DIGITALIZATION IN SHAPING FEMALE AND MALE ENTREPRENEURIAL POTENTIAL

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ABSTRACT

This study examines the impact of digitalization on the context shaping male and female entrepreneurial potential across 78 economies, utilizing the Female Entrepreneurship Index (FEI) and the Male Entrepreneurship Index (MEI). By analyzing the effects of digital transformation, the study aims to understand whether digital tools can reduce gender disparities in entrepreneurship or if they primarily benefit one gender. Findings indicate a positive effect of digitalization on both FEI and MEI, affirming that digital readiness enhances entrepreneurial opportunities for all. However, in economies where MEI surpasses FEI, digitalization tends to widen the gender gap, with male entrepreneurs gaining a disproportionate advantage. Conversely, in contexts where female entrepreneurship dominates, digitalization does not significantly impact the MEI–FEI gap. Additional analyses reveal that factors like economic development (gross domestic product per capita) and gender inequalities (political empowerment of women) interact with digitalization to support both genders, though competitive environments are notably more influential on female entrepreneurial potential. These insights highlight the nuanced role of digitalization in fostering entrepreneurship, suggesting policies must consider these dynamics to effectively support gender-balanced growth in entrepreneurial ecosystems.

Keywords: entrepreneurship, female entrepreneurship, male entrepreneurship, gender, Female Entrepreneurship Index (FEI), Male Entrepreneurship Index (MEI), digitalization

JEL codes: L26, O33, J16

I. INTRODUCTION

Digital technologies have radically disrupted every aspect of business (Nambisan, Wright, and Feldman 2019, Vial 2019). Digitalization enables firms to cut costs and distinguish their products, especially when addressing organizational slack and environmental uncertainty (Zhang, Pang, and Li 2024). Digitalization also fosters the development of new skills, empowering businesses to adapt quickly, innovate, meet consumer needs, and achieve competitive advantages (Sun et al. 2023). Kreiterling (2023) shows that digital innovation, such as cloud services, social media, and other digital tools, reduces costs, boosts sales, and strengthens customer relationships, supporting business growth. Digitalized firms (e.g., with an online presence) are more resilient because digitalization helps them survive economic shocks (Szücs 2020, Nose and Honda 2023). In addition, Gaweł, Mroczek-Dąbrowskam and Pietrzykowski (2023) emphasize that digitalization lowers barriers and speeds up entry into international markets. Bhandari et al. (2023) also confirm that firms integrate digitalization with internationalization efforts to achieve higher profitability. At the same time, Kraus et al. (2023) find that digitalization promotes disruptive innovation, particularly in firms with low entrepreneurial orientation. In addition, Rosin et al. (2020) note that digitalization enhances efficiency and flexibility, although the savings in resources are indirect. In summary, digitalization enhances competitiveness, efficiency, flexibility, and innovation while strengthening resilience through the adoption of new technologies and skills.

While the number of businesses led by women is increasing worldwide (Entrepreneurship Database, World Bank),[1] research indicates that several barriers still hinder female entrepreneurship (Vossenberg 2013; Laguía et al. 2019; Mishra, Mangla, and Maheshwari 2024). As digital technology increasingly impacts business, it is essential to reconsider support strategies and programs for enterprises owned by women. There is an ongoing debate about whether digitalization can help close the gap between men and women in accessing essential business conditions and resources (Ughetto et al. 2020).

The literature suggests digitalization has a dual effect on female entrepreneurship, either alleviating or exacerbating existing challenges. On the one hand, according to the literature, it positively impacts female entrepreneurship, potentially narrowing the gender gap in entrepreneurship (e.g., Pergelova et al. 2019; Yang, Huang, and Gao 2022; Boateng et al. 2023; Irwin, McDowell, and Ribeiro-Navarrete 2023). Early feminist theories examined how technology upheld patriarchy, while modern cyberfeminist writings view digital technologies as a challenge to traditional gender differences (Wajcman 2010). On the other hand, the most recent cyberfeminist literature explores how technology often undermines women's interests and can worsen disparities between male and female entrepreneurs (e.g., Gutiérrez-Esteban et al. 2021, Wang et al. 2023). Despite extensive literature on the impact of digitalization on entrepreneurship, there is limited research addressing how digital technology specifically affects female entrepreneurs. Alhajri and Aloud (2024) review 18 studies on female digital entrepreneurship from 2017 to 2022 to find that the literature is limited and lacks theoretical and methodological diversity, thus highlighting the need for more research, especially on cross-national and gender differences. Therefore, this study's central research questions are: To what extent can female entrepreneurs benefit from digitalization compared to their male counterparts? Can digitalization be a transformative tool in reducing the gender gap in the entrepreneurial landscape?

The literature review in Section II explores the existing research on digitalization and entrepreneurship, with a focus on identifying the challenges and opportunities that digital tools present to female entrepreneurs. Further, the research gap is identified, upon which the research

[1] World Bank. Entrepreneurship Database. www.worldbank.org/en/programs/entrepreneurship/gender (accessed 25 September 2024).

objectives and hypotheses are also defined. Section III outlines the variables (data sources, descriptive statistics) that are used to assess the impact of digitalization on female and male entrepreneurship, and presents the research methodology applied. Section IV presents the findings from the econometric analyses, comparing the effects of digitalization on both female and male entrepreneurship and highlighting any gender-specific impacts. In Section V, we conclude the paper by summarizing the key insights and offering recommendations for policy aimed at supporting female entrepreneurs in the digital age.

II. LITERATURE REVIEW

A. Women Entrepreneurs and Digitalization: Empowering

The positive impact of digitalization on female entrepreneurship has been well documented in several studies. Shukla et al. (2021) study the relationship between women's internet skills (operative, informational, and creative) and their entrepreneurial intentions, and find that women with strong internet skills are more likely to pursue entrepreneurship. The authors conclude that information and communication technology (ICT) is key to empowering women as entrepreneurs, particularly by enabling them to run businesses remotely. Promoting digital skills among women, especially those without entrepreneurial backgrounds, can boost their entrepreneurial intentions. Moeini Gharagozloo et al. (2023) investigate how digital readiness affects women's participation in entrepreneurship, analyzing 385 economy-year observations from 2010 to 2016. The research examines how an economy's digital capacity affects women's involvement in entrepreneurship and reduces gender inequality. Results show that, in digitally advanced economies, women gain easier access to information and networks, lowering costs and creating a more equitable landscape for resources and connections compared to men.

Salamzadeh et al. (2024) find that digital technology helps Iranian women entrepreneurs overcome gender stereotypes, resource limits, and cultural norms by accessing markets, expanding networks, and building skills. While digital literacy, flexible work, and e-commerce support business growth, the study also notes that persistent gender stereotypes and societal biases continue to impact women's confidence and entrepreneurial aspirations. McAdam, Crowley, and Harrison (2019) state that digital entrepreneurship significantly empowers women in restrictive environments, such as Saudi Arabia, because digital platforms allow these women to challenge gender norms, achieve financial independence, and transform their social and familial roles. However, they also point out that its effectiveness depends on family support, access to resources, and wider social change because digital entrepreneurship alone cannot address systemic gender inequality.

In addition, digitalization has been shown to empower female entrepreneurs in Ghana by enhancing their economic, psychological, and relational capabilities, helping them optimize operations and achieve positive returns (Boateng et al. 2023). Latin American women tourism entrepreneurs report that digital technologies increase business visibility and expand market reach domestically and internationally, promoting independence and entrepreneurial growth. However, barriers like limited access to digital devices and infrastructure, especially in rural areas, along with lack of training, low confidence in technology use, and concerns about security and privacy, prevent them from fully leveraging these opportunities (Khoo et al. 2024).

Research indicates that digitalization can help reduce gender biases that are linked to traditional funding sources. Irwin, McDowell, and Ribeiro-Navarrete (2023) recommend exploring how technological advancements, such as artificial intelligence (AI), the Internet of Things, blockchain technology, and crowdfunding platforms, can help women entrepreneurs overcome financing

challenges. Yang, Huang, and Gao (2022) find that digital financial inclusion significantly supports the growth and expansion of businesses owned by women, particularly in areas where access to traditional financial services is restricted. Pergelova et al. (2019) examine the international expansion of small and medium-sized enterprises led by women and men to find that digital technologies play a crucial role in helping female entrepreneurs overcome traditional business barriers. Studying 300 Bulgarian entrepreneurs, they observe that women are more inclined to use digital tools for gathering international market intelligence. Mediation models further show that these technologies enhance market intelligence, promoting international expansion, because female entrepreneurs use them to offset limited access to traditional networks. Front-end digital infrastructures (such as websites and online payments) and information systems have a stronger impact on small and medium-sized enterprises led by women, serving as "democratizing" tools that support their growth. Abdelwahed et al. (2024) find that digital technology self-efficacy is a strong predictor of digital innovation and women's empowerment. Female entrepreneurs who are confident in using digital tools are more likely to adopt innovative solutions and feel empowered.

B. Women Entrepreneurs and Digitalization: Mirroring Gender Inequalities

The latest cyberfeminist research indicates that offline gender inequalities are mirrored in the online environment (Dy, Martin, and Marlow 2018). For instance, Gutiérrez-Esteban et al. (2021) point out that, although digitalization opens many opportunities for female entrepreneurs, socioeconomic factors and the gender gap often prevent them from fully taking advantage of these. The research highlights that women encounter a dual digital divide: one related to geography (comparing rural and urban areas) and the other tied to traditional gender roles, including family responsibilities and the "double shift" that many women face. As a result, the authors conclude that merely adopting digital tools is insufficient to close gender disparities because family and social obligations continue to affect women's ability to effectively leverage these technologies.

Pappas et al. (2018) find that Greek women understand the importance of ICT skills for succeeding in the digital age and pursuing entrepreneurship. However, the study reveals that gender inequality and limited access to training contribute significantly to the underrepresentation of women in the digital sector, restricting their entrepreneurial opportunities. Women feel they have fewer chances to gain essential ICT skills because of these barriers. In addition, Wang et al. (2023) conclude that a masculine identity tends to be more advantageous in crowdfunding, requiring women to adopt masculine norms online to increase their chances of success. This poses a challenge to the empowering effects of digitalization for female entrepreneurs because online platforms frequently reflect the same gender inequalities that are found offline.

Dy, Marlow, and Martin (2017) challenge the idea that the internet is a neutral space for entrepreneurship, highlighting that social inequalities remain present online. Their interviews with female digital entrepreneurs in the United Kingdom reveal that traditional gender roles and limited access to resources and networks continue to shape women's online experiences. Although digital entrepreneurship is often seen as flexible, it can heighten the conflict between work and family. Moreover, access to financial and technological resources is tied to social status, disadvantaging women from lower classes in building sustainable digital businesses. Similarly, Dy, Martin, and Marlow (2018) find that, while digital entrepreneurship can create new opportunities for marginalized groups, these are strongly influenced by the social status of individuals. Consequently, digital entrepreneurship alone cannot ensure social empowerment for people with social disadvantages. Martin and Wright (2005) assert that ICT offers valuable

opportunities for female entrepreneurs in the small business sector, but success largely depends on personal traits, resource access, and networking.

Oggero, Rossi, and Ughetto (2020) examine how financial literacy and digital skills affect entrepreneurial choices in Italy, focusing on gender differences. They find that digital skills boost entrepreneurship for both men and women, but the impact is stronger for men. Men with digital skills are more likely to pursue entrepreneurial opportunities, whereas these skills have a less pronounced impact on women's decisions to become entrepreneurs. While digital tools open up new opportunities for women in business, Pappas et al. (2018) reveal a significant gender gap in the ICT sector, with women being underrepresented in both technology roles and digital entrepreneurship. This disparity is largely attributed to cultural norms, stereotypes, and a lack of female role models. Mora-Rodríguez, Verdú-Jover and Gómez-Gras (2020) interview female digital entrepreneurs in Barcelona and find benefits of digitalization such as scalability, easier client access, lower costs, and greater flexibility. However, digital businesses still do not fully address work–life balance issues or eliminate gender inequalities because cultural and educational barriers still hinder women's entrepreneurial participation.

Wang and Keane (2020) study female digital creative entrepreneurs in the People's Republic of China (PRC) and find that these women often grapple with an unstable entrepreneurial identity and minimal recognition in male-dominated technology sectors. Despite growing participation, they continue to face stereotypes and traditional family expectations, which limits their visibility in the digital creative industry. Crittenden, Crittenden, and Ajjan (2019) study how ICT tools—like mobile phones, social media, and computers—help women microentrepreneurs build networks, boost confidence, and achieve empowerment in their personal and professional lives. The research highlights ICT's essential role in facilitating women's entrepreneurial growth, while noting that those with higher self-efficacy use these tools more effectively to expand their networks. In addition, Verheul, van Stel, and Thurik (2006) investigate how technological advancements in ICT create opportunities for business startups. They find that these advancements benefit male entrepreneurs more than female entrepreneurs, who tend to favor service-oriented businesses over high-tech sectors.

