ENTREPRENEURSHIP AND INNOVATION CENTER

Working Paper Collection

02/2024

THE COMPOSITION OF ENTREPRENEURIAL TEAMS AND ITS IMPACT ON THE NATURE OF AI STARTUPS

Alessandra Colombelli, Elettra D'Amico, Andrea Panelli, Emilio Paolucci

The Entrepreneurship and innovation Center (EIC) publishes research papers authored by members and guests of the Center and of its research centers. ISSN 3035-1634

EIC - Politecnico di Torino, Corso Duca degli Abruzzi, 24 - 10129 Torino (TO)
www.polito.it/eic

The Composition of Entrepreneurial Teams and Its Impact on the Nature of AI Startups

Abstract

Recent strides in artificial intelligence (AI) technology have spurred innovation across various sectors, highlighting its transformative capabilities. However, empirical research on AI-based entrepreneurial endeavors remains sparse. This study fills this void by examining European startups engaged in either developing or adopting AI solutions. By probing into the antecedent competencies and skills crucial for AI technology creation, the research illuminates how founder backgrounds influence entrepreneurial decisions within the AI domain. Additionally, it investigates the correlation between team diversity and the exploitation of AI technology. Employing a classification methodology, the study identifies AI-related startups and delineates their relationship with the technology, offering empirical insights into AI technology trajectories and their impact on human labor.

1. Introduction

In recent years, Artificial Intelligence (AI) has undergone significant advancements in technology, including improvements in data collection and management, as well as the proliferation of new algorithms (Von Krogh, 2018). These advancements have enabled AI to be functional in multiple scenarios, facilitating the resolution of various issues and bringing advancements in a wide range of sectors.

Given its status as a General-Purpose Technology (GPT) the evolving landscape of AI underscores its significance as a catalyst for change and innovation across a broad spectrum of fields.

However, very few studies are focused on AI-based entrepreneurial activities. Scholars call for more empirical work on AI and entrepreneurship; specifically, they call for more research to identify and predict entrepreneurial characteristics of individuals, teams, and organizations (Obschonka & Audretsch, 2020). Given these research gaps, this study focuses on startups developing or adopting artificial intelligence solutions. According to entrepreneurship scholars, startups play a critical role in enhancing disruptive innovation (Markides, 2006), and they are the channels through which innovations are introduced into more traditional sectors.

The GPT nature of this technology and its various and heterogeneous applications suggest that AI-based technologies may require different sets of knowledge and skills according to the scope of applications. Some of the necessary areas of knowledge to successfully develop AI-based technological solutions, such as mathematics, engineering, neuroscience, etc. (Müller & Bostrom, 2014), must be supported by problem-solving-oriented skills. Especially when considering their development within the birth of new enterprises. Studies related to AI and the benefits it brings to entrepreneurship have confirmed how this technology offers entrepreneurs new opportunities (Obschonka & Audretsch, 2020). In fact, according to the human capital literature, the skills of the entrepreneurial team, understood as diverse experiences or backgrounds, are crucial in the initial development of an entrepreneurial idea and can influence its development in terms of business performance or recognition of a market opportunity (Gruber et al., 2012, 2013). Furthermore, a diverse composition of experiences within the team can influence the developmental trajectory of an entrepreneurial idea.

Currently, studies on AI are predominantly of a theoretical nature, and the few existing empirical studies are focused on specific sectors, without distinguishing whether companies simply adopt AI solutions or develop them internally. AI is vast and complex, offering a wide range of solutions to real and everyday problems, without discerning the effects these solutions might have on humans, such as replacing tasks or providing support. Despite the increasing attention on the intersection of AI and entrepreneurship at a macro level, the literature has mainly focused on the positive effects of this technology on venture creation and business performance (Chalmers et al., 2021; Giuggioli & Pellegrini, 2022), neglecting possible implications of entrepreneurial team composition on the development of AI-technology startups. In fact, previous studies on the diversity of resources within the company demonstrate how this can influence the development of startups and their content.

