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(Article begins on next page)

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Women in innovative start-ups and regional inclusiveness: "green" and socially-responsible companies

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Abstract

We explore the link between women in business decision-making roles, regional gender equality in the workforce, and start-up sustainability. We employ unique administrative data on innovative start-ups in Italy and implement a novel crawler-based semantic search of start-ups' websites to identify "green" firms. Our findings on high-tech innovative start-ups confirm established evidence in the female entrepreneurship literature: greater shares of women in decision-making increase the probability of a social focus but decrease the likelihood of STEM-intensive green energy objectives. Instead, the board gender composition does not correlate with non-energy "green" objectives. Non-energy "green" firms emerge more in gender-equal regions, while social start-ups develop where women have fewer employment opportunities.

Keywords: innovative start-ups; gender; sustainable regional development; social business; sustainability

1. Introduction

The grand social challenge of our times revolves around the pressing issues of socio-economic inequalities, climate change, environmental degradation, and resource depletion (Schaltegger & Wagner, 2011; United Nations, 2015). Addressing these unprecedented challenges demands innovative approaches, and innovative start-ups can play a pivotal role, serving as catalysts for local growth, socio-cultural and ecological transformation, and sustainable development (Audretsch et al., 2020; Dean & McMullen, 2007; Horne et al., 2020; Sullivan et al., 2018).

Despite their potential for change, start-ups are still quite conservative in their gender composition (EIC, 2021; Scale-up Europe, 2020). This lack of talent diversity may be a missed opportunity. Diverse teams have been associated with innovation and the ability to foresee shifts in consumption patterns, enhancing competitiveness (Hechavarría & Ingram, 2019; Østergaard et al., 2011; Terjesen et al., 2009; Tonoyan & Boudreaux, 2023), and to the achievement of sustainability objectives (Marino and Quatraro, 2022; Tiba et al., 2021). If gender equality promotes sustainable start-up creation in the high-tech realm, it could be a trigger of the transition towards sustainable development. However, the literature on the topic is still nascent (Lammers et al., 2022).

This paper studies whether gender equality increases the likelihood of a sustainable engagement in innovative start-ups. Sustainability, as defined by the Brundtland Commission (WCED, 1987), encompasses not only environmental but also social goals. Thus, we refer to "sustainable start-ups" as newly funded firms whose business model contributes to one or more Sustainable Development Goals, considering both "green" and "social" vocations (Tiba et al., 2021; United Nations, 2015).[1]

[1] Some authors view environmental goals in entrepreneurship as social goals, while others see them as separate (see e.g., the review in Gast et al., 2017). In the literature on gender and sustainable entrepreneurship, there are arguments supporting both views. Hence, we consider both types of goals in our empirical analysis.

We focus on a highly skilled, high-tech subset of sustainable start-ups classified as "innovative" in Italian administrative data. Although not representative of all firms engaged in social innovation, nor of start-ups in general, these firms hold the highest potential to drive change and are most likely to deliver sustainable solutions (Audretsch et al., 2020). Yet, they often underrepresent female entrepreneurs, managers, and decision-makers due to their technology and knowledge-intensive nature and significant Science, Technology, Engineering and Mathematics (STEM) orientation (Anna et al., 2000; Hoogendoorn et al., 2020).

Integrating Upper Echelon theory, knowledge spillover theory of entrepreneurship (KSTE), and literature on female entrepreneurship, we recognize the role of both internal and external resources in shaping start-up priorities (Griliches, 1979; Acs et al., 2009; Qian & Acs, 2013), and argue that gender equality may impact sustainability both within and outside the firm. Our research addresses two overarching questions:

> *R1: How does gender representation within start-ups relate to the sustainability orientation (social and environmental) of the company?*
>
> *R2: How does gender representation within a region relate to the sustainability orientation (social and environmental) of a start-up in that region?*

Interestingly, different theoretical perspectives yield contrasting predictions, emphasizing different facets of the start-up creation process. While Upper Echelon theory highlights the role of women in promoting social and environmental goals, feminist empirical studies underscore the challenges faced by women in STEM-intensive ventures, potentially hindering green technology-based initiatives (Anna et al., 2000). The arguments of the knowledge spillover theory may be extended to imply that regional gender equality fosters both the supply and demand of innovative start-ups (Colombelli et al., 2020; Qian & Acs, 2013; Tiba et al., 2021), while the feminist literature indicates that gender equality might reduce female entrepreneurship (Alsos et al., 2006; Carranza et al., 2018; Orser et al., 2006). Overall, we obtain different predictions for "green" start-ups, depending on whether their social vocation or high-tech content is emphasized.

Our analysis focuses on Italy, a country marked by substantial regional disparities in start-up creation and gender equality. The geographic distribution of female-led start-ups strongly suggests a role for regional factors in shaping opportunities for female entrepreneurs (Figure 1).

[Figure 1]

Our empirical analysis draws on administrative data on Italian innovative start-ups, matched with balance sheet data and regional variables over 2015-2020. Our data identify firms with a social vocation or high technological intensity, but do not define "green" firms. A contribution of our work is thus to develop a novel keywords-extraction algorithm to identify environmentally sustainable start-ups.

Our findings reveal that women are more prevalent in decision-making positions in socially oriented start-ups, but not in green start-ups. Moreover, gender equality at the regional level increases the

likelihood of firms being "green," whereas social start-ups tend to emerge in unequal labor markets. These results underscore the impact of equality culture on entrepreneurial opportunities and societal outcomes.

The remainder of the article is organized as follows. Section 2 outlines our theoretical rationale and hypotheses. Section 3 describes the data and identification of green start-ups. Section 4 presents the main results, Section 5 discusses them and Section 6 concludes.

