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Solutions for Unleashing Firm Innovativeness: The Role of Gender Dynamics and Standardisation

Mahelet G. Fikru[1] Fida Karam[2] Chahir Zaki[3]

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Abstract

Innovation in manufacturing and non-manufacturing businesses is crucial for industrial competition, sustainability and economic growth. Past research has examined innovation drivers and barriers, primarily focusing on firm-specific factors. However, strategic actions like adopting international quality standards and the gender dynamics of managerial choice, have been largely underexplored. This study investigates how such strategies impact a firm's ability to innovate in various dimensions: adopting new product lines, introducing novel products to the entire market (pioneer firms), improving processes and investing in research and development (R&D). Analysis based on over 60 thousand firm-level observations across 130+ countries suggests that: (1) certified firms and firms with a female manager have a higher probability of incurring R&D spending, and (2) female-owned businesses with a male manager have a higher probability of innovating new processes.

Keywords: innovation; development; gender; international standards; World Bank Enterprise Survey.

JEL Classification: J16, O31, O32.

[1] 500 West 13th Street, Department of Economics, Missouri University of Science and Technology, Rolla, MO 65409 USA, Email: fikruma@mst.edu

[2] Department of Economics and Finance, Gulf University for Science and Technology, Hawally, Kuwait, Email: karam.f@gust.edu.kw

[3] University of Orléans and Economic Research Forum, Email: chahir.zaki@univ-orleans.fr

1 Introduction

Unleashing innovation amongst manufacturing and non-manufacturing businesses can help drive industrial competition, sustainability and economic growth. In recognition of this, the United Nations' Sustainable Development Goal 9 (SDG) emphasises fostering innovations and promoting inclusive and sustainable industrial systems. A growing number of studies have examined factors that drive or create barriers to a firm's innovativeness. For instance, studies show that in emerging economies, access to capital, resources, skilled human capital (Ayalew et al., 2020), an enabling regulatory environment and market infrastructure, are all important drivers (Lee et al., 2020). In addition, businesses with global outlooks, such as demonstrated through their ownership structure and trade orientation, are found to be more successful in their innovative efforts (Almeida and Fernandes, 2008; Şeker, 2012). Empirical evidence also suggests that the active use of information, communication and technology (ICT) could facilitate product and service innovations (Spiezia, 2011; Arvanitis and Loukis, 2015; Arvanitis et al., 2013; Cuevas-Vargas et al., 2016). Other studies illustrate the importance of firm-specific efforts (e.g., business culture, agility, adaptability, collaboration, customer-centric approaches, etc.) to develop an entrepreneurial mindset amongst employees (Ayalew et al., 2020; Medase and Basit, 2023; Morrison et al., 2008).

Despite the growing literature on firm-level determinants and barriers to business innovations, there are not many studies that conceptualise the role of *intentional firm strategies,* such as the adoption of international quality standards and certification, as well as the choice of managers. Hence, whilst past studies show the impact of individual firm actions/efforts (e.g., adopting ICT, increasing export orientation, investing in human capital, etc.) and specific firm traits and capabilities (e.g., firm age, size, human capital, access to capital, etc.) in driving innovations (Morrison et al., 2008), it is not clearly understood whether and under what scenarios businesses that adopt standardisation are better at maximising innovation efforts than others. Moreover, despite the growing number of studies that indicate potential performance barriers for female-owned businesses (Audretsch et al., 2022; Ayalew et al., 2020), none have studied how such businesses could intentionally and strategically hire a manager to maximise performance and reduce innovation barriers.

This study examines the extent to which strategic actions *enable* firm innovations. In addition to what previous studies have identified as potential innovation drivers (human capital, access to capital, ICT, export orientation, etc.), we consider the following two additional firm strategies: (1) standardisation and streamlining of processes for quality and sustainability via the adoption of international certificates, and (2) hiring male managers for female-owned businesses. Our study contributes to the extant literature on firm innovativeness in at least three major dimensions.

First, whilst previous studies focus on the presence/absence of a single innovation metric (e.g., patents) (Ayalew et al., 2020), we consider four different metrics of firm innovation. This explicitly acknowledges that drivers of one type of innovation may not be effective in driving other types of innovations. The four innovation metrics are: (1) adopting a new product or service for the business (e.g., for diversifying, expanding, or broadening a range of products/services, reaching new markets or customers, creating synergy between existing product lines, etc.), (2) ability to introduce a new product line (or service) to the entire market (e.g., product leader in the industry, pioneer firm), (3) adopting new or improved processes for manufacturing, distribution, delivery, logistics, or other supporting activities, and (4) investing in R&D (in house R&D and/or outsourcing) that could lead to improvements in products, processes and/or technologies.

Second, whilst past studies have looked at the impact of ICT, access to finance, human capital and export orientation, not many have looked at standardisation and managerial delegation. For example, standardising processes for quality and sustainability could positively impact innovativeness after controlling for the effect of digitalisation and firm capabilities. This is because adopting international standards, such as those developed by the International Organisation for Standardisation (ISO), requires quality assurance and risk mitigation, which creates a conducive environment for introducing new technologies or processes. In addition, conforming to ISO or other similar standards can streamline processes for efficiency and free up resources that can be directed to R&D and foster innovation. On the contrary, since certification is often a lengthy and costly process, firms that invest heavily in standardisation (e.g., compliance costs) could have limited resources for R&D. At times, standardised firms may face rigid requirements that are not flexible enough for them to experiment with existing products and processes. There is a need to examine to what extent firms, which have international quality certifications, are in a better position to innovate.

Third, several studies highlight the impact of managerial delegation on firm performance and innovativeness (e.g., owners can focus on strategic planning whilst managers deal with day-to-day operations, providing division of responsibility and efficient allocation of resources) (Vickers, 1985; Fanti et al., 2017), whilst others discuss agency problems where managers may prioritise personal goals and may not act to benefit the firm (Kao et al., 2004; Wang et al., 2014). Several other studies highlight the challenges of female-owned businesses (Ayalew et al., 2020) and the challenges faced by female-managed businesses (Audretsch et al., 2022) in emerging economies (e.g., access to finance and resources, gender-based discrimination, poor institutional environment, etc.). Combining these two concepts suggests that the separation of management from ownership in female-owned businesses could have a complex effect on innovativeness. On one hand, for female-owned businesses, the delegation of managerial responsibilities could enable an efficient and effective creation of new products/services. This is because

a gender-diverse team (e.g., female-owned but male-managed) could leverage experiences, to better generate new ideas by drawing from different points of view and enhancing creativity. Likewise, female-owned businesses could break any gender-based barriers by hiring a male manager and unleashing the most innovative outcomes. In these two scenarios, hiring a manager could be a good strategy to give free rein to innovation amongst female-owned businesses. Similarly, a female-owned but male-managed business, or vice versa, could be owned by family members (e.g., siblings, married couple, etc.), with previous studies (Kula and Tatoglu, 2006; Berent-Braun and Uhlaner, 2012) showing that family-owned and family-run businesses are better at innovating, as compared to businesses that hire outside managers, because they have an invested stake in the business. On the other hand, agency problems may likely be more magnified for female-owned businesses with male managers, hence hindering innovative outcomes. In this study, we examine the impact of management-ownership separation as a *firm strategy* by exclusively focusing on the gender aspect. This has not been previously studied. Our analysis contributes to the identification (if any) and understanding of the role of gender diversity in firm ownership and management measuring how this diversity could unleash or hinder firm innovativeness.

We address research objectives by using the World Bank Enterprise Survey (WBES) database, which includes economic data on over 60 thousand businesses operating in more than 130 countries, collected over multiple years. We use the standardised dataset, which is based on a common set of questions administered to businesses that are located in different countries.[4]

The rest of this paper is structured as follows: In Section 2, we present the conceptual framework, based on which we test hypotheses and establish our contribution to the literature on firm innovations. In Section 3 we present the data based on which hypotheses are tested. Section 3 also presents our empirical methodology and characterises the sample, based on which hypotheses are tested. Section 4 presents the empirical findings in two parts: descriptive analysis and regression analysis. Section 5 provides the conclusion with a summary of the main results.

[4] Details on sampling techniques and standardizing methodologies are available from the Enterprise Survey website (Source: https://www.enterprisesurveys.org/en/data)

2 Literature Review: Economic Emergence and Resource Wealth

Firm innovativeness represents the ability and tendency of a business to generate and implement new ideas, technologies, processes, products, or business models, in order to create value that contributes to its competitive advantage (Hobday, 2005). Firm innovations enable a business to address new market needs, differentiate itself from competitors, improve efficiency and compete in a dynamic marketplace. Firms of all types and sizes could potentially be innovative. We draw on Hobday's definition of firm innovation in the post-1990s' era. Hobday presents innovation as a systems integration and networking model that is customer-focused and supported by advanced information technology. According to Hobday, the innovative firm interacts vertically and horizontally in a strategic way for the co-development of products, processes and systems, is flexible and adaptable, and is focused on improving quality and non-price factors.

The most used metrics of firm innovation are (1) R&D expenditures, (2) the number of patents, and (3) the introduction of new product lines or services. R&D expenditure assesses the amount of investment a firm makes in R&D activities and a higher investment generally indicates a stronger focus on innovation. The number of patents indicates the business's ability to develop novel and unique technologies or products that are not yet commercialised in the market. This makes the innovator a unique supplier of the product, a first mover or pioneer firm, or an innovation leader for the specific product/process. Finally, an innovative firm continually assesses its existing product lines or services, in order to improve or modify based on market needs, or sustainability goals. According to Ayalew et al. (2020), firms that engage in new product/service and process improvements undertake core innovations. However, no single metric can fully capture a firm's innovativeness, so using a combination of several metrics is often insightful to measure the extent of innovative actions.

Figure 1 presents our conceptual framework for testing two hypotheses. Whilst previous studies have examined the effect of several firm-level controls, not many studies examine the impact of certification and gender issues all in one framework. Thus, our study contributes by providing an integrated framework to test the different factors that affect different types of firm innovativeness. As Figure 1 shows, the first variable hypothesised to affect firm innovation is the adoption of international quality standards or certification, as a firm strategy. The second variable is the gender of the owner and manager, capturing gender diversity and managerial delegation. When female-owned businesses hire a male manager, this is discussed in the context of strategic managerial delegation. The last set of factors are several firm-level control variables studied in the literature, as well as a set of industry and country-level control variables. Each of these factors are discussed in the subsequent sub-sections.