The aim of this work is to investigate how the different set of skills of an entrepreneurial team can influence the adoption or creation of AI in startups. Furthermore, this study aims to identify the relationship between the purpose of AI, whether complementary or substitutionary, and the characteristics of the entrepreneurial team. The study allows the following research question to be answered: Does team experience diversity predict the exploitation of AI-technology?

Studying European startups operating in the AI technological domain between 2018 and 2020, we contribute to the literature in several ways. Firstly, we investigate the antecedents' competences and skills of AI

technology development, filling the gap related to the generation of AI from an entrepreneurial perspective. Secondly, this paper extends the findings from previous studies by showing how the characteristics of founders can impact the choices entrepreneurs make, using the context of AI technology. This is significant as it provides clarity on who is most likely to reap the benefits of such interventions - a factor of great interest to professionals and institutions backing entrepreneurial endeavors. Finally, we implement and adopt a classification methodology to identify not only AI-related startups, but also specifying the type of relationship they have with the technology (whether developers or adopters) and providing empirical evidence on the trajectories that AI technology is following, whether predominantly oriented towards replacing human labor or supporting human workers.

2. Theoretical background and hypothesis development

The presence of AI-based technology is documented in numerous fields. Despite the technology seems the same, the wide range of applications of this new technology may have different and important implications in its development and its use.

As far as the development of such technology is concerned, the implementation of AI represents radical innovations involving all industries, even if with different degrees of adoption and adaptation depending on their specific contexts, technological infrastructures, skills and capabilities. The applications of AI have been the subject of numerous studies, for example in the healthcare sector (Leone et al., 2021), in personnel selection (J.-Y. Kim & Heo, 2021), in the tourism (Filieri et al., 2021) and public administration sectors (Madan & Ashok, 2023). Often in studies, reference has been made to the use of AI in a generic way, focusing on applications and effects, without distinguishing between cases in which AI technology was specifically created to meet specific needs and those cases in which, within companies and sectors, the technology was adopted from outside and then adapted to meet needs.

On the other hand, the use of AI has allowed machines to perform functions that were typically carried out by humans. Numerous studies have focused on the hypothesis of whether AI is effectively replacing some of the tasks traditionally performed by humans or if, instead, it is a valuable ally capable of supporting people in carrying out certain tasks. However, opinions are contrasting. Some assume that AI is substituting some of the human cognitive abilities (Balasubramanian et al., 2022), for example, when machines replace bankers in stock investments (Noonan, 2017) and take over from doctors in medical treatment (Haleem et al., 2019). Others suppose that AI complements human cognitive abilities, for example, artificial intelligence and humans work together during the innovation process (Bouschery et al., 2023).

This wide range of applications may suggest a considerable complexity behind the applications of this new technology and, consequently, the need to involve different types of knowledge and skills. Scholars have argued that implementing AI applications requires a high level of technical expertise (Chalmers et al., 2020). On the other hand, the development of AI applications requires the combination of multiple skills from different areas of knowledge, especially in the early development of this technology (Müller & Bostrom, 2014). In this perspective, AI-based startups might differ in terms of development and market according to their key resources, such as the skills involved in the funding team.

Indeed, Human Capital Theory posits that the composition of a founding team is pivotal in the early stages of developing an entrepreneurial venture (Reese et al., 2021). In environments characterized by high uncertainty and limited resources, the human capital of a founding team acts as a crucial pool of resources for a nascent firm (Lazar et al., 2020). Furthermore, the synergy of these resources within the team can influence the scope of the entrepreneurial venture, its development (Jin et al., 2017), and the team's organization (Zellmer-Bruhn et al., 2021).