2. Theoretical background and hypothesis development

Gender equality and sustainability are intertwined issues crucial for building fairer economic systems. However, evidence regarding their relationship remains limited, particularly in the context of innovative entrepreneurship in advanced economies. Previous research has mainly focused on gender gaps in innovation and entrepreneurship, highlighting women's tendency to engage in lower-tech ventures (Foss et al., 2019; Jennings & Brush, 2013). While some studies have explored the link between women in company boardrooms and social values (e.g., Adams & Ferreira, 2009; Adams & Funk, 2012), their connection to environmental sustainability remains largely unexamined.

The nexus between gender and sustainability in innovative start-ups is complex due to the unique nature of these ventures, where the combination of social responsibility and high technology intensity challenges existing interpretative frameworks (Audretsch et al., 2020; Chistov et al., 2023; Choi & Gray, 2008). Hence, to develop our hypotheses, we integrate different theoretical perspectives. At the company level, we merge insights from the female entrepreneurship literature, focusing on disparities in high-tech business opportunities, with findings from the Upper Echelon literature, which examines the influence of women in top management on business strategies (Section 2.1). Then, we recognize that the start-up team composition itself depends on context-dependent factors and study how regional gender equality shapes start-ups' strategic objectives. In so doing, we rely on the theoretical framework of the KSTE (Section 2.2).

2.1 Start-up team gender balance and sustainability vocation

Carranza et al. (2018) offer a taxonomy categorizing differences in management styles between men and women along the dimensions of (i) preferences and choices, (ii) endowments in terms of education, asset ownership, skills, and networks, (iii) external cultural, social and financial constraints, and (iv) internal psychological constraints. Personal characteristics interact in complex ways with social and cultural norms, driving gendered patterns of business management.[2]

[2] Determining whether gender composition or sustainability vocation comes first in start-ups is complex given the unobservable pre-start-up phase. As start-ups evolve from initial ideas to operational businesses, the distinction between the business idea and the founding team becomes blurred (Brixy et al., 2020). Women may self-select into sustainable firms due to preferences, values, and motivations, or they may drive the company toward a sustainable orientation once inside. All these mechanisms are compatible with existing literature, but we cannot distinguish them with our data. Therefore, we aim to explore conditional correlations between gender equality and sustainability rather than establish causality.

Analyzing how the managing team's socio-economic composition affects firm orientation, strategies, and performance, the Upper Echelon literature emphasizes the pro-social preferences of women entrepreneurs (Stephan et al., 2016; Zahra et al., 2014). Women managers tend to enact benevolent, universally concerned, and less power-oriented styles (Adams and Funk, 2012), and to prioritize social, community, and ecological outcomes over economic ones as part of an "ethic of care" (Carranza et al., 2018; Hechavarría et al., 2017). They tend to consider corporate social responsibility more in decision-making and implement human-resource management practices fostering creativity and learning (Li et al., 2017; Tonoyan & Boudreaux, 2023).

The pro-social orientation of women entrepreneurs also derives from external and internal constraints, emphasized in the feminist empiricist literature (Foss et al., 2019), which steer women toward socially-oriented businesses due to disparities in self-efficacy, education, capital endowments, and socio-cultural expectations (Anna et al., 2000; Minniti & Nardone, 2007). Overall, we expect greater female representation in management teams to correlate with a pro-social corporate orientation even in innovative start-ups:

*H1a: Higher shares of women among the managers and shareholders of a start-up are **positively** associated with the probability that a start-up has a **social** vocation.*

Along with social objectives, women entrepreneurs' ethic of care may also prioritize environmental preferences (Hechavarría et al., 2017; Li et al., 2017; Lammers et al., 2022). However, the endowments and external constraints emphasized by Carranza et al. (2018) and in a wide feminist literature may play against this view. STEM-intensive green sectors tend to be male-dominated, hindering women's engagement due to educational and financial disparities and confidence gaps (Anna et al., 2000; Levine & Rubinstein, 2017; Niederle & Vesterlund, 2007). Gender biases in high-tech sectors and practical constraints discourage women from participating in high-tech ventures (Barber & Odean, 2001; Blanco-Gonzalez-Tejero & Cano-Marin, 2023; Exley & Kessler, 2022). Gender gaps in labor market participation and the prevalence of part-time work (Bertrand et al., 2010) are likely to reinforce the negative link:

*H1b: Higher shares of women among the managers and shareholders of a start-up are **negatively** associated with the probability that a startup has a **green** vocation.*

2.2 Regional gender equality and business sustainability

As just discussed, gender norms shape management styles and values and may influence the link between gender representation and sustainability. As gender norms are context-specific, gender equality in entrepreneurial ecosystems affects female entrepreneurship (e.g., Acs et al., 2011; Brush et al., 2019; Chowdhury & Audretsch, 2014; Estrin & Mickiewicz, 2011; Foss et al., 2019) and may also influence the sustainability of startups (Tiba et al., 2021).

The KSTE offers a valuable framework to explore this relationship. It emphasizes that entrepreneurs' local economic and technological landscape shapes their accumulation of resources and skills (Boschma, 2004; Quatraro, 2009). Entrepreneurial ability hinges on the specific blend between internal and external knowledge and resources, which influences the decision to initiate new ventures (Griliches, 1979; Hoogendoorn, 2016; Jaffe, 1986; Qian & Acs, 2013) including sustainable ventures

(Gibbs & O'Neill, 2017; Malecki, 2012; Colombelli and Quatraro, 2019). Diversity increases the pool of available knowledge, hence it can affect entrepreneurship via three main mechanisms: talent attraction, diversified market demand, and broader market opportunities (Qian and Acs 2013).

Drawing on these insights, we argue that regional gender equality may contribute to firm formation and sustainability.

Consider talent attraction first. Inclusive regional systems engaging women in the economy beyond traditionally feminine sectors will have ceteris paribus more talents dedicated to innovative entrepreneurial activities (Kochan et al., 2003). The reward for talent increases purchasing power and spillovers to different sectors, and the demand for the care services that support women's employment. In turn, the reward for talent may further attract creative and innovation-prone human capital (Florida, 2002; Lee et al., 2004). Hence, regional gender equality likely affects the composition of the labour force, its culture, and social capital.

