of firms across countries. *The Quarterly Journal of Economics*, 127(4), 1663–1705.
- Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *The Quarterly Journal of Economics*, 122(4), 1351–1408.
- Bloom, N., & Van Reenen, J. (2010). Why do management practices differ across firms and countries? *Journal of Economic Perspectives*, 24(1), 203–224.
- Boulding, W., Morgan, R., & Staelin, R. (1997). Pulling the plug to stop the new product drain. *Journal of Marketing research*, 34(1), 164–176.
- Brea-Solís, H., Casadesus-Masanell, R., & Grifell-Tatjé, E. (2015). Business model evaluation: Quantifying Walmart's sources of advantage. *Strategic Entrepreneurship Journal*, 9(1), 12–33.
- Bruhn, M., Karlan, D., & Schoar, A. (2018). The impact of consulting services on small and medium enterprises: Evidence from a randomized trial in Mexico. *Journal of Political Economy*, 126(2), 635–687.
- Cain, D. M., Moore, D. A., & Haran, U. (2015). Making sense of overconfidence in market entry. *Strategic Management Journal*, 36(1), 1–18.
- Campos, F., Frese, M., Goldstein, M., Iacovone, L., Johnson, H. C., McKenzie, D., & Mensmann, M. (2018). Is personal initiative training a substitute or complement to the existing human capital of women? Results from a randomized trial in Togo. *AEA Papers and Proceedings*, 108, 256–61.
- Camuffo, A., Cordova, A., Gambardella, A., & Spina, C. (2020). A scientific approach to entrepreneurial decision making: Evidence from a randomized control trial. *Management Science*, 66(2), 564–586.

- Cardon, M. S., Post, C., & Forster, W. R. (2017). Team entrepreneurial passion: Its emergence and influence in new venture teams. *Academy of Management Review*, 42(2), 283–305.
- Chatterji, A., Delecourt, S., Hasan, S., & Koning, R. (2018). When does advice impact startup performance? *Strategic Management Journal*, 40(3), 331–356.
- Chen, J. S., Croson, D. C., Elfenbein, D. W., & Posen, H. E. (2018). The impact of learning and overconfidence on entrepreneurial entry and exit. *Organization Science*, 29(6), 989–1009.
- Chen, J. S., Elfenbein, D. W., & Posen, H. E. (2020). The problems and promise of entrepreneurial partnerships: Decision making, overconfidence, and learning in founding teams. *Academy of Management Review*.
- Chen, J. S., Elfenbein, D. W., Posen, H. E., & Wang, M. Zhu. (2022). Programs of experimentation and pivoting for (overconfident) entrepreneurs. *Academy of Management Review*.
- Churchill, N., & Lewis, V. (1983). The five stages of small business growth. *Harvard Business Review*. Retrieved from <https://hbr.org/1983/05/the-five-stages-of-small-business-growth>.
- Csaszar, F., & Laureiro-Martínez, D. (2018). Individual and organizational antecedents of strategic foresight: A representational approach. *Strategy Science*, 3(3), 513–532.
- Davidsson, P. (2004). *Researching entrepreneurship* (Vol. 5). New York: Springer.
- Decker, R., Haltiwanger, J., Jarmin, R., & Miranda, J. (2014). The role of entrepreneurship in US job creation and economic dynamism. *Journal of Economic Perspectives*, 28(3), 3–24.
- Ehrig, T., & Schmidt, J. (2022). Theory-based learning and experimentation: How strategists can systematically generate knowledge at the edge between the known and the unknown. *Strategic Management Journal*. <https://doi.org/10.1002/smj.3381>
- Eisenhardt, K.M., & Bingham, C.B. (2017). Superior strategy in entrepreneurial settings: Thinking, doing, and the logic of opportunity. *Strategy Science*, 2(4), 246–257.
- Eisenhardt, K. M., & Brown, S. L. (1999). Patching. *Harvard business review*, 77(3), 72–73.
- Felin, T., Gambardella, A., Stern, S., & Zenger, T. (2020a). Lean startup and the business model: Experimentation revisited. *Long Range Planning*, 53(4).
- Felin, T., Kauffman, S., & Zenger, T. (2020b). Microfoundations of resources: A theory. *Available at SSRN*.
- Felin, T., & Zenger, T. (2009). Entrepreneurs as theorists: On the origins of collective beliefs and novel strategies. *Strategic Entrepreneurship Journal*, 3(2), 127–146.
- Felin, T., & Zenger, T. (2016). CROSSROADS—Strategy, problems, and a theory for the Firm. *Organization Science*, 27(1).
- Felin, T., & Zenger, T. (2017). The theory-based view: Economic actors as theorists. *SSRN Electronic Journal*, 2(4), 211–287.
- Folta, T. (1998). Governance and uncertainty: The trade-off between administrative control and commitment. *Strategic Management Journal*, 19(11), 1007–1028.
- Forbes, D. P. (2005). Managerial determinants of decision speed in new ventures. *Strategic Management Journal*, 26(4), 355–366.
- Foss, N., & Klein, P. (2012). *Organizing entrepreneurial judgment*. Cambridge: Cambridge University Press.
- Gans, J., & Stern, S. (2003). The product market and the market for “ideas”: Commercialization strategies for technology entrepreneurs. *Research Policy*, 32(2), 333–350.
- Gans, J., Stern, S., & Wu, J. (2019). Foundations of entrepreneurial strategy. *Strategic Management Journal*, 40(5), 736–756.
- Gary, M.S., & Wood, R.E. (2011). Mental models, decision rules, and performance heterogeneity. *Strategic Management Journal*, 32(6), 569–594.
- Gavetti, G., & Levinthal, D. (2001). Bringing cognition back in and moving forward. *Journal of Management and Governance*, 5(3), 213–216.
- Gavetti, G., & Levinthal, D. (2000). Looking forward and looking backward: Cognitive and experiential search. *Administrative science quarterly*, 45(1), 113–137.
- Gavetti, G., & Rivkin, J. W. (2007). On the origin of strategy: Action and cognition over time. *Organization Science*, 18(3), 420–439.
- Gerber, A. S., & Green, D. P. (2012). *Field experiments: Design, analysis, and interpretation*. New York, NY: WW Norton.



