Smart cities and economic development: synergies among technology, social forces and female entrepreneurship

Filippo Marchesani and Francesca Masciarelli
Department of Management and Business Administration, University "G. d'Annunzio" of Chieti-Pescara, Pescara, Italy

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Abstract

Purpose – This study aims to investigate the synergies between the economic environment and the smart living dimension embedded in the current smart city initiatives, focusing on the localization of female entrepreneurship in contemporary cities. This interaction is under-investigated and controversial as it includes cities' practices enabling users and citizens to develop their potential and build their own lives, affecting entrepreneurial and economic outcomes. Building upon the perspective of the innovation ecosystems, this study focuses on the impact of smart living dimensions and R&D investments on the localization of female entrepreneurial activities.

Design/methodology/approach – The study uses a Generalized Method of Moments (GMM) and a panel dataset that considers 30 Italian smart city projects for 12 years to demonstrate the relationship between smart living practices in cities and the localization of female entrepreneurship. The complementary effect of public R&D investment is also included as a driver in the "smart" city transition.

Findings – The study found that the advancement of smart living practices in cities drives the localization of female entrepreneurship. The study highlights the empirical results, the interaction over the years and a current overview through choropleth maps. The public R&D investment also affects this relationship.

Practical implications – This study advances the theoretical discussion on (1) female entrepreneurial intentions, (2) smart city advancement (as a context) and (3) smart living dimension (as a driver) and offers valuable insight for governance and policymakers.

Social implications – This study offers empirical contributions to the preliminary academic debate on enterprise development and smart city trajectories at the intersection between human-based practices and female entrepreneurship.

Originality/value – This study offers empirical contributions to the preliminary academic debate on enterprise development and smart city trajectories at the intersection between human-based practices and female entrepreneurship. The findings provide valuable insights into the localization of female entrepreneurship in the context of smart cities.

Keywords Smart city, Smart living, Female entrepreneurship, Entrepreneurial activities, R&D

Paper type Research paper

1. Introduction

In recent years, cities have changed their urban trajectories, moving from a static local environment into a more dynamic context capable of providing a technological, sustainable and efficient environment that affects the quality of life of citizens and stakeholders (Albino *et al.*, 2015; Caragliu and Del Bo, 2019; Vanolo, 2014). This transformation opens up a new vision of the city that moves towards a more liveable and human-based urban context, which

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involves different areas that can be classified into the six dimensions of the smart city development such as smart economy, smart mobility, a smart environment, smart people, smart living and smart governance (Appio *et al.*, 2019; Caragliu and Del Bo, 2022; Christofi *et al.*, 2021; Vanolo, 2014).

In these trajectories, technology is a primary but not an essential driver in the development of cities that allows all these fundamental dimensions in the evolution from city to smart city to be connected and influence the citizens and stakeholders (Christofi *et al.*, 2021; Ibrahim *et al.*, 2018; Ooms *et al.*, 2020). Thus, going beyond mere technological development, the city must be built around users, adapting and, at the same time, influencing and advancing the urban environment into a user-centric perspective (Appio *et al.*, 2019; Neirotti *et al.*, 2014; Vanolo, 2014). In this context, the *smart living* dimension has assumed a dichotomic role that lacks a current academic and practical conceptualization. Although, on the one hand, it is essential to create a liveable, safe, inclusive and advanced social environment, on the other hand, it is difficult to evaluate both the construct and the outcome and the impact on the territory (Appio *et al.*, 2019; De Falco *et al.*, 2019; Vanolo, 2014).

Following the current academic debate, we know that the *smart living* dimension includes city practices concerning the quality of life, measured in terms of the availability of cultural and educational services, social cohesion, healthy environment, personal safety and housing (Vanolo, 2014, p. 887). Moreover, these practices directly contribute to the cities' environment by influencing urban development and economic growth (Adler and Florida, 2021; Knudsen *et al.*, 2007; Neirotti *et al.*, 2014). Based on this intersection, this paper aims to investigate the synergies between the economic environment and the smart living dimension with a particular focus on the localization of female entrepreneurial activities. These activities include all businesses initiated and managed by women, whether they are relocated from other cities or founded within the city itself, and are registered annually with the Chamber of Commerce in each respective city. We focused on female entrepreneurship, identified as the most sensitive actors to the living dimension in contemporary cities (Harrison *et al.*, 2020; Rosenthal and Strange, 2012; Shayan and Kim, 2023).

The vital role of female entrepreneurs in driving socio-economic development cannot be understated (Estrin and Mickiewicz, 2011; Kogut and Mejri, 2022; Rosenthal and Strange, 2012). Their contributions to job creation, innovation and community development have garnered increasing recognition in recent years (Allen, 2022; Kimbu and Ngoasong, 2016; Rosca *et al.*, 2020). However, their entrepreneurial endeavors are intricately intertwined with the urban landscape they operate within. The urban context provides both opportunities and challenges that shape the trajectories of female entrepreneurship. Emerging from this dynamic relationship is the concept of "smart cities," where advancements in technology, infrastructure and data-driven solutions converge to enhance various aspects of urban life. Within this all-encompassing smart city context, the interplay between technological innovation, economic dynamics and social well-being takes center stage (Shayan and Kim, 2023, p. 6).

As urbanization continues to shape the global landscape, understanding the nuanced dynamics between female entrepreneurship, urban liveability and the technological underpinnings of smart cities becomes imperative. This convergence of economic, social and technological domains holds potential for synergistic growth, where fostering female entrepreneurship aligns with the goals of creating sustainable and inclusive urban ecosystems (Faggian *et al.*, 2007; Nguyen, 2021; Shayan and Kim, 2023). However, to fully grasp the intricacies of this interplay, it is essential to develop a comprehensive theoretical framework that encapsulates the multifaceted dimensions of this relationship. Such a framework would not only provide a clearer lens through which to analyze the interaction but also offer actionable insights for policymakers, urban planners and stakeholders invested in

fostering entrepreneurial ecosystems within the context of evolving smart cities (Allen, 2022; Rahmayanti *et al.*, 2020; Rosenthal and Strange, 2012; Shayan and Kim, 2023).

A significant gap persists in comprehending the intricate interplay between smart cities, urban livability and female entrepreneurship within the urban context. This gap underscores several crucial points. First, the connection between smart cities trajectories and the entrepreneurial environment in cities remains inadequately explored (Kummitha, 2019; Kummitha and Crutzen, 2019). This connection offers a unique arena where technology-driven innovations, digital infrastructures and novel entrepreneurial opportunities converge, potentially reshaping the entrepreneurial landscape. Second, the specific outcomes and implications of the smart living dimension in relation to the entrepreneurial context have not been thoroughly explored (Vanolo, 2014; Liu, 2012). This represents a crucial research void that needs to be addressed to unveil how the advancements in smart living might directly impact and nurture female-led entrepreneurial ventures. Lastly, there exists a pressing need to elevate the understanding of urban and economic environments within cities to a new level, one rooted in a comprehensive and human-centric perspective (Caragliu and Del Bo, 2022; Shelton *et al.*, 2015; Vanolo, 2014). This understanding goes beyond traditional economic indicators and urban planning principles, focusing on how cities function as ecosystems where socio-economic factors, technological innovations and quality of life converge to shape the entrepreneurial ecosystem. Such a comprehensive approach is essential to harness the potential synergies between smart cities, urban livability and female entrepreneurship, ultimately leading to more inclusive urban growth.

In conclusion, while research on female entrepreneurship has gained momentum, the intricate interplay between smart cities, urban livability and entrepreneurial endeavors remains relatively unexplored. Bridging this gap not only holds the potential to uncover new insights into the ways cities can foster female-led businesses but also presents an opportunity to create holistic urban environments that empower diverse entrepreneurial talent. To address these research gaps, a multidisciplinary approach that integrates insights from urban planning, technology, economics and gender studies is crucial for a comprehensive understanding of this complex interaction.