Local norms and values concerning gender roles socially frame firms' opportunities and may affect business goals, determining access to capital and the ability to convert entrepreneurial intentions into start-ups (McKeever et al., 2014; Weiss et al., 2019). Gender equality increases openness to new ideas and non-standard behaviour and may reward "feminine" values in the market, such as intergenerational justice and sustainability (Mickiewicz et al., 2019; Hechavarria & Ingram, 2016). This may reduce the stereotypical barriers hindering financing and social support for women-led start-ups (McDonnell & Morley, 2015) and more broadly increase the support for sustainable ventures. In line with this interpretation, Tiba et al., (2021) find higher shares of sustainable enterprises in entrepreneurial ecosystems with high GDP and high shares of female start-up founders.

Second, from a demand side, gender equality may also generate new needs, leading to new business opportunities. Stratification into traditional gender roles restricts occupational mobility and the range of products and services demanded by women (and men) as consumers, constraining the demand for green and social innovation and the potential for business creation in green sectors (Migheli, 2021; Kerr & Mandorff, 2023). By contrast, gender equality implies greater variety in the roles of women and men in society and in the products and services that they demand.

Third, gender equality may affect sustainable entrepreneurship by providing a diversity of perceptions in market opportunities. The KSTE argues that entrepreneurial opportunities for start-ups hinge on unexploited knowledge investments by incumbent firms or research institutions. Diverse backgrounds and perspectives lead to heterogeneous assessments of the market potential of such opportunities (Audretsch et al., 2010) and increase the probability of their commercial exploitation (Qian, 2018). A broad literature supports the argument that diversity affects productivity, innovation, and entrepreneurship (Alesina & La Ferrara, 2005; Backman & Kohlhase, 2022; Colombelli et al., 2020; Brixy et al., 2020), and finds specific evidence for technology-oriented start-ups (Audretsch et al., 2010; Ghio et al., 2016). The capability to combine heterogeneous knowledge inputs is critical for all types of innovation and particularly green innovation (Orsatti et al., 2020). Cognitive diversity increases the likelihood that different knowledge inputs are recombined into green innovations (Marino & Quatraro, 2022).

If women and men embody diverse perspectives about values and opportunities, egalitarian regions will have more cognitive diversity to exploit and more approaches to problem-solving and heuristics (Hong & Page, 2004; Kilduff et al., 2001), implying different perceptions of business opportunities that widen the range of sectors in which new businesses may be launched (Colombelli et al., 2020). Hence, we expect gender equality to broaden the range of ideas from which green entrepreneurship may cater for new ventures. Similar arguments may apply to social entrepreneurship: despite the variety of activities captured with this term, the literature tends to agree that social enterprises, in combining social objectives with economic value creation, entail innovative combinations of resources that require both entrepreneurial and pro-social competencies (Saebi et al., 2019; Zahra et al., 2009).

Overall, there are numerous arguments supporting the expectation of a relationship between sustainability orientation and regional gender equality in green and social companies alike:

H2a. Greater gender equality in the region is associated with a greater presence of green and social start-ups.

Again, we may derive opposite implications from a different set of considerations based on the literature on female entrepreneurship. According to Carranza et al., (2018), due to different priorities and gender roles, women often prefer wage employment over self-employment. Hence, their entrepreneurial activities can reflect a reaction to the lack of employment opportunities in incumbent firms. Flexibility and independence would make entrepreneurship a necessity-driven, rather than opportunity-driven, option that is especially suitable for women (Fairlie & Fossen, 2019, Taylor 1996, Pines et al., 2010). If this explanation applies, we may observe that gender equality in the labour market reduces female entrepreneurship and the creation of innovative start-ups embodying "feminine" values. Based on these arguments, the alternative hypothesis may apply:

H2b. Greater gender equality in the region is associated with a lower presence of green and social start-ups.

3. Data and Methods

Our analysis draws on a unique dataset on the population of so-called "innovative start-ups" in Italy, identified under a 2012 law[3] as new companies that qualify for fiscal exemptions and credit support given their high innovative potential. These firms must meet specific criteria: (i) at least 3% of production costs or value invested in R&D expenditure; (ii) at least 1/5 of the labour force with a PhD or 1/3 of personnel with a specialist degree; or (iii) at least one patent or equivalent proprietary knowledge. The dataset, managed by the Chamber of Commerce, covers the period 2015-2020[4] and includes nearly 12,000 firms. It provides details on their names, legal status, location, founding dates, online presence, sector, size, social and high-tech value and eligibility criteria. This database has been used in many studies on innovative start-up creation in Italy (e.g., Colombelli, D'Amico, et al., 2023; Colombelli, Paolucci, et al., 2023; Colombelli & Quatraro, 2019). Yet, it should be

[3] Decreto-legge of 18 October 2012 n. 179. Later laws integrated the initial decree: Decreto-legge of 28 June 2013 n. 76, Decreto-legge 24 January 2015 n.3, and Legge of 11 December 2016 n.232.
[4] Earlier data was not available by Registro Imprese and we could not ensure that all start-ups registered in the latest available version. We stop in 2020 to avoid the drastic changes following the COVID-19 pandemic.

clear that it does not represent less innovative firms nor the broader population of start-ups and social enterprises in the country.

We merge the data on start-ups with firm-level variables from the Aida-Bureau van Dijk database and with regional characteristics drawn from the Italian Statistical Office, ISTAT. Retaining only firms with valid information about turnover, employees, and board members in Aida reduces the dataset to about 7000 firms. The Appendix provides summary statistics and a correlation matrix for the variables. Innovative start-ups concentrate in the economically most dynamic regions of Italy, such as Lombardy and Lazio, in the North-East, but also Centre-South (e.g. Campania). Figure 2 maps their distribution on the Italian territory.

