

Gender differences and tech-based entrepreneurship: a literature review and research agenda

NICOLETTA BURATTI* ELENA CASPRINI• MARIA COLURCIO♦ TOMMASO PUCCI**

Framing of the research. *Despite the widespread recognition of the growing, positive contribution of female entrepreneurship in economic and social development processes, women are still less involved in high-growth entrepreneurship, especially in Europe, where their participation is lower than in most part of the world, and where they show some of the lowest rates of entrepreneurial perceptions (seeing new business opportunities, having the skills to start a new business, being undeterred by fear of failure), according to Women's Entrepreneurship GEM Report (2021). Gender gap in entrepreneurship and management is confirmed by the European Institute for Gender Equality, whose statistics show that across the EU, women business owners make up only 33.2% of self-employed people, and management boards are dominated by men (EIGE Report, 2021). This gap is somewhat larger in tech-based industries, where founding and managing a technology-based firm has been commonly considered to be a male affair (Green et al., 2003; Nelson and Levesque, 2007) and prominently within STEM fields (Poggesi et al., 2020), where women entrepreneurs are still strongly underrepresented (Dautzenberg, 2012; Tonoyan and Strohmeyer, 2021).*

Since the seminal contribution of Schwartz (1976), the debate surrounding women and entrepreneurship has grown up, focusing on their underrepresentation and their “marginalization” into sectors with low growth perspectives (Carter et al., 2000). There has been, among scholars as well as policymakers, a tendency to interpret this evidence as the expression of female structural weaknesses, to be fixed through specific programs aimed at training women to adopt prototypical entrepreneurial attitudes (Marlow, 2019). Despite this generalized view, a different perspective emerged in the same years, suggesting that female entrepreneurship specificities had to be considered as the result of a generalized gendered subordination (Fischer, 1993; Jennings and Brush, 2013).

Purpose of the paper. *Even though this topic has given rise to a substantial body of literature, there are relatively few studies dedicated to investigating the presence of women entrepreneurs in technology-based sectors. Except for a few recent works (Wheadon and Duval-Couetil, 2019; Poggesi et al., 2020) that propose a literature review on the topic of gender and technology entrepreneurship, there is currently no dedicated strand of research that, in the field of management, identifies the issue of gender differences with reference to high-tech entrepreneurship. This is even more surprising, when considering that today technology plays a pervasive role and that even mature industries are undergoing strong changes precisely because of the spread of new technologies related to STEM fields. This opens great opportunities from which, once again, women risk being excluded or marginalized. It is therefore important, in our opinion, to examine this issue in depth and take stock of the results of the research conducted so far.*

Given the above, our study has two overarching objectives. The first is to document the development of the body of work related to gender differences and high-tech entrepreneurship. The second is to assess its contributions vis-a-vis the broader corpus of literature on female entrepreneurship.

Methodology. *We decided to adopt bibliometric techniques already used by other authors for systematic review purposes (see for example Appio et al., 2017; Casprini et al., 2020). In particular, the analysis relied on bibliographic coupling “to group papers based on their shared references. The higher the reference overlap between the two papers, the more these two papers were deemed to belong to the same community” (Casprini et al., 2020, p. 4). We recurred to VOSviewer 1.6.8 software (Van Eck e Waltman, 2010) since among the most flexible and useful to the research aim.*

The analysis followed different steps (Table 1). We used SCOPUS database, recurring to keywords linking the concepts of «gender», «new entrepreneurship» «technology/innovation». We excluded contributions of the current year (2022). The analysis was limited to international top level (based on Academic Journal Guide -ABS) publication sources. We manually refined the database: the authors read the abstracts, excluding those papers that appeared not focused on the core topic. The final core comprised 39 scientific contributions, but VOSViewer’s algorithm only considered 36 documents. Nonetheless, in our analysis, we also paid attention to the 3 excluded contributions.