C. Research Positioning

According to the literature in Section IIA, "digital spaces" tend to be less hierarchical and less gender-biased. Overall, the literature suggests digitalization could give women the opportunity to compete with men. However, these analyses usually focus only on women and overlook how digitalization benefits male entrepreneurs. Although digitalization can positively impact both genders, men may benefit more, meaning women's relative position might not improve despite overall progress. Therefore, to scientifically demonstrate that digitalization reduces the gender gap, it is essential to examine its effects on both men and women.

At the same time, Section IIB highlights that, while digitalization and ICT provide valuable opportunities for female entrepreneurs, socioeconomic factors and gender inequalities often limit their ability to fully benefit. Women also face added challenges from geographic divides and traditional gender roles, which restrict their success in digital entrepreneurship. Although digital tools offer flexibility and empowerment, they alone cannot overcome social disadvantages or close the gender gap in entrepreneurship. Ultimately, the success of female entrepreneurs in the digital space depends heavily on access to resources, education, and navigating both social and digital barriers. The literature in this section highlights the importance of contextual factors: how existing social inequalities can create obstacles for women who are pursuing entrepreneurship in the digital age. Therefore, Vossenberg (2013) argues that policies promoting women's

entrepreneurship may be ineffective if they do not tackle the deeper gender biases in the entrepreneurial environment. In other words, even with programs supporting women entrepreneurs, real economic or social progress is unlikely if underlying systemic inequalities and cultural norms stay the same.

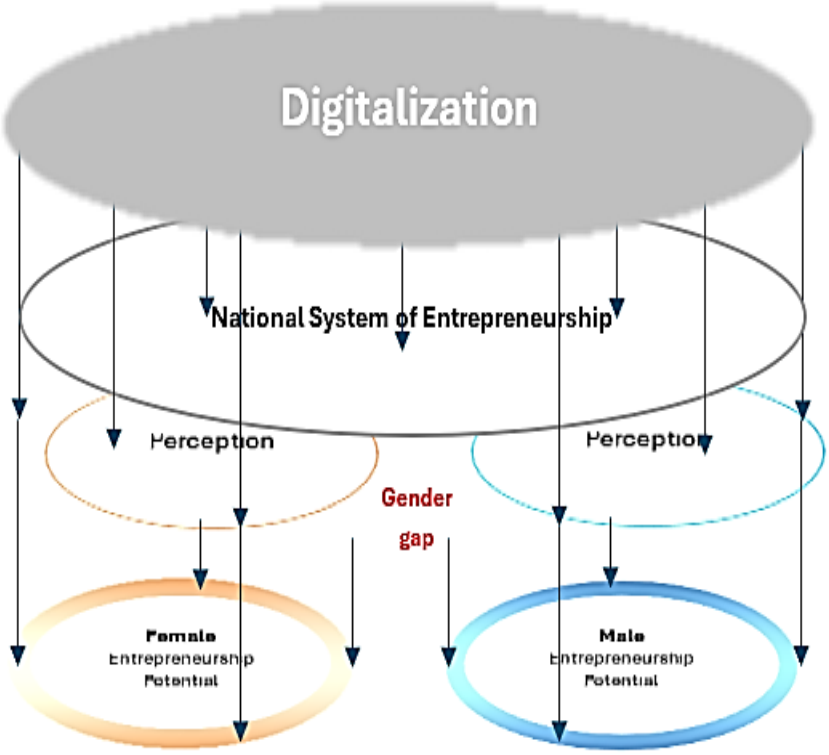
Numerous studies have explored how digitalization directly affects entrepreneurship, allowing entrepreneurs to test new business models, work more efficiently, and add value for their customers through digital tools (Autio et al. 2018). However, as noted in Section IIB, the success of digitalization in supporting entrepreneurship for both women and men largely depends on the specific context in which entrepreneurship is embedded. Digitalization and the transformative changes it triggers impact the entrepreneurial environment that shapes the entrepreneurial potential of both women and men.

National-level institutional-contextual factors create a complex system that shapes how entrepreneurship functions and grows in each economy. Acs, Autio, and Szerb (2014) introduced the national system of entrepreneurship (NSE) framework to identify the institutional and contextual factors that either support or limit entrepreneurship potential. The NSE framework suggests that individuals' interest in entrepreneurial opportunities drives resource allocation dynamic at the national level, promoting productive uses of resources. In each economy, this process is shaped by individual choices that direct resources toward either low- or high-productivity entrepreneurial activities. According to Acs, Autio, and Szerb, individuals, as potential entrepreneurs, drive this process, though their choices are influenced by national context. NSE theory suggests people decide to invest their time, money, or other resources in entrepreneurship based on the broader national institutional environment. Thus, an economy's entrepreneurial potential depends on its institutional context and how individuals perceive and respond to it.

Digitalization brings a new dimension to the NSE framework. This includes, for instance, how well an economy's education system develops digital skills and literacy; and how digitalization enables new funding options (like crowdfunding), supports efficient governance (e-governance) and business operations, improves access to skilled talent, such as software and app developers skilled in these technologies, or protects society from the potential dangers of digitalization, such as cybercrime, through effective regulations. However, neither the NSE framework nor the Global Entrepreneurship Index (GEI)—an earlier composite measure of national-level entrepreneurial potential—currently considers digitalization or its effects on the entrepreneurial potential of women and men at the national level. In each economy, men and women are surrounded by the same NSE, yet, because of gender inequalities, they perceive this context differently, especially in terms of resource accessibility. If there were no differences in perception between men and women, Figure 1 would show only one "perception" circle instead of two, as both genders would experience the socioeconomic context in the same way.

This study aims to examine how digitalization influences the NSE shaping entrepreneurial potential for women in different economies. Additionally, we seek to determine whether digitalization exerts a stronger impact on the broader context that is shaping female or male entrepreneurial potential.

Figure 1: Conceptual Model



Source*:* Authors' illustration.

Another key critique of the literature is that it relies mostly on qualitative methods, like in-depth interviews and single case studies. There is a need for more quantitative research and multi-case studies to further develop theories beyond the usual approaches (Alhajri and Aloud 2024). The critical review of the literature suggests a lack of studies that:

(i) explore the impact of digitalization on businesses from both male and female perspectives;
(ii) assess how digitalization affects the broader context influencing entrepreneurial potential for both genders, rather than focusing only on individual intentions or outcomes; and
(iii) use quantitative methods, as most research in this area relies heavily on qualitative approaches.

Based on the identified research gap, the study hypothesizes that

H1: Digitalization has a significant positive effect on the context influencing female/male entrepreneurial potential.

H2: Digitalization mediates the influence of socioeconomic and gender inequality factors, such as economic development, firm density, female political empowerment, and sex at birth, on the context that is shaping female/male entrepreneurial potential.

H3: Digitalization has a more pronounced positive impact on the factors influencing male entrepreneurship potential compared to female entrepreneurship potential.

III. DATA AND METHOD

To test these hypotheses, we conducted econometric analyses on data from 78 economies. The models in Section IV include various variables measured by selected indicators. In this section, we explain why these variables were included in the econometric models and describe the indicators used. The second part of the section (Subsections IIIB and IIIC) provides a brief overview of the analytical methods used and presents the descriptive statistics of the indicators.

A. Data

In the econometric models, the dependent variable represents female/male entrepreneurship potential, whereas the independent variable captures aspects of digitalization and technology use. Control variables were added to account for the gender inequalities noted in the literature, and to reflect the direct input, output, and indirect outcome that affect the entrepreneurial potential.

1. Dependent Variable

In the econometric models, composite indicators measuring the institutional context and its perception shaping female and male entrepreneurial potential are used as the dependent variable. Female/male entrepreneurial potential is influenced by the national institutional context. Therefore, we examine whether digitalization affects this context for entrepreneurship in the economies studied. While the GEI broadly examines the institutional environment shaping national entrepreneurial potential, our study focuses specifically on how digitalization impacts the factors shaping female and male entrepreneurial potential at the national level. To this end, the Female Entrepreneurship Index (FEI) and the Male Entrepreneurship Index (MEI) have been developed, each designed to identify elements that facilitate the success of promising female and male entrepreneurs—those who lead ventures distinguished by innovation, market growth, and an emphasis on exports. The FEI/MEI framework allows for international comparisons and evaluations of entrepreneurial environment that typically influence productive female/male entrepreneurship. As composite indices, the FEI/MEI provide an in-depth analysis of the global landscape of female and male entrepreneurial potential, highlighting support systems, opportunities, and perceptions that impact high-potential female and male entrepreneurs. This section provides a brief overview of the indices, with additional details available in Appendix A.[2] The FEI and MEI were both developed at the request of the Asian Development Bank, with detailed descriptions of their structure, methodology, and results provided in the Working Paper "The Global Index of Female Entrepreneurship Systems 2024" (Komlósi et al. 2025). Both the FEI and MEI cover the same set of 78 economies (Appendix B) and are based on the NSE framework developed by Acs, Autio, and Szerb (2014), originally designed for the GEI.

National-level entrepreneurship potential has been conceptualized as "the dynamic, institutionally rooted interplay between entrepreneurial mindsets, capabilities, and ambitions of individuals, which steers resource allocation through the establishment and management of new business ventures" (Acs, Autio, and Szerb 2014). Based on this conceptualization, a five-tier index structure is proposed: (i) indicators, (ii) variables, (iii) pillars, (iv) subindices, and, ultimately, (v) the overarching index. The FEI/MEI framework is shown in Figure A1 in Appendix A. Each of the three subindices—Entrepreneurial Attitudes, Entrepreneurial Abilities, and Entrepreneurial Aspirations—encompasses multiple pillars, which can be viewed as relatively autonomous components of this entrepreneurship metric. The three subindices are built upon 14 foundational pillars. Each pillar has two parts. One reflects individual perceptions of entrepreneurship in

[2] The appendix is available at http://dx.doi.org/10.22617/WPS250314-2.

society, especially among entrepreneurs. The other represents national-level institutional factors. This dual approach covers both the micro and the macro aspects of entrepreneurship.

All individual-level indicators come from the Global Entrepreneurship Monitor (GEM) Adult Population Survey. It was examined which economies had GEM data available for the 2017–2019 (pre–coronavirus disease [COVID-19]) and 2020–2022 (post–COVID-19) periods. For each economy, the most recent year with available GEM data was used to calculate the FEI and the MEI. This includes economies with data only for the 2017–2019 period (17 economies) and those with data only for the 2020–2022 period (61 economies). The institutional variables are drawn from several reputable international sources, including indicators from Transparency International; the United Nations Educational, Scientific and Cultural Organization; the World Economic Forum; the United Nations; The Heritage Foundation; and the World Bank. The latest institutional indicators and variables are available as of 20 August 2024. Detailed steps for calculating the FEI and MEI composite indices, along with a list of the individual and institutional factors used, and the calculated scores, are provided in Appendix A.

2. Independent Variable

In this study, digitalization serves as the independent variable in the models presented. To demonstrate the impact of digitalization on the context shaping female/male entrepreneurial potential, we relied on indicators derived from specific pillars of the Network Readiness Index (NRI) (Portulans Institute 2025). The NRI is a composite indicator that measures the digital and technological preparedness of economies worldwide. From 2016, the NRI is developed and regularly updated by the Portulans Institute. The NRI shows which economies can use digital technologies to boost economic and social development, and to what extent. The 2023 edition ranks 134 economies, evaluating them on digital infrastructure, governance, human skills, and the societal impact of technology. This provides insights into each economy's readiness for digital transformation and ability to harness digital advancements for growth. It is structured around four main pillars:

(i) **Technology.** This pillar assesses the level of ICT infrastructure, access, and usage within the economy, covering elements like broadband internet, mobile network quality, and cloud adoption.
(ii) **People.** This pillar evaluates the skills and engagement of individuals, businesses, and governments in digital technologies, including digital skills training, workforce competencies, and participation in the digital economy.
(iii) **Governance.** Here, the focus is on the policies, regulations, and institutions that support an economy's digital transformation, assessing aspects such as cybersecurity, privacy policies, and regulatory frameworks.
(iv) **Impact.** This pillar measures the broader economic and social effects of digital adoption, examining how technology influences gross domestic product (GDP) growth, quality of life, and sustainable development goals.

