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Closing the gap
Gender and innovation

Laura Barasa*

UONGOZI Institute

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UONGOZI Institute, Plot No. 100, 1 Magogoni Street, Kivukoni, P.O. Box 105753, Dar es Salaam, Tanzania

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Katajanokanlaituri 6 B, 00160 Helsinki, Finland

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[*]School of Economics, University of Nairobi, Nairobi, Kenya, email lauranelima@uonbi.ac.ke

Abstract: Innovation generally takes place in male-dominated industries. A gender gap might therefore exist. This study used data from the 2015 Tanzania Firm-Level Skills Survey to investigate the gender innovation gap between female-owned enterprises and male-owned enterprises. A non-linear Blinder–Oaxaca decomposition was used to decompose the mean differences in innovation performance into the endowments effect that reflects resource endowments and the coefficients effect relating to resource utilization. The study found that female-owned enterprises faced an 18.1 percentage point lower probability of innovation when compared to male-owned enterprises. The endowments effect had a positive association with the gender innovation gap. In contrast, the coefficients effect was negatively associated with the gender innovation gap. Policies aimed at reducing gender inequalities in innovation need to strike a balance between enhancing resource acquisition by female-owned enterprises and improving resource utilization by their male counterparts to prevent reversals in the gender innovation gap.

Key words: female-owned enterprises, non-linear Blinder–Oaxaca decomposition, gender gap, innovation, Tanzania

JEL classification: J16, O30, O31

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1. Introduction

The gender performance gap is a key area of female entrepreneurship that has received significant attention in the past decade. If factors causing gender differences in firm performance exist, the implication would be that the human and physical capital are underutilized. Ultimately this undermines the growth potential of female-owned enterprises and economic growth (Sabarwal et al. 2009).

Enhancing participation of women in private sector development is vital for achieving the global development agenda contained in the Sustainable Development Goals (SDGs).1 In particular, women's participation in private sector development promotes the achievement of gender equality and women's empowerment: SDG 5. In addition, the global development agenda recognizes the need for supporting and achieving economic growth through innovation, and socio-economic inclusion for all: SDG 8, SDG 9, and SDG 10. At the continental level, Africa's Agenda 2063 encapsulates the importance of achieving gender equality by eliminating obstacles impeding female entrepreneurship and innovation. Furthermore, Agenda 2063 underscores that Science, Technology, and Innovation (ST&I) underpins inclusive and sustainable growth. In line with this, the Science, Technology, and Innovation Strategy for Africa 2024 (STISA-2024) was developed in tandem with Agenda 2063 because Africa's success is hinged on research and development (R&D) investment and innovation (African Union 2014).

Policies aimed at guiding R&D in Tanzania have evolved over several decades. The 1960s era focused on Science Policies. This evolved to Science and Technology policies in the early 1970s. The 1980s saw the introduction of ST&I policies, which integrated R&D into the national development strategy. Tanzania's Development Vision 2025 underpins the importance of achieving industrial growth through gender equality and innovation as outlined in the Five Year Development Plan 2016/17–2020/21 (FYDP II). Tanzania's Development Plans and ST&I policies identify gender inequality and limited technological advancement as fundamental challenges. Wide disparities have been observed in accessing R&D resources and opportunities. As such, affirmative action initiatives have been undertaken by the National Economic Empowerment Council and the Tanzania Commission for Science and Technology to ensure that R&D activities do not discriminate against disadvantaged groups. Notwithstanding, innovation is still constrained by limited public sector and private sector R&D investment. This is further exacerbated by an inadequately skilled labour force. Taking gender into consideration, women are generally under-represented in business ownership (Ritter-Hayashi et al. 2019). Furthermore, female-owned enterprises—defined as businesses that are wholly or majority female owned—may face gender-based challenges that undermine investment in productive assets and human capital capabilities that are critical for superior innovation performance.