Our research is centered on a pivotal intersection where the domains of smart living practices and female entrepreneurship seamlessly merge under the guiding framework of the Innovation Ecosystem. This framework underscores the interconnectedness and collaborative dynamics that shape innovation and economic growth (Bartoloni *et al.*, 2022; Camboim *et al.*, 2019; Oh *et al.*, 2016). Our inquiry takes us into the intricate terrain of public research and development (R&D) investment within the context of smart cities. Through the lens of the Innovation Ecosystem, we aim to investigate the synergies between the economic environment and the localization of female entrepreneurship, while also considering the public R&D investment embedded in the smart city development. Within the Innovation Ecosystem, female entrepreneurs emerge as pivotal innovation actors. As we navigate the interconnected pathways of this framework, we explore the ways in which smart living practices, supported by public R&D investment, facilitate an environment conducive to the localization and activities of female-led enterprises. Public R&D investment takes center stage as the bedrock of the innovation infrastructure (Backman and Lööf, 2015; Lee *et al.*, 2013). It acts as a catalyst, fostering technological advancements and providing the essential groundwork for innovative solutions to emerge. In the context of smart cities, this investment enriches the arsenal of resources available to female entrepreneurs, empowering them to harness cutting-edge approaches and technologies in their ventures (Strohmeyer *et al.*, 2017). The Innovation Ecosystem perspective enables us to unravel the intricate threads connecting R&D investment, innovation infrastructure and the entrepreneurial aspirations of women. Thus, referring to the relationship between cities' trajectories and economic growth, we

investigate the relationship between the smart living dimension and female entrepreneurship when moderated by public R&D investment considered a driver for smart city development.

At the heart of our investigation lies the recognition that the urban environment plays a primary role in affecting entrepreneurial activities, and public R&D investment plays a pivotal role in shaping the evolution of smart cities. By allocating resources to research, innovation and technological advancement, cities enhance their capacity to introduce cutting-edge solutions that transform urban landscapes into intelligent, connected ecosystems (Camboim *et al.*, 2019; Kummitha, 2019; Linde *et al.*, 2021).

To investigate those relationships, we build our research using a Generalized Method of Moment (GMM) and a panel dataset of 12 years that considers 30 Italian cities equally distributed by size and economic development. Specifically, we hypothesize that cities with advanced smart living practices positively affect the localization of female entrepreneurship in the city. By investigating this moderating role, we aspire to uncover how strategic investments in research and innovation can enhance the transformative potential of smart living dimensions, creating an environment where female entrepreneurs can thrive.

In essence, our research strives to establish a comprehensive understanding of the intricate synergies between smart living practices, public R&D investment and female entrepreneurship to offer new insight into the interception between smart city and female entrepreneurship and to provide a foundation for informed policymaking and urban planning strategies that prioritize gender-inclusive entrepreneurial innovation ecosystems. Furthermore, our study contributes to the broader discourse on smart city development by highlighting the potential of synergistic collaborations between technological advancements, livability enhancements and the entrepreneurial environment.

2. Theoretical background

2.1 Smart living dimension in urban development

In the context of smart cities, the *smart living* dimension has recently acquired great importance within city development. However, embedded in the current smart cities' pillars, *smart living* is still not a clear phenomenon in the academic debate (Albino *et al.*, 2015; Ismagilova *et al.*, 2019; Han and Kim, 2021). In this sense, the *smart living* dimension is not limited to the intelligent lifestyle facilitated by smart technology but aims to emphasize the quality of living produced by the independent implementation of smart technology under sustainable conditions (Han and Kim, 2021).

This interaction between people and the *smart living* dimension takes on a specific value that is increasingly important in the city context and, more widely, in urban development strategies (Gagliardi *et al.*, 2017; Neirotti *et al.*, 2014; Vanolo, 2014). Cities aim to boost these practices through engagement with residents using advanced alternative or novel notions of urban and economic development, social inclusion or greater urban planning (Martin *et al.*, 2018). The goal is to offer an urban context suited to the needs of its stakeholders in combination with the other dimensions of smart cities, allowing them to not only offer a socially evolved context but also to manage and direct the main intrinsic problems in their current development (Camboim *et al.*, 2019; Ismagilova *et al.*, 2019). Thus, citizens and users will be considered the main actors throughout the smart transformation by becoming part of the remodeling and construction of the city itself (Shelton *et al.*, 2015).

Today, the phenomenon of smart cities is at the center of the urban debate, helping to shape its future trajectories. Dimensions such as the environment, mobility and governance clearly impact the current local and economic environment, and their interrelation fuels increasingly defined debates and perspectives (Caragliu and Del Bo, 2022; Leitheiser and Follmann, 2020; Vanolo, 2014). In this context, the dimension of *smart living* is still at a preliminary stage in the literature related to smart city development but will be increasingly

placed at the center of future planning. This dimension includes a social and inclusive perspective of the city directly impacting not only service provision and improvement but also living conditions, which are increasingly crucial for residents and the community (Cornelius and Wallace, 2010). Thus, in the trajectories from cities to smart cities, orchestrating social and inclusive perspective rather than mere smart city advancement would lead to an evolution of the smart city as a means to an end and not an end in itself (Spicer *et al.*, 2021; Van De Poel and Royakkers, 2007).

However, this evolution in cities is also confirmed in terms of inclusion, health services, citizen care and, more broadly, in regard to the city's social and ethical perspective (Chauhan *et al.*, 2021; Kumar *et al.*, 2018; Sharma and Manocha, 2021), since the excessive development of smart city practices could have a negative effect on the local context (Morgan and Webb, 2020). This development evidences problematic and contradictory relationships between smart "living" policies and stakeholder perception that open up discussion about the impact and implementation of these practices (Jirón *et al.*, 2021; Vidiasova and Cronemberger, 2020). In this development area, many cities and urban areas have not managed to cope with globalization through public policy reorganization and internal practices such as inclusion and citizen-care recalibration (Martin *et al.*, 2018). Consequently, this reorganization and internal practices directly affect the social and economic outcomes of the city (Grossi and Pianezzi, 2017; Krishnan *et al.*, 2020). Building on this understanding, the following section delves into the central debate on smart city trajectories, with a specific focus on exploring the synergies between the smart living dimension, economic environment and female entrepreneurship. To construct our first hypothesis, it will shed light on the interaction between entrepreneurial activities and the development of the smart city context, with a specific focus on how smart living practices influence the relationships between the urban environment and the localization of female entrepreneurship, recognizing female entrepreneurship as a sensitive actor to the smart living dimension.

2.2 Smart living dimension, economic environment and female entrepreneurship

The relationship between city trajectories and the economic environment is at the center of the current smart cities debate (Hollands, 2015; Kummitha, 2019; Kummitha and Crutzen, 2017). In this intersection, smart cities represent a context in which entrepreneurs must recognize opportunities to create new enterprises and re-shape innovative concepts and business models to shape new industries and restructure the economy (Archibugi *et al.*, 2013; Florida *et al.*, 2017). Specifically, entrepreneurial activities benefit from the development and competitiveness of the local context (Stam and van de Ven, 2021). Furthermore, related to the *smart living* dimension, cities' urban inclusiveness, and livability have also affected the relationships with startups and economic development (Florida *et al.*, 2017; Lowe *et al.*, 2019). Specifically, the growing population and improvement in quality of life raise entrepreneurial incentives to acquire investments to create a new entrepreneurial activity for both male and female entrepreneurs (De Guimarães *et al.*, 2020; Kautonen *et al.*, 2017).