In the econometric models, only the technology pillar and the individual sub-pillar within the people pillar of the NRI were used as variables to represent digitalization (NRI_{TP}). This NRI_{TP} variable measures digitalization by assessing ICT usage and individual digital skills.

The technology pillar of the NRI is structured around three main sub-pillars:

(i) Access. This sub-pillar evaluates the accessibility of ICT infrastructure, examining aspects such as communication infrastructure, internet availability in schools, mobile tariffs, and international internet bandwidth.

(ii) Content. This area focuses on the volume and quality of digital content and applications generated within economy. Key indicators include GitHub commits, internet domain registrations, mobile app development, and scientific publications in AI.

(iii) Future technologies. This sub-pillar assesses readiness for emerging technological advancements. It includes metrics related to the adoption and investment in technologies, such as AI, Internet of Things, robot density, and computer software spending.

Meanwhile, the NRI's people pillar evaluates the readiness of individuals, businesses, and government to effectively use ICT, focusing on digital skills and human capital essential for innovation, economic growth, and social wellbeing. Specifically, the individual subindex within the people pillar assesses individual engagement with technology, covering factors like active mobile broadband subscriptions, ICT skills in education, social media usage, tertiary enrollment rates, adult literacy, and the concentration of AI talent (Dutta and Lanvin 2023).

The additional NRI pillars were not considered in our analysis because they mainly capture broader institutional factors, which are already included in the FEI/MEI composite indicators.

3. Control Variables

GDP per capita (PPP, constant 2021 international $).[3] GDP per capita is a key indicator of economic development, closely tied to institutions, technology access, innovation, and entrepreneurship. Wennekers and Thurik (1999) find that entrepreneurship boosts competition and drives innovation, indirectly enhancing economic dynamism. According to Acs (2006), developed economies have a higher proportion of opportunity-driven entrepreneurs, which correlates with higher GDP per capita. Similarly, Stam and van Stel (2011) show that growth-focused entrepreneurship contributes significantly to economic growth in transition and high-income economies. Institutional factors strongly shape entrepreneurial activity and, in turn, influence economic growth. Stable, supportive institutions encourage entrepreneurs to invest in new projects and facilitate innovation (Sergi et al. 2019; Urbano, Aparicio, and Audretsch 2019).

Digitalization is a key driver of economic growth because it reduces transaction costs (World Bank 2016) and boosts productivity and efficiency (Cardona, Kretschmer, and Strobel 2013; Brynjolfsson and McAfee 2014; OECD 2019; Hawash and Lang 2020). For developing economies, digitalization offers the potential to catch up economically (Dahlman, Mealy, and Wermelinger 2016; Niebel 2018; Solomon and van Klyton 2020), while, in advanced economies, it supports sustainable development (Uçar, Le Dain, and Joly 2020; Mishakov, Daitov, and Gordienko 2021) and enhances business agility (Škare and Soriano 2021). Higher-income economies often have better digital infrastructure; for instance, Brodny and Tutak (2022) find that "old European Union" economies adopt digital technologies more quickly than "new European Union" economies. Therefore, controlling for GDP per capita helps isolate the direct impact of digitalization on female/male entrepreneurship potential by removing confounding effects linked to economic differences. Understanding the role of digitalization independently of income level offers clearer insights for policy and investment decisions.

Firm density (proxy for competition).[4] Firm density—measuring the total number of registered firms with limited liability per 1,000 working-age people (ages 15–64) at the end of each calendar

[3] World Bank. World Development Indicators Database. https://data.worldbank.org/indicator (accessed 15 December 2024).

[4] World Bank. Entrepreneurship Database. www.worldbank.org/en/programs/entrepreneurship (accessed 15 December 2024).

day—serves as a key indicator of a region's pre-existing entrepreneurial activity and market saturation.

On the one hand, digital adoption by firms lowers the costs of starting new businesses, which encourages new firms to enter the market and increases overall firm density, and shifting individuals toward salaried employment options (Shapiro and Mandelman 2021). On the other hand, digitalization affects the business environment, including firm density, which influences market dynamics like entry barriers and resource competition. Higher firm density often means more competition for resources, which pushes firms to innovate and adopt technologies like ICT to improve performance and stay competitive (Haller and Siedschlag 2011). Studies have shown that competition is a key driver of ICT adoption (Dasgupta et al. 1999; Sadowski, Maitland, and van Dongen 2002; Dholakia and Kshetri 2004; Hollenstein 2004). Controlling for firm density (proxy for competition) helps isolate digitalization's effect on the context of entrepreneurial potential, ensuring the presence of established businesses does not distort the results.

Female political empowerment (as a proxy for gender gap). The political empowerment subindex of the Global Gender Gap (GGG) Report (World Economic Forum 2024) measures gender gap in political representation and participation in governance.

As discussed in Section II, studies show that digitalization has great potential to empower women in entrepreneurship by lowering entry barriers; improving access to resources, markets, and networks; and offering flexibility to balance work and personal life, which helps address traditional business challenges faced by women (Sun et al. 2024). However, gender-related challenges remain, especially in low- and middle-income economies, where women often lack essential digital skills. This skills gap stems from sociocultural barriers that reinforce the digital gender gap: (i) traditional gender roles restrict women's access to technology; (ii) socialization and education frequently discourage women from gaining technological or entrepreneurial skills, especially in digital areas; (iii) stereotypes further limit opportunities for women; and (iv) community and family support may also be lacking (Mariscal et al. 2019). Similar issues affect Spanish women, with cultural and social norms shaping self-perception and confidence, often discouraging entrepreneurial pursuits (Mora-Rodriguez, Verdú-Jover and Gómez-Gras 2020). These challenges are not unique to low- and middle-income economies; Davaki (2018), in a study for the European Parliament's Committee on Women's Rights and Gender Equality, found similar issues contributing to the digital gender gap in Europe. These points clearly show that gender inequality, shaped by sociocultural factors, can impact how effectively women in any society, whether in low- or high-income economies, can harness digitalization to enhance their entrepreneurial potential. Therefore, to accurately evaluate digitalization's role in female/male entrepreneurial potential without biased results from gender inequality, it is essential to control for this factor.

A comprehensive indicator reflecting sociocultural barriers that maintain gender inequality across multiple economies is not available, so a proxy variable is needed to represent these factors effectively. In this study, we use the political empowerment subindex from the GGG Report, which measures the gender gap in political representation and participation in governance. The presence or absence of sociocultural barriers that sustain gender inequality is effectively illustrated by political empowerment. This subindex specifically focuses on the disparities between men and women in political leadership and decision-making roles. The subindex is designed to highlight the extent to which women have achieved equality in political power and decision making, reflecting their influence and participation at the highest levels of governance. A higher score indicates a smaller gender gap, with the goal being full equality in political representation and leadership roles. It is composed of several key indicators:

(i) **Women in parliament.** This measures the ratio of women to men in the national parliament or equivalent legislative body.
(ii) **Women in ministerial positions.** This evaluates the ratio of women to men holding ministerial-level positions in the government.
(iii) **Years with female head of state.** This indicator assesses the proportion of the past 50 years during which an economy has had a woman as the head of state (either president or prime minister) (Pal et al. 2024).

The GGG Report provides additional indicators, but many of these indicators measure the quality of an economy's institutional framework, which is already incorporated into the FEI/MEI.

Additionally, as part of a robustness check, we tested the Women, Business and the Law (WBL) 1.0[5] composite indicator from the World Bank as a proxy for capturing an economy's gender gap, alongside the GGG political empowerment variable. The WBL 1.0 indicator measures laws affecting women's economic opportunities. The results, which yielded similar findings, are presented in Appendix C.

Sex ratio at birth.[6] The sex ratio at birth (male births per female births) indicator measures the number of male births for every female birth in a population. Numerous studies investigate the link between sex ratio at birth (or sex imbalances) and entrepreneurial activity, particularly in regions with highly skewed ratios. Wei and Zhang (2011) find that, in the PRC, a male-skewed sex ratio correlates with increased entrepreneurship and economic growth, as families with sons are more inclined to start businesses and put in extra effort. Chang and Zhang (2015) further conclude that sex ratios directly influence entrepreneurial activity, suggesting marriage market pressures may drive some men toward entrepreneurship. Their research highlighted Taipei,China's high male-to-female ratio in 1949, after the civil war in the runup to the creation of the PRC, leading to increased competition among men and, thus, a higher likelihood of entrepreneurial pursuits. Durante et al. (2012) note that sex ratios impact the career and family planning choices of women in the United States; when fewer men are present in a community, women are often more inclined to focus on financial independence. The relevance of the "sex ratio at birth" (or sex imbalance) is reinforced by Chao et al. (2019), whose study identifies imbalances in sex ratio at birth in parts of Asia, especially because of sex-selective abortions over recent decades. Analyzing data from 202 economies, the study finds significant skewed sex ratios in 12 economies, notably the PRC and India, with an estimated 23.1 million "missing" female births from 1970 to 2017.

In summary, sex ratio at birth is a relevant control variable because it captures socio-demographic pressures and cultural dynamics that influence entrepreneurship. Including sex ratio at birth as a control enables a clearer analysis of digitalization's impact on entrepreneurship by accounting for demographic imbalances that might otherwise skew results. By controlling for the sex ratio, the model can better isolate the specific effects of digitalization on entrepreneurial potential without conflating it with the demographic-driven entrepreneurial motivations noted in the literature.

B. Methods

Building on the results from the literature provided above we concluded that a statistically significant relationship between entrepreneurship and digitalization could be assumed. To prove

[5] World Bank. Women, Business and the Law Data. https://wbl.worldbank.org/en/wbl-data (accessed 15 December 2024).
[6] World Bank. World Development Indicators Database. https://data.worldbank.org/indicator (accessed 15 December 2024).

this hypothesis, we first constructed a multiple regression model using ordinary least squares (OLS). The OLS framework was chosen as our primary tool for analysis because the relationship examined is assumed to be quite complex, hence it is inevitably influenced by various factors. Taking all these effects into consideration requires an analytical framework that accounts for multiple predictors. Further, since OLS minimizes the sum of squared residuals, it is a straightforward and an efficient approach to obtain consistent parameter estimates and, consequently, is widely used for its interpretability. Building on this characteristic of the OLS method, we could compare our results for male and female entrepreneurship, respectively.

To assess the unique contribution of digitalization to entrepreneurship, we started with a baseline model that included only the control variables, which were our socioeconomic and gender inequality factors, to test how these variables independently influence the outcome. Using this stepwise approach enabled us to enhance the interpretability and robustness of the model by clearly isolating the effects of digitalization after accounting for control variables.

Drawing on the existing literature, we also conducted mediation analyses because digitalization can be presumed to serve as a bridge linking socioeconomic and gender inequality factors with entrepreneurship. Mediation analysis is an appropriate tool for distinguishing between the direct effect and the indirect effect through digitalization, which can reveal whether digitalization significantly changes the dynamics observed in our baseline models.

Moreover, we also examined at the difference between MEI and FEI values to determine whether digitalization increased or decreased the gap between male and female entrepreneurship. We developed additional OLS models, applying Chow tests to identify structural breaks in the data, in order to examine how digitalization impacted economies with varying MEI and FEI characteristics.

C. Descriptive Statistics

Table 1: Descriptive Statistics of Variables

	FEI	MEI	NRI	GDP per cap	GGG polemp	Firm density	Sex at birth
Mean	0.38	0.39	49.58	35,995.55	0.25	4.50	105.31
Median	0.35	0.36	49.54	33,221.13	0.22	2.95	105.30
Standard deviation	0.16	0.17	12.24	26,066.51	0.16	4.72	1.43
Minimum	0.05	0.06	14.00	1,606.63	0.02	0.12	101.85
Maximum	0.78	0.81	73.83	135,506.16	0.68	24.74	110.63
Cases	78	78	73	78	75	73	78

FEI = female entrepreneurship index, GDP = gross domestic product, GGG = Global Gender Gap Report, MEI = male entrepreneur index, NRI = Network Readiness Index.
Source: Authors' calculations.

The descriptive statistics in Table 1 show that entrepreneurship measured on a 0–1 scale tends to vary between 0.05 and 0.81 with Madagascar having the lowest and the United States having the highest level of entrepreneurship. Further, MEI scores tend to be higher than FEI scores on average. Regarding digitalization, Burkina Faso has the lowest score. The United States has the highest yet again. Looking at economic development, we can see that there is a very significant difference between the GDP per capita of Madagascar, which is the lowest of all economies, and

that of Luxembourg, which is more than 84 times Madagascar's. Gender equality measured through GGG political empowerment on a scale of 0–1 shows that, while Kuwait and Lebanon lag significantly behind in these aspects, Finland is a frontrunner. Firm density statistics show Pakistan has the lowest number of registered firms, while Estonia has the most, with 24.74 firms per 1,000 working-age people (ages 15–64). Sex at birth rate is lowest in Angola, while it is highest in the PRC.