[Figure 2]

3.1 Female prevalence in innovative start-ups and regional gender balance

To calculate the share of women that can influence the decision-making process in an innovative start-up, we focus on shareholders and managerial/top administrative roles for each company. We define an overall measure of female prevalence, calculated as

$$female\ prevalence\ (FP) = \frac{\%\ female\ shareholders + \%\ female\ managers}{2}$$

We thus focus on the average number of women amongst the shareholders and managers of the company. In start-ups, these roles are likely to represent the founders or early joiners of the company, hence to have a say in the `vocation' of the enterprise (Roach & Sauermann, 2015).

Regional gender equality is approximated by the female-to-male ratio in the labour force. Southern Italian regions like Basilicata, Calabria, Campania, Puglia, and Sicilia score less than 0.6, while Emilia-Romagna, Liguria, Piemonte, Toscana, Trentino-Alto Adige, Umbria, and Valle d'Aosta score over 0.8. None exceed one, with Valle d'Aosta closest to gender parity with nearly 9 women employed every 10 men. Figure 3 illustrates gender ratio distributions across Italy, with a notable North-South divide, though some Northeastern regions also score low on gender equality.

[Figure 3]

3.2 Defining social vocation, green and energy start-ups

To analyze innovative start-ups with a sustainability focus, we must first identify them. While data on socially-oriented firms is self-reported, our study introduces a methodology to identify "green" companies, which aren't directly identifiable from Chamber of Commerce databases. We detail this categorization process in subsequent sections.

3.2.1 Innovative start-ups with social sustainability orientation

Among the innovative start-ups registered by the Chamber of Commerce companies, we straightforwardly identify those that have a "social vocation", since the entrepreneurs themselves can declare it in the registration of the company to qualify for further fiscal incentives, providing some mandatory evidence for their social impact. Despite some reporting burden, we assume that most eligible companies applied for it to access the incentives. The policy identifies the following categories as "social": social and health assistance, education and training, valorisation of cultural activities, and importantly for our analysis, protection of the environment and ecosystems. Accordingly, a range of start-ups falls under this designation. Some have a purely social orientation, such as those focused on facilitating the social integration of refugees, offering e-medicine services, or enhancing children's learning through technology. Others incorporate "green" objectives, such as initiatives related to waste management and the promotion of the circular economy.

3.2.2 Innovative start-ups with green sustainability orientation

Regarding "green" start-ups, instead, our database is uninformative. Hence, we have designed a specific methodology to identify those declaring an environmental focus publicly. While the European Commission works on defining "sustainable" activities through the EU taxonomy that identifies Environmental, Social and Governance (ESG) practices for financial investors, the concept of a "green firm" remains uncertain. We decided to examine the textual material presented in start-ups' websites to publicize their business activities as they tend to offer a succinct depiction of their operations in a limited number of webpages, as opposed to the large and complex online platforms of large corporations.

We apply an iterative process of semantic search for relevant keywords related to green, eco-friendly, and sustainable business practices using a web crawler on all the websites of the innovative start-ups registered in the Chamber of Commerce.[5] First of all, we produced different lists of keywords related to corporate sustainability from literature and reports related to the green economy, ESG principles, and policy documents on sustainable development and the private sector, and tested them on the companies' websites to identify the most effective keywords that could capture the green vocation of start-ups. Each round of searches was manually cross-validated examining all resulting websites (as well as random samples of the companies that did not yield any results with the set of keywords), with a snowballing procedure to identify new keywords and to establish the effectiveness of the algorithm in identifying the appropriate companies, or instead yielding false positives. The process was repeated in five iterations with two researchers validating websites separately. The process eliminated generic keywords used with multiple meanings- such as "environment", "green", "carbon"- and included more effective composite words – e.g., "sustainable farming", "sustainable fashion" or "sustainable production" instead of just "sustainable". The list of keywords included terms in Italian and English since many of these Italian start-ups have an international customer base and thus a bilingual website. We converged

[5] The crawler was designed in Python using a Beautiful Soup library: after parsing the HTML text from the start-up's website, it extracted the keywords corresponding to the predefined list of sustainable keywords designed for the tagging of green companies. In summary, the crawler iterated through a list of sanitized URLs, downloaded corresponding HTML files, extracted visible text, matched keywords, and finally recorded the results in JSON files.

on a total of 323 keywords (some of which are iterations of the same semantic key) for the identification of green start-ups.

The Chamber of Commerce database complements the above information by categorizing high-tech energy companies. Like social ones, energy start-ups report that they produce products or services with high value for the energy sector. The sector is male-dominated, rooted in STEM skills and in mechanical, electric and electronics, and energy engineering competencies (IEA, 2023). Hence, this information can help assess gender equality within advanced technology-driven green companies.

Figure 4 shows the share of green and social innovative start-ups: the distribution does not quite correspond to the regions with the highest density of innovative entrepreneurship shown in Figure 2.

[Figure 4]

3.5 Empirical specification

To operationalize our hypotheses, we examine the probability that start-up *i* in region *r* has a social or green vocation as a function of the share of women within the firm and gender equality in the region. We define two separate binary dependent variables, y_{ir}={Social, Green} which are equal to one if the firm has a social (green) vocation and zero otherwise. In a first step, we employ simple multivariate probit models to explore how these variables correlate with our variables of interest (Wooldridge, 2010) in a basic cross-sectional dimension.

$$Pr(y_{ir}) = Pr(\alpha + \beta_1 Women_i + \beta_2 GenderRatio_r + X_i\gamma + X_r\delta + \eta_r\rho + \sigma_i\theta > \varepsilon_{ir}) \quad (1)$$

We are interested in the role of women in top decision-making positions within the company, captured by the share of women among managers and shareholders of the start-up (*Women*), and of regional gender equality, measured as the female-to-male ratio of employees in the workforce (*GenderRatio*).