This favorable development is intrinsic to a city's development from a smart perspective, given that the creation of public value is a key goal of governance and policymaking, providing both a social and a business environment based on smart practices in the public sphere (Neumann *et al.*, 2019). This is because smart city policies can act as facilitators for the economic environment (Borrás and Edler, 2020). In the current literature, we know that smart city development affects business opportunities for local enterprises, and external entrepreneurs are encouraged to establish in a favorable context (Adler *et al.*, 2019; Oztemel and Gursev, 2020; Sofronijević *et al.*, 2014). However, the current relationship between *smart living*, the entrepreneurial environment and female entrepreneurship in smart city trajectories is still uncertain. Specifically, amidst the ongoing transformation towards

smart cities, uncertainties persist regarding the potential outcomes and synergies. These uncertainties align with existing critiques of the smart city transformation and its previously discussed technological panacea (Datta and Odendaal, 2019; Hollands, 2015; Kummitha, 2019). However, insights from entrepreneurial and urban literature highlight converging points that underscore significant interactions with the economic environment and female entrepreneurial activities (Nguyen, 2021; Rosenthal and Strange, 2012; Solesvik *et al.*, 2019). As we strive towards a comprehensive understanding of smart city dynamics, it becomes evident that this holds promise in fostering a secure, inclusive and supportive environment that meets the current needs of users and stakeholders while also contributing to shaping a more dynamic and inclusive interaction with local entrepreneurs (Adler and Florida, 2021; Marchesani *et al.*, 2023; Muñoz and Cohen, 2016; Vanolo, 2014).

Today, we know that the relationship between the local environment and entrepreneurship also has a clear effect on female entrepreneurship, identified as one of the subjects most sensitive to the "living" dimension (Collins and Low, 2010; Nguyen, 2021; Poggesi *et al.*, 2016). To build the relationship between *smart living* practices and female entrepreneurship, we must refer first to entrepreneurial motivation. Entrepreneurial motivation is a complex construct that can be summarized as the desire or tendency to organize, manipulate and master organizations, human beings or ideas as quickly and independently as possible (Johnson, 1990). In the case of female entrepreneurs, where social, health, educational and safety levels are well-advanced and human-based, the opportunities for self-expression and confidence are increased following the perception of the local environment (Florida, 2005; Solesvik *et al.*, 2019). Thus, women might be strongly motivated to engage in entrepreneurial activity to realize themselves in a safe and human-centric city (Nesti, 2019; Rosca *et al.*, 2020).

At the current state of the art, we know that the social perception of female entrepreneurs influences the pursuit of business opportunities and the development of their businesses (Nguyen, 2021; Shirokova *et al.*, 2018; Solesvik *et al.*, 2019). For example, focusing on the states of California and Massachusetts, Guzman and Kacperczyk (2019) highlight that only a third of new enterprises are female-led, emphasizing gender differences in initial startup orientation and entrepreneurial performance. However, the relationship between the social environment and female entrepreneurship lacks current understanding. A plethora of recent studies assume that the majority of the local public practices are conducive to male entrepreneurship and are, as a matter of course, not beneficial to female entrepreneurship, and vice versa (Estrin and Mickiewicz, 2011; Nguyen, 2021; Powell and Eddleston, 2013). However, in an all-encompassing vision of the smart cities concept, these practices could detach from this distinction but have a positive effect on the promotion of female entrepreneurship that finds a safe, inclusive and supportive environment for its current needs (Collins and Low, 2010; Guzman and Kacperczyk, 2019; Kirkwood, 2009). Building upon the previous debate, we hypothesize that the *living dimension* of a city contributes to affecting the relationship between the city and female entrepreneurial activities, impacting their localization (either through foundation or relocation from other cities). Thus, we posit the following hypothesis.

H1. Cities with more advanced smart living dimensions are more likely to affect the localization of female entrepreneurship

2.3 Public R&D investments in smart cities trajectories

Moreover, another important aspect of this relationship concerns the role of public investment in the city (Christofi *et al.*, 2021; Ullah *et al.*, 2021). To understand the current cities' trajectories, it is important to highlight the impact of public R&D investment as an important (non-essential) driver in smart cities development (Lee *et al.*, 2013; Siokas *et al.*, 2021).

Although central governments are expanding R&D in local policies and planning, R&D investment in smart cities remains at the center of the current debate due to the still uncertain outcome and the lack of clear and well-established way to achieve their objectives (Min *et al.*, 2020; Ullah *et al.*, 2021). The implementation of smart cities faces challenges due to the ongoing nature of this process, where defining and refining the expected outcomes takes time. While efficiency, inclusivity and sustainability are clear guiding principles, the specific paths to attain them and the desired results are yet to be fully determined (Hollands, 2008; Linde *et al.*, 2021; Vanolo, 2014). Moreover, this continuous development is costly and cannot be undertaken individually by cities; rather, it necessitates guidance from central governments, such as the European Union in the case of Europe, to steer the processes and implementations effectively (Caragliu and Del Bo, 2019, 2022).

Based on the previous discussions and considering the interaction between smart living practices and entrepreneurial activities, investing in a livable environment that prioritizes citizens-needs at the center of urban policies can have mainly positive implications for economic growth (Betz *et al.*, 2016; Datta, 2015; Han and Kim, 2021). As highlighted by Adler *et al.* (2019), who follow the spatial organization of Schumpeterian entrepreneurship, focusing on the emergence of entrepreneurial clusters and ecosystems, there exists a strong correlation between inclusive and livable cities and entrepreneurial activities, particularly in certain cities or well-developed sub-districts. Given that smart city policies and R&D investments aim to enhance services, practices and infrastructure, resulting in increased urban efficiency and adaptability (Cohen *et al.*, 2016), it is reasonable to expect a favorable environment for local entrepreneurship as well.

Moreover, R&D investment should affect residential quality embedded in the smart living dimension to new economic dynamics and societal transformations (see, e.g. Florida *et al.*, 2017; Romão *et al.*, 2018; Sassen, 2013) lending to a positive externalities, which serve as direct drivers of the current cities' advancement trajectories (Romão *et al.*, 2018, p. 73).

Today, many geographical areas such as the U.S., Europe and Japan are also driving R&D initiatives in implementing smart city trajectories, with the primary aim of addressing current urban problems such as efficiency and sustainability but also affecting the livability of the cities focusing on health and education (Lee *et al.*, 2013, p. 287). This perspective challenges the excessive techno-centric focus due to its limitations in addressing the social and cultural challenges associated with smart city realities and focusing on a more inclusive vision of the city (Marchesani, 2022; Zhao *et al.*, 2021). Specifically, although the technological utopia of smart cities presents a panacea to advance the aspirations of cities to improve their effectiveness and efficiency (Kummitha and Crutzen, 2017, p. 335), prioritizing a citizen-centric rather than techno-centric development of the city, emphasizing inclusivity and the city's livability for its people, represents an important driver to ensure the prosperity and future development of cities (Lee *et al.*, 2004; Morgan and Webb, 2020).

Building on the previous state-of-the-art, considering the smart living dimension of the city, Public R&D investment should affect the relationship between the smart living dimension of the city and the female entrepreneurial activities as it represents an instrument that may help to accelerate the smart transition in the city and support local economic development (Cohen and Amorós, 2014). In this line, Abramovsky *et al.* (2007), focusing on policy issues in the UK, shed light on the links between public R&D, businesses and the role of geographic proximity in public-private sector interactions and the following effect on entrepreneurial activities.

We assume that the level of public R&D investment affects the cities' roadmap and contributes to the interrelation between the advancement of internal practices (i.e. Living, Mobility or Environment), the external output (i.e. efficiency and sustainability) and the expected outcomes (economic and social environment). We expect that (1) the high level of public R&D Investments will increase the effect of *smart living* practices on female

entrepreneurship, and (2) the effect of public R&D Investments will increase with a larger advance of *smart living* practices. Thus, in evaluating the effect of Public R&D Investment, we consider the dynamic interplay and transformative potential that these investments and practices have on the economic and social environment of the cities, which act complementarily within the urban environment. Thus, we posit.

H2. Public R&D investments and smart living practices are complementary in affecting female entrepreneurship in the city

To test these hypotheses, we followed the structure outlined in Figure 1, which illustrates the research framework of the study, depicting the direct hypothesis and the moderation hypothesis concerning female entrepreneurship. Additionally, the framework introduces the variables used to construct the "smart living" variable, which are operationalized and described in Table 1.