- Ghemawat, P., & Levinthal, D. (2008). Choice interactions and business strategy. *Management Science*, 54(9), 1638-1651.
- Ghosh, S., Thomke, S., & Pourkhalkhali, H. (2020). The effects of hierarchy on learning and performance in business experimentation. EDITORS. *Academy of management proceedings*, 2020(1), 20500).
- Greenstein, S. (2012). Economic experiments and the development of Wi-Fi. *History and strategy*, 29, 3–33.
- Greiner, L.E. (1972). Evolution and revolution as organizations grow. *Harvard Business Review*, 76(3), 55–64.
- Gruber, M., MacMillan, I. C., & Thompson, J. D. (2013). Escaping the prior knowledge corridor: What shapes the number and variety of market opportunities identified before market entry of technology start-ups?. *Organization Science*, 24(1), 280–300.
- Gruber, M., & Tal, S. (2017). *Where to play*. Upper Saddle River, New Jersey: FT Publishing International.
- Gutierrez, C., Astebro, T., & Obloj, T. (2020). The impact of overconfidence and ambiguity attitude on market entry. *Organization Science*, 14204.
- Guzman, J., & Stern, S. (2016). The state of American entrepreneurship: New estimates of the quantity and quality of entrepreneurship for 15 US states, 1988–2014. *National Bureau of Economic Research* (w22095).
- Hayward, M. L., Forster, W. R., Sarasvathy, S. D., & Fredrickson, B. L. (2010). Beyond hubris: How highly confident entrepreneurs rebound to venture again. *Journal of Business Venturing*, 25(6), 569–578.
- Heimeriks, K. H., Schijven, M., & Gates, S. (2012). Manifestations of higher-order routines: The underlying mechanisms of deliberate learning in the context of postacquisition integration. *Academy of Management Journal*, 55(3), 703–726.
- Hodgkinson, G. P., & Sadler-Smith, E. (2018). The dynamics of intuition and analysis in managerial and organizational decision making. *Academy of Management Perspectives*, 32(4), 473–492.
- Hogarth, R. M., & Karelaia, N. (2011). Entrepreneurial success and failure: Confidence and fallible judgment. *Organization Science*, 23(6), 1733–1747.
- Karlan, D., Knight, R., & Udry, C. (2015). Consulting and capital experiments with microenterprise tailors in Ghana. *Journal of Economic Behavior & Organization*, 118, 281–302.
- Keil, M., & Mähring, M. (2010). Is your project turning into a black hole?. *California Management Review*, 53(1), 6–31.
- King, A., Goldfarb, B., & Simcoe, T. (2021). Learning from testimony on quantitative research in management. *Academy of Management Review*, 46(3), 465-488.
- Kirtley, J., & O'Mahony, S. (2020). What is a pivot? Explaining when and how entrepreneurial firms decide to make strategic change and pivot. *Strategic Management Journal*.
- Klepper, S., & Sleeper, S. (2005). Entry by spinoffs. *Management Science*, 51(8), 1291–1306.
- Kohavi, R., & Thomke, S. (2017). The surprising power of online experiments. *Harvard Business Review*, 95(5), 74–82.
- Koning, R., Hasan, S. and Chatterji, A. (2022). Experimentation and Start-up Performance: Evidence from A/B Testing. *Management Science*.
- Lazear, E. P. (2004). Balanced skills and entrepreneurship. *American Economic Review*, 94(2), 208–211.
- Leatherbee, M., & Katila, R. (2020). The lean startup method: Early-stage teams and hypothesis-based probing of business ideas. *Strategic Entrepreneurship Journal*, 14(4), 570–593.
- Leiblein, M. J., Reuer, J. J., & Zenger, T. (2018). What makes a decision strategic?. *Strategy Science*, 3(4), 558–573.
- Lerner, J. (2009). *Boulevard of broken dreams: Why public efforts to boost entrepreneurship and venture capital have failed--and what to do about it*. Princeton, New Jersey: Princeton University Press.
- Levinthal, D.A. (2017). Mendel in the c-suite: Design and the evolution of strategies. *Strategy Science*, 2(4), 282–287.
- Levitt, B., & March, J. G. (1988). Organizational learning. *Annual review of sociology*, 14(1), 319-338.

- Lippman, S. A., & McCall, J. J. (1976). The economics of job search: A survey. *Economic inquiry*, 14(2), 155-189.
- Lipton, P. (2017). Inference to the best explanation. *A Companion to the Philosophy of Science*, 184-193.
- McBride, R., & Wuebker, R. (2020). Social objectivity and entrepreneurial opportunities: Implications for entrepreneurship and management. Available at SSRN 2427142.
- McDonald, R.M., & Eisenhardt, K.M. (2020). Parallel play: Startups, nascent markets, and effective business-model design. *Administrative Science Quarterly*, 65(2), 483-523.
- McGrath, R. (1997). A real options logic for initiating technology positioning investments. *Academy of Management Review*, 22(4), 974-996.
- McGrath, R. (1999). Falling forward: Real options reasoning and entrepreneurial failure. *The Academy of Management Review*, 24(1), 13.
- McGrath, R. (2001). Exploratory learning, innovative capacity, and managerial oversight. *Academy of Management Journal*, 44(1), 118-131.
- McKenzie, D. (2021). Small business training to improve management practices in developing countries: re-assessing the evidence for 'training doesn't work'. *Oxford Review of Economic Policy*, 37(2), 276-301.
- McMullen, J. S., & Shepherd, D. A. (2006). Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. *Academy of Management Review*, 31(1), 132-152.
- Moeen, M., & Agarwal, R. (2017). Incubation of an industry: Heterogeneous knowledge bases and modes of value capture. *Strategic Management Journal*, 38(3), 566-587.
- Moeen, M., Agarwal, R., & Shah, S. K. (2020). Building industries by building knowledge: Uncertainty reduction over industry milestones. *Strategy Science*, 5(3), 218-244.
- Murray, F., & Tripsas, M. (2004). The exploratory processes of entrepreneurial firms: The role of purposeful experimentation. *Advances in Strategic Management*, 21, 45-75.
- Osterwalder, A., Pigneur, Y., & Clark, T. (2010). *Business model generation*. Hoboken, New Jersey: John Wiley & Sons.
- Ott, T., & Eisenhardt, K. (2020). Decision weaving: Forming novel, complex strategy in entrepreneurial settings. *Strategic Management Journal*, 41(12), 2275-2314.
- Ott, T. E., Eisenhardt, K. M., & Bingham, C. B. (2017). Strategy formation in entrepreneurial settings: Past insights and future directions. *Strategic Entrepreneurship Journal*, 11(3), 306-325.
- Packard, M. D., Clark, B. B., & Klein, P. G. (2017). Uncertainty types and transitions in the entrepreneurial process. *Organization Science*, 28(5), 840-856
- Pillai, S. D., Goldfarb, B., & Kirsch, D. A. (2020). The origins of firm strategy: Learning by economic experimentation and strategic pivots in the early automobile industry. *Strategic Management Journal*, 41(3), 369-399.
- Porter, M. E. (Ed.). (1986). *Competition in global industries*. Harvard Business Press.
- Reynolds, P. D. (2017). When is a firm born? Alternative criteria and consequences. *Business Economics*, 52(1), 41-56.
- Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. New York, NY: Crown Publishing Group.
- Rios, L. A. (2021). On the origin of technological acquisition strategy: The interaction between organizational plasticity and environmental munificence. *Strategic Management Journal*, 42(7), 1299-1325.
- Sarasvathy, S. D. (2009). *Effectuation: Elements of entrepreneurial expertise*. Cheltenham: Edward Elgar Publishing.
- Shah, S. K., Agarwal, R., & Echambadi, R. (2019). Jewels in the crown: Exploring the motivations and team building processes of employee entrepreneurs. *Strategic Management Journal*, 40(9), 1417-1452.
- Shepherd, D., & Gruber, M. (2020). The lean startup framework: closing the academic-practitioner divide. *Entrepreneurship Theory and Practice*, 45(5), 967-998.
- Siggelkow, N. (2002). Evolution toward fit. *Administrative Science Quarterly*, 47(1), 125-159.
- Thomke, S. (2003). *Experimentation matters*. Boston, Mass.: Harvard Business School Press.