IV. RESULTS

A. Effect of Digitalization on Female Entrepreneurship Index

This section presents the findings of the econometric analysis investigating the impact of digitalization on the context shaping female entrepreneurial potential. The analysis uses the FEI as the dependent variable, while the key independent variable is digitalization, represented by the NRI (NRI_{TP}). Control variables, including GDP per capita, the GGG political empowerment subindex sex ratio at birth, and firm density, are also included in the regression models to isolate the specific effect of digitalization on female entrepreneurship potential. The model in equation form:

$$y_{FEI} = \beta_0 + \beta_1 * x_{NRI_{TP}} + \beta_{GDP_{percap}} + \beta_{GGG_{polemp}} + \beta_{sexatbirth} + \beta_{firmdensity} + \varepsilon$$

where:

y_{FEI} is the Female Entrepreneurship Index,

$x_{NRI_{TP}}$ is the digitalization indicator,

$x_{GDP_{percap}}, x_{GGG_{polemp}}, x_{sexatbirth}, x_{firmdensity}$ are the control variables,

β_0 is the constant (intercept),

$\beta_1, \ldots, \beta_5$ are the coefficients for each variable,

ε is the error term.

The OLS method was applied. In the first step (M1/a), only the control variables were included, to see their effect on female entrepreneurship potential. In the second step (M1/b), we added the digitalization indicator (NRI_{TP}) to assess its impact. Analyzing in two steps helps clarify the individual effects of the control variables before introducing the main explanatory variable. By first isolating the control variables, we can see their importance and their impact on the dependent variable. Then, adding digitalization in the second step shows whether it adds explanatory power and improves the model's fit, highlighting its specific contribution while controlling for other factors.

Step 1: Control variables only (Model M1/a). In the first step, the regression model includes only the control variables, to assess their relationship with FEI. Table 2 summarizes the results.

The R-squared for this model is 0.7468, meaning the model explains about 74.68% of the variance in the FEI. All the control variables have a significant effect on female entrepreneurship at a 5% significance level.

(i) GDP per capita has a very strong positive association with FEI ($\beta = 0.643233$, $p < 0.0001$), indicating that higher economic wealth significantly supports female entrepreneurial activity.

(ii) Political empowerment is also positively related to FEI (β = 0.149554, p = 0.0223), suggesting that economies with greater gender equality in political leadership tend to have a more favorable ecosystem for female entrepreneurship.
(iii) Firm density shows a positive and statistically significant impact (β = 0.165882, p = 0.0129), implying that the availability of registered firms in the economy is associated with stronger female entrepreneurial activity.
(iv) Sex ratio at birth, although significant, has a smaller effect (β = 0.121690, p = 0.0390), indicating that demographic factors also play a role, though less substantially.

Step 2: Adding the explanatory variable (Model M1/b). In the second step, the explanatory variable for digitalization (NRI_{TP}) is introduced into the model (Table 3).

Table 2: Ordinary Least Squares Model M1/a, Dependent Variable is Female Entrepreneurship Index

Variable	Coefficient	SE	t-ratio	p-value	
Constant	−0.00989141	0.0585029	−0.1691	0,8663	***
GDP per capita (s_GDP_{percap})	0.643233	0.0685803	9.379	<0,0001	**
Political empowerment (s_GGG_{polemp})	0.149554	0.0639206	2.340	0,0223	**
Firm density (s_firmdensity)	0.165882	0.0649340	2.555	0,0129	**
Sex at birth (s_sexatbirth)	0.121690	0.0577710	2.106	0,0390	***
Mean dependent var.	0.014376		SD dependent var.	0.950444	
Sum squared resid.	16.01192		SE of regression	0.492549	
R-squared	0.746783		Adjusted R-squared	0.731437	
F(4, 66)	48.66158		p-value (F)	5.30e-19	
Log-likelihood	−47.87283		Akaike criterion	105.7457	
Schwarz criterion	117.0591		Hannan-Quinn	110.2446	

GDP = gross domestic product, GGG = Global Gender Gap Report, SD = standard deviation, SE = standard error.
Note: Using observations 1–78 (n = 71), missing or incomplete observations dropped: 7. * p < 0.10, ** p < 0.05, *** p < 0.01.
Source: Authors' calculations.

Table 3: Ordinary Least Squares Model M1/b, Dependent Variable Is Female Entrepreneurship Index, Explanatory Variable Included

Variable	Coefficient	SE	t-ratio	p-value	
Constant	0.0171507	0.0469874	0.3650	0,7163	
GDP per capita (s_GDP_{percap})	0.416913	0.0642303	6.491	<0,0001	***
Political empowerment (s_GGG_{polemp})	0.0890898	0.0512416	1.739	0,0870	*
Firm density (s_C_firmdensity)	0.109221	0.0520260	2.099	0,0398	**
Sex at birth (s_sexatbirth)	−0.0550857	0.0538828	−1.022	0,3105	
NRI (s_NRI_{TP})	0.453289	0.0693119	6.540	<0,0001	***
Mean dependent var.	0.042350		SD dependent var.	0.944271	
Sum squared resid.	9.490158		SE of regression	0.388120	
R-squared	0.843480		Adjusted R-squared	0.831057	
F(4, 66)	67.90069		p-value (F)	4.69e-24	
Log-likelihood	−29.46389		Akaike criterion	70.92778	
Schwarz criterion	84.33242		Hannan-Quinn	76.24585	

GDP = gross domestic product, GGG = Global Gender Gap Report, SD = standard deviation, SE = standard error.
Note: Using observations 1–78 (n = 69), missing or incomplete observations dropped: 9. * p < 0.10, ** p < 0.05, *** p < 0.01.
Source: Authors' calculations.

The inclusion of the digitalization variable improves the explanatory power of the model, with the R-squared increasing to 0.8435, indicating that the model explains 84.35% of the variance in the FEI. This represents a substantial improvement over the previous model with control variables only.

(i) Digitalization has a highly significant and positive effect on female entrepreneurship (β = 0.453289, p <0.0001). This suggests that higher levels of digital readiness, particularly in terms of individual digital skills and access to ICT tools, significantly contribute to the growth and success of female entrepreneurial potential.
(ii) GDP per capita continues to exhibit a strong and positive relationship with FEI (β = 0.416913, p <0.0001), though its effect size decreases slightly compared to Model M1/a.
(iii) Political empowerment remains significant but at a lower level (β = 0.0890898, p = 0.0870), suggesting that, while political equality still matters, its impact diminishes slightly when digitalization is considered.
(iv) Firm density maintains its significance (β = 0.109221, p = 0.0398), reinforcing the importance of a vibrant business environment for female entrepreneurship.
(v) Sex at birth becomes insignificant in this model (p = 0.3105), indicating that the demographic factor may not be as crucial when digitalization is considered.

The improvement in the adjusted R-squared value is significant when the digitalization variable (NRI_{TP}) is added to the regression. In the first model (M1/a), the adjusted R^2 value is 0.731, whereas it is 0.831 in the second model (M1/b). Specifically, the R^2 change (deltaR^2) was also tested to see if it was significant on its own. The corresponding p-value is also below 0.001,

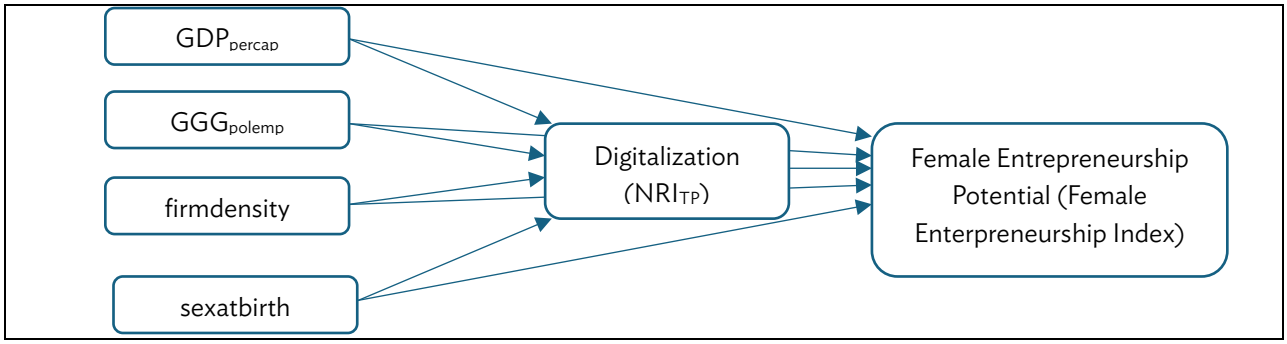
indicating that the improvement in the model is statistically significant. Further, the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC) values, which also measure model fit, significantly decreased in the second model compared to the first model, suggesting that the inclusion of the digitalization variable resulted in a better model.

The results show that digitalization (NRI_{TP}) is essential for boosting female entrepreneurship potential. The continued importance of GDP per capita, political empowerment of women, and firm density highlights the complex nature of female entrepreneurship, where economic strength, competition, a gender-sensitive society, and digital readiness all play key roles.

B. Mediation Models for Female Entrepreneurship Index

The literature in Section IIIA shows that the control variables affect female entrepreneurial potential, but digitalization may mediate some of these effects. Thus, the second analysis examines whether digitalization acts as a mediator between the control variables and FEI (Figure 2).

Figure 2: Digitalization as a Mediator Between Control Variables and Female Entrepreneurship Index



GDP = gross domestic product, GGG = Global Gender Gap Report, NRI = Network Readiness Index.
Source: Authors' illustration.

Table 4 provides estimates of how much of the effect of the control variables on female entrepreneurship is mediated by digitalization. We can determine whether digitalization acts as a mediator by examining the indirect effects through the pathway from the control variables to the dependent variable (FEI) via digitalization (NRI_{TP}). For digitalization to be a significant mediator, these indirect effects should be statistically significant (p-value <0.05) and substantial:

(i) The indirect effect of GDP per capita on FEI through digitalization is 0.2202, with a p-value of <0.001, indicating a significant mediation effect.
(ii) Similarly, sex ratio at birth shows a significant indirect effect of 0.1676, with a p-value of <0.001, meaning digitalization mediates the relationship between the sex ratio and FEI.
(iii) For political empowerment and firm density, the indirect effects are not statistically significant (p-values >0.05), indicating that digitalization does not mediate the effects of these variables in a statistically significant way.

Table 4 also shows the direct effect of each control variable on FEI. If the indirect effect is significant, and the direct effect decreases but remains significant, this suggests that digitalization partially mediates the relationship:

(i) The direct effect of GDP per capita on FEI is 0.4169 ($p < 0.001$), showing that, while GDP per capita has a strong direct influence on FEI, a portion of its effect is mediated by digitalization, as demonstrated by the significant indirect effect.
(ii) The direct effect of the sex ratio at birth is not significant ($p = 0.285$), but the indirect effect through digitalization is highly significant, suggesting that digitalization fully mediates the relationship between sex ratio at birth and FEI.

The total effect of GDP on female entrepreneurship potential (FEI) is 0.6432. Out of this, 0.2202 is an indirect effect—meaning it comes from the influence of GDP on digitalization, which then impacts FEI. This suggests that digitalization is a significant pathway through which GDP enhances female entrepreneurship potential. The total effect of the sex ratio at birth on FEI is 0.1217, with a higher indirect effect of 0.1676 mediated by digitalization. This implies that sex ratio at birth impacts female entrepreneurship mostly through its effect on digitalization, which then influences FEI.

