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THE IMPACT OF ET PROGRAMS ON SCIENTIFIC ENTREPRENEURS

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1 Introduction

Entrepreneurs face several challenges when launching and developing their start-up, especially in the early-stage phase, which involves several fundamental decisions (Gans et al., 2019). Prior literature has shown that entrepreneurs use various approaches to make these decisions, ranging from trial-and-error attempts (Dencker et al., 2009) to more structured and scientific courses of actions (Murray and Tripsas, 2004; Camuffo et al., 2019). All approaches involve a combination of thinking and doing (Ott et al., 2017), which prior studies have shown to be influenced by the personal characteristics and background of decision makers (Busenitz & Barney, 1997; Sarasvathy, 2009). Some studies have also highlighted what personal characteristics matter for the adoption of non-predictive approaches to decision-making, such as effectuation (Dew et al., 2009). However, we have limited knowledge of the individual characteristics that influence the adoption of more structured approaches, such as a scientific approach to decision-making (Camuffo et al., 2020).

This paper addresses this question and examines whether the educational background of the entrepreneurs affects the adoption of a scientific approach to decision-making (systematic and purposeful method of information gathering and analysis) and impacts start-up performance. There is initial evidence that the educational background of decision-makers impacts structured approaches to new business creation. For instance, Leatherbee and Katila (2017) find that when entrepreneurs with an MBA develop new business ideas through the NSF program (which uses the lean start-up approach), they gather less information than other entrepreneurs. In a similar vein, Chatterji et al. (2019) find that entrepreneurs with an MBA are less likely to listen to the advice from fellow entrepreneurs. In this paper, we focus on the science-related background of entrepreneurs. Previous research provided insights on the mechanisms through which scientists create value and develop early-stage start-ups (Murray, 2004; Toole and Czarnitzki, 2009). Science-educated entrepreneurs face different challenges when launching their business idea, such as cognitive distance from potential customers and lack of business expertise (Krabel and Mueller, 2009, Miozzo and DiVito, 2016). However, with a scientific approach, they can leverage their prior expertise in the field of natural sciences and apply it to the artificial world. For this reason, we focus on the educational background of entrepreneurs and analyse if a background in science enables them to apply more effectively a scientific approach as they make decisions related to their nascent businesses.

Our basic prediction is that entrepreneurs with a background in science absorb and apply a scientific approach better than other entrepreneurs, further improving their precision as they make crucial choices for their business. These decisions, in turn, translate into higher performances. We test these predictions with a field experiment with early-stage entrepreneurial firms undergoing a pre-acceleration program. Treated entrepreneurs learn how to use a scientific approach to decision-making, while the control group receives comparable training but does not learn about the scientific approach. Since the two

groups have been randomized based on a number of covariates, including the educational background of entrepreneurs, we can clearly estimate the impact of the scientific approach and the educational background on performance.

This paper is still a preliminary work, but we aim to make several contributions. Firstly, it replicates the prior field experiment of Camuffo et al. (2020) addressing concerns about replicability in science, as described by Goldfarb and King (2016). Secondly, this paper extends the findings from previous studies (Sarasvathy, S.,D., 2001;) by showing how the background of founders can impact the choices entrepreneurs make. This is important because it clarifies who is more likely to benefit from this type of interventions – an aspect that practitioners and institutions supporting entrepreneurial efforts would be greatly interested in. Finally, this paper adds to the current conversation on experimentation (Kerr W.R., Nanda R., Rhodes-Kropf M. 2014;) and clarifies that some individuals might have an advantage in using structured approaches to experimentation.

2 Theoretical background

2.1 Scientific approach to entrepreneurial decision making

According to existing research, entrepreneurs tend to use trial-and-errors or more structural approaches to decision-making (Sarasvathy, S.,D. 2001; Ries 2011; Shepherd, D.,A. et al. 2012;). On the one hand, entrepreneurs can adopt a trial-and-errors approach (Nicholls-Nixon et al. 2000, Dencker et al. 2009) so that they experiment sequentially until they reach a satisfactory solution. On the other hand, entrepreneurs can adopt a more structured approach to decision-making. This implies a clear course of actions (Delmar and Shane, 2003; Blank 2006; Ries 2011). The scientific approach (Camuffo et al. 2019) is part of this second category. Entrepreneurs using a scientific approach to entrepreneurial decision-making apply a set of steps – similar to those applied by scientists – to develop their business idea. When using this approach, entrepreneurs start with the definition of a mental representation or a "theory" (Csaszar and Ostler 2019; Felin and Zenger 2009) that frames the business problem that entrepreneurs wish to solve and logically links the components of the business model. They then explicitly formulate falsifiable hypotheses to validate or confute the theory. The falsifiability of such hypotheses allows them to mitigate confirmatory biases. To falsify their hypotheses, entrepreneurs design and execute tests. The tests should be conducted by designing them coherently with the theory, by targeting the correct sample, by setting appropriate decision rules, as well as valid metrics to evaluate the results. The final steps of this process consist in the evaluation of results of the experiments. In this phase, subjective judgment is essential when using data to inform a specific decision (Pfeffer and Sutton, 2006).