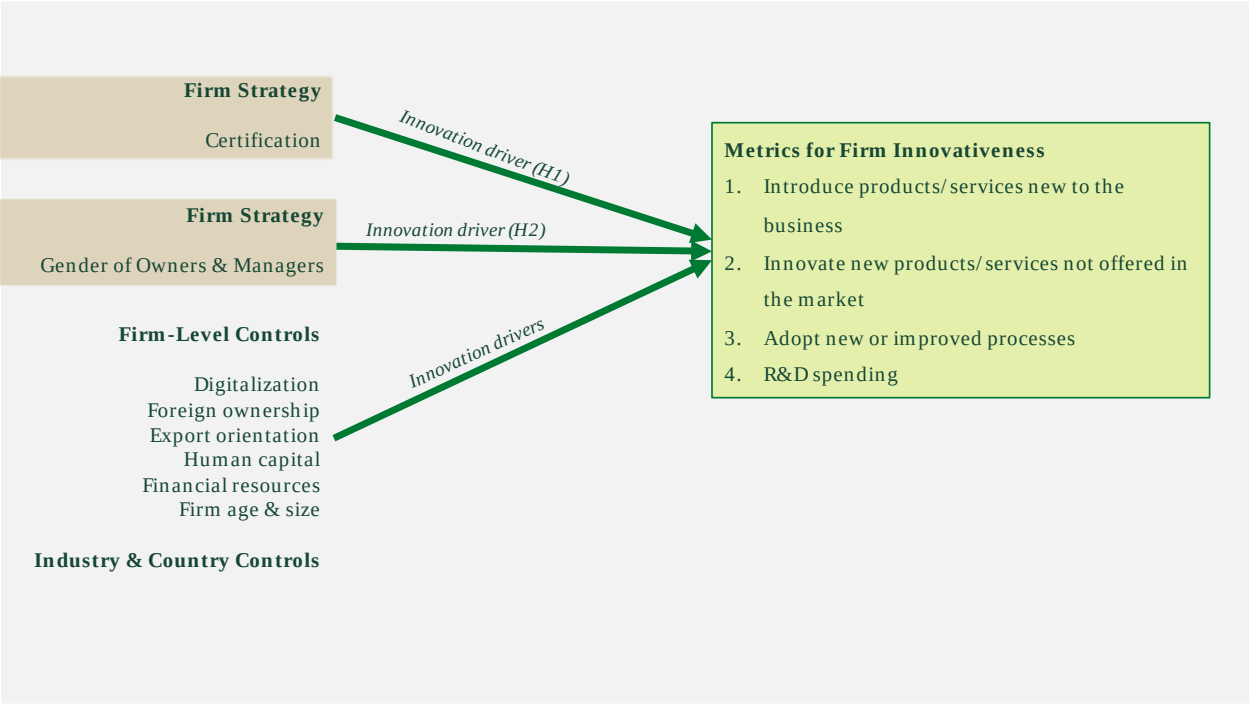

Figure 1: Conceptual framework (Source: Authors' own elaboration)

2.1 The role of certification, managerial delegation and gender

Certification: Whilst several studies quantify the impact of certification on financial performance and profitability, very few studies have examined the impacts of certification (e.g., ISO certification) on firm innovations, yielding mixed results. Existing studies are also limited to a given region or country rather than using a global sample of businesses. For instance, the study by Mangiarotti and Riilli (2014), based in the European context, finds an association between quality certifications and firm innovations where ISO certifications were found to increase product and process innovations. In Spain, Escrig-Tena et al. (2018) show that ISO 9001-certified firms can continuously improve innovation in high-tech industries. In the context of French firms, Pekovic and Gali (2009) find evidence for the impact of quality certification, such as ISO 9000, on firm innovations. Ullah (2022) shows, for a sample of small and medium-sized enterprises in Eastern Europe and Central Asia, that certified firms are more innovative and this effect is particularly true for smaller firms located in countries with weaker institutions. More recently, on survey data from 11 African countries, Medase and Basit (2023) found a positive effect of quality certification on product innovation.

On the contrary, Terziovski and Guerrero (2014) show that amongst a sample of 220 Australian organisations, the ISO 9000 standard has an impact on process but not product

innovations (Terziovski and Guerrero-Cusumano, 2009). Manders et al. (2016) argue that for ISO to influence innovation, there are several factors that come into the picture, such as the extent of certification, what led up to the process of certification and how useful ISO is to create a signalling mechanism for high-quality firms. Ratnasingam et al. (2013), based on a survey of ISO-certified Malaysian manufacturers, show that the ISO 9001 certification has a positive correlation with process but not product innovation. Due to these mixed results and the regional focus of existing studies, it is not clearly understood whether and to what extent certification enables firm innovations across the globe, with the certification-innovation nexus remaining largely understudied (Terziovski and Guerrero, 2014).

We hypothesise that firms with international certifications are in the best position to innovate, because standardisation can provide a framework for continuous improvement. Furthermore, certifications provide a competitive advantage in the marketplace (e.g., customer loyalty and trust), which creates opportunities to attract new customers and establish partnerships which can, in turn, drive innovation. Firms that have ISO standards are also more proactive in identifying and mitigating risks, and more adaptable to changing market conditions, which can foster the exploration of new strategies and technologies to address emerging risks and opportunities. Finally, sustainability standards (e.g., ISO 14000) can spur firms to focus on developing eco-friendly products and processes.

> *Hypothesis 1*: Firms that adopt international certification for quality and sustainability are more likely to be innovative than firms that do not, after controlling for other factors.

The alternative hypothesis is that certification could be a resource-intensive strategy that could limit funds for R&D (Fikru, 2016). In addition, standardisation could create rigidity (e.g., adherence to a set of procedures) making it challenging to experiment with innovative but riskier processes. Moreover, when standards are not updated with the most innovative practices (e.g., lags), businesses may find it hard to keep pace with technological advancements.

Gender and Managerial Delegation: Crowley and Bourke (2018) argue that management can affect innovation activities through their practices, experiences and incentives, highlighting the need to focus on the firm's internal capability. Teece (2010) augments the theory of the firm to better understand the role of management and internal structure in affecting firm innovativeness. The study argues for the need to have dynamic capabilities to create and capture value, and the need to have skilled managers (e.g., coordination skills, flexibility, etc.) to capitalise on opportunities. Managerial delegation may have a significant impact on firm innovation, where leadership teams that are gender diverse may be in a better position to generate new ideas by drawing on different points of

view. Managerial delegation can play a role in enhancing innovation, by empowering decision-makers to come up with creative solutions that are distributed across the organisation (Vickers, 1985; Fanti et al., 2017). However, agency problems could create misalignment between managers' and owners' goals, where managers may be more risk averse when it comes to innovations (e.g., fear of failure, focus on short-term performance like cost reduction, lack of managerial incentive to think out of the box, etc.) (Kao et al., 2004; Wang et al., 2014).

Empirical studies show that businesses with a female manager may be less likely to innovate, due to different types of gender-based discrimination that make it difficult to obtain loans to finance innovations (Ayalew et al., 2020). Similarly, Audretsch et al. (2022) find evidence that women-led firms will be innovative if there are resources to cover innovation costs and fewer uncertainties in the institutional environment. Related to this, studies show that female-owned businesses may be less likely to innovate if the female is less educated (Ayalew et al., 2020). For female-owned businesses, it is not clear whether managerial delegation in general and specifically hiring male managers could help reduce innovation barriers (e.g., male managers can apply for loans when institutional factors create hurdles for the female owner). On one hand, a gender-diverse leadership team (e.g., female-owned but male-managed) could leverage experiences to better generate new ideas, by drawing on different points of view and enhancing creativity. In this scenario, female-owned businesses could strategically hire a male manager to reduce performance barriers. On the other hand, when agency problems are present, hiring male managers may not benefit female-owned businesses. We test whether the separation of management from ownership amongst female-owned businesses creates an environment that facilitates innovation, due to the potential to benefit from diverse points of view and the opportunity to break barriers that are specific to female-owned businesses (if any).

Hypothesis 2: Female-owned businesses that are managed by a male manager are more likely to be innovative than other firms, after controlling for other factors.

2.2 Firm-level and other innovation drivers

In this sub-section, we discuss the role of the following firm-level innovation drivers: digitalisation or ICT, export orientation, foreign ownership, employee training (human capital), access to credit, firm size and age (Ayalew et al., 2020; Medase and Basit, 2023). These are widely discussed in the literature and we control for these effects as innovation drivers, as presented in Figure 1.

Digitalisation (ICT): Digitalisation has an important effect on firm innovation, by transforming the way businesses operate and interact with customers, suppliers, as well as with potential competitors. There are a growing number of studies that examine the role

of digitalisation in facilitating firm innovations in developing and developed countries (Wagner, 2021; Wellalage et al., 2021). Alam et al. (2022) examine the effect of ICT on firm-level innovation, based on survey data collected from Australian small and medium-scale businesses, finding that ICT strategies and skills are important innovation drivers.

For a sample of OECD countries, Spiezia (2011) finds that ICTs can facilitate innovations in the service and manufacturing sectors. Their findings suggest that whilst digitalisation could *enable* businesses to innovate more, it may not necessarily increase innovation capabilities that are determined by firm resources. Moreover, Spiezia (2011) argues that computer use does not seem to be a relevant criterion any longer, as virtually all firms use computers. Given the dominance of IP-based networks, Internet use - particularly broadband- is what makes a firm an ICT user.

For a sample of European countries, Arvanitis and Loukis (2015) find that ICTs have a positive effect on product and process innovation, whilst for the United States, Arvanitis et al. (2013) find that electronic sales have an impact on process innovation, whilst electronic recruitment does not. The study by Cuevas-Vargas et al. (2016), based in Mexico, argues that ICT is a facilitator of innovation which, in turn, affects the performance of businesses. In the UK, Higon (2012) finds that ICT enhances efficiency and makes the firm market-oriented, which, in turn, enhances the firm's competitiveness to develop innovations. Lorenz and Pommet (2021) find that the use of ICT, specifically when related to financing (e.g., mobile money), facilitates firm innovations in East Africa, with this effect being particularly stronger for smaller than larger firms. Other studies that find a role for ICT in influencing innovations include Ollo-Lopez and Aramendia-Muneta (2012), Zoroja (2016), and Zhu et al. (2021). Following this line of literature, we test for the impact of using digital communication with clients and suppliers as a potential driver for innovation.

Other firm-level controls: Morrison et al. (2008) argue for the need to consider firm-specific efforts that enable firms to develop technological capabilities in developing countries. The most common firm-level variables discussed in the literature are firm size (e.g., measured by sales or number of workers), firm age, availability of resources (e.g., access to capital, skilled workers), export orientation and ownership (foreign/local ownership, multi-national firms, etc.). For example, Ayalew et al. (2020) show that the probability of innovation is positively affected by firm size, export orientation, foreign ownership, as well as access to credit and employee training. Larger firms typically have enough financial resources to innovate and have a greater chance of securing finances for risky R&D projects.