To avoid capturing other elements correlated with the presence of green or social start-ups, we control for firm-level factors and region-level characteristics: X_i is a vector of start-up controls including the age of the firm, its revenues from sales (in log), whether it is a firm in the energy sector, and if it was included in the registry of innovative start-ups based on the R&D expenditure criteria, having a patent, or the high education of its workforce. To address the proposed mechanism that green values overlap with social values, we control for whether the firm is green when y_{ir}={Social}, and for whether the firm has a social orientation when y_{ir}={Green}.[6] X_r is a vector of regional controls that are standard in the analysis of the drivers of start-up creation (e.g., Colombelli & Quatraro, 2019). These include per capita GDP, population, percentage of people with a high-tech specialization, net start-up creation rate, gross regional investment by GDP and, importantly, the number of green patents in that region (expressed as the total stock since the year

[6] All our results are robust to removing the dummies for "social", "green" and "energy".

2000 for every thousand inhabitants). Beyond these controls, we include dummies for the largest regions (η)[7] and sectoral (σ) effects, either with broad macro-categories (manufacturing, agriculture, services, tourism) or controlling for the five largest sectors in which innovative start-ups operate.[8] Due to the possible correlation in the errors between firms located in the same region, we cluster the standard errors at the region level.

We also test a time-varying version of our baseline model, considering the probability that a start-up born in a given year is sustainable (green or social). Our model becomes:

$$Pr(y_{irt}) = \quad Pr(\alpha + \beta_1 Women_{it} + \beta_2 GenderRatio_{r(t-1)} + X_{it}\gamma + X_{r(t-1)}\delta + \eta_r\rho + \sigma_i\kappa + \tau_t\theta > \varepsilon_{irt}) \quad (2)$$

Where *t* is the year a start-up is born. In this model, we add year fixed effects to take into account time-varying factors that make it more or less likely that a start-up with a social or green orientation is founded in a particular year.

4. Results

We now present the main results of the probit estimates. First, we examine how gender representation in the board and the regional workforce relates to the probability that a start-up has a social vocation (Table 1). Then, we compare these findings with those concerning green start-ups (Table 2).

[Table 1]

[Table 2]

For social start-ups, we confirm the findings of previous literature: women in leading positions of the company matter for the probability that the firm has a social vocation, albeit with a small magnitude. Doubling the share of women in top positions in start-ups increases by 1% the probability that the start-up has a social vocation, supporting hypothesis H1a. The results are also in line with the interpretation that social start-up creation is a form of "necessity entrepreneurship" for women: regional labour market gender equality is negatively associated with start-ups with a social vocation. The importance of controlling for regional differences emerges clearly from this analysis: in the first specification without any regional dummies, the regional female-to-male employment seems to have a positive correlation with social firms (column 1), but including regional dummies reverses the sign of the relationship (column 2). Results are robust to the inclusion of broad and specific sectoral dummies (columns 3 to 5).[9] Hence, this set of estimates supports hypothesis H2b.

[7] We control for the regions with the highest green and social prevalence of innovative start-ups (Lombardia, Lazio, Campania, Veneto, Emilia-Romagna, Piemonte, Liguria, Puglia, Trentino-Alto Adige) and conduct robustness checks with different numbers of dummies.

[8] In the ATECO 2007 classification, these sectors are J62 (Software, IT consultancy and related activities), J63 (Information and other IT services), M72 (Scientific Research and Development), C28 (Manufacturing of machines and other equipment), M74 (Other professional, scientific, and technical activities). Each of them has at least 3% of companies from our sample registered in it, altogether making up almost 70% of all innovative start-ups.

[9] We experimented with different sets of regional dummies, ranked by the number of green and social start-ups in each region, and a clear pattern emerged: regions with the highest numbers of start-ups are also comparatively gender-equal,

Results are remarkably different for green start-ups. In this case, a higher share of leading women does not relate positively or negatively to the nature of the start-up. This result does not support hypothesis H1b, nor the alternative interpretation that the "green" vocation of firms goes hand in hand with their "social" priorities. Rather, the green orientation of start-ups appears orthogonal to the gender composition. We also find that, relative to the average start-up, green start-ups are more likely to fall in the energy domain. We further qualify this result in Section 4.1.

The findings for green start-ups are also different from social start-ups for what concerns regional gender equality. In line with the KSTE-based hypothesis H2a, a regional workforce with more balanced gender participation is linked to a significantly higher probability of the start-up being green. These results are robust to the inclusion of a battery of fixed effects. Including regional dummies and dummies to control for broad or specific sectoral heterogeneity does not change the insights.[10]

In terms of the magnitude of the coefficients, our estimates imply that an increase in the regional gender representation of women in the workforce - for example from the sample mean of 0.72 (indicatively, the gender share in the region of Veneto, with 0.73) to 0.82, the value in Trentino-Alto Adige - would increase the probability that a start-up is green by 3%.

Tables 3 and 4 report the estimates of the probability that a social/green start-up is established in a particular year, given the (lagged) time-varying characteristics of the region. The previous results are confirmed.

[Table 3]

[Table 4]

4.1 Robustness: energy and non-energy green firms

The null effect we find for leading women in green start-ups may result from mutually offsetting effects on heterogeneous green firms. According to our definition, green start-ups operate in renewable and bioenergy sectors, and in other environmentally responsible activities (e.g., circular economy, soft mobility, second-hand, regenerative agriculture). As mentioned, it is important to distinguish energy start-ups as they represent male-dominated industries. Tables 5 and 6 present the results separately for green firms operating in the energy sector, versus all other green start-ups.

[Table 5]

[Table 6]

The results show significant heterogeneity between green start-ups. We can see that in green energy companies, women are underrepresented in decision-making positions, in line with H1b. Conversely, non-energy green firms align with our previous results of a neutral gender representation in green or non-green start-ups and do not support the hypothesis. The effect of regional gender equality is

hence including more regional dummies makes the significance of the relationship emerge more clearly. Results are available upon request.