Previous studies show that – regardless of the educational background - entrepreneurs applying a scientific approach, unlike those who apply a trial-and-error approach, make more informed and unbiased decisions that ultimately lead to superior outcomes (Camuffo et al., 2020: Camuffo et al., 2021). Like scientists, entrepreneurs applying a scientific approach develop theories, formulate hypotheses, and collect evidence by testing them. This rigor allows them to get a realistic assessment of the business idea that they are developing. Entrepreneurs using a scientific approach make decisions based on a more precise assessment of the value of their business idea. Therefore, they are less likely to incur in false positive or false negative. This results in a higher likely to abandon their project earlier than other entrepreneurs since they realize if they were overestimating the value of their business idea. At the same time, they are more likely to pivot than other entrepreneurs. Moreover, since they pivot to better ideas with more precision, they are more likely to earn higher revenue than entrepreneurs who do not adopt a scientific approach (Camuffo et al. 2019).

2.2 Scientific entrepreneurs using a scientific approach to entrepreneurial decision making.

The studies by Camuffo and colleagues (2020 and 2021), do not examine what facilitates or hinders the adoption of a scientific approach to entrepreneurial decision-making. In this paper, we focus on this aspect and analyse closely teams composition. Beside the fact that the majority of early-stage start-ups have more than one founder (almost 55% according to Crunchbase data, 2016), the average number of members in the founding teams seems to be low (about two, according to the same data). In this light, we expect that start-ups whose main decision-maker has an educational background in science adopt more effectively the scientific approach.

We focused on the educational background of the start-up team decision-maker, defined as the most committed founder. In early-stage entrepreneurial firms, the decision-making process tends to be highly centralized and controlled by the leader, the CEO or the founder (Wasserman 2017, Nelson 2003), given the variability over time of the teams in this phase. We theorize that it is easier for science-educated entrepreneurs than for other entrepreneurs to assimilate and apply a scientific approach to decision-making.

Assimilating external knowledge far from prior knowledge can be difficult because of cognitive barriers. Indeed, especially when external knowledge has the potential to change the firm's strategy, it might be discarded or not fully absorbed (Cohen and Levinthal, 1990). We argue that entrepreneurs with a scientific background would be better at recognizing the value of the scientific approach, assimilating it, and applying it to business goals since it is strictly related to their prior knowledge. Their capacity to absorb a scientific approach to entrepreneurial

decision-making is therefore higher than other entrepreneurs. As a consequence, they are more precise in their assessment of their business idea than entrepreneurs who adopt the scientific approach but do not have an educational background in science. This translates in a reinforcement of the predictions made before for the adoption of the scientific approach:

H1: Science-educated entrepreneurs using a scientific approach are more likely to abandon their entrepreneurial idea than other entrepreneurs
H2: Science-educated entrepreneurs using a scientific approach are less likely to pivot than other entrepreneurs
H3: Science-educated entrepreneurs using a scientific approach are more likely to earn higher revenue than entrepreneurs using a non-scientific approach

2.4 Case study

In order to understand how entrepreneurs with a scientific background use the scientific approach to decision making, we performed a case study with one of the start-ups led by a science-educated entrepreneur who participated to the pre-acceleration program: Nib Biotech.

Nib Biotech is a biomedical start-up proposing an innovative solution to screening prostate tumours. At the beginning of the program, Nib Biotech have already developed a prototype of the solution and was targeting the public health system as primarily and first customer. During the program, the members of the start-up were taught about how to use a scientific approach to entrepreneurial decision making. At first, they started defining a theory on their business and how their value proposition could solve public health problems related to prostate tumours screening. They based their first theory on literature on prostate tumours screening and public data available on the problem. From the theory, they drew the hypothesis and tested them.

"We started from the literature and public data available on the problems our potential customers were facing, then we formulated the hypotheses trying to detach us from the solution that we had and therefore trying to be a more aseptic regarding our solution."