Starr, E., Balasubramanian, N., & Sakakibara, M. (2018). Screening spinouts? How noncompetitive enforceability affects the creation, growth, and survival of new firms. *Management Science*, 64(2), 552-572.

Van den Steen, E. (2018). Strategy and the strategist: How it matters who develops the strategy. *Management Science*, 64(10), 4533-4551.

Wooldridge, J. (2007). What's new in econometrics? Lecture 10 difference-in-differences estimation. *NBER Summer Institute*, 9(2011), 85. [www.nber.org/WNE/Slides7-31-07/slides\\_10\\_diffindiffs.pdf](http://www.nber.org/WNE/Slides7-31-07/slides_10_diffindiffs.pdf).

Yang, M. J., Christensen, M., Bloom, N., Sadun, R., & Rivkin, J. (2020). How do CEOs make strategy?. *National Bureau of Economic Research*, (w27952).

Zellweger, T. M., & Zenger, T. R. (2021). Entrepreneurs as scientists: A pragmatist approach to producing value out of uncertainty. *Academy of Management Review*, (ja).

Zellweger, T., & Zenger, T. (2022). Entrepreneurs as scientists: A pragmatist alternative to the creation-discovery debate. *Academy of Management Review*, 47(4), 696-699.

Zenger, T. (2015). New ways to compete: Build a theory, then a strategy. *Harvard Business Review*.

Zollo, M., & Winter, S.G. (2004). Deliberate learning and the evolution of dynamic capabilities. *Organization science*, 13(3), 339-351.

## TABLES

**Table 1. Balance checks**

Variable	Elaboration	Treatment		Control		Difference	
		Mean	SD	Mean	SD	b	p
Business Age	Age of the business (years)	2.48	3.22	3.28	5.17	0.8	(0.14)
Team size	Number of team members	1.8	2.09	1.9	2.21	0.09	(0.72)
Gender (Female)	Proportion of women in the team	0.42	0.42	0.5	0.44	0.08	(0.12)
Age	Age (team average)	35.76	8.43	36.37	9.2	0.61	(0.58)
Hours - Total Weekly	Weekly hours dedicated to the company (team average)	31.51	18.29	29.61	17.12	-1.89	(0.39)
Background - Economics	Team members with Economics backgrounds (%)	0.14	0.29	0.15	0.29	0.01	(0.85)
Background - STEM	Team members with a STEM (Science Technology Engineering Mathematics) background (%)	0.29	0.39	0.36	0.43	0.07	(0.19)
Education	Highest educational level attained by team members (5 = PhD, 4 = MBA, 3 = MSc, 2 = BA, 1 = high school, 0 = other; team average)	2.67	0.8	2.58	0.79	-0.1	(0.33)
Confidence	Agreement on a 1–5 scale with the following statements (team average): "We are confident in our entrepreneurial skills", "We are sure we are deploying the best strategy for our business", "We are confident in our ability to manage our business", "We master the competences necessary for our venture", "We are sure there is no better business model for our idea"	3.41	0.69	3.34	0.76	-0.07	(0.44)
Probability Pivot Idea	Probability of making a radical change to the business	45.78	27.86	42.12	26.99	-3.66	(0.28)
Probability Pivot Problem	Probability of changing the problem and customer segment	38.13	25.86	40.55	26.26	2.43	(0.45)
Probability Expansion	Probability of expanding the business outside of the current industry or market	68.32	27.09	66.59	28.12	-1.73	(0.61)
Turnover Annual	Annual turnover (2018) £	57.14	166.3	83.13	226.26	25.99	(0.29)
Turnover Monthly	Monthly turnover (January 2019) £	5.81	20.26	7.04	28.29	1.24	(0.69)
Hours - % Innovation yearly	Working hours dedicated to the design of new products or services in the last year (2018, %)	45.92	32.98	40.02	32.68	-5.9	(0.15)
Hours - % Innovation monthly	Working hours dedicated to the design of new products or services in the last month (January 2019, %)	39.24	33.8	36.84	34.59	-2.41	(0.57)
Idea Value - Mean	Estimated value of the project (mean, 0 to 100)	66.83	16.8	66.62	20.22	-0.21	(0.93)
Idea Value - Range	Estimated value of the project (range, 0 to 100)	39.26	21.7	38	21.94	-1.26	(0.64)
Experience - Industry	Number of years of experience in industry (Team Average)	6.66	6.31	7.66	7.51	1	(0.25)
Experience - Work	Number of years of work experience (Team Average)	12.99	7.86	13.51	8.53	0.52	(0.61)
Experience - Entrepreneurial	Number of years of entrepreneurial experience (team average)	3.81	3.41	4.58	5.86	0.78	(0.20)
Experience - Managerial	Number of years of managerial experience (team average)	5.88	5.12	6.15	6.02	0.27	(0.69)
Observations		133		128		261	

**Table 2 Descriptive statistics and pairwise correlations**

	Obs	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12
1 Intervention	522	0.5096	0.5004	0.0000	1.0000	1											
2 Revenue (Log 1+£ 000)	522	1.2738	1.6735	0.0000	7.2904	-0.048	1										
3 Degree of business development (Probability of not making radical changes)	522	56.0115	27.4184	0.0000	100.0000	-0.0667	0.0886	1									
4 Annual revenue at the baseline (in 000 GBP)	522	60.5103	171.2932	0.0000	1500.0000	-0.0657	0.4781	0.1018	1								
5 Confidence	522	3.3778	0.7225	1.2000	5.0000	0.0484	0.0415	0.2518	0.117	1							
6 Prior experience (work)	522	13.2439	8.1736	0.0000	40.0000	-0.0317	0.0859	-0.0915	0.01	-0.1153	1						
7 Prior experience (industry)	522	7.1516	6.9189	0.0000	35.0000	-0.0724	0.0694	-0.1254	0.0487	-0.0481	0.6048	1					
8 Prior experience (managerial)	522	6.0106	5.5664	0.0000	30.0000	-0.0245	-0.0283	-0.1504	-0.0202	-0.033	0.7447	0.517	1				
9 Prior experience (entrepreneurial)	522	4.1898	4.7739	0.0000	30.0000	-0.0813	-0.0092	-0.1492	-0.0399	0.0539	0.5558	0.4634	0.6081	1			
10 Value expectation	223	3.5864	0.2878	0.6931	4.1109	0.0021	0.1374	0.0933	0.0498	0.081	-0.058	-0.0495	-0.0296	-0.0984	1		
11 Certainty	223	0.3342	0.2333	0.0000	0.6931	-0.1392	0.0713	0.0449	-0.0667	-0.0574	0.0191	0.044	-0.0205	-0.0581	0.2403	1	
12 Scientific intensity	522	2.679678	1.147471	0	5	0.0748	0.051	0.0544	-0.0428	0.0216	-0.1931	-0.1751	-0.1323	-0.1409	0.1604	0.0343	1