Studies also show that new firms or start-ups have a higher probability of innovation compared to older firms (Ayalew et al, 2020). Yet a few other studies show that older firms are more likely to innovate, due to unique learning-by-doing effects that lead to more efficient processes. Many empirical studies show a negative effect of firm age on innovation (see Ayalew et al., 2020 for more details).

Firms with access to capital tend to be more innovative, as they can invest in R&D, hire skilled employees and acquire other firms with innovative technologies or products.

Kaur et al. (2022) show that access to different external finance sources and collateral requirements affects firm innovation activities in India. Hanh and Xu (2021) study the impact of financial accessibility (e.g., availability of overdraft provisions, line of credit, loans, etc.) on a firm's technology innovation strategies in Vietnam, revealing that external finance plays a role in enhancing the innovative capacity of businesses. Firms with a highly educated and skilled workforce tend to be more innovative, as their employees are more capable of generating and implementing new ideas. Businesses that formally train their permanent employees are more likely to innovate (Ayalew et al., 2020). Ritter-Hayashi et al. (2020) show that for downsizing firms, labour flexibility (seasonal employment, training and wage flexibility) is essential to maintain innovations.

Businesses that trade their products in the global market face stronger competition which, in turn, could encourage them to invest in R&D to maintain their competitive advantage. Firms trading globally could also benefit from potential technology transfers across nations, as well as access to foreign-based technologies and partnerships that provide opportunities for growth and innovation (Ayalew et al., 2020). Almeida and Fernandes (2008) use firm-level data from developing countries to show that exporters and importers are likely to innovate more, whilst firms that are majority foreign-owned are less likely to innovate. The latter result holds because foreign-owned firms can transfer their already existing technologies to their subsidiaries located in developing countries. Based on firms in Eastern Europe and Central Asia, Şeker (2012) provides evidence that firms that import and export are the most innovative amongst others.

Following previous studies, we control for firm size (employment size), age, international exposure (exporters, foreign-owned), employee training programmes and access to financial markets. Finally, we control for industry and country-level variations using industry and country dummy variables. This is following past studies, which show that industry characteristics (Love and Roper, 1999; Bhattacharya and Bloch, 2004; Ayyagari et al., 2014) and country-level determinants (e.g., regulatory requirements, governance and rule of law, social and political institutions, etc.) (Nam et al., 2014; Ayyagari et al., 2014; Lee et al., 2020) could affect firm innovations.

3 Data Source, Sample Characteristics, and Methods

Data used in this study is obtained from the World Bank's Enterprise Survey covering several countries across the globe. The original survey, obtained from https://www.enterprisesurveys.org/en/enterprisesurveys contains data for a total of 191,862 businesses, out of which 55% are manufacturers and the remaining 45% are in service, retail, or wholesale (Table A in the appendix presents the number of observations by country of operation and shows that no single country dominates the sample). The most common type of non-manufacturing activity is services (19%) followed by retail (14%). The type of manufacturing significantly varies from food production (9%) to garments and

textiles (7%) to metals (4%). The large number of business observations from across the globe makes this study distinct from past studies, which have largely used firm-level data from a given country, region, or continent.

Since not all businesses reported complete data, we restrict our analysis to those businesses that have complete information on their business innovations. We measure business innovations using four different variables, indicating whether a firm adopted an innovative measure for its main product or service line: (1) *new product innovation for the business*: measured as a dummy variable differentiating firms that introduced, in the past three years, a new or improved product and service to their businesses (e.g., products with superior or enhanced performance), (2) *new product innovations for the main market*: measured as a dummy variable differentiating firms that introduced, in the past three years, a new or improved product/service into the main market before other competitors (e.g., potentially patented items or ingredients, first mover, pioneer firms, etc.), (3) *new or improved processes:* measured by a dummy variable for businesses that, in the past three years, improved methods of manufacturing their products or offering their services, logistics, delivery, distribution and other supporting activities (e.g., introducing new software, automation, internet-based delivery, self-service, etc.), and (4) a dummy variable for firms that reported spending, during the last fiscal year, on research and development (R&D), with the intention of improving their products, services, or processes. The responses on the availability of innovative activities are based on what the businesses reported to have done in the previous one to three years as a reference period, thus the responses capture the most recent activities relative to the time of survey collection.

3.1 Sample characteristics

Table 1 presents descriptive statistics for all variables used in the analysis, along with units of measurement. As the table illustrates, since not all firms provide complete responses to all questions, the empirical analysis performed for testing hypotheses is based on available data. On average, close to 35% of the businesses reported having adopted new product/service innovations for their operations, whilst 67% reported having introduced a new product/service to their main market. About one-third of the firms have improved their processes or adopted new processes and 19% invested in R&D expenditure. The examination of responses to these questions on firm innovations shows that the four innovation metrics significantly vary, where firms that adopted one innovative measure may not have adopted other measures. In addition, although there is a positive correlation between these four innovation measures, the correlations are not particularly strong (See Table B in the Appendix for a correlation matrix).[5]

[5] For instance, the highest correlation amongst the four variables is for firms that have new product innovations for their businesses with those that have new or improved processes (correlation coefficient of 0.48, p-value<0.000).

Close to one-quarter of the sample have an internationally-recognised quality certification, such as ISO 9001 and other internationally recognised industry-specific certificates for quality and environmental management practices. This dummy variable is used to test *Hypothesis 1*.

Whilst close to one-third of the businesses have a female owner (sole owner or amongst owners), only 19% reported having a female top manager. This seems to suggest that some of the female owners are not managing their businesses. We find that amongst businesses with a female owner, only 37% have female top managers. Hence, we generate a dummy variable to differentiate female-owned businesses that have a male manager from the rest. This variable is used to test *Hypothesis 2*. There can be several reasons why some female-owned businesses may have male managers. These reasons are often influenced by a variety of factors, including business needs, personal choices and circumstances. Sometimes, female business owners hire male managers because they possess specific expertise, skills, or experience that complement the owner's strengths. This decision is based on the belief that the (hired) manager can contribute significantly to the business's success. Delegating managerial responsibility can allow owners to focus on strategic and long-term planning, as well as provide flexibility. Furthermore, female owners may form strategic partnerships or collaborations with individuals who have a unique entrepreneurial or negotiating skill set, or someone who has an established business network and reputation. Another strategic decision could be the ability of a male manager (e.g., a hired manager, or a family member such as a spouse) to help reduce institutional barriers that female-owned businesses face in certain contexts.

The average firm in the sample is about 28 years old at the time of data collection and borrows close to 13% of working capital from banks. Approximately 36% of the sample reported having a formal training programme for permanent full-time workers (e.g., in-house training) in the previous year. Close to 24% of the sample are exporters and 12% have some foreign ownership. A majority of the sample, 71%, reported currently using email to communicate with clients and suppliers. This variable is used to measure the impact of digitalisation and ICT on firm innovativeness.

Table 1: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Dependent Variables: Measures of Innovation					
New product innovation for business (1=yes, 0=no)	139,905	0.35	0.48	0.00	1.00
New product innovation for main market (1=yes,0=no)	43,387	0.67	0.47	0.00	1.00
New/improved processes (1=yes,0=no)	138,058	0.33	0.47	0.00	1.00
R&D spending (1=yes, 0=no)	138,560	0.19	0.39	0.00	1.00
Firm Strategy: Certification					
International certification (1=yes, 0=no)	188,429	0.23	0.42	0.00	1.00
Firm Strategy: Gender of Owner and Manager					
Female owner (1=yes, 0=no)	181,897	0.32	0.46	0.00	1.00
Female manager (1=yes, 0=no)	162,971	0.15	0.36	0.00	1.00
Firm-Level Controls					
Email communication (1=yes, 0=no)	135,743	0.71	0.45	0.00	1.00
Age (years)	189, 358	27.96	17.30	1	352
Working capital from banks (%)	173,045	12.65	23.59	0.00	100
Formal training for full-time employees (1=yes, 0=no)	168,459	0.36	0.48	0.00	1.00
Exporter (1=yes, 0=no)	191,862	0.24	0.43	0.00	1.00
Foreign owner (1=yes, 0=no)	191,862	0.12	0.32	0.00	1.00

Source: Authors' own elaboration based on WBES.

Our analysis is based on data from 136 countries where data on business innovation measures are available. Figure 2 presents a distribution of countries in our sample, along with a measure of the average firm innovativeness, measured by taking a mean of the four innovation variables. The green shades represent countries where data is available (our sample), whereas the grey shaded countries are not included in the analysis due to a lack of data. As the figure suggests, firms operating in Europe (e.g., Finland, Denmark, Sweden) have, on average, more firms (e.g., >60% of firms in the given sample) engaging in some type of innovations (e.g., process, product, R&D, or all). Amongst African nations, Namibia, Uganda and the Central African Republic stand out as having a higher degree of innovation. In South America, Ecuador, Bolivia, Papua New Guinea and Peru have higher degrees of innovation.