After testing their hypothesis, the founders realized that public health could represent one of their potential customers, but Nib Biotech would have had several problems in addressing them due to the high bureaucracy associated with public institutions. As result of this first testing, Nib Biotech iterated on the potential customers to be addressed with its product. The team decided to pivot on its theory in order to address as customer segment the private sector and prostate tumor screening tools vendors . Then the team turned back to develop new hypotheses and test them on the field. In this second iteration of the scientific approach, the founders figured out how the private sector could be their beach head market as private firms are more flexible and more concerned about efficiency in their operations than public institutions.

"The course helped us in understanding a method. We understood how to apply it to other realities and then, using it, we understood that the main target we had identified before 'The Startup Lab' was not our first target. More specifically, we understood that public institutions should be our target market in the long period, but they cannot be the early adopters of our product as they are not technology fanatics and they have a lot of bureaucratic issues to buy our prostate test". In our case, the first customers should be private hospitals, as they have completely different purchasing dynamics. A private hospital has to make money, so if you propose a product that can help them making money it is easier being part of their suppliers. Product performance still matters for them, but there is much less bureaucracy in its evaluation."

After this epiphany, they decided to stick on their theory, asserting the importance of trying to segment as much as possible their possible customers. For example, they tried to figure out the possible needs of the final users. On the one hand, this approach seemed to reduce the uncertainty related to their business and making clearer for them the value proposed to the customers and stakeholders. On the other hand, the new insides on the market and the possible customers leaded the team to revise in deep their prototype of the solution. This in deep revisions of the prototype required a huge amount of time, slowly down the other activities of the team.

"As I said before, we are technical researchers, so unfortunately at the beginning we have spent 95% of the resources in the technical part."

As the CEO of Nib Biotech stated, the path dependency due to the presence of a consolidated prototype and the new information on the customers and the market brought the team to continually postpone the enter on the market, to understand how to hit the market with a product suited for their customers.

"The most critical thing on using this approach was having a well-defined prototype, knowing that it works and that somebody told you that it's good, because you start asking yourself why you should rehash everything…. Instead it is the right path and we should have done it before. If we had used this approach in the pure research phase, we would have surely optimized better the resources we spent. Afterwards we spent too much energy on the technical side when we should have, for example, told ourselves: "We have analyzed 10 cases. Does the product work like this? Perfect. Let's then try some tests to see if this customer likes it or not with this design."

3. Methodology

3.1 Experimental Design

In order to be consistent previous work exploring the relationships between the scientific approach to decision-making and entrepreneurial performance, we replicate the experimental settings presented in Camuffo et al. (2020) and Camuffo et al. (2021). Accordingly, we embed a field experiment in a pre-accelerator program by randomly assigning entrepreneurs to either a treatment (being taught how to use a scientific approach when developing a business idea) or a control group (being taught how to develop a business idea).

This pre-accelerator program –which took place in Turin (Italy)- provides training to early-stage entrepreneurs for a short period of time (three months). Consistently with previous studies, we targeted early-stage entrepreneurs. After a call for application, that resulted in a total of 149 start-up applications, we excluded seven applicants as they were already in a later-stage of development of their start-up. Our initial sample thus included 142 start-ups admitted to the program. Then, each start-up was randomly assigned to either a treatment or a control group through simple randomization. We checked that treatment (71 start-ups) and control groups (71 start-ups) were balanced on 38 key covariates that might affect the absorption of the treatment and subsequent outcomes. Such covariates include – for instance- background STEM, entrepreneurial experience, managerial experience, industrial experience, and level of scientific intensity in their decision making. Differences between treatment and control are small in magnitude, and there are no significant differences between the two groups.

Treated and control teams have been trained during seven sessions from October 2018 to February 2019 (21 hours of training for each group). Consistently with the training supplied by Camuffo et al. (2020), our pre-accelerator program focused on market validation, a series of activities aimed at testing the desirability of a product or service concept against a potential target market. The content and length of each session was the same for both groups, but start-ups in the treatment group were taught how to make entrepreneurial decisions according to the scientific approach. In each class of the treatment group, start-ups were taught to elaborate a theory behind their choices, articulate hypotheses and test them rigorously. The control group, instead, did not learn about the scientific approach, but followed the traditional approach to decision-making used by entrepreneurs, that relies on trial-and-error techniques. We avoid contamination and other threats to internal validity following the same approach used by Camuffo et al. (2020).