Numerous studies examine the gender gap in firm performance indicators comprising sales growth and employment growth (Conroy and Weiler 2016). Notwithstanding, little is known regarding the gender gap in innovation relating to gender inequality in the introduction of new or significantly improved products and manufacturing methods: product innovation and process innovation. The innovation gap thus reflects the difference in innovation performance between female-owned and male-owned enterprises (Dohse et al. 2019; Marvel et al. 2015). There is sparse empirical evidence on factors contributing to innovation performance differences between female-owned and male-owned enterprises in developing countries in sub-Saharan Africa (Amoroso and Link 2018; Idris 2009; Strohmeyer et al. 2017). The research questions this study aims to address to fill this research gap are: Do gender differences in innovation exist in the private sector in Tanzania? If so, what factors contribute to the innovation gap between female-owned enterprises and male-owned enterprises?

Accordingly, this study makes several contributions. First, it adds to the growing body of literature concerning the gender innovation gap. Second, this study sheds light on specific factors constraining innovation in female-owned enterprises. Lastly, this study promotes the debate on mainstreaming gender perspectives in the formulation and implementation of ST&I policies.

[1] The SDGs refer to the global goals adopted by all the United Nations member states in 2015. They are a universal call to action aimed at ending poverty, protecting the planet, and ensuring that 'all people enjoy peace and prosperity by 2030' (United Nations 2015).

2. Theoretical background

Two strands of literature dominate the subject of female entrepreneurship. These include the constraint-driven gaps theory and the preference-driven gaps theory. The constraint-driven gaps framework theorizes that female entrepreneurship is constrained by gender-based barriers that undermine firm performance. Some of the barriers that may hamper innovation include difficulties that female entrepreneurs face in accessing financial resources and information (Idris 2009). Social norms also undermine female participation by limiting mobility and time spent on running an enterprise. In addition, social and cultural norms have been found to constrain female ownership of productive assets, further widening gender asset and wealth gaps (Deere and Doss 2006; Doss et al. 2014; Ravazzini and Chesters 2018). These challenges pose serious obstacles to innovation and overall firm growth for female-owned enterprises (Sabarwal et al. 2009).

The preference-driven gaps theory acknowledges that there are inherent differences in male and female entrepreneurship. Preference gaps linked to innovation include the choice of industry and risk taking. Female entrepreneurs are more likely to cluster in industries with low innovation potential. Also, female entrepreneurs engaging in innovation activities are likely to encounter industry-specific skills gaps and skills shortages (Marvel et al. 2015). However, various authors contend that the choice of industry may be linked to inequality of opportunity (Marvel et al. 2015; Sabarwal et al. 2009). Furthermore, technological innovation typically occurs in high-technology industries that are generally male dominated. Considering that entrepreneurial innovation involves significant risk and uncertainty, the gender innovation gap may exist since women are more risk averse than men (Hillesland 2019; Klapper and Parker 2011; Sabarwal et al. 2009).

This study adopts the constraint-driven gaps and preference-driven gaps theories to examine the gender innovation gap. These theories provide valuable insight into how gender differentials may affect innovation. In addition, both frameworks set out the factors that may cause gender differentials in innovation performance in the context of Tanzania. In particular, Rutashobya (2001) suggests that the female-entrepreneurship landscape in Tanzania faces severe constraints arising from social and cultural norms. For instance, women are disadvantaged in the acquisition of high-return productive assets. Furthermore, gender roles encourage women to adopt household-centred strategies rather than business-centred strategies. Consequently, female entrepreneurs are likely to cluster in low-technology industrial sectors.

2.1. Firm investment and the gender innovation gap

Private firm investment is instrumental in driving economic growth in developing countries in Africa. Firm investment refers to the acquisition of fixed assets aimed at boosting future returns. Acquisition of fixed assets is generally associated with increased productivity and innovation (Islam et al. 2018). It is also an innovation activity when firms purchase assets that have substantially different characteristics than the existing equipment used in production processes. Substantial capital outlays are generally required to purchase fixed assets. However, financial constraints associated with acquisition of assets by female entrepreneurs hamper firm performance. Moreover, female entrepreneurs are more likely to operate small businesses. This leads to low investment and concomitantly low innovation prospects.

Investment in fixed assets also involves significant risk and uncertainty. However, women tend to be more risk averse and are more likely to make small-scale investments. Thus, the main sources of capital for female entrepreneurs in Tanzania include informal social networks, family networks, personal savings, and the community credit system (Nziku and Struthers 2018). However, these sources are also more likely to offer smaller amounts of capital for the purchase of fixed assets when compared to formal sources of financing. Various authors suggests that breaking into the ‘old boys’ network might play a critical role in facilitating female entrepreneurs’ access to economic networks and financial resources in a male-dominated society (McAdam et al. 2019; Ozkazanc-Pan and Muntean 2018; Winn 2004). Yet, this does not diminish the hurdles women presently face in the acquisition, ownership, and management of productive assets (Doss et al. 2019; Rutashobya 2001). As such, this study proposes that:

H1. Firm investment is positively associated with the gender gap in innovation.