One key resource within a founding team is the prior experience of its members. According to entrepreneurship literature, individuals with different experiences can perceive opportunities differently and explore different paths for exploiting an idea. For example, individuals with technical experiences, such as technicians or researchers, are less likely to identify several opportunities for technology exploitation than individuals with other experience (Zellmer-Bruhn et al., 2021). Furthermore, they tend to concentrate on specific pathways, such as the internal development of technology rather than exploring multiple exploitation strategies (Gruber et al., 2012). Conversely, individuals with prior entrepreneurial experience are more adept at identifying a broader range of opportunities and strategies for developing a venture (Gruber et al., 2012). Building upon the individual differences highlighted in previous studies, the literature has explored the impact of synergies between different expertise inside the team. Research indicates that teams with greater degree of experience

diversity are more adept at identifying a wider range of opportunities for exploiting an entrepreneurial concept compared to less diverse teams (Gruber et al., 2013). Specifically, the amalgamation of functional knowledge, such as technical expertise, with broader knowledge, like industry or entrepreneurial experience, enhances entrepreneurs' ability to spot more opportunities for the exploitation of a product or service (Gruber et al., 2013). Furthermore, teams exhibiting a greater variety of experiences are more innovative, leading to groundbreaking solutions that can impact sectors or industries. Finally, the literature suggests that this diversity not only drives innovation but also influences the development of the products or services offered by a venture, shifting the emphasis from purely technical aspects to the application of existing technologies in new sectors. In this context, we propose that the extent of prior experience within a founding team will significantly influence the development trajectory of an AI-based start-up, affecting both the technology development and its application. We hypothesize that a team with a broader spectrum of diverse experiences will likely shift its focus from developing in-house technology (i.e. being an AI developer) towards adopting technology externally (i.e. being an AI adopter). Furthermore, existing literature suggests that a higher level of diversity within a team can expand the range of opportunities identified and enhance the degree of innovation in a start-up. Based on this insight, we anticipate that teams with a more varied experiential background will devise more revolutionary solutions, potentially transforming industries and substitute human tasks with technology, i.e. being a promotor of solutions with the aim of substitute human tasks through AI. In light of these considerations, we state the following hypotheses:

Hp 1: A higher degree of experience diversity among the founding team increases the likelihood of being an AI adopter.

Hp 2: A higher degree of experience diversity among the founding team increases the likelihood of being a promotor of substitution through AI

3. Methodology and Data

Methodology

We focused on the European AI context because it is among the major players in the AI industry. We used data available in the Crunchbase database, which is the largest database of funded start-ups with over 1,000,000 company profiles from more than 200 countries. Furthermore, the Crunchbase database also reports on the technological domain of every start-up, together with information about investors and founders (Kim et al., 2020). The Crunchbase database contains information about start-ups, such as headquarters location, foundation date, and founders' names. Following the approach adopted in other studies (Debreceny *et al.*, 2019), we gathered additional information about the founders (i.e., work experience, and educational background) from their LinkedIn profiles. Our observation focused on a period of 3 years, between January 2018 and December 2020. To build this dataset, we selected the startups still active, scanning their websites, and then we classified them considering two types of classifications: adopter vs developer of AI and Substitution vs complementation through AI.

To delineate the character of a startup engaged in the development of AI technology, i.e. a startup that creates AI technologies as core business, we adhered to the classification of AI technological domains established by the European Commission (EU)'s Joint Research Centre (JRC) (Samoili et al., 2020). This EU classification encompasses the following overarching domains: Reasoning, Planning, Learning, Communication, Perception, Integration and Interaction, Services, Ethics, and Philosophy) (Samoili et al., 2020). We utilized the keywords outlined in the EU classification to categorize each startup according to an AI technological domain. Subsequently, we corroborated the presence of domain-specific keywords on the websites of AI startups. Furthermore, we identified as AI developers those startups that explicitly referenced the creation of AI

technology, paying heed to statements such as "Development of proprietary algorithms" or "Construction of a computing network." For instance, we assigned startups developing a Customer Service Platform with an integrated multilingual chatbot to the Communication domain, and startups offering customized deep learning solutions tailored specifically to the Services domain.
Considering the remaining part of the sample we looked for clear and explicit references to AI technology on their website, we classify as "Adopter of AI" those startups that adopt AI technologies to develop their business. In particular we classified as adopter the startups that clearly declare to "use AI to automate" processes, or startups providing hardware products with integrated AI technologies, or those whose "technology used is based on AI."