3.2 Data Collection procedure

We collected detailed information on all the entrepreneurs using telephone interviews. Consistently with Camuffo et al. (2020), we conducted regular telephone interviews with each start-up. Each telephone interview usually lasted for about 30 minutes and included questions on changes in the entrepreneurial team, about the activities conducted and on performance. Through these calls, we are able to measure whether entrepreneurs abandon their business idea or pivot to a different one. We conducted

telephone interviews from the end of the training up to February 2020 on all the 132 start-ups that completed the pre-accelerator program (10 start-ups were not considered as they abandoned the course while it was in place, or they did not show up at any lesson).

3.3 Dependent Variables

We performed our analysis using linear regressions and negative binomial regressions on four dependent variables. Building on previous studies on the scientific approach to entrepreneurial decision making (Camuffo et al., 2020: Camuffo et al., 2021), these variables capture the effectiveness of the scientific approach in letting entrepreneurs recognizing the (low) value of their business idea, to change their business idea according to market needs and to capitalize their business idea through some revenues. Table 1 reports the description of the dependent variables used in our analysis.

Table 1 : Dependent Variables

Variable	Description
Exit	Dummy variable equal to 0 until entrepreneurs exit (they abandon the program and cease their start-up), 1 when entrepreneurs decide to exit.
Pivot	Dummy variable equal to 1 when the start-up pivoted, 0 elsewhere
Revenue	Revenue flow of the startup

3.4 Independent Variables

In the same vein, we used two main independence variables in our analises. Table 2 reports the description of the independent variables used in our analysis.

Table 2 : Indipendent Variables

Variable	Description
Intervention	This is a binary variable equal to 1 for start-ups in the treatment group, and 0 otherwise.
Leader STEM	This is a binary variable taking the value 1 if the leader of the founding team of each start-up (usually the CEO) has education in the fields of Science, Technology, Engineering or Mathematics.

4. Results

4.1 Replication of Camuffo et al. (2019)

Table 3, models 1 and 2, compare results by Camuffo et al. (2020) with our results on the decision of entrepreneurs to abandon the development of their idea. Data show that, consistently with the results obtained by previous experiment, treated firms abandon their business more and earlier than firms in the

control group (the coefficient of intervention in both models 1 and 2 are positive and statistically significant). This corroborates evidence that a scientific approach increases exit from entrepreneurial idea, and it is consistent with the theory that treated start-ups realize early on that their business idea is not worth pursuing.

Table 3, models 3 and 4, compare results for the two experiments regarding pivot as a dependent variable. Contrary to what showed by Camuffo et al. (2020), the effect of the treatment is negative and significant on pivots (see model 4), thus suggesting that treated firms tend to pivot less than firms in the control group. This latter result perfectly replicates later evidence of Camuffo et al. (2021), and thus provides further corroboration to the impact of the treatment on the decision of start-ups to pivot, as treated start-ups converge earlier toward a definitive business idea or toward the decision to abandon the project as it is not worth pursuing.

Table 3, models 5 and 6, present results for the effect of treatment on revenue. Consistently with Camuffo et al. (2020), we found that treated firms earn higher revenue than firms in the control group (see model 6). These results are consistent with the idea that treated start-ups are more precise in targeting their customers or offering a product that customers appreciate and, therefore, they earn higher revenue

Table 3 : Replication of Camuffo et al. (2019)

	(1)	(2)	(3)	(4)	(5)	(6)
	Exit (Linear Probability)		**Pivot** (Negative binomial)		**Revenue** (Linear probability)	
	Original experiment	Replication from this experiment	Original experiment	Replication from this experiment	Original experiment	Replication from this experiment
Intervention	0.035**	0.161**	0.803***	-0.361***	2,666.8***	2,418.4**
	(0.045)	(0.026)	(0.000)	(0.000)	(0,008)	(0.017)
Constant	0.316	0.083**	-0.944	0.613***	-833.4	-1,151.8
	(0.533)	(0.024)	(0.244)	(0.003)	(0.754)	(0.511)
Teacher FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116	132	116	132	116	132
R-squared	0.183	0.062	-	-	0.276	0.079
Clustered Errors	Intervention	Intervention	Intervention	Intervention	Intervention	Intervention

4.2 The moderating role of a science-educated entrepreneur in explaining the impact of the treatment on exit, pivot and revenues[1].