[10] These results are qualitatively insensitive to the specific set of regional dummies included.

confirmed in both cases, again supporting H2a. Looking at the energy breakdown in our time-varying specification, the regional gender balance becomes insignificant for green energy firms but is stable for green non-energy ones (Appendix A1). Hence, regional gender equality seems to matter mostly for non-energy green start-ups.

For further robustness, we consider a model with the interaction of the firm-level and regional-level gender equality measures. Results are unchanged (see Appendix A2).

5. Discussion

This paper explores the link between gender representation and the probability that Italian innovative start-ups embrace sustainable objectives. Our findings contribute to various strands of literature: First, we add to the emerging literature on firm composition and sustainable enterprises. Second, we delve into the role of gender diversity in high-tech start-ups. Third, we contribute to the discussion on regional factors influencing entrepreneurial outcomes.

We observe asymmetric results for social and green start-ups, indicating significant heterogeneity between these types of sustainable enterprises. Indicating higher shares of women in social innovative startups and lower shares in high-tech green ones, our findings for high-tech start-ups essentially confirm established results for lower-tech firms.

Instead, the board gender composition of non-energy green companies appears irrelevant to their objectives. This suggests that the motivations and human capital driving the creation of non-energy green start-ups may be gender-neutral, contrasting with the gender biases observed in social and green energy innovative start-ups. Yet, it is also possible that the highly educated and innovative entrepreneurs in our data simply share similar values and constraints regardless of their gender (Caviggioli et al., 2022).

Furthermore, we highlight the role of external factors for sustainable entrepreneurship, showing that green start-ups are more likely to emerge in gender-equal regions, consistent with both demand and supply channels influencing these sustainable ventures. By contrast, social start-ups are more likely to emerge in gender-unequal regions, where women face limited dependent employment opportunities, suggesting that innovative start-ups may represent a peculiar form of necessity-driven entrepreneurship, which complements previous findings about the persistence of spatial and sectoral segregation between women and men even in high-tech businesses (Mayer, 2008).

6. Conclusions

This paper studies the relationship between gender representation and the probability that Italian innovative start-ups display a sustainability orientation. Our study shows that while established findings in female entrepreneurship literature apply to high-tech innovative start-ups, the gender composition of the board does not correlate with non-energy "green" objectives. Further research may explore other socio-economic characteristics like age and social status, as well as intrinsic motivations such as environmental sensitivity, which may influence this goal.

Additionally, our findings confirm that the sustainability of a company may relate to the local socio-economic context, emphasizing the importance of regional diversity and inclusion in driving sustainable innovation to market. Promoting inclusion within entrepreneurial ecosystems can stimulate the creation of green start-ups and better match demand and supply of skills in disadvantaged labor markets. These insights bear implications for start-up policies in countries with similar regional disparities (Reynolds et al., 2006), although their generalization to different contexts requires careful consideration of the underlying channel—demand, supply, or talent attraction—and of cultural factors affecting gender norms and priorities. Policymakers should leverage gender effects appropriately, tailoring interventions to local circumstances (Wenqi et al., 2022). In regions with limited labor market opportunities for women, supporting small entrepreneurial activities can provide flexible income sources and spur innovative social services. Conversely, in inclusive regions, green start-ups may require different forms of public support, particularly to enhance inclusivity in green energy companies.

Further research should cross-validate our results with different data, considering alternative definitions of "green" companies. While our detailed checks of the identified sample of green start-ups should minimize the risk of overestimating the phenomenon, the definition of what is “green” is still debated. Moreover, our method is not designed to capture green start-ups that do not publicize their sustainable activities on their websites. Online presence represents a key tool for visibility and fundraising, but alternative approaches may explore different definitions, e.g., those that declare some degree of compliance with Sustainable Development Goals.

Innovative sustainable start-ups present an opportunity to promote triple-bottom-line values while addressing challenges related to inclusion and gender equality. Given the exacerbation of gender inequality during the COVID-19 pandemic, future research should explore the implications of female-led start-ups for sustainability in the post-pandemic era. Achieving gender equality is not only a priority but also a means to enhance social inclusiveness and sustainability within business ecosystems, thereby ensuring overall regional socio-economic and ecological welfare.

Declaration of interest statement

No conflict of interest

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Tables with captions

Table 1. Probability that an innovative start-up has a social vocation

	(1)	(2)	(3)	(4)	(5)
Share of top women in the start-up	0.01***	0.02***	0.02***	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Regional share of women/men employees	0.10*	-0.24**	-0.24***	-0.26***	-0.27***
	(0.06)	(0.10)	(0.09)	(0.09)	(0.09)
Energy	-0.01***	-0.01***	-0.02***	-0.09***	-0.09***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Green	0.00	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Observations	6674	6674	6620	6674	6620
Controls	YES	YES	YES	YES	YES
Region FE	NO	YES	YES	YES	YES
Sector FE	NO	NO	broad	specific	broad and specific

Coefficients represent marginal effects. Robust standard errors clustered at the regional level in parentheses. *p<0.10, **p<0.05, ***p<0.01. Controls for firm revenues, age, pre-requisite for innovative start-up; and regional green patents, population, high tech specialists, net start-up rate, and regional investment by GDP. Broad sectors refer to Agriculture, Trade, Manufacturing, Services, and Tourism. Specific sectors are the five top sectoral codes for innovative start-ups (J62, J63, M72, C28, M74).