Notes. The requirement that entrepreneurs have fewer than 10 employees was a criterion we imposed for firms at the time of our baseline observation. As some of these firms grew during the program, some of them reached a higher number of employees. The maximum value of the number of employees in the table equals 15 and reflects this increase in size. The maximum number of employees at the baseline was 10 (instead of what we would expect, i.e., 9). This is because four firms had 10 employees at the baseline. Even though we targeted firms with fewer than 10 employees and admitted into the program only firms that met this threshold, four firms told us that their baseline answer was incorrect subsequent to their admission into the program. We therefore kept these firms in our sample but reported them with the correct number of employees. We have replicated our analyses without including these firms and results were consistent with those reported in the paper.

**Table 3. Impact of the treatment on performance.**

VARIABLES	(1)	(2)
	Log (1+) Revenue OLS Panel	Log (1+) Revenue OLS Panel
Treatment X Post (B5)	-0.1197 (0.4596)	-1.1558 (0.0029)
Treatment X Post X Degree of business development (B7)		0.0184 (0.0020)
Treatment (B1)	-0.0814 (0.5779)	-0.1428 (0.6325)
Post (B4)	1.0572 (0.0000)	1.6783 (0.0000)
Degree of business development (B2)	0.0052 (0.1145)	0.0052 (0.1799)
Treatment X Degree of business development (B3)		0.0011 (0.8342)
Post X Degree of business devel- opment (B6)		-0.0107 (0.0221)
Constant (B0)	0.5238 (0.0096)	0.5272 (0.0168)
Observations	522	522
R squared	0.0987	0.1115
Number of id	261	261
Clustered Errors	Firm	Firm

Notes. Robust pval in parentheses

**Table 4. Conceptual schema of the main results and evidence in support of the abductive explanations**

<p><b>Research question</b>            What is the impact of the degree of business development in moderating the impact of a scientific approach to decision-making on performance?</p>
<p><b>Main result: Pattern of evidence</b></p> <ul style="list-style-type: none"> <li>• Section 4: Table 3 and Figure 1: Treated firms at a higher degree of business development achieve higher performance than control firms; treated firms at a lower degree of business development achieve lower performance than control firms</li> </ul>
<p><b>Testing the robustness of the main result</b></p> <ul style="list-style-type: none"> <li>• Outliers: Appendix, Table A2</li> <li>• Alternative measures of degree of business development: Appendix, Table A3</li> <li>• Attrition: Appendix, Table A4a, A4b, A4c</li> </ul>
<p><b>Abductive explanation</b>            Firms at a higher degree of business development, whose strategy is already crystallized, face decisions that concern peripheral aspects of their firm strategy. Firms at a lower degree of business developments face decisions that concern more core aspects of their firm strategy. A scientific approach to decision-making encourages both types of firms to articulate, question, and validate the theory underlying their strategy. This questioning attitude induces the former to fine-tune their already defined strategy, with a relatively quick positive effect on economic performance. It instead enables the latter to gather insights that might eventually change the direction of the still uncrystallized firm strategy more significantly. But this change may not immediately translate to firm performance and rather result in an increase in uncertainty on the firm strategy. In contrast, firms that do not use a scientific approach do not articulate, question, or validate the theory underlying their strategy. When their strategy is not yet crystallized, the lack of this questioning attitude leads them to quickly pursue unvalidated opportunities as they emerge—and might even lead to positive outcomes in the short term. But for firms at a higher degree of development, the lack of a questioning attitude pushes them to pursue business as usual, with limited performance improvements.</p>
<p><b>Excluding alternative explanations: Confidence and experience</b></p> <ul style="list-style-type: none"> <li>• Is the result explained by the entrepreneurs' confidence? No, Section 5, Table 5.</li> <li>• Is the result explained by the entrepreneurs' experience? No, Section 5, Table 5</li> </ul>
<p><b>Supporting the abductive explanation: Choice commitment and uncertainty resolution</b></p> <ul style="list-style-type: none"> <li>• Qualitative illustrative evidence: Section 5, Table 6</li> <li>• Quantitative evidence- Value expectations and certainty: Section 5, Table 7.</li> </ul>

**Table 5 Excluding alternative explanations**

VARIABLES	(1)	(2)
	Log (1+) Revenue (in £ 000) OLS Panel	Log (1+) Revenue (in £ 000) OLS Panel
Treatment X Post	-0.4123 (0.5777)	0.1090 (0.7152)
Treatment X Post X Confidence	0.0865 (0.6889)	
Treatment X Post X Work Experience		-0.0166 (0.4032)
Treatment	0.1016 (0.8853)	-0.2634 (0.3072)
Confidence	0.1290 (0.3908)	
Treatment X Confi- dence	-0.0619 (0.7684)	
Post	1.1809 (0.0328)	0.7079 (0.0016)
Post X Confidence	-0.0370 (0.8151)	
Work Experience		0.0023 (0.8319)
Treatment X Work Experience		0.0126 (0.4383)
Post X Work Expe- rience		0.0259 (0.0930)
Constant	0.3959 (0.4329)	0.7954 (0.0000)
Observations	522	522
R-squared	0.0934	0.1010
Number of id	261	261
Clustered Errors	Firm	Firm

Notes. Robust pval in parentheses. As alternative measures of prior experience we used the average number of years of industry and the managerial and entrepreneurial experience of the individuals working in the firm. Results, reported in Table A5 in the Appendix, are consistent with those presented in this Table.