3. Methodology

3.1 Sample of analysis

Our empirical analysis focused on the 30 Italian cities ranging 12 years from 1 January 2010 to 31 December 2021. We focus on the Italian context as it is considered at the center of the academic and political debate on smart city trajectories (Abid *et al.*, 2022; Vanolo, 2014), constituting a prominent empirical focus for the debates on urban development in Europe (Christofi *et al.*, 2021, p. 961). This research uses city-level variables constructed from data from different databases. To ensure the high heterogeneity in the sample, we follow the probability-proportional-to-size sampling proposed by Levy and Lemeshow (2013), taking into account the geographical position, economic development and size of the cities. In conducting this process, we first define the "stratification" of the sample based on specific criteria, such as geographical location, economic factors and population size. This stratification is essential for ensuring the sample includes a diverse range of cities with varying characteristics. Within each stratum of geographical location, economic development and population, we applied the probability-proportional-to-size method (Levy and Lemeshow, 2013). This approach involves selecting cities with a probability directly proportional to their characteristics within the different strata. In other words, larger cities have a higher chance of being included in the sample, while smaller cities still have a chance of being selected, ensuring a fair representation of cities of different sizes, economic development and locations.

This approach aims to provide a high level of heterogeneity in the sample and aligns with Europe's policies [1]. Initially, we had access to data from 38 Italian cities. However, to maintain a balanced and diverse sample, we reduced the number to 30. This reduction was necessary to prevent any potential bias and to ensure that the sample reflects the

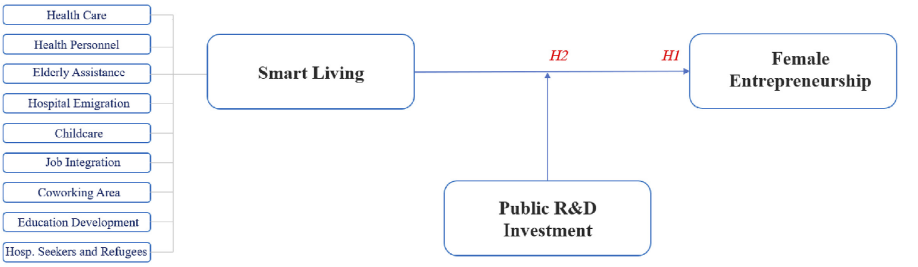


Figure 1.
Research framework

Source(s): Created by authors

Model	Variable	Description	Measurement	Source
DV	*Female Entrepreneurship*	Total number of new enterprises with the female entrepreneur in the city over the total number of enterprises active in the city yearly	Constant	ISTAT-ASIA
Index (IV)	*Health Care*	Natural logarithm of the total number of public and private hospitalization services in the city over the population yearly	Constant	ISTAT
Index (IV)	*Health personnel*	Natural logarithm of the number of employees in public and private hospitals in the city over the population yearly	Constant	ISTAT-IPS
Index (IV)	*Elderly assistance*	The natural logarithm of the number of public and private elderly reception services in the city over the population yearly	Constant	ISTAT-IPS
Index (IV)	*Hospital Emigration*	The natural logarithm of the number of hospital emigrations to other regions for ordinary hospitalizations over the population yearly	Constant	ISTAT-IPS
Index (IV)	*Childcare*	The natural logarithm of childcare assistance based on private and public services over the population yearly	Constant	ISTAT
Index (IV)	*Job integration*	Natural logarithm of new residents who work permanently in the city and new residents who found a job in the first six months over the population yearly	Percentage	ISTAT
Index (IV)	*Coworking area*	The natural logarithm of the number of coworking services in the city over the total enterprise in the city yearly	Percentage	FPA- OECD
Index (IV)	*Education Development*	Number of people in the city who interacted with services offered in the educational field (public schools, courses, master's or services in the educational field) over the population yearly	Percentage	MIUR
Index (IV)	*Hospitality seekers and refugees*	The natural logarithm of the variable based on the reception of political and needy refugees in the city, tutored and reported by the local authorities over the population yearly	Constant	SPRAR
CV	*Population*	Descriptive number of the total population in the city yearly	Constant	ANPR-ISTAT
CV	*City Size*	Dummy variable structure as (1) cities with a population greater than 300,000 and (0) cities with a lower population	Binary *(Values 1 or 0)*	ISTAT
CV	*GDP*	Gross Domestic Product of the city over the population yearly	Constant	EUROSTAT - ISTAT

(*continued*)

Table 1.
Variable description

Model	Variable	Description	Measurement	Source
CV	*City Development*	Dummy variable structure as less- and medium-economically developed cities (0) and well-economically developed cities (0)	Binary *(Values 1 or 0)*	ISTAT
CV	*R&D Public*	The total amount of public sector investments in R&D in the city over the population yearly	Constant	ISTAT
CV	*R&D Private*	The total amount of private sector investments in R&D in the city over the population yearly	Constant	ISTAT
CV	*Total enterprise*	Total number of enterprises active in the city yearly	Constant	CoC
CV	*New enterprise*	Total number of new enterprises in the city over the total number of enterprises active in the city yearly	Constant	CoC
CV	*Employment*	Total number of workers aged 15–64 over the population in the city yearly	Constant	ISTAT

Note(s): Database:ASIA: Archivio Statistico delle Imprese Attive ANPR: Anagrafe Nazionale della Popolazione Residente, Coc: Chamber of Commerce; ISTAT; Italian National Institute of Statistics; EUROSTAT: Statistical office of the European Union; MIUR: Ministero della Pubblica Istruzione; IPS: Sistema Statistico Sanitario; OECD - Organisation for Economic Co-operation and Development; IBS: Italian Business FPA: European Financial Planning Association; SPRAR: Protection system for asylum seekers and refugees

Source(s): Created by authors

Table 1.

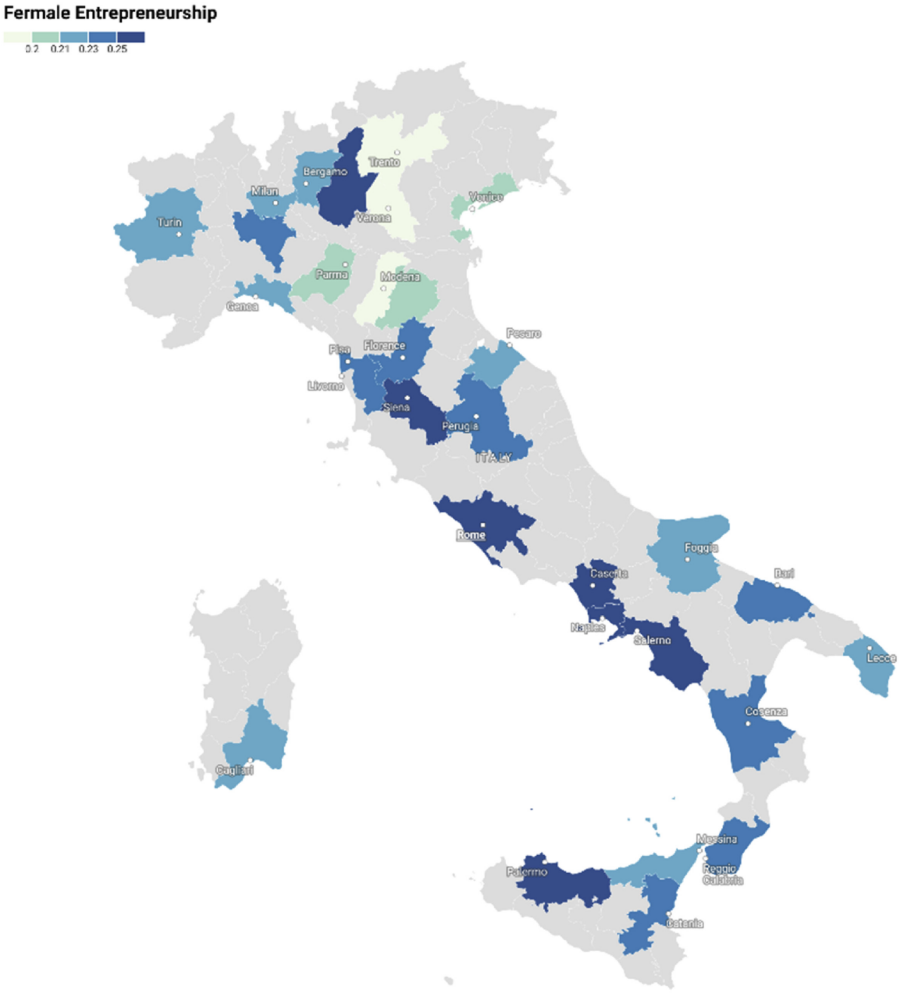
heterogeneity present in various cities across Italy. Based on this process, the final sample size of 30 Italian cities was determined, taking into account statistical considerations to strike a balance between having a heterogeneous distribution of cities within the country and ensuring data homogeneity. By implementing this methodology, we aim to assess a representative sample that captures the complexities and diversities of urban dynamics across Italy, contributing to a broader understanding of urban studies in Europe (Caragliu and Del Bo, 2019; Marchesani *et al.*, 2022; Vanolo, 2014).