Table 4: Direct, Indirect, and Total Effects of Socioeconomic Factors on Female Entrepreneurship Index with NRI_{TP} as a Mediator, 95% Confidence Interval (a)

Type	Effect	Estimate	SE	Lower	Upper	β	z	p
Indirect	$s\_GGG_{polemp} \Rightarrow s\_NRI_{TP} \Rightarrow s\_FEI$	0.0612	0.0407	-0.01847	0.1409	0.0664	1.51	0.132
	$s\_sexatbirth \Rightarrow s\_NRI_{TP} \Rightarrow s\_FEI$	0.1676	0.0446	0.08010	0.2551	0.1778	3.75	<.001
	$s\_firmdensity \Rightarrow s\_NRI_{TP} \Rightarrow s\_FEI$	0.0565	0.0412	-0.02432	0.1373	0.0610	1.37	0.171
	$s\_GDP_{percap} \Rightarrow s\_NRI_{TP} \Rightarrow s\_FEI$	0.2202	0.0538	0.11486	0.3256	0.2366	4.10	<.001
Component	$s\_GGG_{polemp} \Rightarrow s\_NRI_{TP}$	0.1351	0.0875	-0.03644	0.3066	0.1408	1.54	0.123
	$s\_NRI_{TP} \Rightarrow s\_FEI$	0.4533	0.0662	0.32348	0.5831	0.4719	6.84	<.001
	$s\_sexatbirth \Rightarrow s\_NRI_{TP}$	0.3697	0.0823	0.20833	0.5311	0.3767	4.49	<.001
	$s\_firmdensity \Rightarrow s\_NRI_{TP}$	0.1246	0.0891	-0.05005	0.2993	0.1293	1.40	0.162
	$s\_GDP_{percap} \Rightarrow s\_NRI_{TP}$	0.4858	0.0950	0.29963	0.6720	0.5013	5.11	<.001
Direct	$s\_GGG_{polemp} \Rightarrow s\_FEI$	0.0891	0.0490	-0.00688	0.1851	0.0967	1.82	0.069
	$s\_sexatbirth \Rightarrow s\_FEI$	-0.0551	0.0515	-0.15600	0.0458	-0.0584	-1.07	0.285

Continued on the next page

Type	Effect	Estimate	SE	Lower	Upper	β	z	p
	s_firmdensity ⇒ s_FEI	0.1092	0.0497	0.01179	0.2067	0.1180	2.20	0.028
	s_GDP_{percap} ⇒ s_FEI	0.4169	0.0614	0.29662	0.5372	0.4479	6.79	<.001
Total	s_GGG_{polemp} ⇒ s_FEI	0.1496	0.0621	0.02790	0.2712	0.1591	2.41	0.016
	s_sexatbirth ⇒ s_FEI	0.1217	0.0561	0.01174	0.2316	0.1313	2.17	0.030
	s_firmdensity ⇒ s_FEI	0.1659	0.0631	0.04230	0.2895	0.1768	2.63	0.009
	s_GDP_{percap} ⇒ s_FEI	0.6432	0.0666	0.51271	0.7738	0.6858	9.66	<.001

FEI = Female Entrepreneurship Index, GDP = gross domestic product, GGG = Global Gender Gap Report, NRI = Network Readiness Index, SE = standard error.
Notes: 1. Confidence intervals computed with method: Standard (Delta method). 2. Betas are completely standardized effect sizes. Statistically significant results are highlighted in green.
Source: Authors' calculations.

C. Effect of Digitalization on Male Entrepreneurship Index

This section presents the results of the econometric analysis on how digitalization affects male entrepreneurial potential. The MEI is the dependent variable, with digitalization (NRI_{TP}) as the main independent variable. The same control variable was used. The model in equation form:

$$y_{MEI} = \beta_0 + \beta_1 * x_{NRI_{TP}} + \beta_{GDP_{percap}} + \beta_{GGG_{polemp}} + \beta_{sexatbirth} + \beta_{firmdensity} + \varepsilon$$

where:

y_{MEI} is the Male Entrepreneurship Index,

$x_{NRI_{TP}}$ is the digitalization indicator,

$x_{GDP_{percap}}, x_{GGG_{polemp}}, x_{sexatbirth}, x_{firmdensity}$ are the control variables,

β_0 is the constant (intercept),

$\beta_1, \ldots, \beta_5$ are the coefficients for each variable,

ε is the error term.

In this case as well, the first step (M2/a) includes only the control variables, to see their effect on the MEI. In the second step (M2/b), the digitalization indicator (NRI_{TP}) is added to assess its impact on male entrepreneurship potential. This two-step approach clarifies the individual effects of the control variables before adding digitalization and helps evaluate its additional contribution to the model's explanatory power.

Step 1: Control variables only (Model M2/a). In the first step, the regression model includes only the control variables, to assess their relationship with MEI. Table 5 summarizes the results.

Table 5: Ordinary Least Squares Model M2/a, Dependent Variable is Male Entrepreneurship Index

Variable	Coefficient	SE	t-ratio	p-value	
Constant	−0.00571556	0.0620142	−0.09217	0.9268	
GDP per capita (s_GDP_{percap})	0.624406	0.0726964	8.589	<0.0001	***
Political empowerment (s_GGG_{polemp})	0.189070	0.0677570	2.790	0.0069	***
Firm density (s_firmdensity)	0.137167	0.0688312	1.993	0.0504	*
Sex at birth (s_sexatbirth)	0.129183	0.0612384	2.110	0.0387	**
Mean dependent var.	0.018661		SD dependent var.	0.955446	
Sum squared resid.	17.99162		SE of regression	0.522111	
R-squared	0.718447		Adjusted R-squared	0.701383	
F(4, 66)	42.10357		p-value (F)	1.69e-17	
Log-likelihood	−52.01118		Akaike criterion	114.0224	
Schwarz criterion	125.3358		Hannan-Quinn	118.5213	

GDP = gross domestic product, GGG = Global Gender Gap Report, SD = standard deviation, SE = standard error.
Note: Using observations 1–78 (n = 71), missing or incomplete observations dropped: 7. * p < 0.10, ** p < 0.05, *** p < 0.01.
Source: Authors' calculations.

In Table 5, the R-squared value is 0.718, meaning that about 71.8% of the variation in MEI is explained by the model. The F-statistic is highly significant (F = 42.10357, p-value <0.0001), indicating that the model is statistically significant.

(i) **GDP per capita.** This variable shows a highly significant positive coefficient (0.624), with a t-ratio of 8.589 and a p-value of less than 0.0001, indicating a strong positive relationship between GDP per capita and MEI.
(ii) **Political empowerment.** The coefficient for political empowerment is also positive (0.189) and statistically significant, with a t-ratio of 2.790 and a p-value of 0.0069. This suggests that greater political empowerment is associated with higher male entrepreneurship levels.
(iii) **Firm density.** The coefficient is 0.137, with a t-ratio of 1.993 and a p-value of 0.0504, which is marginally significant. This indicates that the density of firms has a weak positive impact on male entrepreneurship.
(iv) **Sex at birth.** This variable also shows a positive effect on MEI, with a coefficient of 0.129, and is significant at the 0.05 level (p-value = 0.0387). This implies that gender factors (male sex at birth) have a statistically significant effect on male entrepreneurship.

The analysis reveals that GDP per capita and political empowerment have the strongest positive associations with male entrepreneurship, while firm density and sex at birth also show statistically significant, but somewhat weaker, effects. The model demonstrates a good fit, explaining a large proportion of the variance in MEI.

Step 2: Adding the explanatory variable (Model M2/b). In the second step, the explanatory variable for digitalization (NRI_{TP}) is introduced into the model (Table 6).

Table 6: Ordinary Least Squares Model M2/b, Dependent Variable Is Male Entrepreneurship Index, Explanatory Variable Included

Variable	Coefficient	SE	t-ratio	p-value	
Constant	0.0229840	0.0497408	0.4621	0.6456	
GDP per capita (s_GDP_{percap})	0.385762	0.0679940	5.673	<0.0001	***
Political empowerment (s_GGG_{polemp})	0.124483	0.0542443	2.295	0.0251	**
Firm density (s_firmdensity)	0.0756527	0.0550746	1.374	0.1744	
Sex at birth (s_sexatbirth)	−0.0547125	0.0570402	−0.9592	0.3411	
NRI (s_NRI_{TP})	0.482369	0.0733734	6.574	<0.0001	***
Mean dependent var.	0.046596		SD dependent var.	0.951154	
Sum squared resid.	10.63494		SE of regression	0.410863	
R-squared	0.827128		Adjusted R-squared	0.813408	
F(4, 66)	60.28640		P-value (F)	1.04e-22	
Log-likelihood	−33.39308		Akaike criterion	78.78615	
Schwarz criterion	92.19079		Hannan-Quinn	84.10422	

GDP = gross domestic product, GGG = Global Gender Gap Report, NRI = Network Readiness Index, SD = standard deviation, SE = standard error.
Note: Using observations 1–78 (n = 69), missing or incomplete observations dropped: 9. ** p < 0.05, *** p < 0.01.
Source: Authors' calculations.

Table 6 shows the results of the OLS Model M2/b, with MEI as the dependent variable and the digitalization indicator (NRI_{TP}) as the main explanatory variable. Key findings include:

(i) NRI_{TP}, the digitalization variable, has a strong positive and highly significant effect on MEI. The coefficient is 0.482, with a t-ratio of 6.574 and a p-value of less than 0.0001. This indicates that an increase in digitalization significantly contributes to higher male entrepreneurship activity.
(ii) GDP per capita continues to show a positive and significant effect (coefficient = 0.386, t-ratio = 5.673, p <0.0001), although its impact has slightly decreased with the inclusion of digitalization in the model.
(iii) Political empowerment remains positive and significant (p = 0.0251), but its coefficient is lower (0.124) compared to the previous model.
(iv) Firm density is no longer significant in this model (p = 0.1744), suggesting that it does not have a notable impact on MEI when digitalization is accounted for.
(v) The effect of the sex at birth variable is negative in this case, but not statistically significant (p = 0.3411), indicating it has no considerable effect on MEI when digitalization is included in the model.

The R-squared value is 0.827, meaning the model explains 82.7% of the variance in MEI, showing an improvement in model fit with the inclusion of digitalization. The F-statistic is highly significant (F = 60.286, p-value <0.0001), indicating that the model is statistically significant. The Akaike criterion (78.786) and the Hannan-Quinn criterion (84.104) indicate that the model fit has improved compared to the previous model (M2/a). In summary, the inclusion of the digitalization

variable significantly enhances the explanatory power of the model. Digitalization has a positive and significant impact on the MEI, while some of the control variables' effects diminish or lose significance when digitalization is considered.

We also concluded that R-squared and adjusted R-squared are slightly higher in the case of the FEI model (M1/b) than in the case of the MEI model (M2/b) (Table 3 and Table 6).

Table 7: Comparison of the Coefficients (M1/b and M2/b)

	FEI	p-value (FEI)	MEI	p-value (MEI)
Digitalization (s_NRI_{TP})	0.4533	<0.0001	0.4824	<0.0001
GDP per capita (s_GDP_{percap})	0.4169	<0.0001	0.3858	<0.0001
Political empowerment (s_GGG_{polemp})	0.0891	0.0870	0.1245	0.0251
Sex at birth (s_sexatbirth)	-0.0551	0.3105	-0.0547	0.3411
Firm density (s_firmdensity)	0.1092	0.0398	0.0757	0.1744

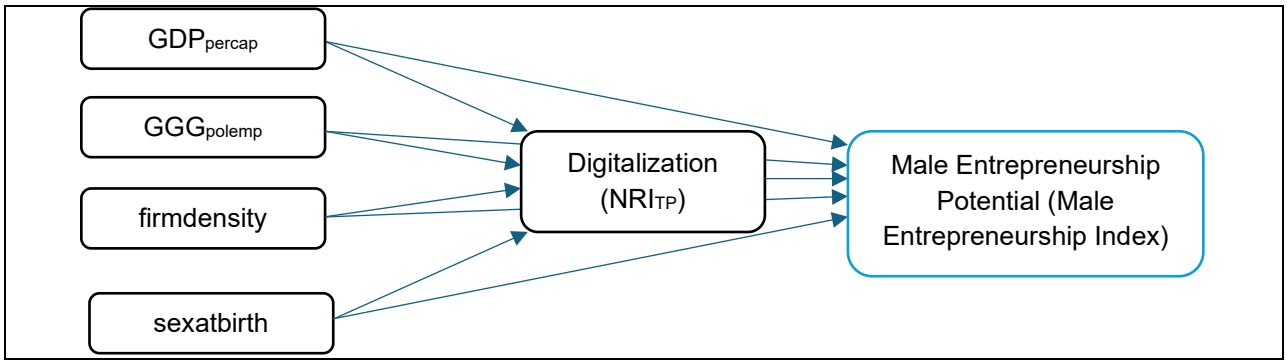
FEI = Female Entrepreneurship Index, GDP = gross domestic product, GGG = Global Gender Gap Report, MEI = Male Entrepreneurship Index, NRI = Network Readiness Index.
Source: Authors' calculations.

According to Table 7, digitalization and GDP per capita appear to have similar effects on both the FEI and the MEI, with no notable differences in their impact on the two indices. The variable for political empowerment also exhibits a comparable influence in both models. However, it reaches statistical significance at the α=5% level in the MEI model, whereas in the FEI model it is only significant at the α=10% level. The variable for sex at birth shows no statistical significance in either model. The most pronounced distinction between the MEI and FEI models lies in the effect of firm density (competition), which has a significant impact on FEI, but does not demonstrate any effect on MEI when digitalization is included.