**Table 6 Qualitative illustrative evidence of the impact of a scientific approach for firms at a low vs. high degree of business development**

Category	Case	
<p><b>Treatment, Low Degree of business development.</b>                      We found illustrative evidence that the treatment induced firms in this category to articulate, question, and validate their theory and assumptions and that this process helped them to learn that some aspects of their original ideas needed to be revised. The early feedback was useful, but it increased uncertainty for the entrepreneur. This process tends to trigger novel search processes, which will require time to be completed, but that are meant to set the entrepreneur on a better trajectory in the future.</p>		
Treatment, Low Degree of business development	1	<p>The entrepreneurs join the business support program with a business at a low level of development. Their idea is to create a service like Spotify, which enables customers to choose what they listen to in public or shared spaces (i.e., cafes, parties, etc.). Before joining the program, the entrepreneurs were ready to develop a proof-of-concept (Minimum Viable Product, MVP“): <i>“So we’ve got our sort of visual prototype and are working on an MVP. So over the next year we really want to sort of validate our sort of value and growth hypothesis and really see how people are going to use it. (...) So our goal is to work on actually building, at least the MVP, to get to a point where we can start actually testing”</i> (Baseline interview).                      The business support program encourages them to articulate, question, or validate the theory underlying their strategy. This leads them to understand that they are still uncertain about their potential customers’ pain points. This induces them to pause and engage in further search before advancing the idea: <i>“So before coming into the (program), we had a very clear vision of which problem we were solving. But as we’ve gone through and sort of, you know, rigorously tested our hypothesis and our ideas, we’re a little bit less clear on which points, which pain we’re sort of reducing for our users. So that’s the thing we’re trying to ensure and struggling a little bit to get clarity on”</i> (Interview 1).</p>
Treatment, Low Degree of business development	2	<p>The entrepreneur joins the program with a business at low level of development, offering venue styling services for parties, weddings, and similar events. Before joining the program, she was sure about market demand for a similar service and identified marketing her services as a priority because she already had a few customers: <i>“OK, I said, so one of the things that I would love to do is to try and find out how I can use what I already have to try and get more awareness out there”</i> (Baseline Interview).                      Through the training program and the encouragement to develop theory, hypotheses, and conduct tests, the entrepreneur realizes that she still has to address a lot of uncertainty about the characteristics of the market, which is essential to be able to market her services and convey an appealing value proposition to customers. Addressing uncertainty in this area will require time: <i>“I just need to work better on my target audience and who my clients and values proposition are. (...) So that’s why we just had to redefine everything. (...) I think right now we’re just sort of everywhere. So, it’s really finding out exactly who the main target audience will be. So, we’ve sort of stepped back, it is needed to improve ourselves and then to come out better. So, for the next one year we are not going to do anything, so I just need to reforecast, re-plan, and get my new target audience and just work out on my marketing strategies. We both came for the (program), just realized that there were quite a little bit that I actually needed to improve on in understanding the market properly”</i> (Interview 8).</p>
Treatment, Low Degree of business development	3	<p>The entrepreneurs join the program with a business at a low level of business development, offering an online business that enables its customers to swap clothes. The initial target is university students, and before joining the program the entrepreneurs identify the promotion of the business and the identification of ways to make it cost-effective as key priorities: <i>“Well I think the main problem is working out how to promote it and how to make sure that we can make it cost-effective for ourselves”</i> (Baseline interview).                      After being exposed to the intervention and being, therefore, induced to articulate, question, and validate their theory, the entrepreneurs realize that trust in an exchange-based market and long-term customer loyalty are fundamental, but they are uncertain about all the intricacies associated with matching clothes to swap. This brings them back to the drawing board and leads them to engage in another round of search: <i>“Originally our plan was purely to do a swapping thing. So, the idea was that you went along, and you had a pink sparkly top and this girl had a silver sparkly top and then you’d swap and it would all be really easy. What we realized is that it’s obviously more complicated than that mainly because of finding people who have something, who may not want to swap. (...) We’re starting to look beyond the boundaries of what was effectively sort of a very narrow project which we realize we, whilst it may work, we’re now looking longer term and thinking how can we actually turn that into a more viable business more quickly by creating a trust with people on a longer term basis”</i> (Interview 5). <i>“So we thought that we just needed the app, but as I said (...) the app’s proved to be a bit of a disaster, so we’re going back to the drawing board”</i> (Interview 8).</p>
Treatment, Low Degree of business development	4	<p>The entrepreneur joins with a business at a low level of development focused on creating online education for women of color to learn how to code and about cybersecurity. The content includes workshops, e-books, and online sessions and aimed to foster an online community. After joining the program and questioning her theory she realizes that the ultimate goal of her customers is to gain employment in the IT sector. She therefore realizes she has to establish corporate connections and add a new aspect to her strategy that requires significant time to be developed: <i>“We’re changing our deliverables. So we’re doing events and we do webinars, but we’re changing ourselves to employ instructors that do online courses. Because I saw that there was a need for our customers to have it more structured, because the events and lectures are on specific topics in cybersecurity, and from our feedback that we’re getting from the events and webinars we’re doing, a lot of our members say that they would like a course format. So the idea was if I was to put the video, would people buy it? I thought that that should work, but more people bought the video rather than becoming members, so I realized that people prefer the kind of pay when I want to subscription model. So based on that, I’m thinking next year when we’re actually going about our courses to change it to be more of a people pay for courses rather than people becoming members. The job board was a new concept I never thought about, because I spent so much time focusing on how do I get people interested in the service (...) that didn’t think about (...) approaching corporate as another, I guess, key client or key target market”</i> (Interview 8).</p>
Treatment, Low Degree of business development	5	<p>The entrepreneur joins the program with a business at a low level of development, where the entrepreneur aims to bring medical equipment that had been made redundant in the UK (but was still in good and usable condition) to support research and hospitals in emerging economies. This is a direct business model where the entrepreneur acquires the equipment and sells it to the new customers. After being exposed to the intervention and being, therefore, invited to articulate, question, and validate his theory he understands that the solution he has in mind is not scalable and that the way his business could create value would rather be through a platform business model. This however requires time to be implemented, especially because the entrepreneur has to first address the uncertainty that concerns how to operate a platform business model: <i>“To be honest, it wasn’t until I came to the (program) that I</i></p>