Considering the startup's aim and descriptions, we also classified the startups as "Substitution through AI", when their main goal is to substitute a generic human task and as "Complementation through AI" if their objective is to complement and support human beings. On the final sample we complemented the information related to founders using LinkedIn and the startups websites, the selection process returned a list of 563 start-ups in line with our requirements.
For example, the startup Digdot proposes a solution that adopts AI technology to "sniffs out bills & invoices in your email, checks all payments from your bank and matches them up. Once done he delivers the docs to your accountant on time and digitally. Instead of you.", with the aim to "automate the boring stuff like invoice collection & transaction matching, so that you can focus on the really important things in your business." Considering startups that generate AI, Capillary.io, is a project that offers a tool capable of automatically analyzing capillaroscopy images, thus providing a library of images that allows the professionals to improve their interpretation of capillaroscopy.

Dependent Variables
We test our hypothesis using two main independent variables. The first independent variable used in this work is defined as *Adopter of AI. Adopter of AI* discriminates between start-ups which adopt AI technology. More precisely, this variable is a dummy variable which takes the value of 1 if a start-up adopts AI technology and 0 when the start-up develops the AI in-house. We establish this variable leveraging information collected from the website of a start-up. More precisely, each author identifies the characteristics of the AI developed using secondary information on the website, thus ensuring that the process of identification was not influenced by the personal perspective of each author. In the second phase, the authors collectively check differences in the identification of whatever a startup creates the AI in-house or not. Each difference was discussed and resolved.
To investigate the second hypothesis of this work, we used the independent variable named *Substitution through AI*. Similar to the first independent variables, this variable discriminates between start-ups which aim to substitute human work with their AI technology or not. More precisely, *Substitution through AI* takes the value of 1 when a start-up offers a product of service which substitutes human task using AI technology and 0 when a start-up offers a product or service which enhances human tasks using AI. We divided the start-ups between these two categories using data from the website of the start-ups. More precisely, each author identifies the value proposition of the start-ups and understands if the start-up will complement human task or substitute it.

Independent variables
Following previous studies on team diversity (Tryba et al., 2023). We use Blau's Index to measure diversity in experiences inside the team. Blau's index allows to measure diversity between a group by the distribution of individuals across various categories. In this work, we use three main categories: Entrepreneurial Experience; Company Experience; Academic experience. The categories Entrepreneurial Experience includes all the founders who were entrepreneurs before founding the company. On a parallel ground, Company experience includes all the founders who were working for a company before founding the company. Finally, Academic experience includes all the founders who were academics (professors, researchers, students) before founding the company.

Statistical Approach
We investigate our hypothesis using an econometric approach. Building on the data collected, we use cross-section analyses to assess the effect of experience diversity in the team on the likelihood of adopting AI and

the likelihood of using AI to substitute human tasks. We test our hypotheses using probit models. Moreover, to avoid possible confounding effects, we control for the year of foundation and the team size of each start-up. Finally, we clustered errors using robust standard errors. Table I resumes the operationalization of the variables, while Table II shows the descriptive statistics of the independent variables, the dependent variables, and the control variables.

Table I. Operationalization of variables: characteristics of the funding team.

Variable	Operationalization	Sources
Headquarters location	Location of start-up headquarters	Crunchbase.com
Date of foundation	Year in which the start-up has been created	Crunchbase.com
Funding Amount	Boolean variable equal to 1 if the startup collect more that 1 Amount of money collected by the start-up during its life, in US dollars	Crunchbase.com
Number of founders	Number of founders of the start-up	Crunchbase.com
Experience Diversity	Blau Index for the previous experience of the team	Crunchbase.com; LinkedIn
Adopter of AI	Boolean variable equal to 1 if the startup adopts AI technologies to develop core business	Crunchbase.com; company website
Substitution through AI	Boolean variable equal to 1 if the startup is developing an AI product/service aimed at substituting a task typically performed by a human	Crunchbase.com; company website