Table 2. Probability that an innovative start-up has a green vocation

	(1)	(2)	(3)	(4)	(5)
Share of top women in the start-up	-0.00	0.00	-0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regional share of women/men employees	0.32***	0.30**	0.32***	0.32***	0.33***
	(0.07)	(0.12)	(0.08)	(0.11)	(0.08)
Energy	0.07***	0.07***	0.09***	0.14***	0.12***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Social	0.02	0.02	0.03	0.01	0.02
	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Observations	6674	6674	6659	6674	6659
Controls	YES	YES	YES	YES	YES
Region FE	NO	YES	YES	YES	YES
Sector FE	NO	NO	broad	specific	broad + specific

Coefficients represent marginal effects. Robust standard errors clustered at the regional level in parentheses. *p<0.10, **p<0.05, ***p<0.01. Controls for firm revenues, age, pre-requisite for innovative start-up; and regional green patents, population, high tech specialists, net start-up rate, and regional investment by GDP. Broad sectors refer to Agriculture, Trade, Manufacturing, Services, and Tourism. Specific sectors are the five top sectoral codes for innovative start-ups (J62, J63, M72, C28, M74).

Table 3. Probability of social vocation in an innovative start-up born in a specific year

	(1)	(2)	(3)	(4)	(5)
Share of top women in the start-up	0.02***	0.02***	0.02***	0.01**	0.01**
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
Regional share women to men employees	-0.07	-0.10*	-0.10**	-0.09*	-0.09*
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
Energy	-0.01***	-0.01***	-0.02***	-0.09***	-0.09***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Green	0.00	0.00	0.01	0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Observations	6583	6583	6530	6583	6530
Controls	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Region FE	NO	YES	YES	YES	YES
Sector	NO	NO	broad	specific	broad + specific

Coefficients represent marginal effects. Robust standard errors clustered at the regional level in parentheses. *p<0.10, **p<0.05, ***p<0.01. Controls for firm revenues, age, pre-requisite for innovative start-up; and regional green patents, population, high tech specialists, net start-up rate and regional investment by GDP. Broad sectors refer to Agriculture, Trade, Manufacturing, Services, and Tourism. Specific sectors are the five top sectoral codes for innovative start-ups (J62, J63, M72, C28, M74).

Table 4. Probability of green vocation in an innovative start-up born in a specific year

	(1)	(2)	(3)	(4)	(5)
Share of top women in the start-up	0.00	0.00	0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regional share women to men employees	0.16**	0.18***	0.17***	0.17***	0.16***
	(0.08)	(0.07)	(0.06)	(0.06)	(0.06)
Energy	0.07***	0.07***	0.09***	0.14***	0.12***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Social	0.02	0.02	0.03	0.01	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	6583	6583	6569	6583	6569
Controls	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Region FE	NO	YES	YES	YES	YES
Sector	NO	NO	broad	specific	broad + specific

Coefficients represent marginal effects. Robust standard errors clustered at the regional level in parentheses. *p<0.10, **p<0.05, ***p<0.01. Controls for firm revenues, age, pre-requisite for innovative start-up; and regional green patents, population, high tech specialists, net start-up rate and regional investment by GDP. Broad sectors refer to Agriculture, Trade, Manufacturing, Services, and Tourism. Specific sectors are the five top sectoral codes for innovative start-ups (J62, J63, M72, C28, M74).

Table 5. Probability that an innovative start-up has a green-energy vocation

	(1)	(2)	(3)	(4)	(5)
Share of top women in the start-up	-0.02***	-0.02***	-0.02***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regional share of women/men employees	0.12***	0.16**	0.17**	0.28***	0.31***
	(0.05)	(0.07)	(0.07)	(0.10)	(0.11)
Observations	6674	6674	6320	3481	3127
Controls	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES
Sector FE	NO	NO	broad	specific	oad + specific

Coefficients represent marginal effects. Robust standard errors clustered at the regional level in parentheses. *p<0.10, **p<0.05, ***p<0.01. Controls for social start-ups, firm revenues, age, pre-requisite for innovative start-up; and regional green patents, population, high tech specialists, net start-up rate, and regional investment by GDP. Broad sectors refer to Agriculture, Trade, Manufacturing, Services, and Tourism. Specific sectors are the five top sectoral codes for innovative start-ups (J62, J63, M72, C28, M74).

Table 6. Probability that an innovative start-up has a green-non-energy vocation

	(1)	(2)	(3)	(4)	(5)
Share of top women in the start-up	0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regional share of women/men employees	0.21***	0.20**	0.22***	0.27**	0.28***
	(0.06)	(0.08)	(0.05)	(0.11)	(0.08)
Observations	6674	6674	6659	5735	5720
Controls	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES
Sector FE	NO	NO	broad	specific	oad + specific

Coefficients represent marginal effects. Robust standard errors clustered at the regional level in parentheses. *p<0.10, **p<0.05, ***p<0.01. Controls for social start-ups, firm revenues, age, pre-requisite for innovative start-up; and regional green patents, population, high tech specialists, net start-up rate, and regional investment by GDP. Broad sectors refer to Agriculture, Trade, Manufacturing, Services, and Tourism. Specific sectors are the five top sectoral codes for innovative start-ups (J62, J63, M72, C28, M74).

Figures

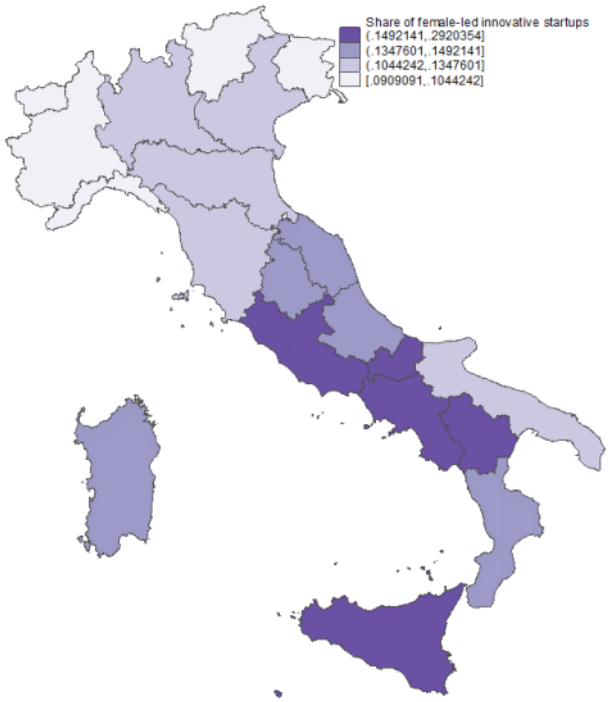


Figure 1. Share of innovative start-ups with >50% of women in decision-making positions (over total number of innovative start-ups in the region). Source: authors' own elaboration on data from the Italian Chamber of Commerce.