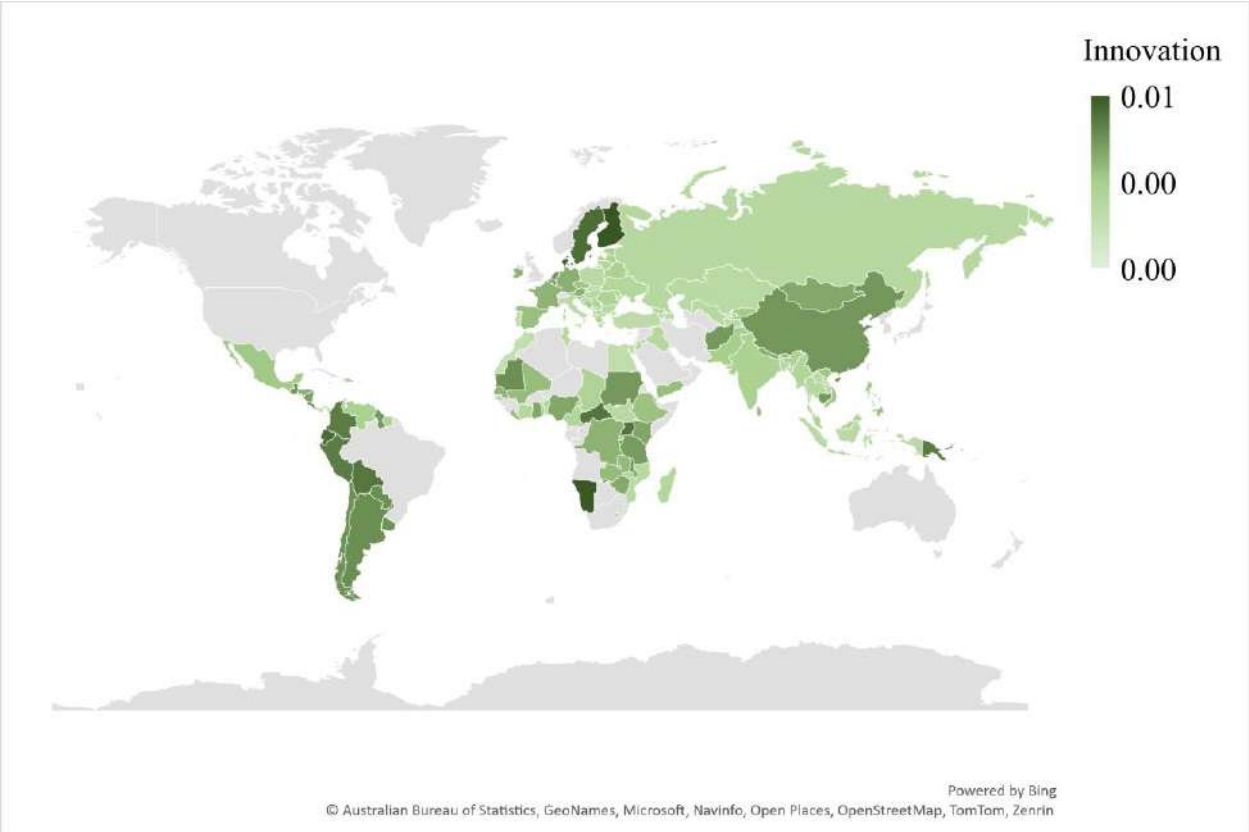

**Figure 2: The average percent of firms reporting innovative activities (based on 186,987 firm observations). Innovation presents the average of the four innovation metrics per country
(Source: constructed by authors using the WBES).**

3.2 Empirical approaches

Since the four innovation metrics are all dummy variables (*Y=1* or *0*), the Probit model is the chosen regression model to fit data. This is particularly useful when examining the determinants of innovation, as it allows us to identify the influence of various factors on the likelihood of a firm engaging in innovative activities.

The estimated equation is presented as follows, where $\varphi(.)$ is the cdf of the normal distribution, *G* represents the gender dummy variables as (1) female owned businesses, (2) female managed businesses, and (3) female owned businesses with a male manager, to test *Hypothesis 2*. The variable C represents international certification to test for *Hypothesis* 1 and *X* is a vector of firm-level control variables:

$$\Pr(Y = 1|X) = \varphi(\beta_0 + \beta_1 X + \beta_2 C + \beta_3 G)$$

The coefficients β_2 and β_3 measure the direct impact of certification and gender variables on the probability of innovations respectively, whilst the coefficient β_1 controls for the impact coming from control variables (denoted by vector X) on the probability to innovate. The model also includes three additional dummy variables: industry of business, regional locations (e.g., Africa, East Asia and Pacific, Middle East, and North Africa, etc.), year of WBES survey and country-level indicators.

Our regression results provide valuable insights into the factors driving innovation and make informed decisions to foster a culture of innovation within organisations and industries. One issue with fitting the above equation is endogeneity, where firms that choose to obtain international certification may be systematically different from those that do not (self-selection bias) with unobserved firm characteristics possibly driving the decision to certificate and the decision to engage in innovative activities. For instance, firms with a higher probability of innovation may be more likely to pursue ISO quality or environmental standard certifications. Another source of endogeneity is simultaneity, where the relationship between innovation and certification could be bi-directional. This could happen if firms with a culture of innovation are more likely to obtain certification, whilst at the same time, certification encourages and facilitates innovation within a firm. In some cases, it may also be that firms decide to certify and standardise, in reaction to declining innovation or related problems.

To test for the endogeneity of the variable used to measure certification, we perform the Smith-Blundell and Wald tests of exogeneity, whose null hypothesis states that certification is an exogenous variable (Smith and Blundell, 1986). Under the alternative hypothesis, the potentially endogenous variable (that is, certification) is fitted as a function of an instrument that affects a given business's certification decision but is not related to the firm's innovations. Such an instrument is constructed by aggregating the certification rate of the firm's industry within the firm's city of operation. Businesses that operate in sectors and locations that have a higher rate of certification have a higher likelihood of conforming to the norm to certify (e.g., it is an industry norm to use ISO, clustering effect, etc.) (Fikru, 2016). However, such an aggregated measure of certification is not expected to affect a firm's decision to be involved in innovative activities. The residuals from fitting the impact of aggregated certification rate on certification decisions are added to the model where, under the null hypothesis, these residuals have no explanatory power. We use the two exogeneity tests (Smith-Blundell and Wald test) for all four innovation measures, by including all firm-level controls (vector X), the gender of owners and managers (G), and certification (C) explained by the proposed instrumental variable (i.e., aggregated certification rate). We then fit an instrumental variable probit model to control for the potential endogeneity of the certification variable. Regression results are reported for both the exogenous (certification treated as exogenous) and endogenous (certification treated as an endogenous variable) models.

The chosen instrumental variable is valid and appropriate because of its high correlation with the certification variable (correlation coefficient of 0.51, $p<0.000$) and low correlation with the innovation variables (correlation coefficient less than 0.19, $p<0.000$). That is, a firm is likely to be certified if it operates in a city and in an industry where the majority of firms have certified See Appendix A for a box plot of the instrumental variable). However, a firm is not necessarily expected to innovate in response to the certification rate of its industry and location of operation.

4 Results and Discussion

In section 4.1, we perform exploratory and categorical data analytics consistent with our hypotheses. Whilst such categorical data analysis does not control for the impact of other factors (like in the Probit model), it enables us to understand trends and patterns in the data. Section 4.2. presents results from fitting the Probit model - without and with certification treated as an endogenous covariate.

4.1 Categorical data analysis

Figure 3 presents a comparison of the four innovation metrics for firms with an international certification (IC) versus those who do not have an international certification. The figure indicates that firms with IC are more likely to be innovative in all four dimensions than firms without IC, with the mean differences presented in the bars all yield statistically significant mean differences (at a 1 % significance level) when applying a two-sample t-test.

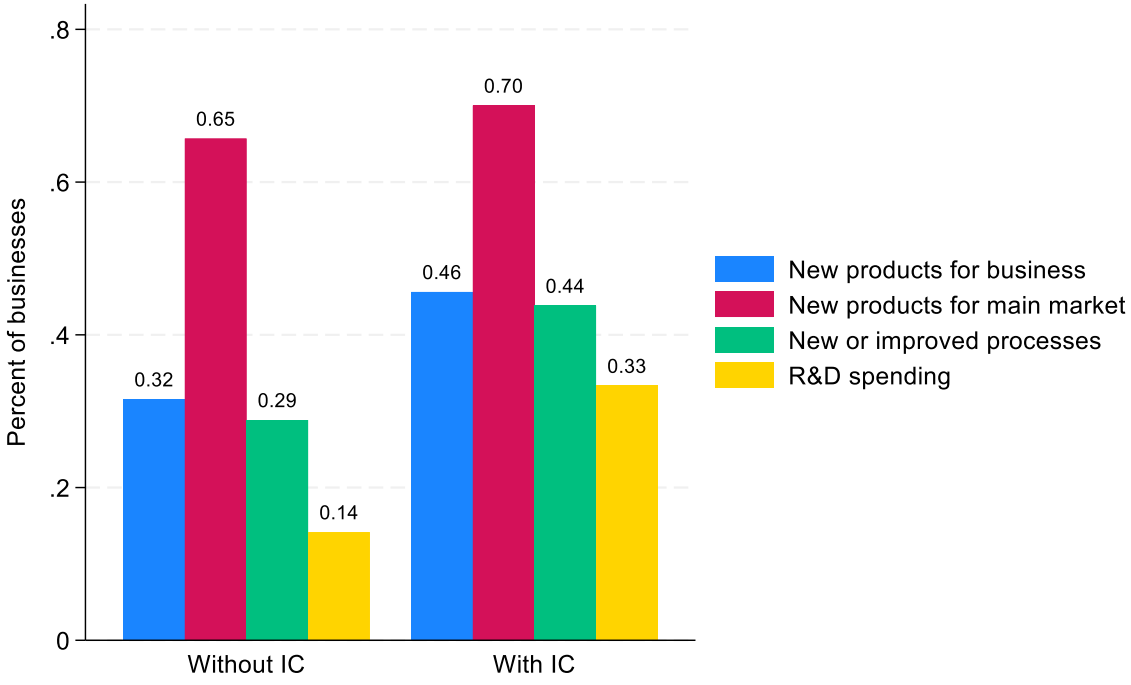

Figure 3: Certification and innovation
(Source: constructed by authors using the WBES).

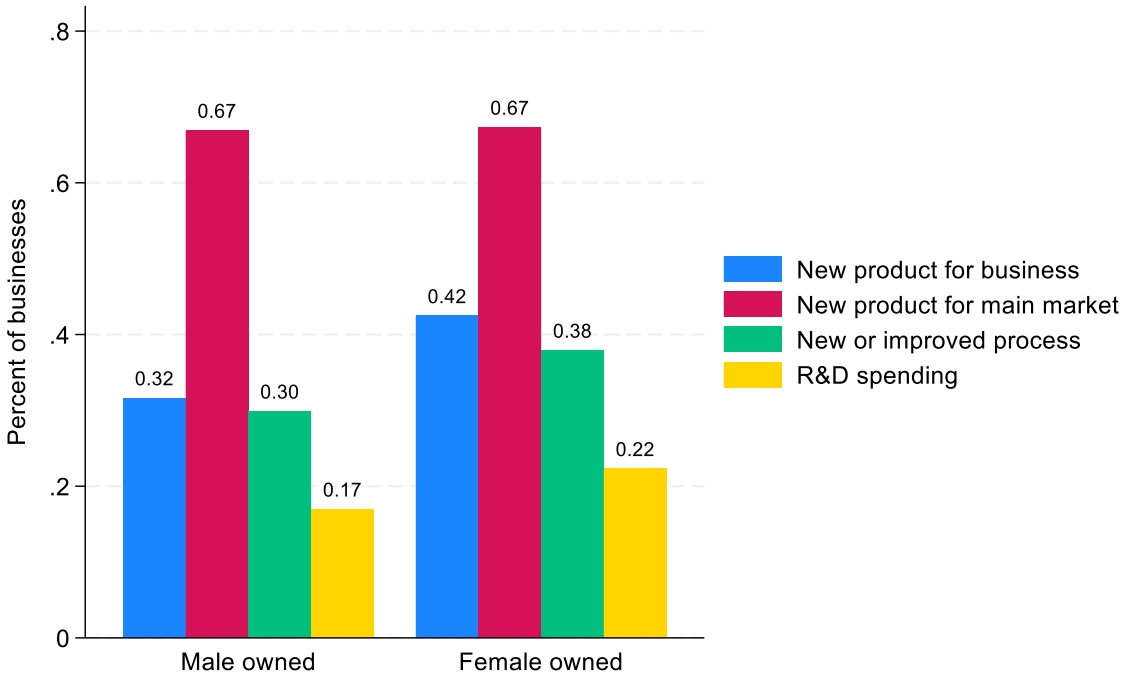

Figure 4: Gender of business owner and innovation
(Source: constructed by authors using the WBES).