		<i>understood, and I am a scientist, so I know about testing and I know about research. (...) But I never ever thought about using it in a business model, and that's what really attracted me to it. (...) Due to the impact of the (program), what we were thinking before was different to now. The way I'm thinking is different now and I have to, what you call it, cascade that to them so that they can understand what we're doing. (...) But when I got into (the program), I realized that actually a platform, having a platform may work, because a platform would be a place where the supplier and the users can come together and on that platform"</i> (Interview 1). <i>"We are not functioning yet, we are not functioning yet, because we've come back and what we are now is actually doing up our processes, so we're trying to draw up our processes based on using a platform model. We never had a platform before, it was getting the equipment from the supplier, supplier will come to me, I will email (...) but this new process is actually what is taking our time now to look at how we design it, what are the features that we want on the platform"</i> (Interview 8).
<b>Control, Low Degree of business development</b>		
Similar to entrepreneurs in the previous category, entrepreneurs in this category joined the program with strategies that were at a lower stage of development. But instead of articulating and questioning their theory, and using this process to guide their tests, they tended to pursue opportunities that emerged with little hesitation. Not questioning their theory and assumptions made entrepreneurs in this category quicker to implement solutions, which generated some revenue in the short term. But these solutions were not necessarily "thought through," so there was no guarantee that they would perform well in the long run.		
Control, Low Degree of business development	7	The entrepreneurs join the business support program with a two-sided model business that connected cybersecurity consultants with small businesses. Prior to joining the program, the entrepreneurs have already read articles on the subject and talked to small businesses, conducting open-ended and unstructured interviews; they are unable to mention how many people they spoke to. After starting the program, they focus on execution and avoid further exploration, starting to sell fairly quickly. They see their initial sales as validation for their idea. They note the positive feedback obtained in customer conversations, but they do not conduct any systematic testing: <i>"No change to the value proposition, no. It's a constant redefining of the nuances of the value proposition and no real change. Well we've been good at selling it so there's really a market"</i> (Interview 8).
Control, Low Degree of business development	8	The entrepreneur joins the program with a business at a low level of development offering an app to pre-order artisan meals from restaurants and cafés at a discounted price. The entrepreneur collects feedback without a theory underlying the strategy, so they follow feedback as it comes and are encouraged by general data that were not specific to their strategies: <i>"The only business that I have (...) is the restaurant which I'm going to demo. Other than that, what I want to do is talk with a number of restaurants, so which is why I'm trying to launch this project with (the program). (...) The restaurant owner, she had a quick look, she has two restaurants, she said that this kind of app is more suited for her secondary restaurant which is more near the train station and it's serving the working community. So she's quite interested there. Yes, so that is one of the people who are giving me requirements as well. (...) I was really looking at the data that I had gathered. So whilst the things that I've learnt by re-looking at the data is that in the UK people spend up to £4,000 per year, which is more than 10% of the UK survey, eating out. So we think this is will be quite great"</i> (Interview 8).
Control, Low Degree of business development	9	The entrepreneur joins the business support program with a business at low level of development selling clothing online. The entrepreneur conducts a few surveys applying the content taught in the sessions, the main goal of the survey being to better understand customers' preferences. The entrepreneur does not have clear predictions or assumptions to test, nor does she conduct the survey following scientific principles. Instead, she uses suggestions from their existing customers to tweak the existing offering, particularly with regards to the delivery options available: <i>"I think the main conclusion was that (...) most of the people who answering that they were willing to spend up to £100. So we might think of changing a little bit the prices, doing a slightly even lower rate on the prices, we're going to see that now. We're reviewing this. We have two weeks, to three weeks until the website is on again, to review again the prices. And so the survey, it was clearly seen that we need to do speedy delivery and we will pay for it. So I think that we have an extra cost for the delivery options"</i> (Interview number).
Control, Low Degree of business development	6	The entrepreneurs join the business support program with a B2B business at a low level of development that offers training to entrepreneurs who want to start a blockchain-based business. They start with a general idea of offering services to start-ups around blockchain, but they then decide to offer consulting-based services that provide tailored advice on blockchain based businesses. The change does not originate from a rigorous, theory-guided test of ideas, but rather from direct observation of potential customers as well as other competitors at a large conference: <i>"So we went to the conference and we saw that there were many types of clients to which you can address. The type of client that we are interested in, so entrepreneurs or companies that want to enter the blockchain world, they were interested in a conference that offered this kind of solution, coding and consulting. So basically we spotted the solution from the existing competitors, understanding that the existing competitors are all shifting towards offering consulting and development of blockchain solutions. So it means that at the moment this is what was the market and this is where we should go"</i> (Interview 3). The entrepreneur does not explore further if this opportunity is worth pursuing or not, but rather goes straight into hiring developers and refocuses the project in this direction: <i>"(The change) It's big because we have to change the idea of the kind of team that we are building because we need a programmer, so that would be the first change, and yes, the image of the project also changes, and as you said, we're looking for different kinds of clients. We already hired a developer"</i> (Interview 3).
Control, Low Degree of business development	10	The entrepreneur joins the program with a business idea at a low level of development and the goal of alleviating depression in patients with dementia using virtual reality techniques that can take them to visit happy places. During the course, the entrepreneur runs a small proof-of-concept with 10 patients based on basic questions (whether they liked the product and what they would like to see) before developing the app. Based on this limited feedback the entrepreneur goes ahead and develops the app: <i>"I want to raise our seed funding to build the app that I envision, like the ideal one because right now it's very restricted. (...) Didn't do any AB testing unfortunately, didn't have the time. (...) Yes, I know, I don't have time to do that—So what we ended up doing was actually asking the direct questions, so after the experience, asking them how they feel. So that's the feedback we took on"</i> (Interview 3).
<b>Treatment, High Degree of business development.</b>		