D. Mediation Models of Male Entrepreneurship Index

In this section, we investigate how the control variables (GDP per capita, political empowerment, firm density, and sex at birth) impact the MEI both directly and indirectly through the mediating effect of digitalization (NRI_{TP}) (Figure 3).

Figure 3: Digitalization as a Mediator Between Control Variables and Male Entrepreneurship Index



GDP = gross domestic product, GGG = Global Gender Gap Report, NRI = Network Readiness Index.
Source: Authors' illustration.

GDP per capita has both significant direct and indirect effects on MEI, with digitalization mediating part of the relationship. Political empowerment exerts a significant total effect on MEI, although its indirect effect through digitalization is not significant. Firm density has a significant total effect, despite lacking individually significant direct or indirect effects. Sex at birth influences MEI mainly through its indirect effects via digitalization. This analysis highlights the key role of digitalization as a mediator for certain socioeconomic factors, especially in the case of GDP per capita and sex at birth. The mediation model for MEI shows a similar pattern to the mediation model for FEI.

Table 8: Direct, Indirect, and Total Effects of Socioeconomic Factors on Male Entrepreneurship with Digitalization (NRI_{TP}) as a Mediator, 95% Confidence Interval (a)

Type	Effect	Estimate	SE	Lower	Upper	β	z	p
Indirect	s_GDP_{percap} ⇒ s_NRI_{TP} ⇒ s_MEI	0.2343	0.0571	0.12244	0.3463	0.2500	4.10	<.001
	s_GGG_{polemp}⇒ s_ NRI_{TP} ⇒ s_MEI	0.0652	0.0433	-0.01963	0.1499	0.0702	1.51	0.132
	s_firmdensity ⇒ s_ NRI_{TP} ⇒ s_MEI	0.0601	0.0439	-0.02586	0.1461	0.0645	1.37	0.171
	s_sexatbirth ⇒ s_ NRI_{TP} ⇒ s_MEI	0.1783	0.0474	0.08538	0.2713	0.1878	3.76	<.001
Component	s_GDP_{percap} ⇒ s_ NRI_{TP}	0.4858	0.0950	0.29963	0.6720	0.5013	5.11	<.001
	s_ NRI_{TP} ⇒ s_MEI	0.4824	0.0701	0.34495	0.6198	0.4986	6.88	<.001
	s_GGG_{polemp} ⇒ s_ NRI_{TP}	0.1351	0.0875	-0.03644	0.3066	0.1408	1.54	0.123
	s_firmdensity ⇒ s_ NRI_{TP}	0.1246	0.0891	-0.05005	0.2993	0.1293	1.40	0.162
	s_sexatbirth ⇒ s_ NRI_{TP}	0.3697	0.0823	0.20833	0.5311	0.3767	4.49	<.001

Continued on the next page

Type	Effect	Estimate	SE	Lower	Upper	β	z	p
Direct	s_GDP_{percap} ⇒ s_MEI	0.3858	0.0650	0.25842	0.5131	0.4115	5.94	<.001
	s_GGG_{polemp} ⇒ s_MEI	0.1245	0.0518	0.02289	0.2261	0.1341	2.40	0.016
	s_firmdensity ⇒ s_MEI	0.0757	0.0526	-0.02749	0.1788	0.0812	1.44	0.151
	s_sexatbirth ⇒ s_MEI	-0.0547	0.0545	-0.16154	0.0521	-0.0576	-1.00	0.315
Total	s_GDP_{percap} ⇒ s_MEI	0.6244	0.0706	0.48605	0.7628	0.6623	8.85	<.001
	s_GGG_{polemp} ⇒ s_MEI	0.1891	0.0658	0.06012	0.3180	0.2001	2.87	0.004
	s_firmdensity ⇒ s_MEI	0.1372	0.0668	0.00617	0.2682	0.1454	2.05	0.040
	s_sexatbirth ⇒ s_MEI	0.1292	0.0595	0.01264	0.2457	0.1387	2.17	0.030

GDP = gross domestic product, GGG = Global Gender Gap Report, MEI = Male Entrepreneurship Index, NRI = Network Readiness Index, SE = standard error.
Notes: 1. Confidence intervals computed with method: Standard (Delta method). 2. Betas are completely standardized effect sizes. Statistically significant results are highlighted in green.
Source: Authors' calculations.

D. Further Analyses on Dependent Variables Derived from Female Entrepreneurship Index and Male Entrepreneurship Index

The following set of models analyzes the effect of digitalization (s_NRI_{TP}) on the difference between the MEI and the FEI across economies. The main goal is to see whether digitalization increases or decreases the gap between male and female entrepreneurship. The analysis includes structural breaks based on whether an economy's FEI is higher than its MEI, splitting the data into two subsamples: (i) economies where FEI is higher than MEI and (ii) economies where MEI is higher than FEI.[7]

Table 9: Ordinary Least Squares, Using Only Digitalization, Dependent Variable is s_MEI-FEI

Variable	Coefficient	SE	t-ratio	p-value	
Constant	0.0227056	0.118325	0.1919	0,8484	
NRI s_NRI_ave	0.221007	0.119143	1.855	0,0678	*
Mean dependent var.	0.022706		SD dependent var.	1.027959	
Sum squared resid.	72.56558		SE of regression	1.010965	

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[7] Further breakpoints, based on the relationship between FEI and MEI as well as on the female labor force participation rate, were also tested, but the results did not show the presence of any further structural break.

Variable	Coefficient	SE	t-ratio	p-value
R-squared	0.046223		Adjusted R-squared	0.032790
F(4, 66)	3.440905		p-value (F)	0.067753
Log-likelihood	−103.3647		Akaike criterion	210.7293
Schwarz criterion	215.3102		Hannan-Quinn	212.5549

FEI = Female Entrepreneurship Index, MEI = Male Entrepreneurship Index, NRI = Network Readiness Index, SD = standard deviation, SE = standard error.
Note: Using observations 1–78 (n = 73), missing or incomplete observations dropped: 5. * p < 0.10.
Source: Authors' calculations.

According to Table 9, digitalization has a positive and significant effect on the MEI-FEI difference (coefficient = 0.0221, p-value = 0.00678). This indicates that higher levels of digitalization increase the gap between MEI and FEI, with MEI typically benefiting more than FEI from digitalization. The model has an R-squared value of 0.046, suggesting that digitalization explains only a small portion of the variation in the MEI-FEI difference. The F-statistic (p = 0.0067753) indicates that the model is statistically significant.

In Table 10, the Chow test indicates a structural break between economies where FEI is higher than MEI and those where MEI is higher than FEI (F(2, 69) = 29.919, p-value = 4.4e-10). This confirms that the relationship between digitalization and the MEI-FEI difference differs significantly between these two groups of economies.

Table 10: Results of the Chow Test

Variable	Coefficient	Std error	t-ratio	p-value
Constant	0.54070	0.11071	4.88400	6.48e-06 ***
s_NRI_ave	0.20994	0.09389	2.23600	0.0286 **
FEIhigher0no1yes	−1.41388	0.18279	−7.735	6.10e-011 ***
FE_s_NRI_ave	−0.207431	0.28255	−0.7341	0.4653
Mean dependent var.	0.0227	SD dependent var.	1.02796	
Sum squared resid.	38.8630	SE of regression	0.75049	
R-squared	0.4892	Adjusted R-squared	0.46699	
F(3, 69)	22.0273	p-value (F)	0.00000	
Log-likelihood	−80.57227	Akaike criterion	169.14450	
Schwarz criterion	178.3064	Hannan-Quinn	172.79570	

FEI = Female Entrepreneurship Index, NRI = Network Readiness Index, SD = standard deviation, SE = standard error.
Note: Using observations 1–78 (n = 73), missing or incomplete observations dropped: 5. ** p < 0.05, *** p < 0.01.
Source: Authors' calculations.

Based on the results of our Chow test, we decided to test our subsamples separately. For the 30 economies where FEI was higher, the MEI-FEI difference was affected by digitalization the following way (Table 11):

Table 11: Ordinary Least Squares, Using Only Digitalization, Dependent Variable Is s_MEI-FEI, Economies Where FEI > MEI

Variable	Coefficient	SE	t-ratio	p-value	
Constant	−0.873190	0.0737641	−11.84	<0,0001	***
NRI s_NRI_ave	0.00251050	0.135147	0.01858	0,9853	
Mean dependent var.	−0.873352		SD dependent var.	0.373209	
Sum squared resid.	3.621356		SE of regression	0.380597	
R-squared	0.000014		Adjusted R-squared	-0.039986	
F(4, 66)	0.000345		p-value(F)	0.985327	
Log-likelihood	−11.19000		Akaike criterion	26.38000	
Schwarz criterion	28.97167		Hannan-Quinn	27.15064	

FEI = Female Entrepreneurship Index, MEI = Male Entrepreneurship Index, NRI = Network Readiness Index, SE = standard error of the estimate, std error = standard error.
Note: Using observations 1–30 (n = 27), missing or incomplete observations dropped: 3. *** p < 0.01.
Source: Authors' calculations.

For the 30 economies where FEI is higher than MEI, digitalization does not have a significant effect on the MEI-FEI difference (coefficient = 0.00025, p-value = 0.9853). This suggests that, in economies where female entrepreneurship dominates, digitalization does not significantly impact the gap between male and female entrepreneurship. The model explains almost none of the variance in the MEI-FEI difference, with an R-squared of virtually zero (0.000014).

Table 12: Ordinary Least Squares, Using Only Digitalization, Dependent Variable Is s_MEI-FEI, Economies Where MEI > FEI

Variable	Coefficient	SE	t-ratio	p-value	
Constant	0.540695	0.132022	4.095	0,0002	***
NRI s_NRI_ave	0.209942	0.111965	1.875	0,0674	*
Mean dependent var.	0.548652		SD dependent var.	0.919633	
Sum squared resid.	35.24162		SE of regression	0.894956	
R-squared	0.073993		Adjusted R-squared	0.052948	
F(4, 66)	3.515848		p-value(F)	0.067431	
Log-likelihood	−59.14366		Akaike criterion	122.2873	
Schwarz criterion	125.9446		Hannan-Quinn	123.6574	

FEI = Female Entrepreneurship Index, MEI = Male Entrepreneurship Index, NRI = Network Readiness Index, SD = standard deviation, SE = standard error.
Note: Using observations 1–48 (n = 46), missing or incomplete observations dropped: 2. * p < 0.10, *** p < 0.01.
Source: Authors' calculations.

For the 48 economies where MEI is higher than FEI, digitalization has a positive and significant effect on the MEI-FEI difference (coefficient = 0.2099, p-value = 0.0674) (Table 12). This indicates that, in economies where male entrepreneurship is dominant, digitalization further increases the advantage of MEI over FEI, widening the gap between male and female entrepreneurship. The model has a low but notable R-squared of 0.074, indicating that digitalization accounts for a small portion of the variation in the MEI-FEI difference.

F. Robustness Check

In Appendix C, we include additional analyses:

(i) To measure the gender gap, the WBL 1.0 indicator was also used instead of the GGG Report's political empowerment measure as an economy-specific proxy for gender inequalities. This analysis produced similar results (Appendix C, Robustness 1).

(ii) Using the FEI and the MEI further, dependent variables were created and tested: (a) FEI/MEI ratio, (b) MEI-FEI difference, and (c) MEI-FEI absolute difference. These models showed little or no explanatory power, supporting the need to examine digitalization's impact on FEI and MEI separately (Appendix C, Robustness 2).

(iii) Lastly, a Chow test using FEI/MEI ratio as the dependent variable was conducted, with results like those for the MEI-FEI difference (Appendix C, Robustness 3).

V. DISCUSSION

Digital transformation has reshaped industries, creating new opportunities and challenges for entrepreneurs. Therefore, understanding its effects on businesses led by women is essential. Digitalization has the potential to bridge gaps in resources, networks, and visibility that female entrepreneurs have historically faced. By studying this impact, we can assess whether digital tools effectively enhance their participation in the economy or if barriers still persist. This study looks at how digitalization supports the context shaping entrepreneurial potential for both women and men across different economies and focuses on whether digital tools and technologies can help reduce gender gaps in entrepreneurship. Three hypotheses were developed based on the research goals.