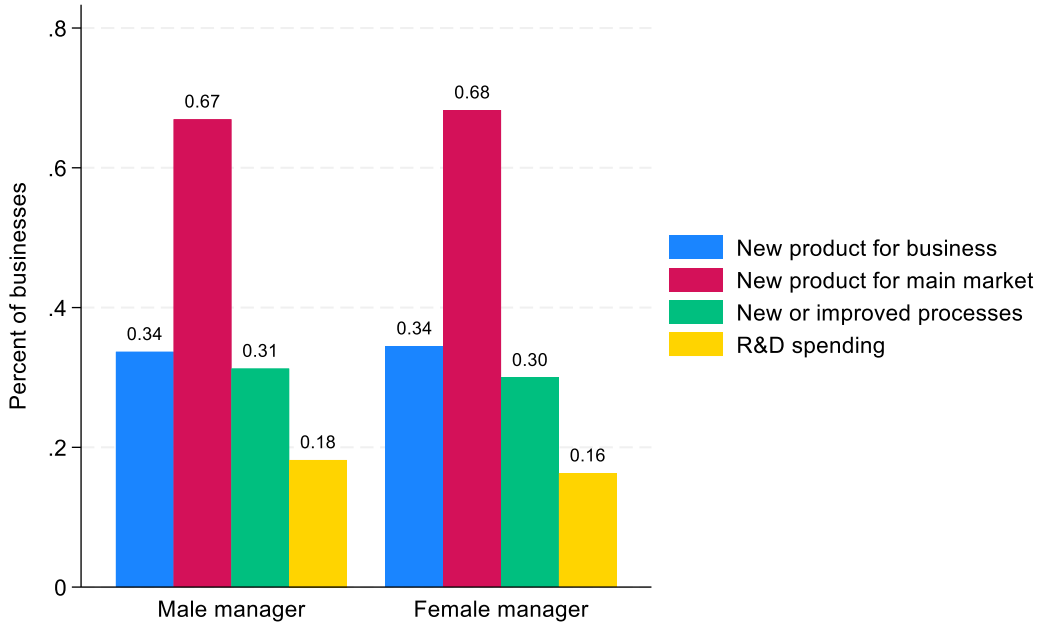

Figure 5: Gender of business manager and innovation (Source: constructed by authors using the WBES).

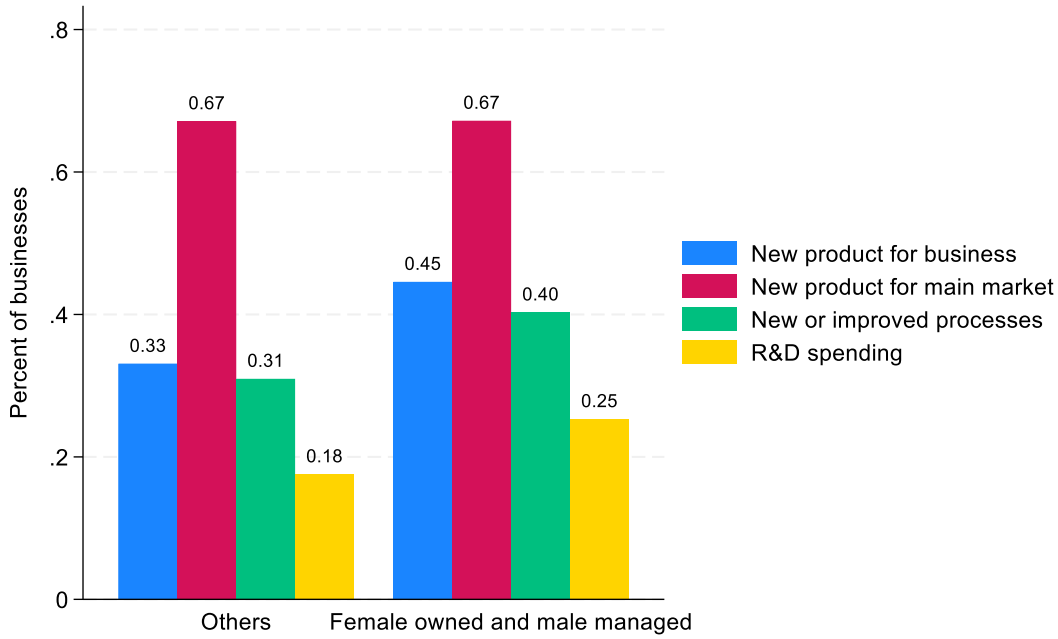

Figure 6: Comparing female-owned firms that have a male manager with the rest of the firms in the sample (Source: constructed by authors using the WBES).

Figures 4, 5, and 6 present the percentage of innovative businesses based on the gender of owners and managers. Figure 4 shows that female-owned businesses have higher innovations for new products introduced for the business and for adopting new and improved processes, as well as for investing in R&D. This sheds light on the possibility that managerial delegation (in this case hiring a male manager) could help spur innovations for female-owned businesses (see additional figures in Appendix B). Both male and female-owned businesses have similar rates of being pioneer firms, in terms of introducing new products to the entire market. Figure 5 shows that female-managed businesses are very similar to male-managed businesses, with respect to all four innovation metrics (with a slightly lower R&D frequency for female-managed firms). Figure 6 identifies female-owned businesses that are led by a male top manager and shows that such firms have a higher frequency of innovation, with respect to all measures, except introducing new products to the main market. Overall, these statistics suggest that female-owned businesses do not necessarily perform less in terms of innovativeness.

Table 2: Probit regression results with robust standard errors (SEs). P-values of 0.05 or less are highlighted in pink. Age and working capital are log-transformed.

Panel 2A: Using female ownership dummy												
	New product to business			**New product to market**			**New process**			**R&D spending**		
	Coefficients	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*
Age	-0.085	0.035	0.014	-0.103	0.064	0.104	-0.097	0.042	0.022	-0.183	0.042	0.000
Working capital from bank	0.011	0.009	0.192	0.014	0.014	0.318	0.037	0.010	0.000	0.041	0.010	0.000
Employee formal training	0.414	0.032	0.000	0.166	0.051	0.001	0.419	0.034	0.000	0.541	0.041	0.000
Foreign owner	0.077	0.059	0.190	0.015	0.076	0.848	-0.018	0.077	0.818	-0.105	0.056	0.062
Email	0.349	0.045	0.000	0.117	0.071	0.098	0.406	0.052	0.000	0.270	0.062	0.000
Exporter	0.248	0.040	0.000	0.021	0.053	0.688	0.232	0.052	0.000	0.415	0.051	0.000
Certification	0.169	0.037	0.000	0.046	0.056	0.412	0.074	0.040	0.063	0.213	0.046	0.000
Female owner	0.023	0.030	0.457	-0.055	0.046	0.229	0.060	0.036	0.094	-0.031	0.039	0.418
Constant	0.741	0.395	0.061	0.220	0.588	0.709	-0.522	0.383	0.173	-0.540	0.429	0.208
Observations	67,419			25,536			66,951			66,836		

Panel 2B: Using female manager dummy variable												
	New product to business			**New product to market**			**New process**			**R&D spending**		
	Coefficients	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*
Age	-0.085	0.035	0.016	-0.073	0.065	0.260	-0.095	0.042	0.024	-0.199	0.043	0.000
Working capital from bank	0.009	0.009	0.281	0.016	0.014	0.222	0.034	0.010	0.000	0.039	0.010	0.000
Employee formal training	0.412	0.032	0.000	0.202	0.059	0.001	0.415	0.034	0.000	0.528	0.042	0.000
Foreign owner	0.121	0.062	0.049	-0.071	0.121	0.554	0.003	0.076	0.972	-0.049	0.072	0.498
Email	0.354	0.045	0.000	0.120	0.071	0.090	0.407	0.052	0.000	0.281	0.062	0.000
Exporter	0.233	0.040	0.000	0.036	0.054	0.512	0.226	0.051	0.000	0.403	0.050	0.000
Certification	0.185	0.038	0.000	-0.002	0.068	0.978	0.092	0.040	0.021	0.227	0.048	0.000
Female manager	0.065	0.042	0.121	0.017	0.062	0.783	0.037	0.046	0.425	0.139	0.056	0.014
Constant	0.721	0.393	0.067	-0.030	0.593	0.960	-0.486	0.379	0.200	-0.443	0.420	0.292
Observations	68,087			25,865			67,597			67,489		

Panel 2C: Using dummy variable for female-owned and male managed businesses												
	New product to business			**New product to market**			**New process**			**R&D spending**		
	Coefficients	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*
Age	-0.085	0.035	0.015	-0.066	0.065	0.309	-0.099	0.042	0.019	-0.196	0.043	0.000
Working capital from bank	0.010	0.009	0.275	0.016	0.014	0.223	0.034	0.010	0.000	0.040	0.010	0.000
Employee formal training	0.413	0.032	0.000	0.205	0.059	0.001	0.414	0.034	0.000	0.533	0.042	0.000
Foreign owner	0.121	0.061	0.048	-0.075	0.121	0.535	0.005	0.075	0.945	-0.051	0.072	0.476
Email	0.350	0.045	0.000	0.115	0.071	0.105	0.407	0.052	0.000	0.279	0.061	0.000
Exporter	0.232	0.040	0.000	0.038	0.054	0.482	0.222	0.051	0.000	0.404	0.050	0.000
Certification	0.185	0.038	0.000	0.001	0.068	0.990	0.094	0.040	0.019	0.233	0.048	0.000
Female owner male manager	0.007	0.033	0.819	-0.078	0.049	0.112	0.088	0.039	0.024	-0.016	0.038	0.683
Constant	0.735	0.392	0.061	0.014	0.592	0.981	-0.499	0.381	0.191	-0.399	0.425	0.348
Observations	68,687			26,059			68,190			68,092		

Table 3: Instrumental variable Probit model with robust standard errors (SEs). P-values of 0.05 or less are highlighted in pink. Age and working capital are log-transformed.