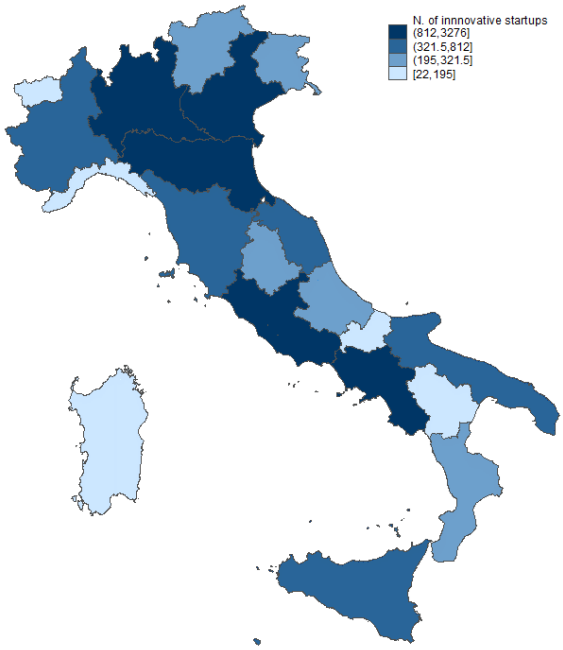


Figure 2. Distribution of innovative start-ups across Italian regions.

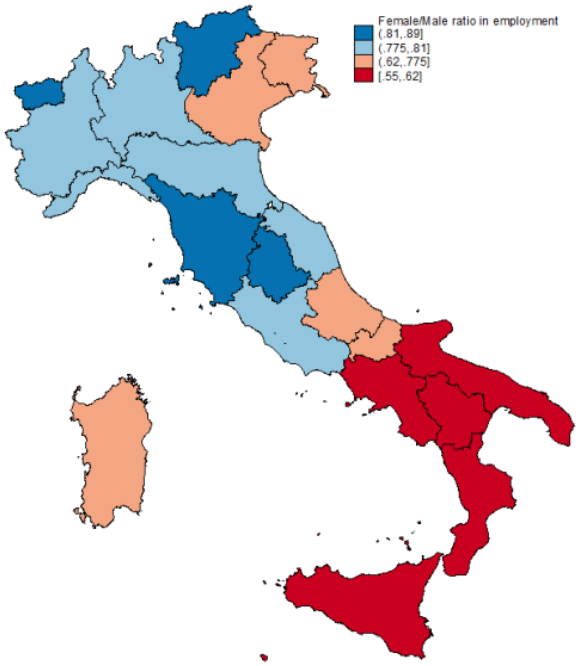


Figure 3. Regional gender equality: female to male ratios in the local labour force.

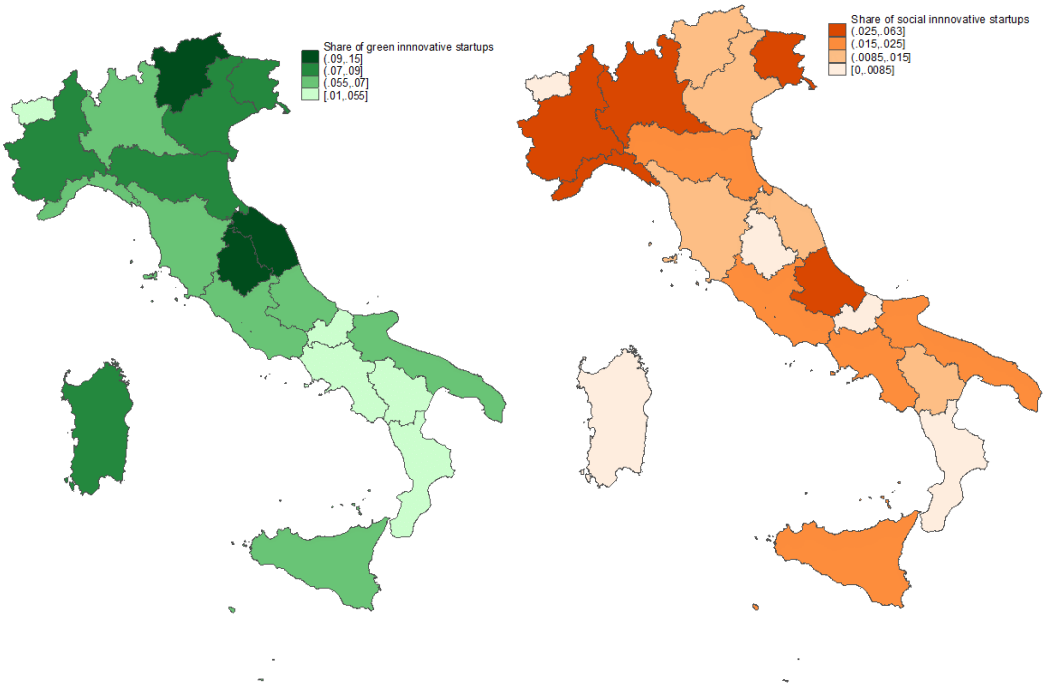


Figure 4. Number of green and social innovative start-ups per region.

Figures captions (as a list)

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