* Associate professor of *Management* - University of Genova, Italy
e-mail: buratti@economia.unige.it

• Senior researcher of *Management* - University of Siena, Italy
e-mail: elena.casprini@unisi.it

♦ Full professor of *Management* - University of Catanzaro, Italy
e-mail: mariacolurcio@unicz.it

** Associate professor of *Management* - University of Siena, Italy
e-mail: tommaso.pucci@unisi.it

Tab. 1: Data collection procedure

Step	Action	No. Docs
1	Search (<i>TITLE-ABS-KEY</i> (“gender diff*”) <i>OR</i> (“gender div*”) <i>OR</i> (woman) <i>OR</i> (women) <i>OR</i> (female)) <i>AND</i> <i>TITLE-ABS-KEY</i> ((entrepren*) <i>OR</i> (start-up*) <i>OR</i> (“new venture*”) <i>OR</i> (spin-off*) <i>OR</i> (“new business*”) <i>OR</i> (“new firm*”) <i>OR</i> (“nascent firm*”) <i>OR</i> (“new compan*”) <i>OR</i> (early-stage*) <i>OR</i> (pre-seed) <i>OR</i> (nhtv*) <i>OR</i> (spin-out*) <i>OR</i> (start*up) <i>OR</i> (startup*) <i>OR</i> (spinoff*) <i>OR</i> (spinout*)) <i>AND</i> <i>TITLE-ABS-KEY</i> ((tech*) <i>OR</i> (innovat*) <i>OR</i> (new <i>AND</i> product*) <i>OR</i> (high-tech*) <i>OR</i> (r&d) <i>OR</i> (invent*) <i>OR</i> (npd*) <i>OR</i> (“new process*”))) <i>AND</i> (<i>LIMIT-TO</i> (<i>DOCTYPE</i> , “ar”)) <i>AND</i> (<i>LIMIT-TO</i> (<i>SUBJAREA</i> , “BUSI”)) <i>AND</i> (<i>LIMIT-TO</i> (<i>LANGUAGE</i> , “English”)) <i>AND</i> (<i>EXCLUDE</i> (<i>PUBYEAR</i> , 2022))	-
2	Selection of: - Articles or review - In English - Published on Journal	-
3	Definition of the timespan, with 2022 (year) excluded	723
4	Further selection of ABS sources (Association of Business School) following the Academic Journal Guide 2021 (3, 4 e 4*)	120
5	Cleaning of the database, through abstracts analysis (documents not attaining the aim of the study have been excluded)	39
7	Exclusion of 3 documents resulting as outliers when applying the bibliographic coupling analysis	36

Source: Authors

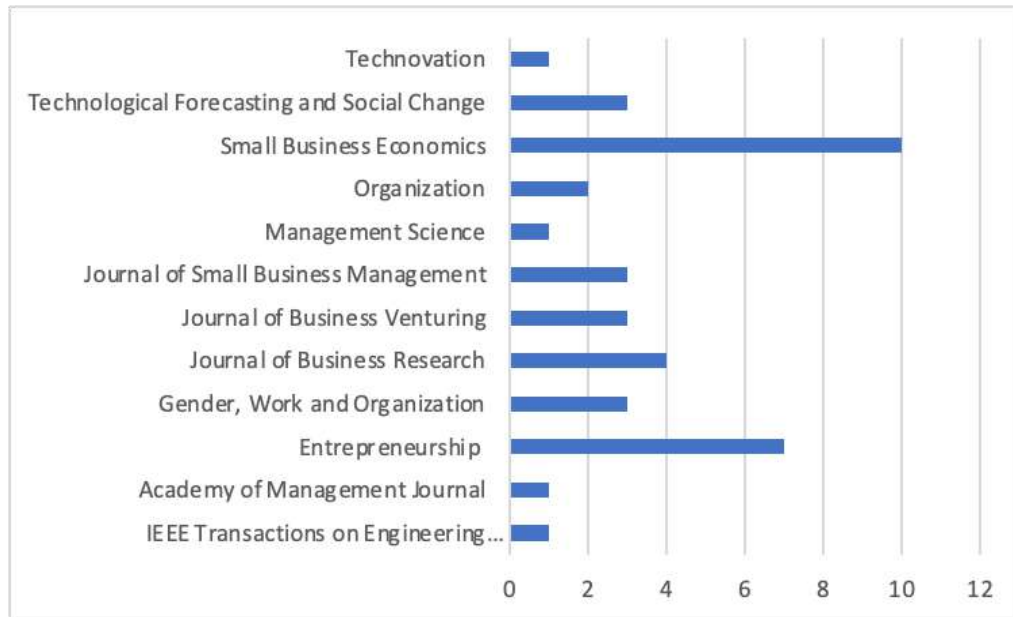
Results. Starting from the descriptive analysis of scientific production, the temporal distribution of the contributions covered by the intellectual core has shown a growing trend, in line with the growing importance that the issue of the gender gap has been assuming in recent years in the international debate in reference to STEM areas. (Figure 1).