This sampling has led us to consider cities with a population ranging from 14.884 (Urbino) to 2.582.000 (Rome), allowing us to cover 23% of the Italian population and 61% of the main 100 Italian cities. Figure 2 shows the distribution of the sample of analysis within the territory, including the choropleth mapping of our dependent variable (*Female Entrepreneurship*) in Italy over the last decade (2010–2021).

3.2 Data collection and variables

This research uses city-level variables and collects data from databases at the national (ASIA, ISTAT, IPS, MIUR, SPRAR and CoC) and international (EUROSTAT and OECD) levels. Table 1 describes the variables adopted in the empirical analysis and displays the type of variables, operationalization, short descriptions and sources.

3.2.1 Dependent variable. The dependent variable is *Female Entrepreneurship* in the city. In assessing *Female Entrepreneurship*, we consider the number of businesses registered with the Chamber of Commerce in each city, focusing on enterprises that are founded and managed by women or those with a female ownership stake exceeding 51%. This includes enterprises established annually in the city as well as those that have relocated from other cities to set up within the city over the years. To construct the variable, we first identify the number of female-owned enterprises officially registered with the Chamber of Commerce.



Source(s): Created by authors

Figure 2.
Sample of analysis and female entrepreneurship distribution

Next, we consider the total number of enterprises registered in the city yearly. We then operationalize this data by calculating the proportion of female-owned enterprises over the total registered enterprises annually in each city. Finally, we employ the logarithm transformation to ensure a more consistent and robust analysis, mitigating potential bias values and facilitating comparisons across different cities.

This procedure allows us to understand the development of the female entrepreneurial activities of each city in relation to each economic and geographical context. Following the reference literature, the connection between female entrepreneurship and the local environment is well established in the current entrepreneurial environment indicating that cultural, economic and social urban context in developed countries provides more possibilities for female entrepreneurs (Rosenthal and Strange, 2012; Solesvik *et al.*, 2019, p. 684).

3.2.2 Independent variables. We considered two independent variables in our model *Smart Living* and *Public R&D* investment. *Smart Living* is the first independent variable that assesses the living dimensions of each city. It is closely linked to the all-encompassing dimension of urban life, evaluating the inclusivity, integrative capabilities and social services available in a human-based context (Chauhan *et al.*, 2021; Sharma and Manocha, 2021). To assess this variable, we construct an index based on a set of indicators, incorporating a range of variables such as healthcare, childcare, elderly care, education, hospitality, job integration and working services (see Table 1). The choice of this set of variables is built on the smart cities literature as the smart living variable represents a comprehensive category, encompassing not only services related to citizens and stakeholders but also the city's development practices aimed at integrating and supporting residents and users (Lytras and Visvizi, 2018; Vanolo, 2014).

To construct our index, which aggregates diverse values into a single summary value and is weighted for the sample of analysis, we initially standardized the variables to ensure comparability with each other using the same unit of measurement. We tested this process to assess the stability of our variables, employing methods like standardization with z-scores and then compared the results. In order to achieve a consistent and balanced variable distribution, our index is based on the 30 cities, taking into consideration various city characteristics, such as size, population and economic development. To further ensure the stability of our indexes, we conducted a factorial analysis using Principal Component Analysis (PCA) (Bro and Smilde, 2014). This analysis demonstrated that the values derived from both applied techniques were consistent and confirmed the stability of our indexes. As a result, our indexes are uniformly valued within an interval of [0, 1], where a value close to 0 indicates a low level of development, and a value close to 1 signifies a high level of development. Interacting city characteristics and variables, the final results rank the cities from the most advanced smart living practices (such as Milano, Florence and Bologna) to those less-developed ones (e.g. Foggia, Messina and Reggio Calabria).

Our model also includes *Public R&D* investment variable, which is a key moderating variable, measured by the total amount of public sector investments in R&D in the city over the population yearly. In considering these variables, we focus on the current debate on the effect of public R&D investments in smart city trajectories (Lee *et al.*, 2013; Linde *et al.*, 2021). Specifically, public R&D investment could provide sufficient leverage to disseminate innovations drive city transformation more widely, and influence cities' services and quality of life perception (Florida, 2002; Harrison *et al.*, 2010; Simmons *et al.*, 2018).

3.2.3 Control variables. In assessing the model, we control for city characteristics and urban and economic environment according to the reference literature to control possible biases and guarantee the robustness of our results (Black and Henderson, 1999; Glaeser, 2000; Laursen *et al.*, 2016; Marchesani *et al.*, 2022, 2023). Specifically, focusing on a city's characteristics, we control for the *population* in the city, Gross Domestic Product (*GDP*) per city, and two dummy variables useful to assess the city size and city development. Moreover, we also consider the possible effect of the economic environment. Thus, we control for the *total enterprises* active yearly in the city, the total number of *new enterprises* active yearly and the *employment* rate in each city per year. The inclusion of these sets of controls allows us to evaluate the possible influences of the city and the economic environment on our model. Finally, as an additional control, we consider *private R&D* investments closely linked to the entrepreneurial development of the urban economic environment (Alam *et al.*, 2020; Backman and Lööf, 2015) and public investments in R&D linked to city transformation policies and practices (Harabi, 1997; Lee *et al.*, 2013).

3.3 Estimation model

In this work, we implement the dynamic Generalized Methods of Moments (GMM) methods. In adopting this method, we first considered various estimation techniques, including

Generalized Least Squares (GLS), Ordinary Least Squares (OLS), Two-Stage Least Squares (2SLS) and Fixed Effects (FE) or Random Effects (RE) models, to address our research objective of analyzing the impact of our independent variable and its interaction on the dependent variable. The comparison of these databases allowed us to evaluate the strengths and weaknesses of each approach (Breitung and Salish, 2021; Hooper *et al.*, 2008; Roodman, 2009b).

To validate our methodological approach, we conducted a series of tests. Firstly, we employed the Akaike Information Criterion (AIC) for model selection (Sakamoto *et al.*, 1986). The Generalized Method of Moments (GMM) model consistently outperformed GLS, OLS, 2SLS and FE/RE models, exhibiting lower AIC values, indicating a better fit to the data without overcomplicating the model (Hooper *et al.*, 2008, p. 54). Additionally, we subjected the GMM model to the Hausman test to compare its efficiency against FE/RE models (Breitung and Salish, 2021). The Hausman test confirmed that the differences between the estimated coefficients of GMM and FE/RE models were statistically insignificant. This result supported GMM's efficiency, providing evidence in favor of its suitability (Arellano and Bond, 1991). Furthermore, we conducted a Heteroscedasticity test to examine the robustness of the GMM model to potential heteroscedasticity in the data. The test indicated that GMM effectively handled heteroscedasticity, providing reliable and consistent parameter estimates (Baum *et al.*, 2003).

Following the presented methodological approach, the decision to use GMM is statistically supported, considering its ability to effectively address endogeneity, heteroscedasticity and the characteristics of our dataset. Specifically, in terms of data and a sample of analysis, our panel-dataset considered a wide cross-section (30 cities) and a relatively short time period (11 Years), including both time and city-fixed effects (Lee and Yu, 2014; Roodman, 2009b; Windmeijer, 2005). Thus, according to Roodman's approach (Roodman, 2009a, b), we consider the internal instruments from lagged variables useful to prevent the over-identification problem (Windmeijer, 2005).