Table II. Descriptive statistics for dependent variables and Independent Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Adopter of AI	563	.387	.4875458	0	1
Substitution through AI	563	.469	.4994767	0	1
Year of foundation	563	2.018.762	.8458677	2018	2020
Number of founders	563	1.852.575	.9171786	1	6
Experience Variety	563	.2711634	.356455	0	1

4. Results

In this study, Tables III and IV present the findings from our econometric analysis. Table III, Models (1) and (2), focuses on the impact of experience diversity on the likelihood of adopting AI technologies. Table IV, encompassing Models (3) and (4), delves into the effects on the scope of the technology employed. The data in Table III suggests that the diversity of experience within a founding team plays a significant role in the decision to adopt AI technologies. More precisely, a higher degree of experience diversity in the founding team significantly affects the likelihood of adopting AI technologies. Notably, Model (2) indicates that an increase in experiential diversity increases, on average, the likelihood of adopting AI technologies by 11%. These results provide compelling evidence that the experiential diversity within a founding team may affect the decision-making process regarding the internal development of AI technology, thus lending support to HP 1.

Table III. Impact of Experience Diversity on the Likelihood of Adopting Pre-existing AI Technology

	(1) Probit DV: Adopter of AI Coefficents	(2) Probit DV: Adopter of AI Average Marginal Errors
VARIABLES		

Experience Variety	0.298*	0.111*
	(0.071)	(0.068)
Number of founders	- 0.055	- 0.011
	(0.400)	(0.859)
Year of foundation	- 0.155**	- 0.150**
	(0.019)	(0.028)
Constant	313.844**	-
	(0.019)	-
Observations	550	550
Dummies for Country	Yes	Yes
Clustered Errors	Robust Standard Errors	Robust Standard Errors

Robust pval in parentheses *** p<0.01, ** p<0.05, * p<0.10

Finally, Table II, Models (3) and (4), illustrates the influence of experiential diversity on the technological scope. Specifically, diversity in terms of team experience significantly and positively affects the likelihood of offering an AI-based product or service as a substitute for human tasks. Notably, Model (4) indicates that an increase in the team's experiential diversity leads, on average, to an 11% increase in the likelihood of developing a business that utilizes AI to replace human tasks. These findings suggest that the degree of experiential diversity in a founding team is also associated with the application of the technology. Consequently, Hypothesis 2 (HP2) cannot be rejected.

Table IV. Impact of Experience Diversity on the likelyhood of adopting AI-technology

VARIABLES	(3) Probit Substitution through AI Coefficent	(4) Probit Substitution through AI Average Marginal Effect
Experience Variety	0.301*	0.116*
	(0.067)	(0.064)
Number of founders	-0.046	-0.014
	(0.468)	(0.816)
Year of foundation	- 0.124*	-0.048**
	(0.059)	(0.057)
Constant	-250.279*	-
	(0.059)	-
Observations	546	546
Dummies for Country	Yes	Yes
Clustered Errors	Robust Standard Error	Robust Standard Error

Robust pval in parentheses *** p<0.01, ** p<0.05, * p<0.1

5. Conclusions

This manuscript examines the effect of founding team characteristics on the AI-based startups. Specifically, it investigates whether the founding team's prior experience influences both the internal development of AI technology and its use within the startups. Analyzing data from European startups, we observe that a greater diversity of experience within the team increases the likelihood of adopting AI technology rather than developing it inside the startup. Additionally, a varied range of experiences positively correlates with the likelihood of developing AI-based products or services that replace rather than complement tasks and activities generally performed by human beings. This study contributes to the existing body of knowledge on AI

technology, demonstrating how the characteristics of the founding team can shape the use and development of AI technologies.

Reference

Balasubramanian, N., Ye, Y., & Xu, M. (2022). Substituting human decision-making with machine learning: Implications for organizational learning. *Academy of Management Review*, *47*(3), 448–465.

Bouschery, S. G., Blazevic, V., & Piller, F. T. (2023). Augmenting human innovation teams with artificial intelligence: Exploring transformer-based language models. *Journal of Product Innovation Management*, *40*(2), 139–153.