Fig. 1: Trend of intellectual core



The analysis of the journals of the 39 core publications (gender gap and high-tech relationship) (Figure 2, Table 2) showed a strong receptivity of the specialized journals on the topics of small businesses and entrepreneurship. More markedly innovation-centered journals (Technovation and Technological Forecasting and Social Change) seem to have paid less attention to the relationship between entrepreneurship / high-tech innovation and gender diversity; even the citation analysis shows little influence of these contributions in terms of their impact on research on the topic.

Fig. 2: Main journals



Source: Authors' elaboration

Tab. 2: Main journals

Source	Documents	Citations
Small Business Economics	10	199
Entrepreneurship: Theory and Practice	4	235
Journal of Business Research	4	80
Entrepreneurship and Regional Development	3	175
Gender, Work and Organization	3	24
Journal of Business Venturing	3	889
Journal of Small Business Management	3	155
Organization	2	32
Technological Forecasting and Social Change	2	17
The Academy of Management Journal	1	418
IEEE Transactions on Engineering Management	1	16
International Small Business Journal	1	64
Management Science	1	2
Technovation	1	0

Source: Authors' elaboration

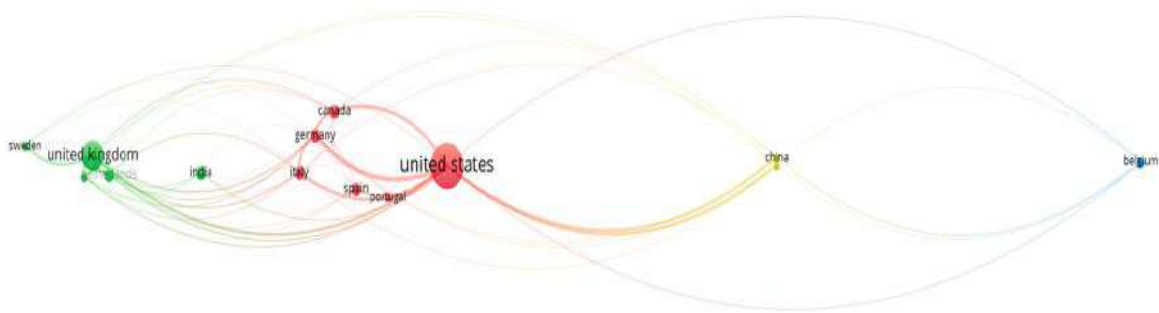
The most cited article is one of the first contributions, in chronological terms, "Cultural diversity in management, firm performance, and the moderating role of entrepreneurial orientation dimensions", published in *The Academy of Management Journal* in 2004. However, this journal counts only this paper on the topic in the whole period of analysis.

Consistent with the journals analyzed, the main geographical area of reference of the authors of the selected contributions is largely Anglo-Saxon, with the United States and the United Kingdom leading, as represented in 20 and 9 papers, respectively. Italy ranks fifth with 2 articles by Italian authors (Figure 3).

The density map (Figure 4), obtained from a first analysis on recurring key words (Table 3), shows how some terms emerge to characterize the studies in a clear way: education, barriers, expectations, success, legitimacy. The density map is particularly useful for getting an overview of the areas of greatest interest: the color of each point in the map depends on the density of the elements at that point (between red and blue, by default). The greater the number of elements close to a point and the greater the weight of the elements, the closer the color of the point is to red. Conversely, the fewer the number of elements close to a point and the lower the weight of the elements, the closer the color of the point is to blue (Van Eck and Waltman, 2010).