<p>Entrepreneurs in this category joined the program with more defined strategies. They still articulated, questioned, and validated their theories, but their search process focused on specific aspects of their strategy as opposed to macro aspects. Because entrepreneurs in this category applied the scientific approach to a more crystallized strategy, they used the approach to refine some specific aspects (such as product promotion or entry strategy) rather than addressing macro questions about the product or service.</p>		
Treatment, High Degree of business development	11	<p>The entrepreneur joins the program with a business at a high degree of business development, based on the idea of providing self-coaching and business training to minority women to support them in establishing international businesses. The training encourages her to articulate, question, and validate the theory underlying the business: <i>“We hope that will confirm whether our understanding of the problem is correct... basically, we’ve defined the problem is to retain the talent, and second, to re-skill their people within the organization, but now we have to double confirm whether our solutions would be perceived by the end consumer as something that can actually help them feel future proof”</i> (Interview 5).</p> <p>The entrepreneur applies the scientific approach in a targeted way to fine tune the strategy. The macro characteristics of the service are not questioned, and the entrepreneur rather focuses on specific issues such as its promotion and the entry strategy: <i>“Through the program, I changed much the strategy of promotion of the company, not as much the service itself. So my biggest testing and one thing that came out of the program was I tested whether if I promoted the same service to the same people but using my achievements to promote the service people would be more willing to buy it. That has proven right, and this was a big take away”</i> (Interview 2).</p> <p><i>“We were targeting always a number of different locations, and after each of the (tests), we were sort of narrowing down the number of locations. So, now we have finally proved that our product offering would be best launched in East Africa, so that was another outcome of the testing for the last couple of months, that I think is very important”</i> (Interview 5).</p>
Treatment, High Degree of business development	12	<p>The entrepreneur joins the program with a quite developed business based on the idea of a virtual reality tech platform that connects children with curriculum and culture, featuring interactive cultural content inspired by museums and cultural institutions. The entrepreneur uses the scientific approach in a very focused manner, testing specific assumptions the business theory relied upon. Because the key components of the strategy are already crystallized and the scope of the tests is narrow, results from the test can be quickly implemented with positive results on performance: <i>“So we had the children go through the different levels and then we asked them at different points throughout what was easy, difficult (...), and then afterwards we asked them to go through the pack and then got their feedback on that so it was very qualitative. (...) So we found that kids really like to take what they learned in the digital and apply it in the physical and they like to use their hands. Anything to kind of add a tactile component is really good. (...) It was an assumption and that just kind of confirmed it. (...) I think that it helped us to implement more tactile activities in our learning pack. (...) We gained about 30 (new customers)”</i> (Interview 7).</p>
Treatment, High Degree of business development	13	<p>The entrepreneur joins the program with a business proposition about an online marketplace facilitating transactions across the exhibition ecosystem. The platform is pretty much defined, but during the program the entrepreneur is encouraged to articulate, question, and validate the theory, which leads to identifying a new way of using the platform: <i>“It’s complementing what we’re doing with our platform, with an offline service, which essentially fulfils the same goal, but just for the share of the market that is not as familiar with using a (platform), we would be able to still use (the platform) internally, but have an account manager use that on their behalf, and intend to deliver a service enabled by the technology platform, but that is pitched and sold to the client as a service rather than as a subscription to a software that they can use”</i> (Interview 7). The idea is based on a well-defined theory: <i>“There is a whole side of the market which is not quite tech-savvy, and has an interest in our value proposition, but doesn’t feel comfortable using the product, whereas would be much more comfortable using us if we were to provide the same, or address the same issue by offering a service rather than a product that they would need to use independently from us.”</i>(...) <i>“We did do market research and testing, and we started rolling out the service, which will now be advertised as per next week on our website”</i>. The entrepreneur’s testing focuses on some specific aspects of the service: <i>“it’s been based on research that we’ve done, but we are starting to roll out the actual service (...) “everything needs to be tested, go-to-market strategy, pricing, level of satisfaction with the service as it is provided at the moment, costs to the business to provide that service”</i> (Interview 7)</p>
Treatment, High Degree of business development	14	<p>The entrepreneur joins the program with a well-defined business proposition centered around selling electronic products that match customers’ needs. His theory is already well defined: <i>“not all customers are technologically savvy but that they need solving the problems, and we took that misunderstanding in how technology works away, and we made things very simple and that’s exactly why we are on top of our competitors. Our competition is currently selling very specific and technically a lot of details in technical specifications, and what we sell is basically a solution to solve your problem, we don’t overload you with specifications, we just make sure that it works for you.”</i> The program helps them finetuning their strategy: <i>“Yes, we have analyzed the customer journey in much more detail. We identified some bottlenecks and we have also introduced more rigorous testing methods into decision-making and releasing products and services”</i> (Interview 1)</p> <p>The entrepreneur explicitly talks about the benefits of a theory-based scientific approach to decision-making as opposed to just conducting tests and how this helps them reduce uncertainty: <i>“We collected tons metrics because my background is social engineering and big data is my bread and butter (...) but (the scientific approach) places the whole project in hypothesis and theory and (...) it helped us understand. (...) It showed (how) to eliminate your gut feeling and occasionally instead of trying to estimate what feels right, those kinds of things were tested (...), it gives a perspective into the direction that we’re going is correct. (...) We were testing it before but now we find that this is the basic of all our decisions. We collect the data and we have to make predictions, we need a set of different metrics data in order to validate whether our decision is correct. (...) We kind of introduced the scientific method in all the decisions, into which categories, which products do we go? (...) We were testing it before but now we find that this is the basic of all our decisions”</i> (Interview 1) The entrepreneur uses the scientific approach to refine the specific way in which they sell a product, developing a theory of what product description would convert more customers: <i>“We started advertising our products as a solution, some memory solutions for those specific devices”</i> and then testing the theory <i>“once we had these different listings (...) we find out this is the best method (...) right now memory cards is a third of our business, and we are selling 5,000 a month.”</i> (Interview 1)</p>
Treatment, High Degree of business development	15	<p>The entrepreneur joins the program with a quite developed business proposition about automation tools and products for high-volume beverage-consuming venues. They use the scientific approach learned in the program to change a specific aspect of the business, i.e., the revenue model: <i>“It was a hypothesis back when we initially started and now it’s definitely become very much proven concept and we’re working towards finalizing on what parameters we are going to enter into a revenue share model. (...) What I’ve discovered is it is the venue</i></p>

		<i>owners and management are not interested in putting a lot of capital in it to acquire a piece of hardware. So they are more interested in using the machine rather than buying the machine or owning the machine. (...) We are discussing a completely new business model which will work on the revenue share model where we would place the machine at a minimal cost or no cost at all, and we would enter into a revenue share contract with the venue wherein whatever the total sales from the machine are, there's a certain percentage that comes directly to us. So that really helps them by minimizing their one-off heavy cost, while experiencing the improvement and efficiency and the increasing sales, but it helps us because we get a constant flow of cash flow through the revenue share, and also we maintain the ownership of the machine which maybe after a year I could move that's a machine from one venue to another venue depending on what the needs are"</i> (Interview 3).
<b>Control, High Degree of Business Development.</b>		
Similar to entrepreneurs in the previous category, entrepreneurs in this category also joined the program with more developed strategies. Yet the theory underlying their business was never properly articulated or questioned, and the quality of the test they performed was limited, which limited their ability to improve in comparison to the treatment group. Entrepreneurs in this category tended not to question (or do so to a lesser extent) their value proposition throughout the program.		
Control, High Degree of Business Development	16	The entrepreneur joins the program with a quite developed business proposition focused around offering financial training, in particular, on cryptocurrencies. They do not question their strategy during the program: <i>"(The idea was about) the number of people who had heard about Bitcoin, who wanted to understand themselves what all the fuss was about but they were not computer educated so they needed someone who understood the way the computer educated side came from, that wanted to understand it in a more conversational point of view. (...) I was already in close contact with these people anyway because that was my previous business was in financial markets"</i> (Interview 7). Asked about whether they gathered any evidence to verify that their understanding of the problem was correct, and their value proposition valuable, they respond: <i>"No, because we already knew what the product was"</i> (Interview 7).
Control, High Degree of Business Development	17	The entrepreneur joins the program with the idea of providing optical apprenticeships to opticians. The business proposition is already quite developed, based on the entrepreneur's previous work in the area. The entrepreneur does not articulate, question, or validate the theory, which remains quite high level: <i>"I was working with apprenticeships and the likes so it's certainly something that I'm aware of but it's really trying to put that out in the market to make it move forward. (...) My main focus is usually to work on the apprenticeships with a caveat of trying to provide training with them (...)the apprenticeship is working well, the program is in place, but there are also the issues with other staff members would I be happy to assist etc. That would be something I would look at"</i> (Interview 6).
Control, High Degree of Business Development	18	The entrepreneur joins the program with a quite developed strategy based on developing market intelligence (forecast models and reports) for the renewable energy sector. The entrepreneur does not articulate, question, or validate the theory, which remains quite high level: <i>"The problem that (clients) have (...) is to structure the business. So I mentor them and I help them developing their business. (...) It helps them by giving the know-how and giving some advice that they lack because they might not have all the knowledge about the different parts of the business"</i> (Interview 5). When asked about the way in which the entrepreneur gathered evidence, he indicates that evidence is collected in an unstructured way: <i>"On a weekly basis, I talk with them and I mentor. So that is the best source of information, because they are directly (...) my target, and they tell me, 'Uh, yes. I need to do this, I need to learn this, I have this problem.' So I learn directly from them through the different opportunities that I have to talk with them and meet with them. Yeah. (...) Because the nature of what I do (...) mentoring (...) is based on talking with them. But, I mean, without talking to them, I couldn't do mentoring, so (...) it's like eating, you know, going to the restaurant, eating (...) yeah, you go to the restaurant to eat. That is the core experience. So talking with them is a core part of my services"</i> (Interview 5). Asked how, by talking to people, he would understand whether his ideas are supported or not, he replies: <i>"Well, there is a huge demand for mentoring, and the feedback is quite straightforward, to say, 'Oh, you know, I need this, can you help?' So there's not a lot of science there. They tell you directly. So you have a very straightforward feedback. It's not difficult. Yeah. (...) I don't do testing as such. But I keep talking and networking. (...) So it's an informal chat"</i> (Interview 5).
Control, High Degree of Business Development	19	The entrepreneur joins the program with a quite developed business proposition, centered around personal coaching for women entrepreneurs. The theory underlying the business is never properly articulated or questioned, and the test is limited: <i>"I also did a bit more hand-holding, mentoring or one-to-one, something like that. I think for people who are just starting off, it's a bit scary. I did do a test with a lady, we'll be busy doing the test in the next couple of weeks because I'm going to do some LinkedIn as well with details of my course, or rather the workshop, so they are happy to help me, so I think that will probably also... And the plan is when they come for the workshop because it's three events, we will be asking them questions like what they want. (...) I have a list of pain points, what they want, like their sleepless nights, freedom of time, because success is not just money in the bank, being able to go to your child's show or something like that. (...) Those are the questions I think they need, but it might be very different from what actually they need, so that would be just in the test, I think"</i> (Interview 2).
Control, High Degree of Business Development	20	The entrepreneur joins the program with a quite developed business proposition centered around offering property services. The theory behind the strategy is not explicitly articulated or questioned: <i>"Yeah, OK. The value proposition is offering quality accommodation and making it fair, firm and sustainable. (...) Probably a bit ambitious, I must say. Although profitability seems to be the main focus, obviously (...), ultimately you need to be profitable (...), it's highly competitive out there. (...) I know it's going to be better than last year, the results, but still it's below the ... I think it will be still below the 50,000, 50K threshold, but sort of progressing. And consolidating, in these current times, is already a good thing, with all the things that've been happening, and lots of businesses have been closed down. So, I could be more ambitious, but for the moment, I'm just happy with the state"</i> (Interview 8).