Table 2 presents the descriptive statistics of all variables, correlation and the variance inflation factor (VIF) to control for possible multicollinearity. Precisely, the overall value of the VIF is less than 3,62, confirming that our model does not have multicollinearity issues in influencing the results (Akinwande *et al.*, 2015). In testing the correlation matrix, we expect the coefficient between the two variables to be lower than 0.700. When the coefficient exceeded 0.700 (i.e. Population as a control variable), we also tested the model and constructed it considering the assumed multicollinear variables individually. We follow this practice to guarantee the (1) stability of the sign and the significance of the coefficients and (2) the influence of standard errors. Finally, diagnostic tests and additional control (i.e. endogeneity, autocorrelation and heteroskedasticity) to assess the robustness of the results are included and described in the model and discussed in the results section (Arellano and Bond, 1991; Breitung and Salish, 2021).

4. Results

The results of the GMM models are presented in Table 3. To estimate the empirical model, we run stepwise robust regressions (Agostinelli, 2002) by adding the main effects, control variables and interactions. Model I highlights the interaction between the solely dependent variable and independent variables. Model II represents our empirical model estimated with all the controls. Model III highlights the interaction between *Female Entrepreneurship* and *Smart Living* by including *Public R&D* investments and the control variables. Finally, Model IV highlights the interaction between *Female Entrepreneurship* and *Smart Living*, including the moderating effect of *Public R&D* (*Smart Living*Private R&D*) to assess the complementary effect in the model. Between these regressions, no significant incongruence

Table 2.
Correlation matrix and descriptive statistics

	Variables	Vif	Mean	Min	Max	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
[1]	Female Entrepreneurship (n-1)	1.12	0.516	0.257	0.769	1										
[2]	Smart Living	1.98	0.443	0.125	0.683	0.262	1									
[3]	Public R&D	1.32	0.166	0.089	0.237	0.135	0.161	1								
[4]	Population	3.23	3.145	0.932	8.224	−0.362	0.672	−0.212	1							
[5]	City Size	2.16	0.425	0	1	−0.272	−0.245	−0.305	−0.162	1						
[6]	GDP	3.62	1.432	0.965	2.657	0.112	0.376	0.217	−0.242	0.234	1					
[7]	City Development	2.44	0.350	0	1	0.236	0.281	0.255	0.732	−0.236	0.208	1				
[8]	Private R&D	1.83	0.208	0.117	0.573	0.687	0.351	0.199	0.321	−0.218	0.331	0.321	1			
[9]	Total enterprise	1.75	0.565	0.185	0.892	0.137	0.279	0.218	−0.147	0.112	0.274	0.248	0.271	1		
[10]	New enterprise	1.29	0.089	0.053	0.211	0.182	−0.233	0.287	−0.287	0.206	0.210	0.127	0.209	0.196	1	
[11]	Employment	2.04	0.446	0.392	0.687	0.233	0.189	0.216	0.236	0.138	0.228	0.124	0.266	0.277	0.215	1

Note(s): This table reports the variance inflation factor (VIF), descriptive statistics and correlation of the variables used in this study
Source(s): Created by authors

Table 3.
GMM estimation

	Female entrepreneurship (DV)							
	Model (1)		Model (2)		Model (3)		Model (4)	
	Coef	S.E	Coef	S.E	Coef	S.E	Coef	S.E
Female entrepreneurship (n−1)	0.385***	[0.139]	0.348***	[0.144]	0.314***	[0.134]	0.299***	[0.049]
Smart living	0.336***	[0.123]			0.308***	[0.168]	0.302***	[0.272]
Public R&D	0.268*	[0.179]			0.216*	[0.156]	0.197*	[0.302]
Smart living*Public R&D	0.187***	[0.113]					0.132***	[0.087]
Population			0.872*	[0.439]	0.864*	[0.408]	0.876**	[0.443]
City size			−0.336*	[0.203]	−0.329	[0.289]	−0.342	[0.288]
GDP			0.544***	[0.143]	0.538**	[0.183]	0.542**	[0.173]
City development			0.344**	[0.144]	0.363**	[0.238]	0.397**	[0.233]
Private R&D			0.282**	[0.155]	0.262*	[0.148]	2.456*	[0.183]
Total enterprise			0.539*	[0.203]	0.526**	[0.173]	0.516*	[0.180]
New enterprise			0.198*	[0.164]	0.177*	[0.153]	0.159	[0.152]
Employment			0.317***	[0.236]	0.295***	[0.317]	0.273***	[0.198]
City effect	*Included*		*Included*		*Included*		*Included*	
Year effect	*Included*		*Included*		*Included*		*Included*	
Warld χ^2	*182.63*		*164.19*		*161.95*		*159.33*	
AR(2)	1.93		1.84		1.91		1.79	
p-value	0.088		0.093		0.103		0.127	
Hensen test	47.35		51.68		55.21		56.70	
p-value	0.193		0.189		0.203		0.225	
N° observation	330		330		330		330	
N* City	30		30		30		30	

Note(s): DV: Female Entrepreneurship; Arellano-Bond test for AR(2) is used to detect possible autocorrelation issues. The Hansen test is used to detect possible over-identification restrictions in the model, and Wald Chi has been used to determine if a model's explanatory variables are significant; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. Standard errors in [parentheses]. AR(2)

Source(s): Created by authors

is found in relationship signs (both in terms of the direction of the relationships) and relationship strength. For each step, we also control the incremental contribution of the added variables.

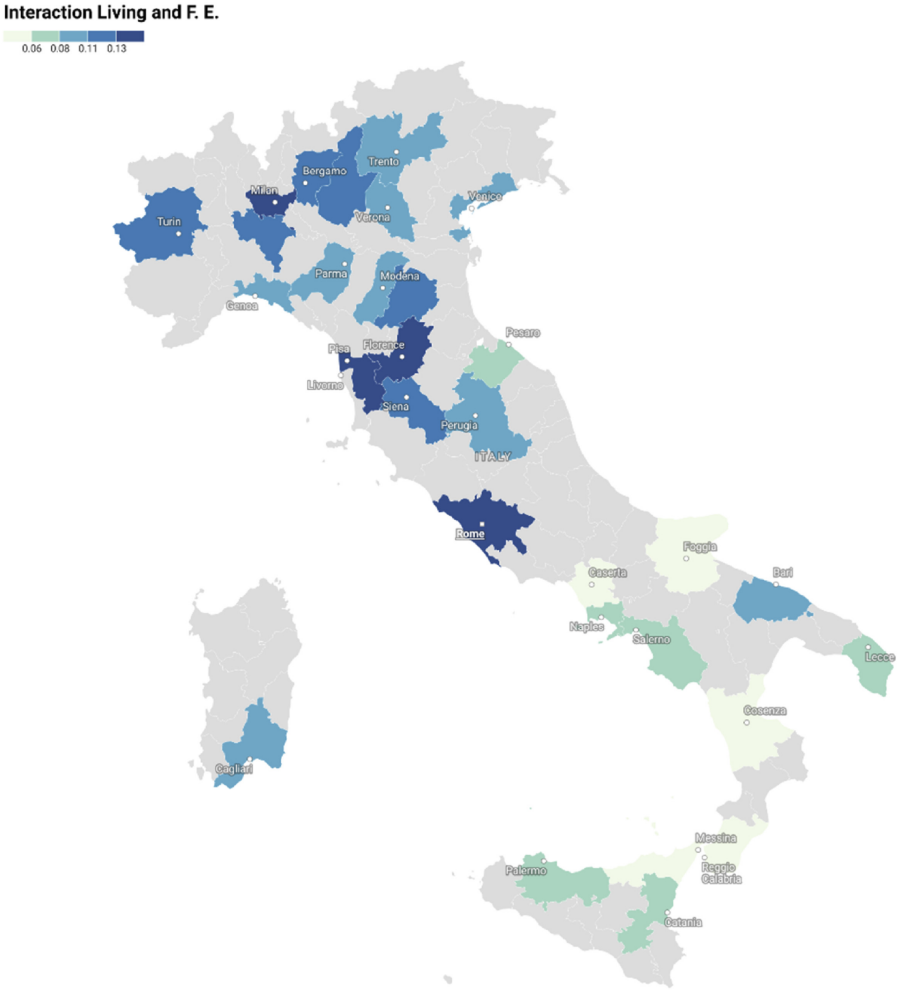
Model III provides support for Hypothesis 1, which assumes a direct effect of S*mart Living* practices on *Female Entrepreneurship* in the city. The parameter for *Smart Living* is positive and significant for explaining the relationship with the localization and advancement of female entrepreneurship in cities ($\beta = 3.168$; $p = 0.001$).