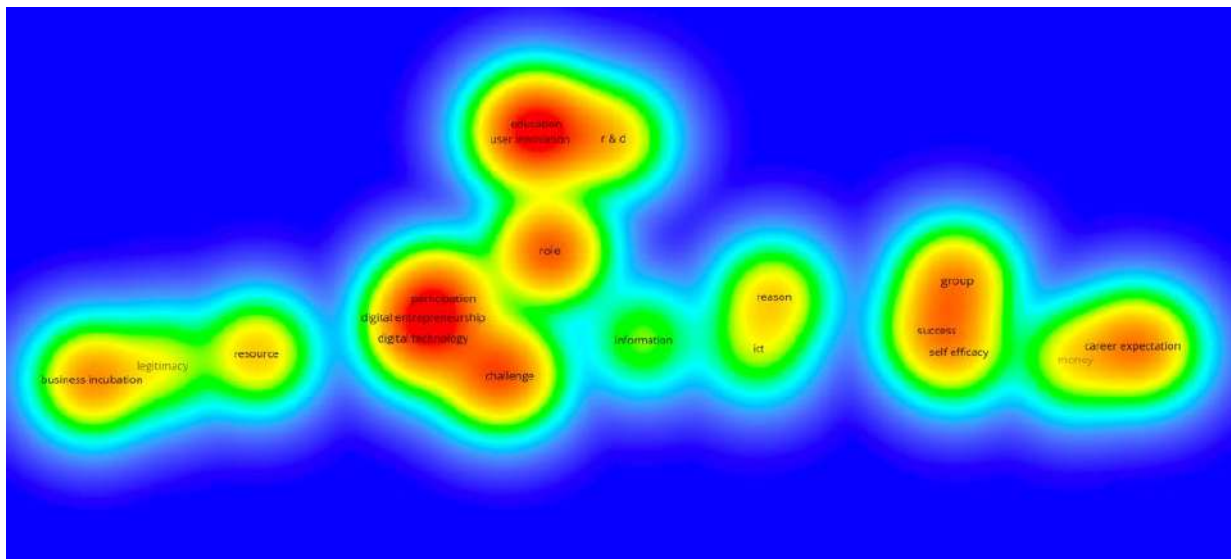
The focus on high-tech seems to confirm the general themes of the studies on female entrepreneurship, mentioned in the introduction, showing, as expected (considering the specific area of analysis), a strong incidence of issues related to digital.