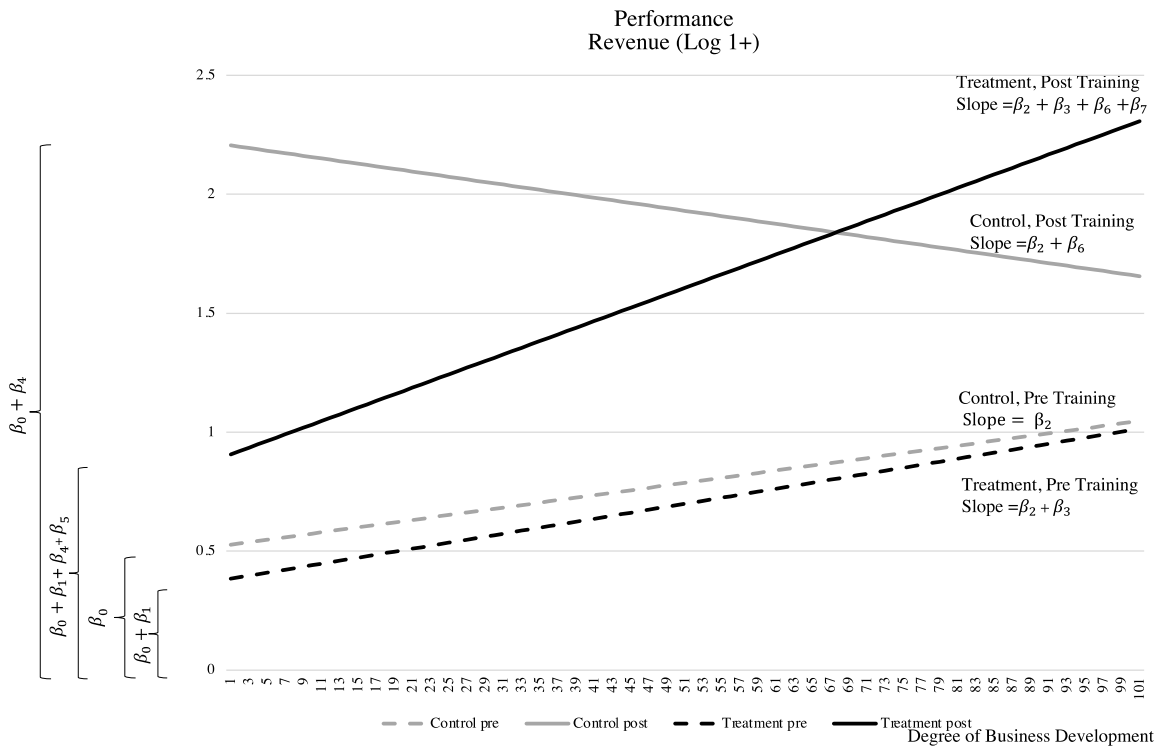
**Table 7. Impact of the treatment on value expectations and certainty about value distribution**

VARIABLES	(1)	(2)	(1)	(2)
	Log (1+) Value ex- pectations OLS Panel	Log (1+) Value ex- pectations OLS Panel	Log (1+) Certainty OLS Panel	Log (1+) Certainty OLS Panel
Treatment	0.0018 (0.9651)	0.1457 (0.2828)	-0.0648 (0.0388)	-0.1941 (0.0042)
Treatment X De- gree of Business Development		-0.0026 (0.1649)		0.0023 (0.0439)
Degree of Business Development	0.0010 (0.2702)	0.0024 (0.1714)	0.0004 (0.5307)	-0.0009 (0.2891)
Constant	3.5316 (0.0000)	3.4525 (0.0000)	0.3491 (0.0000)	0.4202 (0.0000)
Observations	223	223	223	223
R-squared	0.009	0.024	0.021	0.040

Notes. Robust pval in parentheses. We employed a cross-sectional analysis (with dependent variables measured at the end of the observation period) as the measures for the dependent variables used in these analyses were not available at the baseline. The number of observations is lower than in the full sample because some entrepreneurs did not answer this question.

## FIGURES

**Figure 1. Impact of treatment on performance for different degrees of business development**



**Figures 2a and 2b Effect of the treatment on expectations and certainty about value distribution**