This result shows how the advancement of the smart living dimension in the city, which includes practices related to the promotion of cultural and educational services, social cohesion, a healthy environment, personal safety and housing, is perceived by women as a driver and optimal context to push their activities and found new business ventures. In this context, female entrepreneurs are affected by cities that offer a human-based and socio-economic context capable of satisfying their current needs in a safe and advanced environment (Allen, 2022; Martínez-Rodríguez *et al.*, 2022; Nesti, 2019). As a matter of fact, the smart living dimension creates a customized and safe environment and contributes to the user and human-centric trajectories embedded in the smart city scope (Han and Kim, 2021; Vanolo, 2014). Thus, we expected that over the medium and long term, advancing the smart living dimension would be fundamental to developing smart cities and promoting female entrepreneurship. To highlight the interaction between smart living and female entrepreneurship over the recent 12 years, we construct a choropleth map useful to evidence the specific density of the interaction between those two variables (see Figure 3). The map represents data set results and is based on the factual representation of the interception between smart living practice and business creation by female entrepreneurship. The range from light to dark blue shows the degree of interaction between *Smart Living* practices and *Female Entrepreneurship* in cities. The result is in clear contrast with the distribution of *Female Entrepreneurship* (see Figure 2) and shows the strange the *Smart Living* dimension is influencing the geography and trends of entrepreneurship over the years.

Model IV provides support for Hypothesis 2. To test the effect of *Public R&D* investments, we introduced the interaction effect (*Smart Living x Public R&D*). Model IV shows that the parameter for *Smart Living* directly affects *Female Entrepreneurship* ($\beta = 3.218$; $p = 0.042$) and the *Smart Living*Public R&D* is positive and statistically significant for *Female Entrepreneurship* ($\beta = 2.761$; $p = 0.000$). These results suggest that Public R&D investments in cities over the years should have a dual outcome. First, we note that public investment in R&D directly affects female entrepreneurship in cities. Second, advancing smart living practices in cities is complementary in affecting female entrepreneurship. Figure 4 provides graphs of this relationship, which suggest that high levels of *Public R&D* investment are better able to exploit potential *Female Entrepreneurship* for any given advancement of potential *Smart Living* practices in the city. Accordingly, this result provides support for Hypothesis 2.

4.1 Endogeneity concern

To control the potential endogeneity and assess the stability of the GMM approach, we apply several tests and conjectures. First, intrinsic in the GMM model, we follow the Roodman GMM dynamic approach (Roodman, 2009a, b), including a one-year lagged-dependent variable as an instrument to test the persistence of the dependent variable. Thus, to evaluate the robustness of the model and the results, we include diagnostic tests to guarantee the validity of dynamic GMM estimations. Specifically, to guarantee the GMM model's consistency, we include the Sargan test, the Arellano and Bond test and the Wald Chi-Square (Magazzini and Calzolari, 2019). First, we applied the Sargan test (1958) to



Source(s): Created by authors

Figure 3.
Choropleth map of the interaction between SL and FE

control for the presence of over-identification. The test results indicate that it is impossible to reject the null hypothesis confirming the estimates' consistency. As a second test, we also applied the Arellano and Bond test (Arellano and Bond, 1991; Roodman, 2009a, b) to control for the autocorrelation in the idiosyncratic disturbance term in the model. According to this test, we consider the AR (1) and AR (2) tests to control for possible autocorrelation issues. The application of AR (1) and (2) confirms that endogeneity problems do not drive our findings. Finally, going beyond the single estimation test, we applied the Wald Chi-square test to control for the model's validity and robustness. As a result, the Wald chi-square test supports the significance of the smart living variable in the model. The results are reported in Table 3, including the tests and control applied. The results and test are consistent with the model estimations, confirming the robustness of our results and the absence of endogeneity problems in our results.

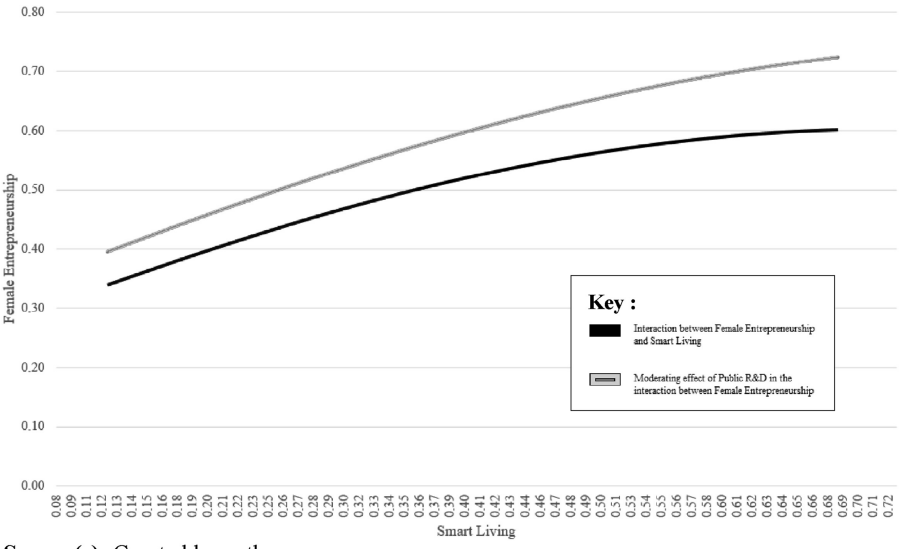


Figure 4.
Predicted relationship between SL and FE moderated by public R&D investment

Source(s): Created by authors

5. Discussion and conclusion

This study investigates how the smart living practices embedded in the smart cities' dimensions affect the economic environment in driving female entrepreneurship in cities. Specifically, this study is one of the first that attempts to quantitatively measure and address the importance of the smart living dimension in the city trajectories considering the human-based practices related to education, health, safety, cohesion and inclusion in cities in affecting entrepreneurial activities.

This study delves into the intricate interplay between smart living practices and female entrepreneurship within the context of smart cities. Our investigation seeks to uncover how the dimensions of smart living embedded within the fabric of smart cities influence the economic landscape, specifically in driving female entrepreneurship. In a pioneering effort, this study quantitatively examines and addresses the significance of the smart living dimension in city trajectories. This dimension encapsulates human-centric practices encompassing education, health, safety, cohesion and inclusion that collectively impact entrepreneurial activities.

Our theoretical framework, the Innovation Ecosystem, guides our exploration and is validated through empirical findings. We posit and substantiate a direct association between advancing the smart living dimension and enhancing female entrepreneurship (Bartoloni *et al.*, 2022; Carvalho, 2015; Oh *et al.*, 2016). City characteristics, reflecting the quality of life through cultural and educational amenities, social cohesion, a healthy environment, personal safety and housing, exhibit a compelling influence on the business establishment and the promotion of female entrepreneurship (Hughes *et al.*, 2012; Shayan and Kim, 2023; Strohmeyer *et al.*, 2017). Notably, this phenomenon is particularly pronounced in cities with elevated levels of smart living practices over time. The underlying mechanism hinges on the advanced smart living dimension, which creates a fertile ground for individuals, citizens and entrepreneurs to thrive, establishing their lives and businesses within the local milieu (Kummitha, 2019, 2020; Ooms *et al.*, 2020; Zhao *et al.*, 2021).