Fig. 3: Authors' country of provenance



Source: Authors' elaboration

Fig. 4: Keywords co-occurrence



Source: Authors' elaboration

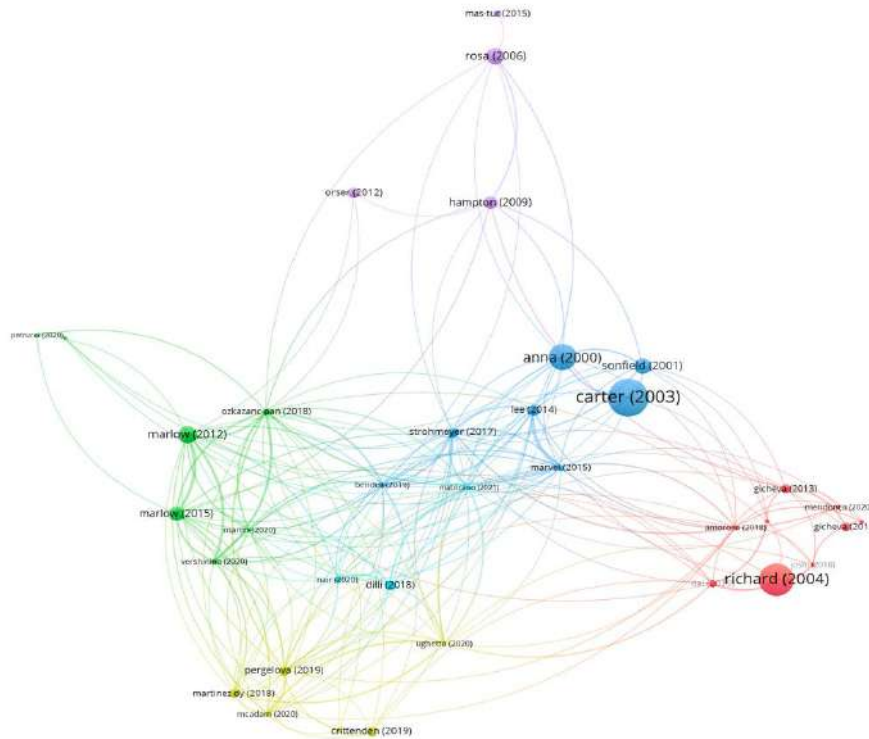
Tab. 3: Most recurring keywords

term	occurrences	term	occurrences
role	15	business incubation	6
group	11	money	6
education	10	participation	6
challenge	9	self efficacy	6
digital entrepreneurship	9	identity work	5
digital technology	9	innovation performance	5
barrier	8	legitimacy	5
career expectation	8	sale	5
resource	8	stage	5
r & d	7	engineering	4
reason	7	ict	4
success	7	information	4
user innovation	7		

Source: Authors' elaboration

The bibliographic coupling analysis, grouping the documents on the basis of shared references (the higher the overlap between the shared sources between two works, the more likely the two articles will be allocated to the same thematic group), highlighted 6 thematic clusters, identified in Figure 5 by the different colours.

Fig. 5: Bibliographic coupling



Source: Authors' elaboration

The study and analysis of the contributions in each of the 6 groupings allows to characterize the latter as represented in Table 4.

The most recurring themes in the analyzed literature are therefore the following:

- Factors that encourage women to start and expand new businesses, especially in technology-based sectors;
- Challenges and barriers encountered by female entrepreneurs in the various stages of setting up a business;
- Gender differences, entrepreneurial intentions and performance of a new business;
- Innovation and gender differences;
- The role and characteristics of women entrepreneurs in the research and allocation of resources, in networking skills and in the decision-making process in the management of technological initiatives;
- The barriers and problems encountered by women in starting businesses based on science, technology, engineering and mathematics (STEM);
- The role and contribution of women entrepreneurs to learning, R&D processes and the innovative performance of companies;
- The paths of legitimacy for successful entrepreneurs, with particular reference to high-tech companies.

Adopting as an interpretative model the Valencia and Lamolla (2005)'s scheme of the presence of women in entrepreneurial activities between 1990 and 2004 (which takes up the 1985 Gartner's scheme of the creation of new businesses), the thematic blocks emerged from citation analysis can be represented as in Figure 6.

Tab. 4: Bibliographic coupling clusters

Clus.	Tempo	N.	Articoli principali	Topics dominanti
1 Red	2004-2021	9	Biga-Diambeidou <i>et al.</i> , 2021; Dai <i>et al.</i> , 2019.	Gender diversity and composition of entrepreneurial teams in relation to innovative performance and / or R&D
2 Green	2012-2021	7	Vershinina <i>et al.</i> 2020; Ozkazanc-Pan e Muntean, 2018; Marlow e McAdam, 2015	Incubation, networking and interpersonal skills
3 Blu	2000-2019	7	Bendell <i>et al.</i> , 2019; Lee e Marvel, 2014 Strohmeyer <i>et al.</i> , 2017	Strategies, leadership and growth / performance (economic and innovative)
4 Yellow	2018-2020	6	McAdam <i>et al.</i> , 2020; Crittenden <i>et al.</i> , 2019; Martinez <i>et al.</i> , 2018	Legitimation and emancipation (with particular reference to emerging economies and digitalisation)
5 Purple	2006-2015	4	Orser <i>et al.</i> , 2012 Rosa e Dawson, 2006	Barriers, career advancement and access to resources
6 Light Blu	2018-2021	3	Dilli e Westershuis, 2018	Training of women entrepreneurs

Source: Authors' elaboration

Fig. 6: Results of the bibliometric analysis

Individual dimension (Cluster 4, 5, and 6)	Organizational dimension (cluster 1 and 3)	Contextual dimension (cluster 2)
<ul style="list-style-type: none"> • Education • Barriers and obstacles • Legitimation • Emancipation 	<ul style="list-style-type: none"> • Entrepreneurial team composition • Strategy and performance 	<ul style="list-style-type: none"> • Relationship with context of reference

Source: Authors' elaboration

Figure 6 provides a summary of the results of the bibliometric analysis by proposing a grouping of the thematic blocks and clusters identified through bibliographic coupling according to the analysis perspective adopted: individual dimension, organizational dimension, and contextual dimension.