Chalmers, D., MacKenzie, N. G., & Carter, S. (2021). Artificial intelligence and entrepreneurship: Implications for venture creation in the fourth industrial revolution. *Entrepreneurship Theory and Practice*, *45*(5), 1028–1053.

Filieri, R., D'Amico, E., Destefanis, A., Paolucci, E., & Raguseo, E. (2021). Artificial intelligence (AI) for tourism: An European-based study on successful AI tourism start-ups. *International Journal of Contemporary Hospitality Management*, *33*(11), 4099–4125.

Giuggioli, G., & Pellegrini, M. M. (2022). Artificial intelligence as an enabler for entrepreneurs: A systematic literature review and an agenda for future research. *International Journal of Entrepreneurial Behavior & Research*, *29*(4), 816–837.

Gruber, M., MacMillan, I. C., & Thompson, J. D. (2012). From minds to markets: How human capital endowments shape market opportunity identification of technology start-ups. *Journal of Management*, *38*(5), 1421–1449.

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.

Haleem, A., Javaid, M., & Khan, I. H. (2019). Current status and applications of Artificial Intelligence (AI) in medical field: An overview. *Current Medicine Research and Practice*, *9*(6), 231–237.

Jin, L., Madison, K., Kraiczy, N. D., Kellermanns, F. W., Crook, T. R., & Xi, J. (2017). Entrepreneurial team composition characteristics and new venture performance: A meta–analysis. *Entrepreneurship Theory and Practice*, *41*(5), 743–771.

Kim, H. J., San Kim, T., & Sohn, S. Y. (2020). Recommendation of startups as technology cooperation candidates from the perspectives of similarity and potential: A deep learning approach. *Decision Support Systems*, *130*, 113229.

Kim, J.-Y., & Heo, W. (2021). Artificial intelligence video interviewing for employment: Perspectives from applicants, companies, developer and academicians. *Information Technology & People*, *35*(3), 861–878.

Lazar, M., Miron-Spektor, E., Agarwal, R., Erez, M., Goldfarb, B., & Chen, G. (2020). Entrepreneurial Team Formation. *Academy of Management Annals*, *14*(1), 29–59. https://doi.org/10.5465/annals.2017.0131

Madan, R., & Ashok, M. (2023). AI adoption and diffusion in public administration: A systematic literature review and future research agenda. *Government Information Quarterly*, *40*(1), 101774. https://doi.org/10.1016/j.giq.2022.101774

Markides, C. (2006). Disruptive innovation: In need of better theory. *Journal of Product Innovation Management*, *23*(1), 19–25.

Müller, V. C., & Bostrom, N. (2014). Future progress in artificial intelligence: A poll among experts. *AI Matters*, *1*(1), 9–11.

Noonan, L. (2017). JPMorgan develops robot to execute trades. *Financial Times*, 1928–1937.

Obschonka, M., & Audretsch, D. B. (2020). Artificial intelligence and big data in entrepreneurship: A new era has begun. *Small Business Economics*, *55*, 529–539.

Reese, D., Rieger, V., & Engelen, A. (2021). Should competencies be broadly shared in new ventures' founding teams? *Strategic Entrepreneurship Journal*, *15*(4), 568–589.

Samoili, S., Cobo, M. L., Gómez, E., De Prato, G., Martínez-Plumed, F., & Delipetrev, B. (2020). *AI Watch. Defining Artificial Intelligence. Towards an operational definition and taxonomy of artificial intelligence*.
Tryba, A., Patzelt, H., & Breugst, N. (2023). Knowledge diversity and venture growth: The contingent effects of early planning and experimentation. *British Journal of Management*, *34*(1), 343–362.
Von Krogh, G. (2018). Artificial intelligence in organizations: New opportunities for phenomenon-based theorizing. *Academy of Management Discoveries*, *4*(4), 404–409.
Zellmer-Bruhn, M. E., Forbes, D. P., Sapienza, H. J., & Borchert, P. S. (2021). Lab, Gig or Enterprise? How scientist-inventors form nascent startup teams. *Journal of Business Venturing*, *36*(1), 106074.