The findings support the first hypothesis, which states that digitalization positively impacts the context shaping entrepreneurial potential of both women and men. Both the FEI and the MEI demonstrated strong positive links with digitalization. Including digitalization as a variable, alongside control factors, enhanced the explanatory power of the econometric model, highlighting its significant role in increasing entrepreneurial potential for both women and men. This supports the existing literature on the general benefits of digitalization for entrepreneurship, confirming that greater digital readiness—measured by access to and use of ICTs—is closely connected to entrepreneurial potential for both genders. These results align with previous research showing that digitalization, especially transformative types, fosters more favorable conditions for growth-oriented and innovation-driven entrepreneurship (Fossen and Sorgner 2021).

When digitalization is included in the models, levels of economic development (GDP per capita) and gender equality (political empowerment) specific to each economy also impact entrepreneurial potentials, for both genders. Overall, this indicates that digitalization and socioeconomic factors work together to effectively support the growth of entrepreneurial potential for both genders.

However, a clear difference appears in the impact of competition (measured by firm density): with digitalization included, firm density strongly affects the context shaping female entrepreneurial potential—but has no effect on male entrepreneurial potential. Female entrepreneurs often face greater socioeconomic barriers and have more limited access to market resources and networks, making the competitive environment more critical for them. However, digitalization allows women to reach new markets and access competitive resources, while male entrepreneurs generally face less competition for these resources because they tend to be more readily available to them. Consequently, in highly competitive environments, supporting digitalization for female entrepreneurs is particularly recommended.

Surprisingly, the political empowerment of women, used as a measure of gender inequality, has a stronger effect on the context shaping male entrepreneurial potential than on female entrepreneurial potential. In other words, in economies with a smaller gender gap, male entrepreneurial potential seems to benefit more than female potential. The following explanations may shed light on this quasi-paradox and generate avenues for future research:

(i) **More developed institutional environment.** In economies with a smaller gender gap (and thus greater political empowerment of women), the institutional environment tends to be more stable and advanced. This stability benefits the economy as a whole and may enhance male entrepreneurial potential, as established institutions, economic support, and resources become more accessible to all entrepreneurs, not just women.

(ii) **Increased competitive environment.** A reduced gender gap, with more female entrepreneurs entering the field, can intensify competition. Men may find themselves in a more competitive landscape, pushing them to be more active, innovate, and seize opportunities, which could, in turn, boost male entrepreneurial potential.

(iii) **Policies focused on gender equality.** Gender equality policies often focus on supporting women through mentorship, networking opportunities, or access to capital. While these initiatives strengthen the entrepreneurial ecosystem overall, male entrepreneurs may also benefit from the economic growth and stability that these gender-centered policies bring.

Overall, a smaller gender gap and greater political equality generally benefit the entire entrepreneurial environment. However, male entrepreneurs may still retain certain preexisting advantages, which may strengthen their potential, while women may need more focused support to achieve similar outcomes.

The second hypothesis, proposing that digitalization mediates the effect of control variables on female and male entrepreneurial potential, finds partial support in the data. The results indicate that economic development (GDP per capita) has a significant positive effect on both FEI and MEI, both directly and indirectly. This suggests that digitalization indeed enhances entrepreneurial potential for both genders, particularly in stable and developed economies.

Sex ratio at birth does not significantly impact female or male entrepreneurship directly.

However, the results show that digitalization plays an important mediating role in this case: while a higher proportion of men does not directly affect entrepreneurial potential, it can still exert influence through digitalization. Further research is needed to examine whether this is related to the tendency in such societies to reinforce gender stereotypes that steer men toward technology-focused “masculine” fields (e.g., engineering, industry), which later drive digitalization forward, even starting from elementary education.

The findings support the third hypothesis that digitalization has a stronger positive effect on male entrepreneurship than on female entrepreneurship potential. Digitalization tends to increase the gap between male and female entrepreneurship. This effect is particularly evident in economies where male entrepreneurship (MEI) is higher than female entrepreneurship (FEI). In economies where FEI is higher than MEI, digitalization has no significant impact on the MEI-FEI difference. However, in economies where MEI is higher than FEI, digitalization significantly widens the gap, favoring male entrepreneurship potential. This suggests that digitalization may exacerbate gender inequalities in entrepreneurship, particularly in economies where men are already more active in entrepreneurship. Overall, digitalization does not seem to have a uniform effect across all economies, and its impact on the balance between male and female entrepreneurship potential depends on the initial entrepreneurial landscape in each economy. This result contrasts with some of the literature, which, without considering the impact of digitalization on men, claims that digitalization alone helps close the gender gap in entrepreneurship. However, our findings show the opposite, and align with the idea that digital skills are more closely tied to entrepreneurship for men than for women (Oggero, Rossi, and Ughetto 2020). This may be because men generally have better access to digital resources and networks, and are more likely to work in high-tech sectors where digitalization is crucial (Verheul, van Stel, and Thurik 2006).

The above findings have important policy implications. While digitalization alone may not reduce gender disparities, our research suggests that comprehensive support addressing socioeconomic barriers can enable women to benefit more fully from digitalization. Efforts to promote female entrepreneurship must address not only the provision of digital tools, but also the broader socioeconomic barriers that women face. Policies aimed at improving digital literacy, creating more inclusive digital networks, and promoting gender equality in political and economic spheres will be critical for ensuring women can fully benefit from digitalization. Without such measures, digitalization alone may not be enough to close the gender gap in entrepreneurship.

REFERENCES

Abdelwahed, Nadia, Safia Bano, Mohammed Al Doghan, Abdulaziz Aljughiman, Naimatullah Shah, and Bahadur Soomro. 2024. “Empowering Women Through Digital Technology: Unraveling the Nexus Between Digital Enablers, Entrepreneurial Orientation and Innovations.” *Equality, Diversity and Inclusion* Ahead of Print.

Acs, Zoltán. 2006. “How Is Entrepreneurship Good for Economic Growth?” *Innovations: Technology, Governance, Globalization* 1(1): 97–107.

Acs, Zoltán, Erkko Autio, and Lázló Szerb. 2014. “National Systems of Entrepreneurship: Measurement Issues and Policy Implications.” *Research Policy* 43(3): 476–494.

Alhajri, Abrar, and Monira Aloud. 2024. “Female Digital Entrepreneurship: A Structured Literature Review.” *International Journal of Entrepreneurial Behavior & Research* 30(2/3): 369–397.

Autio, Erikk, Éva Komlósi, and Hanga Bilicz. 2024. The Global Index of Female Entrepreneurship Systems 2024. Working Paper.

Autio, Erkko, Satish Nambisan, Lars Frederik D. W. Thomas, and Mike Wright. 2018. “Digital Innovation and Entrepreneurship in Platforms and Ecosystems.” In *Entrepreneurship and the Digital Transformation: Managing Disruptive Innovation in a Changing Environment*, edited by Jan Ondrus, Frantz Rowe, and Stefan Haefliger. Edward Elgar.

Bhandari, Krishna, Peter Zamborsky, Mikko Ranta, and Jari Salo. 2023. “Digitalization, Internationalization, and Firm Performance: A Resource-Orchestration Perspective on New OLI Advantages.” *International Business Review* 32(4): 102135. https://doi.org/10.1016/j.ibusrev.2023.102135

Boateng, Janet Serwah, Mavis Serwah Benneh Mensah, Isaac Kosi, Sabena Appiah-Boateng, and Martin Osei. 2023. “Digitalization of Business Operations and Empowerment of Female Entrepreneurs.” In Boateng, Sheena Lovia, Richard Boateng, and Thomas Anning-Dorson (eds). *Empowering Women in the Digital Economy, A Quest for Meaningful Connectivity and Access in Developing Countries.* pp. 35–52. Abingdon: Routledge.

Brodny, Jarosław, and Magdalena Tutak. 2022. “Analyzing the Level of Digitalization among the Enterprises of the European Union Member States and Their Impact on Economic Growth*.” Journal of Open Innovation: Technology*, *Market, and Complexity* 8(2): 70. https://doi.org/10.3390/joitmc8020070

Brynjolfsson, Erik, and Andrew McAfee. 2014. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York: WW Norton & Company.

Cardona, Melisande, Tobias Kretschmer, and Thomas Strobel. 2013. “ICT and Productivity: Conclusions from the Empirical Literature.” *Information Economics and Policy* 25: 109–125. https://doi.org/10.1016/j.infoecopol.2012.12.002

Chang, Simon, and Xiaobo Zhang. 2015. “Mating Competition and Entrepreneurship.” *Journal of Economic Behavior & Organization* 116: 292–309.

Chao, Fengqing, Patrick Gerland, Alex Cook, and Leontine Alkema. 2019. “Systematic Assessment of the Sex Ratio at Birth for All Countries and Estimation of National Imbalances and Regional Reference Levels.” *Proceedings of the National Academy of Sciences* 116(19): 9303–9311.

Crittenden, Victoria, William Crittenden, and Haya Ajjan. 2019. “Empowering Women Micro-Entrepreneurs in Emerging Economies: The Role of Information Communications Technology.” *Journal of Business Research* 98: 191–203.

Dahlman, Carl, Sam Mealy, and Martin Wermelinger. 2016. “Harnessing the Digital Economy for Developing Countries.” OECD Development Centre Working Paper 334. Paris: Organisation for Economic Co-operation and Development.

Dasgupta, Subhasish, Devraj Agarwal, Anthony Ioannidis, and Shanthi Gopalakrishnan. 1999. “Determinants of Information Technology Adoption: An Extension of Existing Models to Firms in a Developing Country.” *Journal of Global Information Management* 7: 30–40.

Davaki, Konstantina. 2018. “The Underlying Causes of the Digital Gender Gap and Possible Solutions for Enhanced Digital Inclusion of Women and Girls.” Study for the European Parliament, Directorate-General for Internal Policies, Committee on Women’s Rights and Gender Equality.

Dholakia, Ruby Roy, and Nir Kshetri. 2004 “Factors Impacting the Adoption of the Internet Among SMEs.” *Small Business Economics* 23: 311–322.

Durante, Kristina, Vladas Griskevicius, Jeffry Simpson, Stephanie Cantú, and Joshua Tybur. 2012. “Sex Ratio and Women’s Career Choice: Does a Scarcity of Men Lead Women to Choose Briefcase over Baby?” *Journal of Personality and Social Psychology* 103(1): 121–134.

Dutta, Soumitra, and Bruno Lanvin (eds). 2023. *Network Readiness Index 2023*. Portulans Institute. https://networkreadinessindex.org/

Dy, Angela Martinez, Susan Marlow, and Lee Martin. 2017. “A Web of Opportunity or the Same Old Story? Women Digital Entrepreneurs and Intersectionality Theory.” *Human Relations* 70(3): 286–311.

Dy, Angela Martinez, Lee Martin, and Susan Marlow. 2018. “Emancipation Through Digital Entrepreneurship? A Critical Realist Analysis.” *Organization* 25(5): 585–608.

Fossen, Frank, and Alina Sorgner. 2021. “Digitalization of Work and Entry into Entrepreneurship.” *Journal of Business Research* 125, 548–563. https://doi.org/10.1016/j.jbusres.2019.09.019

Gaweł, Aleksandra, Katarzyna Mroczek-Dąbrowska, and Maciej Pietrzykowski. 2023. “Digitalization and Its Impact on the Internationalization Models of SMEs.” In Richard Adams, Dietmar Grichnik, Asta Pundziene, and Christine Volkmann (eds). *Artificiality and Sustainability in Entrepreneurship: Exploring the Unforeseen, and Paving the Way to a Sustainable Future*. FGF Studies in Small Business and Entrepreneurship. pp. 19–39. Amsterdam: Springer.

Gutiérrez-Esteban, Prudencia, Francisco Rodríguez-Miranda, Sixto Cubo-Delgado, and Mária Lourdes Hernández-Rincón. 2021. “Digital Inclusion of Businesswomen and Women Entrepreneurs Through Social Networks in the Informal Environment.” *Géneros Multidisciplinary Journal of Gender Studies* 10(3): 201–232.

Haller, Stefanie, and Iulia Siedschlag. 2011. “Determinants of ICT Adoption: Evidence from Firm-Level Data.” *Applied Economics* 43(26): 3775–3788.

Hawash, Ronia, and Guenter Lang. 2020. “Does the Digital Gap Matter? Estimating the Impact of ICT on Productivity in Developing Countries.” *Eurasian Economic Review* 10: 189–209.

Hollenstein, Heinz. 2004. “Determinants of the Adoption of Information and Communication Technologies.” *Structural Change and Economic Dynamics* 15: 315–42.