From an individual perspective, gender diversity in relation to the technological and innovative dimension of business activities is interpreted with a strong reference to the individual determinants of the entrepreneur (woman). The issues addressed are i) the emerging ones, related to the issues of legitimizing the role of women and emancipation from gender stereotypes, with particular reference to digital transformation (cluster 4); ii) those, more consolidated, related to the difficulties of women entrepreneurs in accessing resources, and to the barriers - social and organizational - that slow down the career development of women managers (cluster 5); finally iii) those which, by privileging the education and training of women entrepreneurs, act as a link towards a more organizational dimension (cluster 6).

From an organizational perspective, gender diversity is identified as a determinant of organizational behavior. The issues are mainly related to i) strategic issues, with interesting implications in terms of leadership (cluster 3) and to ii) the impact of gender diversity on economic and/or innovative growth and performance of entrepreneurial activities (cluster 1).

Finally, with the contextual perspective, attention shifts to a more relational dimension; the concept of gender diversity in relation to technology and innovation is explored by highlighting the specificities that characterize women entrepreneurs in terms of interpersonal skills and stakeholder management (cluster 2).

Research limitations. This research has some limitations. The first is the selection of only ABS (Association of Business School) Journal ranking according to the Academic Journal Guide 2021 in 3, 4 and 4 * ranks. Future developments of the work should also take into consideration ranks 1 and 2. Widening the number of contributions under analysis could also decrease the heterogeneity of smaller clusters (e.g. 5 and 6) where the sharing of some references can derive from individual articles with very different focuses. The second limitation is related to the choice of scientific fields of investigation. Our analysis considers only the contributions present in the SCOPUS "Business Management and Accounting" category. This does not exclude that there may be interesting and useful works for the purpose of this study also within different disciplines (e.g. engineering). A final limitation refers to the analysis of the results. Although the use of bibliometric methods helps to reduce subjectivity, this does not exclude the possibility that the analysis of the main topics covered is limited by interpretative distortions.

Managerial implications. Institutional attention and scholarly debate on gender inequality, with specific regards to the gap within the STEM (Science, Technology, Engineering and Mathematics) environment, appears particularly vibrant and intense (Berra and Cavalletto, 2020), and the topic of the gender gap in research and innovation publications has been specifically promoted by the European Commission (She Figures 2021).

Given the widespread policy interest in fostering the entrepreneurial and innovative activities of women in tech-based activities and sectors, we do think that our study, by offering an updated review of the body of literature on the relationships between gender and entrepreneurship in tech-based industries, may propose ideas for future research, also giving some practical hints.

As expected, the systematic literature review confirms that the masculinity embedded in the concept of entrepreneurship has made it difficult for women to successfully run a high growth business, particularly in tech-based industries. In these contexts, women entrepreneurs face greater difficulties in finding the necessary resources to develop their business initiative, due not only to cultural prejudices that limit their opportunities, but also to individual and contextual factors that make it more challenging to overcome barriers to access and participation. Most recent studies underline that it is not just a matter of unequal access to financial and social capital, as other forms of barriers may impede or make it harder to sustain growth. In this vein, Wheadon and Duval-Couetil suggest that "other forms of 'capital', including cognitive attributes and human capital, may provide a useful framework for broadening our research and programming around inclusivity in entrepreneurship and technology" (2019 p. 320).

Consistently, to attain significant increases in women participation and retention in technology fields, it seems necessary to refocus not only research, but also supporting policies: it is indeed important to target eliminating gender differences in individual resources, mainly in skills related to entrepreneurial activity learned on the field, i.e., through channels other than education (e.g., internships), and to create opportunities for women to network with other entrepreneurs. Finally, as gender roles are strongly embedded in cultural institutions, policies aiming to close the gap should target gender differences that emerge during the early stages of an individual's life, particularly at the family level.

Originality of the paper. *The literature on gender diversity and female entrepreneurship is extremely vast, albeit quite recent. However, to the best of the authors' knowledge, there are no systematic literature reviews on this topic specifically related to high-tech sectors and innovation.*

Keywords: *gender, female entrepreneurship, high-tech, innovation*

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