Panel 3A: Using female ownership dummy												
	New product to business			**New product to market**			**New process**			**R&D spending**		
	Coefficients	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*
Certification	0.267	0.153	0.082	0.287	0.179	0.110	0.087	0.170	0.610	0.635	0.168	0.000
Age	-0.088	0.035	0.012	-0.107	0.064	0.093	-0.097	0.043	0.023	-0.194	0.041	0.000
Working capital from bank	0.011	0.009	0.212	0.013	0.014	0.350	0.037	0.010	0.000	0.038	0.010	0.000
Employee formal training	0.404	0.035	0.000	0.139	0.051	0.007	0.418	0.036	0.000	0.493	0.043	0.000
Foreign owner	0.070	0.061	0.251	-0.009	0.078	0.903	-0.019	0.078	0.813	-0.132	0.057	0.020
Email	0.344	0.045	0.000	0.097	0.070	0.168	0.406	0.053	0.000	0.248	0.063	0.000
Exporter	0.236	0.044	0.000	-0.003	0.056	0.963	0.231	0.056	0.000	0.364	0.057	0.000
Female owner	0.020	0.030	0.508	-0.062	0.047	0.184	0.060	0.036	0.093	-0.043	0.039	0.269
Constant	-1.660	0.257	0.000	-0.141	0.407	0.729	-2.329	0.263	0.000	-1.243	0.276	0.000
Observations	67,419			25,536			66,951			66,836		
Smith-Blundell test of exogeneity, Chi-Sq (1)	2.530		0.111	0.000		0.983	0.479		0.489	12.650		0.000
Wald test of exogeneity, Chi-Sq (1)	0.450		0.502	1.710		0.191	0.010		0.937	6.630		0.010

Panel 3B: Using female manager dummy variable

	New product to business			New product to market			New process			R&D spending		
	Coefficients	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*
Certification	0.270	0.152	0.074	0.195	0.178	0.275	0.105	0.166	0.526	0.637	0.169	0.000
Age	-0.087	0.035	0.014	-0.075	0.066	0.253	-0.095	0.042	0.024	-0.209	0.043	0.000
Working capital from bank	0.009	0.009	0.300	0.016	0.014	0.234	0.034	0.010	0.000	0.037	0.010	0.000
Employee formal training	0.404	0.035	0.000	0.182	0.061	0.003	0.414	0.036	0.000	0.483	0.043	0.000
Foreign owner	0.113	0.064	0.075	-0.100	0.128	0.432	0.001	0.078	0.986	-0.086	0.069	0.213
Email	0.350	0.045	0.000	0.102	0.071	0.148	0.407	0.053	0.000	0.259	0.063	0.000
Exporter	0.224	0.043	0.000	0.017	0.057	0.761	0.225	0.055	0.000	0.355	0.057	0.000
Female manager	0.062	0.042	0.137	0.019	0.063	0.764	0.036	0.046	0.426	0.126	0.057	0.028
Constant	-1.707	0.256	0.000	-0.183	0.402	0.649	-2.345	0.261	0.000	-1.290	0.274	0.000
Observations	68,087			25,865			67,597			67,489		
Smith-Blundell test of exogeneity, Chi-Sq (1)	2.176		0.140	0.028		0.866	0.428		0.513	12.040		0.001
Wald test of exogeneity, Ch-Sq (1)	0.360		0.550	1.260		0.261	0.010		0.932	6.300		0.012

Panel 3C: Using dummy variable for female-owned and male managed businesses												
	New product to business			**New product to market**			**New process**			**R&D spending**		
	Coefficients	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*	*Coefficients*	*Robust SEs*	*P-values*
Certification	0.272	0.150	0.069	0.206	0.179	0.249	0.107	0.165	0.516	0.635	0.166	0.000
Age	-0.088	0.035	0.013	-0.068	0.066	0.302	-0.099	0.042	0.019	-0.205	0.042	0.000
Working capital from bank	0.009	0.009	0.294	0.016	0.014	0.235	0.034	0.010	0.000	0.038	0.010	0.000
Employee formal training	0.405	0.035	0.000	0.183	0.061	0.003	0.413	0.036	0.000	0.489	0.043	0.000
Foreign owner	0.112	0.063	0.074	-0.105	0.128	0.412	0.004	0.077	0.960	-0.087	0.068	0.202
Email	0.346	0.045	0.000	0.097	0.071	0.171	0.406	0.052	0.000	0.257	0.062	0.000
Exporter	0.222	0.043	0.000	0.019	0.056	0.737	0.220	0.055	0.000	0.357	0.056	0.000
Female owner male manager	0.006	0.033	0.848	-0.084	0.049	0.089	0.087	0.039	0.025	-0.022	0.038	0.568
Constant	-1.697	0.255	0.000	-0.177	0.400	0.657	-2.349	0.261	0.000	-1.273	0.273	0.000
Observations	68,687			26,059			68,190			68,092		
Smith-Blundell test of exogeneity, Chi-Sq (1)	2.340		0.125	0.028		0.097	0.396		0.529	10.400		0.001
Wald test of exogeneity, Ch-Sq (1)	0.380		0.537	1.370		0.242	0.010		0.930	6.310		0.012

4.2 Regression results

Our regression results from Probit models are presented in Tables 2 (Probit regression) and 3 (instrumental variable Probit regression with the maximum likelihood estimator). We report regression coefficients, robust standard errors and p-values. We interpret statistically significant covariates by using the 1% ($p<0.01$) and 5% ($p<0.05$) statistical significance levels. The Smith-Blundell and Wald test of exogeneity both suggest that certification is endogenous when innovation is measured by R&D spending. In addition, in all first-stage regressions explaining certification decisions (not reported for brevity), the instrumental variable explains certification positively at a 1% statistical significance.

All regressions control for region, country, year and industry dummy variables to control for variations in the probability of innovations across space, year of survey administration and sector of operation. In addition, we add two additional dummy variables, differentiating large-scale and medium-scale firms from small-scale firms, where firm size is measured by the number of employees (that is, small-scale firms hire 20 or else employees, medium-scale firms employ 20-99 workers and large-scale firms hire 100 or more workers). Coefficients from these dummy variables are not reported for brevity. Overall results presented in Tables 2 and 3 are generally consistent.

Comparing the regression results in Tables 2 and 3 suggests that when treating certification as an exogenous variable, it appears to have a positive impact on the probability of innovating new products to the business, new processes and incurring R&D spending. However, once we control for endogeneity, the impact of certification on new products to the business and new processes loses statistical significance. Certification only affects R&D spending probability after controlling for endogeneity. Our result shows that firms that have a quality or sustainability type of certification (in compliance with international standards) are more likely to invest in R&D but are not necessarily involved in the other types of innovation. Our results highlight the importance of controlling for endogeneity of certification, as this will impact its predictive impact on firm innovations. Whilst it may appear that certification could enable firms to improve and streamline their processes whilst also improving their product/service offerings, once we account for drivers of certification (e.g., industry norms, location norms, spatial effects, etc.), its predicted impact on innovation weakens. Hence, we find some limited evidence to support *Hypothesis 1* depending on the metrics of firm innovation: certification does not facilitate all types of innovations.

Whilst studies like Mangiarotti and Riilli (2014) and Medase and Basit (2023) find that certification positively affects product and process innovations, we find that after accounting for the endogeneity of certification this will not hold, with certification only affecting R&D spending and not the other dimensions of innovation. Our findings are also distinct from studies like Terziovski and Guerrero (2014) and Ratnasingam et al. (2013),

who find that certification positively affects process innovation. Our result is different because we account for the factors that are certification drivers before modelling certification as a potential driver for innovation. Whilst Table 2 shows that leaving certification as exogenous appears to positively impact product and process innovations as in past studies (e.g., Terziovski and Guerrero, 2014), once endogeneity is accounted for this effect diminishes.

Results in Table 2 suggest that female-managed businesses have a higher probability of investing in R&D, whilst businesses owned by a female but managed by a male have a higher probability of innovating new processes. These results are also confirmed in Table 3 after accounting for the endogeneity of certification. Hence, we find some limited support for *Hypothesis 2* where gender diversity in ownership and management could facilitate new process development and/or break barriers with respect to innovating in this dimension, but not the rest. Our results highlight the complex relationship between gender issues and firm innovativeness, where the gender of owners and managers has a measurable influence on certain but not all measures of innovation. This finding underlines the importance of controlling for *both* the gender of ownership and the gender of management when studying the role of gender in business performance. Often the literature argues that female-owned businesses do poorly because of capital constraints and lack of access to markets (Morazonni and Sy, 2022). Our results show that this argument may not always be valid or may not be a correct interpretation. Even when the female owner is not a manager, the business can be highly innovative in new and improved processes compared to other firms, due to gender diversity benefits. Therefore, even with a male manager, female ownership could act as a form of empowerment and improve the incentive for process improvement.

The results from the control variables (firm age, percent of working capital borrowed from banks, formal employee training, exporters, foreign ownership and firm size) are overall consistent with previous works (Ayalew et al., 2020; Medase and Basit, 2023). In both Tables 2 and 3, we find that firms that use email to communicate with clients and suppliers are more likely to be innovative and maximise innovative outcomes (Alam et al., 2022) via product innovations for the business, process innovation and R&D expenditure. Overall, digitalisation could create synergy for innovation by enabling firms to adopt multiple innovative strategies. However, using email does not enable firms to innovate new products for the market and, as Spiezia (2011) argues, email use is no longer a relevant enabler of core innovations because virtually all firms use computers.

Our results are consistent with Arvanitis and Loukis (2015), who find that ICTs have a positive effect on product and process innovation, as well as Arvanitis et al. (2013), who find that electronic sales have an impact on process innovation. Our studies are also consistent with several regional studies that find a role for ICT in firm innovations. Examples include Cuevas-Vargas et al. (2016) in Mexico, Higon (2012) in the UK, Lorenz and Pommet (2021) in Africa, and Zhu et al. (2021) in China.

As a firm's age increases, the probability of offering new products/services for the business, adopting new/improved processes and incurring R&D expenditure significantly decreases, although age has no statistically significant impact on offering products/services that are new to the entire market. This result suggests that new firms and start-ups are more likely to be innovative in adopting newer products/services and processes and investing in R&D. However, firm age is not correlated with becoming the first mover in introducing a new product/service before competitors.

Firms that rely more on financing a higher share of their working capital via borrowing from the banking sector (foreign or local banks) are more likely to invest in process innovations and invest in R&D than firms that do not use borrowed money to finance working capital (e.g., those that use retained earnings). This result suggests that financial resources through the formal banking sector could be a driver for some types of firm innovations but not others (e.g., process but not product innovations).

Firms that offer formal training to their permanent full-time workers are more likely to invest in all four types of innovation activities. This result highlights the importance of human capital in enabling not just one but different types of firm innovativeness, potentially maximising innovative outcomes. Our results in Tables 2 and 3 highlight the difficulty in introducing new products to the market which may be facilitated by training employees, but not the other drivers. All other explanatory variables are not strong in explaining the probability of being a pioneer firm in the industry.