Irwin, Kris, William McDowell, and Samuel Ribeiro-Navarrete. 2023. “How Can Women Entrepreneurs Overcome Funding Challenges: The Role of Digitalization and Innovation.” *Venture Capital* 1–23. https://doi.org/10.1080/13691066.2023.2282542

Khoo, Catheryn, Elaine Yang, Rosalie Tan, Marisol Alonso-Vazquez, Carla Ricaurte-Quijano, Mathias Pécot, and Doménica Barahona-Canales. 2024. “Opportunities and Challenges of Digital Competencies for Women Tourism Entrepreneurs in Latin America: A Gendered Perspective.” *Journal of Sustainable Tourism* 32(3): 519–539.

Komlósi, Éva, Hanga Bilicz, Erkko Autio, Mónika Galambosné Tiszberger, and Donghyun Park. 2025. “The Global Index of Female Entrepreneurship Systems.” Working Paper.

Kraus, Sascha, Katarina Vonmetz, Ludovico Bullini Orlandi, Alessandro Zardini, and Cecilia Rossignoli. 2023. “Digital Entrepreneurship: The Role of Entrepreneurial Orientation and Digitalization for Disruptive Innovation.” *Technological Forecasting and Social Change* 193: 122638. https://doi.org/10.1016/j.techfore.2023.122638

Kreiterling, Christoph. 2023. “Digital Innovation and Entrepreneurship: A Review of Challenges in Competitive Markets.” *Journal of Innovation and Entrepreneurship* 12(49). https://doi.org/10.1186/s13731-023-00320-0

Laguía, Ana, Cristina García-Ael, Dominika Wach, and Juan Moriano. 2019. “‘Think Entrepreneur—Think Male’: A Task and Relationship Scale to Measure Gender Stereotypes in Entrepreneurship.” *International Entrepreneurship and Management Journal* 15(3): 749–772.

Mariscal, Judith, Gloria Mayne, Urvashi Aneja, and Alina Sorgner. 2019. “Bridging the Gender Digital Gap.” *Economics: The Open-Access, Open-Assessment E-Journal* 13(2019-9): 1–12.

Martin, Lynn, and Len Wright. 2005. “No Gender in Cyberspace? Empowering Entrepreneurship and Innovation in Female-Run ICT Small Firms.” *International Journal of Entrepreneurial Behavior & Research* 11(2): 162–178.

McAdam, Maura, Caren Crowley, and Richard Harrison. 2019. “‘To Boldly Go Where No [Man] Has Gone Before’ – Institutional Voids and the Development of Women’s Digital Entrepreneurship.” *Technological Forecasting and Social Change* 146: 912–922.

Mishakov, Viktor, Viktor Daitov, and Mikhail Gordienko. 2021. “Impact of Digitalization on Economic Sustainability in Developed and Developing Countries.” In Julia Ragulina, Arutyun Khachaturyan, Arsen Abdulkadyrov, and Zoya Babaeva (eds). *Sustainable Development of Modern Digital Economy*. *Research for Development*. pp. 265–274 New York: Springer Publishing.

Mishra, Divya, Gopika Mangla, and Nidhi Maheshwari. 2024. “Gendered Pathways to Entrepreneurial Success: A Study on Women’s Career Choices in India.” *International Journal of Sociology and Social Policy* 44(11/12): 1000–1023.

Moeini Gharagozloo, Mohammed Mahdi, Mahdi Forghani Bajestani, Ali Moeini Gharagozloo, Amirmahmood Amini Sedeh, and Fatemeh Askarzadeh. 2023. “The Role of Digitalization in Decreasing Gender Gap in Opportunity Driven Entrepreneurship.” *Information Technology for Development* 29(4): 645–664.

Mora-Rodríguez, Cristina, Antonio Verdú-Jover, and Jose Gómez-Gras. 2020. “Analyzing Opportunities for Eliminating Inequality in Female Digital Entrepreneurship in Spain.” In Mehmet Bilgin, Hakan Danis, Gökhan Karabulut, and Giray Gözgor (eds). *Eurasian Economic Perspectives, Eurasian Studies in Business and Economics.* pp. 331–340. Amsterdam: Springer.

Nambisan, Satish, Mike Wright, and Maryann Feldman. 2019. “The Digital Transformation of Innovation and Entrepreneurship: Progress, Challenges and Key Themes.” *Research Policy* 48(8): 103773. https://doi.org/10.1016/j.respol.2019.03.018

Niebel, Thomas. 2018. “ICT and Economic Growth – Comparing Developing, Emerging and Developed Countries.” *World Development* 104: 197–211,

Nose, Manabu, and Jiro Honda. 2023. “Firm-Level Digitalization and Resilience to Shocks: Role of Fiscal Policy.” Working Paper WP/23/95. Washington, DC: International Monetary Fund.

OECD (Organisation for Economic Co-operation and Development). 2019. *OECD Economic Outlook.* Volume 1, 105. Paris: OECD Publishing.

Oggero, Noemi, Maria Cristina Rossi, and Elisa Ughetto. 2020. “Entrepreneurial Spirits in Women and Men: The Role of Financial Literacy and Digital Skills.” *Small Business Economics* 55(2): 313–327.

Pal, Kusum Kal, Kim Piaget, Saadia Zahidi, and Silja Baller. 2024. *Global Gender Gap Report 2024*. Davos: World Economic Forum.

Pappas, Marios, Athanasios Drigas, Yannis Papagerasimou, Helen Dimitriou, Nadia Katsanou, Sofia Papakonstantinou, and Zoi Karabatzaki. 2018. “Female Entrepreneurship and Employability in the Digital Era: The Case of Greece.” *Journal of Open Innovation: Technology, Market, and Complexity* 4(2): 15. https://doi.org/10.3390/joitmc4020015.

Pergelova, Albena, Tatiana Manolova, Ralitsa Simeonova-Ganeva, and Desislava Yordanova. 2019. “Democratizing Entrepreneurship? Digital Technologies and the Internationalization of Female-Led SMEs.” *Journal of Small Business Management* 57(1): 14–39.

Portulans Institute. 2025. “Network Readiness Index 2024.” https://networkreadinessindex.org/.

Rosin, Anna Frieda, Dorian Proksch, Stephan Stubner, and Andreas Pinkwart. 2020. “Digital New Ventures: Assessing the Benefits of Digitalization in Entrepreneurship.” *Journal of Small Business Strategy* 30(2): 59–71.

Sadowski, Bert, Carleen Maitland, and Jos van Dongen. 2002. “Strategic Use of the Internet by Small- and Medium-sized Companies: An Exploratory Study.” *Information Economics and Policy* 14: 75–93.

Salamzadeh, Aidin, Léo-Paul Dana, Javad Ghaffari Feyzabadi, Mortaza Hadizadeh, and Heleh Eslahi Fatmesari. 2024. “Digital Technology as a Disentangling Force for Women Entrepreneurs.” *World* 5(2): 346–364.

Sergi, Bruno, Elena Popkova, Aleksei Bogoviz, and Julia Ragulina. 2019. “Entrepreneurship and Economic Growth: The Experience of Developed and Developing Countries.” In Bruno Sergi, and Cole Scanlon (eds). *Entrepreneurship and Development in the 21st Century (Lab for Entrepreneurship and Development).* pp. 3–32. Leeds: Emerald Publishing Limited.

Shapiro, Alan, and Federick Mandelman. 2021. “Digital Adoption, Automation, and Labor Markets in Developing Countries.” *Journal of Development Economics* 151: 102656. https://doi.org/10.1016/j.jdeveco.2021.102656

Shukla, Anuja, Priyanka Kushwah, Eti Jain, and Shiv Sharma. 2021. “Role of ICT in the Emancipation of Digital Entrepreneurship Among New Generation Women.” *Journal of Enterprising Communities: People and Places in the Global Economy* 15(1): 137–154.

Škare, Marinko, and Domingo Soriano. 2021. “A Dynamic Panel Study on Digitalization and Firm’s Agility: What Drives Agility in Advanced Economies 2009–2018.” *Technological Forecasting and Social Change* 163. https://doi.org/10.1016/j.techfore.2020.120418

Solomon, Edna, and Aaron van Klyton. 2020. “The Impact of Digital Technology Usage on Economic Growth in Africa.” *Utilities Policy* 67: 101104. https://doi.org/10.1016/j.jup.2020.101104

Stam, Erik, and André van Stel. 2011. “Types of Entrepreneurship and Economic Growth.” In Adam Szirmai, Wim Naudé, and Micheline Goedhuys (eds). *Entrepreneurship, Innovation, and Economic Development*. pp. 78–95. Oxford: Oxford University Press.

Sun, Kathy, Xinyi Liu, Yibei Yu, and Jinru Zou. 2024. “Bridging the Gender Gap in Entrepreneurship and Empowering Women via Digital Technologies.” *Academic Journal of Humanities & Social Sciences* 7(6): 102–108.

Sun, Lu, Hue He, Chengi Yue, and Wenmin Lin. 2023. “Unleashing Competitive Edge in the Digital Era: Exploring Information Interaction Capabilities of Emerging Smart Manufacturing Enterprises.” *Journal of Knowledge Economy* 15: 10853–10897.

Szücs, Krisztian. 2020. “Can Online Presence Give Companies a Competitive Edge?” *Pollack Periodica: An International Journal for Engineering and Information Sciences* 15(3): 26–36.

Uçar, Ece, Marie-Anne Le Dain, and Iragaël Joly. 2020. “Digital Technologies in Circular Economy Transition: Evidence from Case Studies.” *Procedia* CIRP 90: 133–136.

Ughetto, Elisa, Mariacristina Rossi, David Audretsch, and Erik Lehmann. 2020. “Female Entrepreneurship in the Digital Era.” *Small Business Economics* 55: 305–312.

Urbano, David, Sebastian Aparicio, and David Audretsch. 2019. “Twenty-Five Years of Research on Institutions, Entrepreneurship, and Economic Growth: What Has Been Learned?” *Small Business Economics* 53: 21–49.

Verheul, Ingrid, André van Stel, and Roy Thurik. 2006. “Explaining Female and Male Entrepreneurship at the Country Level.” *Entrepreneurship & Regional Development* 18(2): 151–183.

Vial, Gregory. 2019. “Understanding Digital Transformation: A Review and a Research Agenda.” *The Journal of Strategic Information Systems* 28(2): 118–144.

Vossenberg, Saskia. 2013. Women Entrepreneurship Promotion in Developing Countries: What Explains the Gender Gap in Entrepreneurship and How to Close It? Working Paper 2013/08. Maastricht: Maastricht School of Management.

Wajcman, Judy. 2010. “Feminist Theories of Technology.” *Cambridge Journal of Economics* 34(1): 143–152. https://doi.org/10.1093/cje/ben057

Wang, Qing, and Michael Keane. 2020. “Struggling to Be More Visible: Female Digital Creative Entrepreneurs in (the People’s Republic of) China.” *Global Media and China* 5(4): 407–422.

Wang, Yalin, Yaokuang Li, Juan Wu, Li Ling, and Dan Long. 2023. “Does Digitalization Sufficiently Empower Female Entrepreneurs? Evidence from Their Online Gender Identities and Crowdfunding Performance.” *Small Business Economic*s 61: 325–348.

Wei, Shang-Jin, and Xiaobo Zhang. 2011. “Sex Ratios, Entrepreneurship, and Economic Growth in the People’s Republic of China.” Working Paper 16800. Cambridge, MA: National Bureau of Economic Research.

Wennekers, Sander, and Roy Thurik. 1999. “Linking Entrepreneurship and Economic Growth.” *Small Business Economics* 13: 27–56.

World Bank. 2016. *World Development Report 2016: Digital Dividends*. Washington, DC: World Bank.

World Economic Forum. 2024. *Global Gender Gap Report 2024*. www.weforum.org/publications/global-gender-gap-report-2024/

Yang, Xiaolen, Yidong Huang, and Mei Gao. 2022. “Can Digital Financial Inclusion Promote Female Entrepreneurship? Evidence and Mechanisms.” *The North American Journal of Economics and Finance* 63: 101800. https://doi.org/10.1016/j.najef.2022.101800

Zhang, Yineng, Jianing Pang, and Huimingmei Li. 2024. “Research on the Influence of Digitalization on Competitive Advantage of Manufacturing Enterprises.” *Managerial and Decision Economics* 45(5): 3316–3334.

Digitalization in Shaping Female and Male Entrepreneurial Potential

This paper analyzes how digitalization enhances entrepreneurial opportunities of both female and male entrepreneurs. The result shows that digitalization widens the gender gap in economies where male entrepreneurship exceeds female entrepreneurship, but has no significant effect where female entrepreneurship dominates. It also finds that competitive environments have a stronger influence on female entrepreneurial potential, underscoring the need for policies that address these dynamics to promote gender-balanced entrepreneurial growth.

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