These results harmonize with existing literature emphasizing the influence of the urban environment on female entrepreneurship (Kogut and Mejri, 2022; Nguyen, 2021; Rosca *et al.*, 2020; Rosenthal and Strange, 2012). Our findings corroborate the sensitivity of women to the

quality of life, educational resources, health services and safety in the city (Allen, 2022; Caragliu and Del Bo, 2022; Nesti, 2019). Specifically, these underscore the divergent impact of the smart living dimension on male and female entrepreneurial activities in urban settings. Although the entrepreneurial activities within cities are marginally influenced by the city's living dimension, there is a distinctly positive effect on female entrepreneurship, which appears to be more sensitive to the dynamics of urban livability compared to its male counterpart. As revealed by previous studies, the allure of a secure and advanced setting fosters a conducive atmosphere for entrepreneurial pursuits among women (Estrin and Mickiewicz, 2011; Solesvik *et al.*, 2019).

Furthermore, our investigation extends to exploring the moderating effect of higher public R&D investment within the city on the nexus between smart living practices and female entrepreneurship. Our analysis underscores a complementary relationship between public R&D investment and smart living practices. This observation aligns with prior research on the role of public R&D investments in shaping urban areas and smart city evolution (Abid *et al.*, 2022; Betz *et al.*, 2016; Laursen *et al.*, 2016; Lee *et al.*, 2013). We propose that the dynamics of female entrepreneurship localization can also be understood through a substitution effect. In cities transitioning towards smart city trajectories, those with robust smart living dimensions and substantial public R&D investments tend to propel female entrepreneurship. This is rooted in the creation of an environment where a human-based context of high quality of life converges with entrepreneurial opportunities, thus underpinning a sustainable ecosystem for innovation and economic growth.

Our study unfolds within the Innovation Ecosystem framework, demonstrating the interdependence of smart living practices, public R&D investment and female entrepreneurship. By navigating these interconnected pathways, we navigate the transformative potential of innovative practices, urban infrastructure and human-centric dimensions in fostering a thriving entrepreneurial landscape within the evolving smart city paradigm.

5.1 Theoretical and practical implications

This study offers practical and theoretical contributions to the academic discourse. The research goes beyond the conventional boundaries of the smart city literature highlighting that, beyond mere technological implementations, the human-based development within smart cities profoundly impacts the urban environment and, in turn, catalyzes positive effects on economic dynamics and entrepreneurial activities (Kummitha, 2019; Muñoz and Cohen, 2016). This research bridges the theoretical and empirical gaps in the realm of female entrepreneurship, showing that entrepreneurial activities benefit from local policies and smart cities' advancement (Kummitha, 2019; Liu, 2012). While a large stream of literature criticizes the current smart implementation and discusses about the possibility of losing the connection with the real needs of the users (Berrone *et al.*, 2016; Datta, 2015; Hollands, 2015), to our knowledge, no research has revealed these effects referring to the human-based perspective as the majority of the critics focusing on the contradictory effect of the overdevelopment of technologies in the city (Kummitha, 2020; Marchesani *et al.*, 2023a, b). This expansion of the existing discourse enriches the theoretical discussion, showing that the advancement of smart cities (as a context), combined with the driving force of the smart living dimension (as a driver), contributes to the entrepreneurial ecosystem and positively affects the localization for female entrepreneurial activities within cities where individuals can thrive and establish their lives. These findings contribute to the academic debate concerning the existing relationship between urban and entrepreneurial ecosystems (Malecki, 2009; Stuart and Sorenson, 2003; Sunny and Shu, 2019; Tsvetkova, 2015) and contribute to the current academic debate about female entrepreneurship (De Vita *et al.*, 2014; Guzman and Kacperczyk, 2019; Harrison *et al.*, 2020; Poggesi *et al.*, 2016).

Moreover, we showed that the advancement of smart living practices in smart city trajectories is crucial for urban advancement and cannot be considered less important than other dimensions of smart cities (i.e. mobility, governance, environment, economy, governance and people). The research underscores the potential of tailoring smart living practices to specific socio-economic contexts, highlighting their role in fostering an inclusive innovation ecosystem. This approach contributes to shaping an advanced and inclusive entrepreneurial environment, particularly benefiting female entrepreneurs and promoting gender-inclusive economic growth. In this line, this research underscores that the advancement of this dimension is essential for holistic urban advancement, emphasizing that the development of the human-centric aspects cannot be overlooked or marginalized (Bartoloni *et al.*, 2022; Caragliu and Del Bo, 2019; Han and Kim, 2021). Policymakers should pay more attention to the management of smart city practices and their impact on the urban environment, coordinating the various dimensions and considering the effects that a city's livability has on the location of female entrepreneurial activities and, more broadly, on the entire entrepreneurial ecosystem. This will help policy makers to assume an integrative view while developing smart city practices and urban investment that promote and support entrepreneurial activities. In developing policy interventions to support entrepreneurial ecosystems in the smart city context, policymakers should pay attention to moving beyond digital advancement since an inclusive and liveable city contributes to shaping entrepreneurial activities.

5.2 Limitations and future directions

This study has some limitations due to the quantitative nature of the research. First, the study focuses on a single country. This limitation is common to most quantitative studies related to the smart city, which often arises from the type of dataset, measurement and policies used. Nonetheless, we consider Italy an appropriate context in which to investigate the current relationship due to the considerable cross-city variation within the country. Second, even though we examined the development of the economic environment in the report, this factor could influence the development of female entrepreneurship. Moreover, we recognize the potential impact of variables like social capital, education and access to capital on the connections between the smart city and the innovation environment. These influences gain prominence, particularly concerning female entrepreneurship, due to global cultural and socio-economic contexts. This perspective underscores the opportunities for further investigation into these complex dynamics. Future research could explore the nuanced effects of the smart city concept on female entrepreneurship within varied socio-economic contexts, such as the differing urban ecosystems of North America, Latin American countries, specific East Asian economies like Japan and South Korea and distinct regions within Africa, including both Sub-Saharan and Northern parts, to understand the role of factors like economic development, cultural influences and policy frameworks.

In this line, we call for future research on the role of entrepreneurship in the context of smart cities, a relationship currently still under-investigated. Third, the current understanding of the smart living dimension is not well-developed. Thus, we have relied on the reference literature to construct our variable. Finally, future research should advance the construction of this dimension, by including its relations with the local (citizens) and economic (enterprise and entrepreneurship) environment.

Note

1. The economic stratification was determined based on the GDP used to measure economic growth. In the breakdown, "low-GDP" cities are those in the region with a GDP per capita below €20,000, "medium-GDP" cities are those in the region with a GDP per capita between €20,000 and €40,000, and "high-GDP" cities are those in the region with a GDP per capita exceeding €40,000. Sources: https://ec.europa.eu/eurostat/web/regions/background

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About the authors

Filippo Marchesani is a researcher at the Department of Management and Business Administration at the university "G. d'Annunzio" Chieti-Pescara. He holds his PhD in Accounting, Management and Business Economics. He was a visiting researcher at the University of Girona (Spain). His research interests focus on Cities competitiveness, Smart Cities, Smart Tourism, Innovation and Entrepreneurship. He serves on the editorial board of Springer Nature Business & Economics Journal and is a peer-reviewer for several international journals. He has recently published these issues in *International Marketing Review, Technological Forecasting and Social Change, Cities, Journal of Cleaner Production, Current Issues in Tourism*. He also published a book with Emerald Publishing and contributed to several Elsevier books. Filippo Marchesani is the corresponding author and can be contacted at: filippo.marchesani@unich.it

Francesca Masciarelli is an Associate Professor at the University G. d'Annunzio. She received her Ph.D. from the University of Trento. She was a visiting researcher at the Copenhagen Business School and at the University of Sussex. Her research interests include social capital, management of innovation and entrepreneurship. She has published on these issues in *Organization Science, Journal of International Business Studies, Journal of Business Ethics, Regional Studies, Industry and Innovation, International Marketing Review and Journal of Small Business and Entrepreneurship*. She has also published two books with the Edward Elgard Publishing, a book with Emerald Publishing and a book with Routledge.