Exporters are more likely to be innovative in the three individual aspects of innovation (product and process innovation, R&D expenditure) but not for introducing new products/services to the entire market. This result also highlights the difficulty in becoming the first mover (leader) in introducing novel products to the market.

The impact of foreign ownership is mixed, yielding a positive coefficient in two of the regressions in Table 2 (foreign-owned firms have a higher probability of introducing new products to their business) and a negative coefficient for one of the endogenous regressions in Table 3 (foreign-owned firms have lower R&D spending probability). The negative impact could be because such businesses prefer to invest in R&D in their origin country instead of the host country. It could also be driven by foreign firms being able to replicate or apply their home-grown innovations in other host countries. Finally, medium and large-scale firms are, in general, more likely to be more innovative in all four measures than small-scale firms and this is consistent with the findings of Ayalew et al. (2020) (results not reported for brevity). Overall, the results from the control variables illustrate the existence of hard-to-break barriers when it comes to introducing a completely new product/service to the industry before any competition (that is, becoming the product innovation leader in the market). Except for the role of human capital in the form of training workers and firm size (e.g., measuring capability, resources), the other control variables (exporter, bank loans and firm age) did not significantly impact new products/services

introduced to the main market, even if they facilitated the businesses' product and process innovation, as well as the decision to invest in R&D.

5 Conclusion

Since firm innovations have been identified as one of the United Nation's SDGs, there has been a growing interest in examining the drivers and barriers of firm innovativeness, with a primary focus on firm-specific factors. Whilst previous studies have elucidated on the significance of variables like managerial experience, resource availability and global outlooks, they have often overlooked the strategic roles played by intentional actions, such as the adoption of international quality standards and certification and the selection of managers. Consequently, this study aims to explore how these strategic manœuvres impact a firm's ability to introduce new products, improve processes, invest in research and development - ultimately driving innovation. By considering the interplay of these strategies with other innovation determinants and assessing various types of innovation, this research extends the existing literature on firm innovativeness. Moreover, it unravels the complexities surrounding the role of gender diversity in both ownership and management, highlighting how this diversity can enhance innovation. This study leverages the World Bank Enterprise Survey database, to analyse a vast array of firm-level observations across multiple countries, employing a Probit model to identify factors influencing the likelihood of firm innovation, thereby contributing valuable insights into the field of innovation research.

After controlling for potential endogeneity, we find some evidence that certification improves the probability of R&D spending, but not process/product innovations. We also find evidence of the role of gender dynamics in affecting some, but not all types of innovations. First, we find that businesses with a female top manager have a higher probability of investing in R&D. Second, we find that female-owned businesses with a male manager have a higher probability of adopting new/improved processes. These results imply that the relationship between gender issues and firm innovativeness is complex, where female ownership and management affect some but not all measures of innovation.

Our results have implications for advancing Goal 9 of the Sustainable Development Goals (SDGs) globally. Our findings imply that ISO certification can advance Goal 9 of the SDGs by promoting industry, innovation and infrastructure. ISO standards provide a framework for organisations to improve efficiency, quality and sustainability in their operations. Achieving ISO certification can demonstrate a commitment to responsible business practices, fostering innovation and contributing to the development of resilient infrastructure, which aligns with Goal 9.

Gender diversity in business management and ownership can also contribute to the advancement of Goal 9 of the SDGs by promoting inclusivity and innovation. When women are actively involved in business ownership, diverse perspectives are brought to the table, leading to more creative problem-solving and innovative solutions in the field of industry, innovation and infrastructure. This, in turn, supports the sustainable development of resilient infrastructure and fosters a more inclusive and equitable business environment, aligning with Goal 9.

Female-owned businesses have the potential to be significant drivers of innovation in various industries and hiring a male manager could be a potential strategy to discover improved and new processes. Whilst the challenges and opportunities for innovation in all businesses are driven by several external and internal factors, there are certain factors specific to female-owned businesses that can influence their approach to innovation and their impact on the economy. For example, female-owned businesses with a delegated manager contribute to innovation by bringing diverse perspectives to management and addressing unique market niches. Female managers may also be more likely to emphasise social and environmental responsibility and foster inclusive and collaborative work environments that contribute to innovation. It is important to note that whilst female-owned businesses have made significant strides in innovation, they continue to face gender-specific challenges, including access to capital, gender bias and unequal opportunities. Efforts to level the playing field and promote gender diversity in entrepreneurship and innovation are essential to fully harness the innovative potential of female-owned businesses, as well as to wholly achieve Goal 9 of the SDGs.

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Appendix A

Table A1: Distribution of businesses by location

Country	Frequency	Percent
Afghanistan	945	0.49
Albania	1,041	0.54
Angola	785	0.41
Antigua and Barbuda	151	0.08
Argentina	3,108	1.62
Armenia	1,280	0.67
Austria	600	0.31
Azerbaijan	995	0.52
Bahamas	150	0.08
Bangladesh	3,944	2.06
Barbados	150	0.08
Belarus	1,233	0.64
Belgium	614	0.32
Belize	150	0.08
Benin	300	0.16
Bhutan	503	0.26
Bolivia	1,339	0.7
Bosnia and Herzegovina	1,083	0.56
Botswana	610	0.32
Brazil	1,802	0.94
Bulgaria	2,368	1.23
Burkina Faso	394	0.21
Burundi	427	0.22
Cambodia	845	0.44
Cameroon	724	0.38
Cape Verde	156	0.08
Central African Republic	150	0.08
Chad	303	0.16
Chile	2,050	1.07
China	2,700	1.41
Colombia	2,935	1.53
Congo	151	0.08
Costa Rica	538	0.28
Croatia	1,397	0.73
Cyprus	240	0.13
Czech Republic	1,006	0.52
Côte d'Ivoire	887	0.46

DRC	1,228	0.64
Denmark	995	0.52
Djibouti	266	0.14
Dominican Republic	869	0.45
Ecuador	1,385	0.72
Egypt	7,786	4.06
El Salvador	1,772	0.92
Eritrea	179	0.09
Estonia	906	0.47
Eswatini	457	0.24
Ethiopia	1,492	0.78
Fiji	164	0.09
Finland	759	0.4
France	1,566	0.82
Gabon	179	0.09
Gambia	325	0.17
Georgia	1,314	0.68
Germany	1,694	0.88
Ghana	1,214	0.63
Greece	600	0.31
Grenada	153	0.08
Guatemala	1,457	0.76
Guinea Bissau	532	0.28
Guyana	165	0.09
Honduras	1,128	0.59
Hungary	1,406	0.73
India	18,657	9.72
Indonesia	2,764	1.44
Iraq	1,775	0.93
Ireland	606	0.32
Israel	483	0.25
Italy	760	0.4
Jamaica	376	0.2
Jordan	1,174	0.61
Kazakhstan	2,590	1.35
Kenya	2,439	1.27
Kosovo	743	0.39
Kyrgyz Republic	865	0.45
Lao PDR	1,330	0.69
Latvia	966	0.5
Lebanon	1,093	0.57

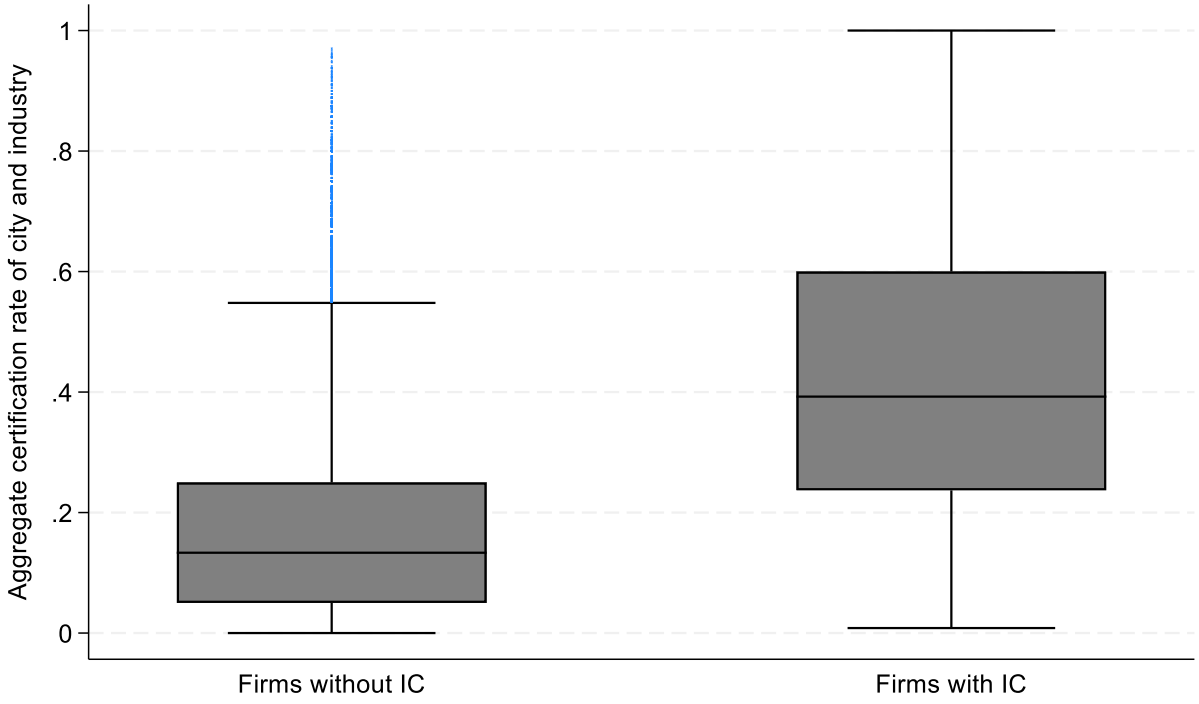
Lesotho	301	0.16
Liberia	301	0.16
Lithuania	904	0.47
Luxembourg	170	0.09
Madagascar	1,379	0.72
Malawi	673	0.35
Malaysia	2,221	1.16
Mali	1,035	0.54
Malta	242	0.13
Mauritania	785	0.41
Mexico	2,960	1.54
Micronesia	68	0.04
Moldova	1,083	0.56
Mongolia	1,082	0.56
Montenegro	416	0.22
Morocco	1,503	0.78
Mozambique	1,080	0.56
Myanmar	1,239	0.65
Namibia	909	0.47
Nepal	850	0.44
Netherlands	808	0.42
Nicaragua	1,147	0.6
Nigeria	4,868	2.54
North Macedonia	1,086	0.57
Pakistan	2,182	1.14
Panama	969	0.51
Papua New Guinea	65	0.03
Paraguay	1,338	0.7
Peru	2,635	1.37
Philippines	2,661	1.39
Poland	2,366	1.23
Portugal	1,062	0.55
Romania	1,895	0.99
Russia	6,547	3.41
Rwanda	813	0.42
Samoa	109	0.06
Senegal	1,107	0.58
Serbia	1,109	0.58
SierraLeone	302	0.16
Slovak Republic	972	0.51
Slovenia	955	0.5