In Table 4, we present results for the effect of having a leader STEM and receiving the treatment on exit and pivot, as well as on the level of revenue (Models 9, 10 and 11). Based on our hypotheses, we should observe that start-ups with STEM leaders should i) abandon more their idea; ii) pivot less than other start-ups; and iii) generate more revenues than others. As presented in Model 9 (Table 4), the treatment has a positive and significant effect on start-ups with STEM leaders, implying that the scientific

[1] For the sake of brevity, we present results of models regressing the performance on the interaction between the intervention and the presence/absence of a STEM leader. These results are robust to the use of 2SLS models using the scientific intensity as independent variable (i.e., the level of absorption of the scientific approach by entrepreneurs) instead of the intervention.

education reinforces the impact that the scientific approach has on their decision to abandon their business project.

We present the results on the impact of having a leader STEM on the decision to pivot in Model 10 in Table 3. We find support for a negative impact of the scientific approach to decision making on the decision to pivot, and we also found that administering the treatment to start-ups having a leader STEM reinforce this effect, decreasing the number of pivots.

We present the results on revenue in model 11 of Table 4. We find no significant effect of moderation between treatment and start-ups with a leader STEM on revenue. Moreover, the results seem to imply that treated start-ups with no STEM leader, and untreated start-ups with STEM leaders outperform in terms of revenues the treated start-ups with a STEM leader. This last evidence seems to confirm what suggested by the case study, implying that treated scientific entrepreneurs may need more time to hit the market and to gain revenue.

Table 4: Exit, Pivot, Revenue

	(9)	(10)	(11)
	Exit	**Pivot**	**Revenue**
VARIABLES	OLS Panel	OLS Panel	OLS Panel
No Intervention X Leader STEM	0.011	-0.046*	0.187**
	(0.652)	(0.080)	(0.039)
Intervention X No Leader STEM	0.034*	-0.035	0.860***
	(0.089)	(0.173)	(0.004)
Intervention X Leader STEM	0.050**	-0.057*	0.209
	(0.033)	(0.098)	(0.301)
Constant	-0.034	0.484***	-0.904***
	(0.302)	(0.000)	(0.002)
Observations	1,817	1,817	1,817
Number of id	132	132	132
Dummies for mentors	Yes	Yes	Yes
Research Assistant	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Clustered Errors	Intervention_Instructor	Intervention_Instructor	Intervention_Instructor

Robust pval in parentheses *** p<0.01, ** p<0.05, * p<0.1. Baseline : No Intervention X No Leader STEM

5. Conclusions

This paper studies the impact of a scientific approach to entrepreneurial decision-making on early-stage start-up performance when the main decision-maker has a scientific background. By analysing data from 132 entrepreneurial firms participating to a field experiment embedded in a pre-acceleration program, we find that scientific entrepreneurs trained to use a scientific approach have a more scientific approach to decision making than other entrepreneurs, abandon their ideas more, and pivot less. We did not find any evidence about the effect of having a leader STEM and receiving the treatment on revenue.

This paper makes several contributions to the literature related to the use of a scientific approach to decision making. First, we answer to the question of Camuffo et al. 2021 about which contingencies can moderate the use of a scientific approach to decision making could be moderate. According to our analysis, scientific educated entrepreneurs seem to partially use better this approach than other entrepreneurs, abandoning more their entrepreneurial idea and making fever pivots than other entrepreneurs. This evidence sheds a first light on possible implications on which kind of entrepreneurs are more likely to benefit from this approach to decision making.

Moreover, we contribute to the literature on the mechanisms through early-stage start-ups created by scientists (Murray, 2004; Toole and Czarnitzki, 2009). Using a scientific approach to decision making, scientific educated entrepreneurs can infer more precise information on their business, having a clearer idea on their potential customers and on the market in which they are involved, reducing potentially cognitive distances highlighted in previous literature (Krabel and Mueller, 2009, Miozzo and DiVito, 2016). This is an important contribution for policymakers, given the contribution of startup founded by scientists to the regional development (Caree et al., 2014). Finally, this paper contributes to the current conversation on whether structured approaches to decision making could be influenced by the background of an entrepreneurs (Leatherbee and Katila, 2017; Chatterji et al., 2019).

This work is not without limitations. Up to now, we have no significant evidence on possible implications of being a scientific entrepreneur and using a scientific approach to decision making on gaining more or less revenue than other entrepreneurs. Further analysis is still underway to understand possible implications of this non-significative effect, starting from the evidence gained during the case study. More precisely, we are investigating if the single steps of the scientific approach to entrepreneurial decision making (i.e. Theory, Hypothesis, Test, and Evaluation) could influence the mechanism through which a treated scientific entrepreneur hit the market and the revenue gained

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