Solomon Islands	151	0.08
South Sudan	2,772	1.44
Spain	1,051	0.55
Sri Lanka	610	0.32
St. Kitts and Nevis	150	0.08
St. Lucia	150	0.08
St Vincent and Grenadines	154	0.08
Sudan	662	0.35
Suriname	385	0.2
Sweden	1,191	0.62
Tajikistan	1,071	0.56
Tanzania	1,232	0.64
Thailand	1,000	0.52
Timor-Leste	514	0.27
Togo	305	0.16
Tonga	150	0.08
Trinidad and Tobago	370	0.19
Tunisia	1,207	0.63
Turkey	4,159	2.17
Uganda	1,325	0.69
Ukraine	3,190	1.66
Uruguay	1,575	0.82
Uzbekistan	1,995	1.04
Vanuatu	128	0.07
Venezuela	820	0.43
Vietnam	2,049	1.07
West Bank and Gaza	799	0.42
Yemen	830	0.43
Zambia	1,805	0.94
Zimbabwe	1,199	0.62
Total	191,862	100

Table A2: Pairwise correlation coefficients with significance levels in bracket

	[1]	[2]	[3]	[4]
New product for business [1]	1.0000			
New product for market [2]	0.0069 (0.1528)	1.0000		
New or improved processes [3]	0.4814 (0.000)	0.1368 (0.0000)	1.000	
R&D spending [4]	0.3632 (0.0000)	0.1117 (0.0000)	0.3732 (0.0000)	1.000

Figure A1: Distribution of the instrumental variable



Appendix B

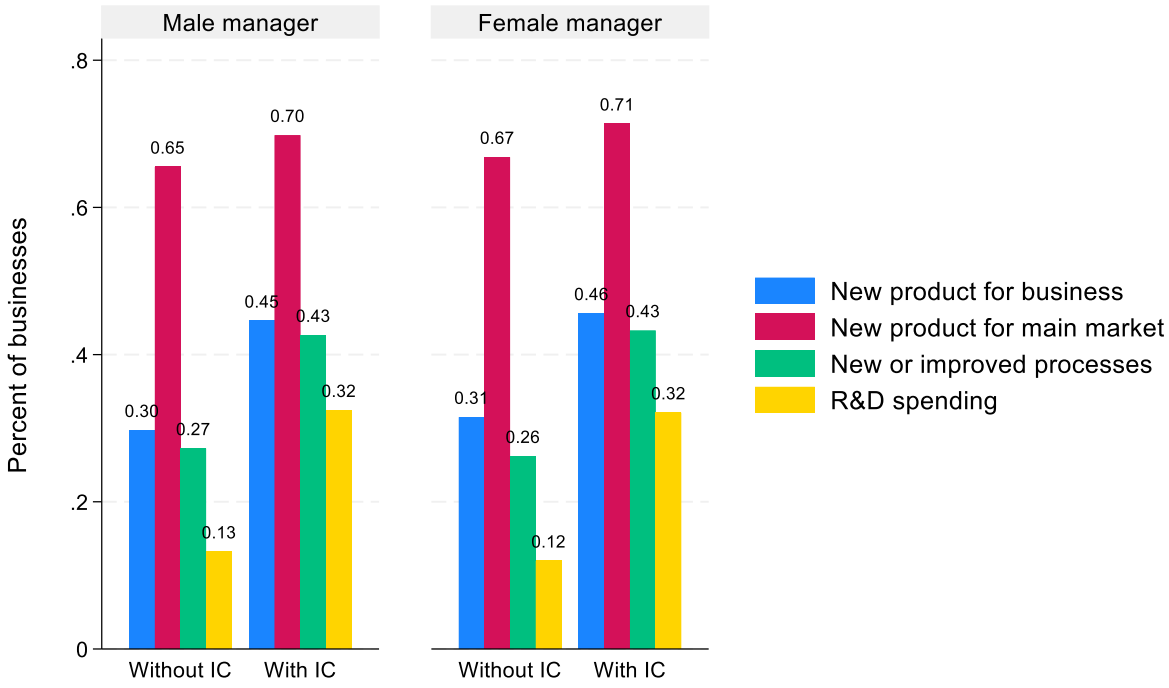


Figure B1: Certification, gender of managers and innovation

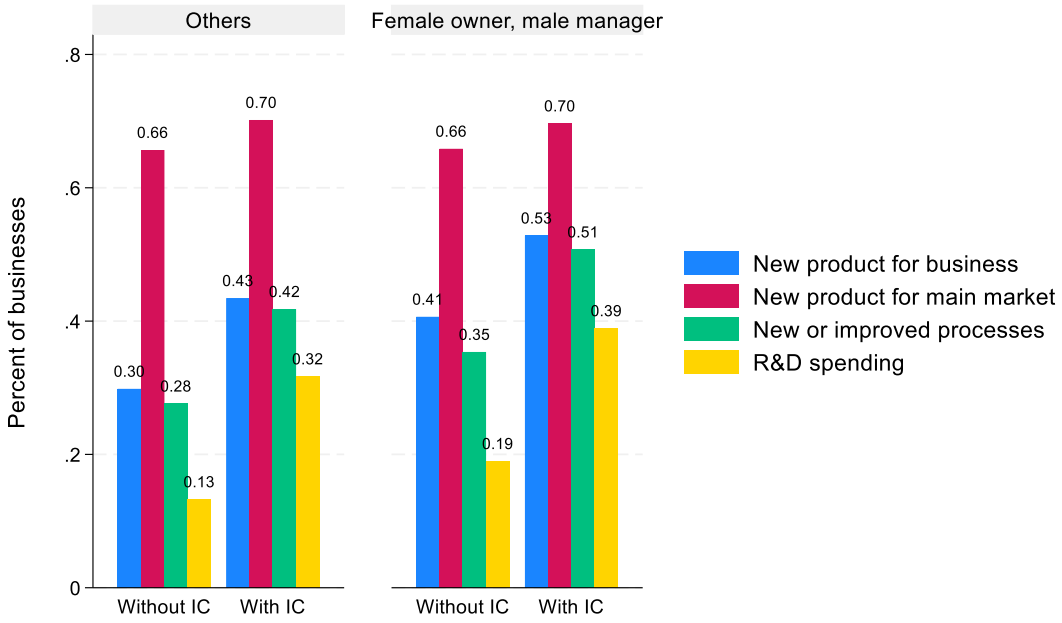


Figure B2: Female-owned business led by a male manager, certification and innovation.

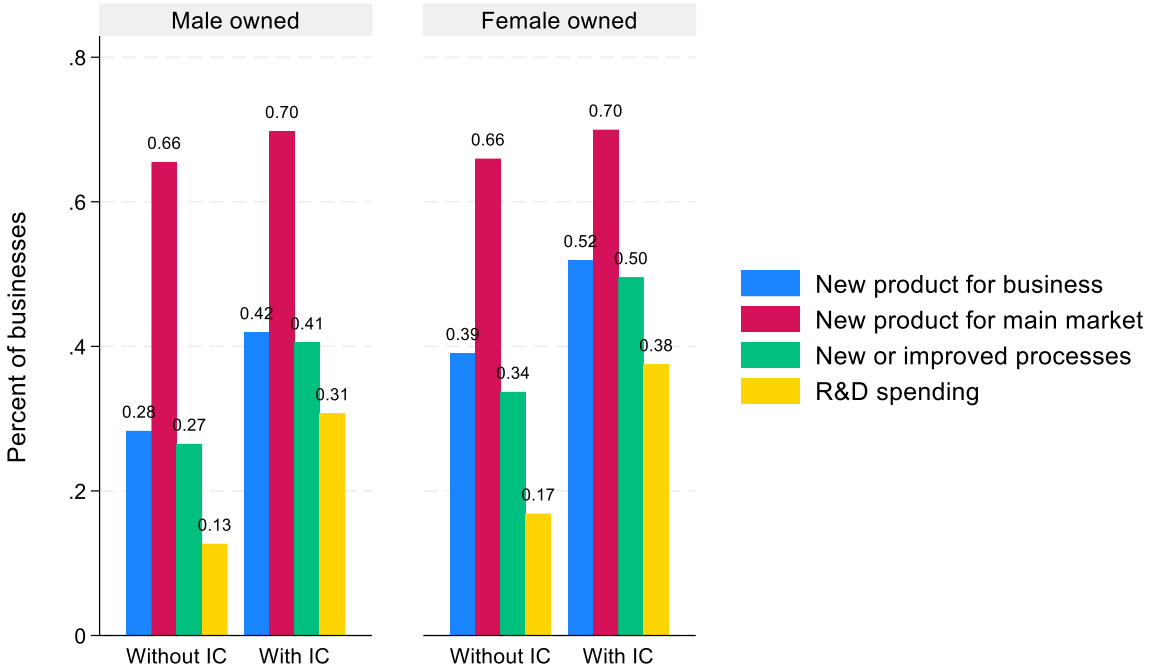


Figure B3: Certification, gender of owners and innovation (Source: constructed by authors using the WBES).

ABOUT EMANES

The Euro-Mediterranean and African Network for Economic Studies (EMANES) is a network of research institutions and think tanks working on socio-economics policy in Europe, the Mediterranean and Africa. EMANES is coordinated by the Euro-Mediterranean Economists Association (EMEA).

The research conducted by EMANES Researchers, Associates and Fellows aims to design sound and innovative socio-economic models that are inclusive, sustainable and employment creative, to devise new models for regional integration and to provide policy recommendations towards this goal.

EMANES research agenda is organized around the following mutually reinforcing and interconnected themes led by EMANES researchers, associates and fellows:

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- Macroeconomic policies and employment creation;
- Private sector, micro, small and medium –sized enterprises development, entrepreneurship and social business;
- Digital economy;
- Healthcare policy;
- Human capital development, education, innovation, skill mismatch and migration;
- Labor markets, employment and employability;
- Finance, financial inclusion and the real economy;
- Sustainable development;
- Regional integration;
- Euro-Mediterranean economic partnership;
- Scenarios analysis and foresight.

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EMANES research and outputs are underpinned on the **four fundamental principles: Independence, Scientific Excellence, Policy Relevance and Deep Knowledge of European, the Mediterranean and African Affairs**.

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