2.2. Type of industry and the gender innovation gap

Various studies demonstrate that female entrepreneurs invest in small-scale and low-value industries such as the retail and service industry (Weiler and Bernasek 2001). Female entrepreneurs are also less likely to conduct business in high-technology industries and the construction industry. These industries remain highly male dominated (Sabarwal et al. 2009). Yet, these industries have high growth potential and are generally more innovative (Osabutey and Jin 2016; Sospeter et al. 2014). For instance, the Tanzania construction industry is characterized by delays in project completion, time over-runs and cost over-runs (Sambasivan et al. 2017). These factors result in increased transaction costs which might affect female entrepreneurs disproportionately (Rutashobya 2001). Choice of industry is also driven by technical and financial barriers. In addition, the motives for choice of industry might be related to balancing business and domestic demands (Kuada 2009). This implies that industry choice by female entrepreneurs is associated with poor innovation outcomes.

In addition, the choice of industry has been associated with risk minimization. Yet, innovation typically involves substantial risks and uncertainty. This paper argues that risk minimization strategies by female entrepreneurs have an adverse effect on innovation. Furthermore, the choice of industry might be linked to inequality of opportunities that result in less educated and less skilled female entrepreneurs (Sospeter et al. 2014). This results in female entrepreneurs operating business in small-scale, low-risk businesses that ultimately yield low innovation returns. This study therefore presents the following hypothesis:
H2. The manufacturing industry and the construction industry are positively associated with the gender gap in innovation in comparison to the service industry.

2.3. Skills gap and the gender innovation gap

While formal qualifications matter for innovation, van Uden et al. (2017) suggest that a wide range of skills and competencies play a pivotal role in fostering innovation. Some of the workforce characteristics and competencies that foster innovation include creativity, cognitive abilities, adaptability to change, social skills, communication skills, technical skills, and problem-solving skills (OECD/Eurostat 2018). Hence, a skilled labour force is critical for superior innovation. Yet, most countries in Africa have an abundance of semi-skilled and unskilled labour. This phenomenon suggests the presence of skills gaps: the difference between the skills that firms need and the skills that employees possess (Freel 1999). Additionally, van Uden et al. (2017) find that skills gaps hamper innovation activities in innovative firms in East Africa. Skills gaps therefore pose a major challenge for innovation in both male-owned and female-owned enterprises.

Notwithstanding, female-owned enterprises are likely to be disproportionately affected by the skills gaps. This is attributed to several factors. First, female-owned enterprises are likely to be small and informal. This renders them less attractive to skilled workers. Second, female-owned enterprises are less likely to invest in recruiting, training, and retaining highly qualified manpower due to financial constraints. Lastly, female entrepreneurs in male-dominated industries must compete for skilled labour with their male counterparts. Female entrepreneurs are thus required to overcome gender biases to succeed (Rutashobya 2001). Consequently, female entrepreneurs face more protracted obstacles relative to their male counterparts. This study therefore hypothesizes that:

H3. Skills gaps are positively associated with the gender gap in innovation.

2.4. Female managers and gender innovation gap

Managerial capabilities influence the manner in which firms exploit resources for innovation. However, female-owned enterprises might generally face impediments in acquiring managers that embody dynamic managerial capabilities, possibly due to resource constraints, limited economic and social networks (McAdam et al. 2019; Ozkazanc-Pan and Muntean 2018), or gender biases that result in subordination by current and potential workers (Ritter-Hayashi et al. 2019; Rutashobya 2001).

Female ownership might also result in gender diversity in the top management, which is likely to benefit knowledge sharing, performance of managerial tasks, and decision making. These factors have been linked to enhanced innovation (Dai et al. 2019; Dohse et al. 2019; Ritter-Hayashi et al. 2019). However, increasing

female participation does not guarantee desirable innovation outcomes in an unfavourable organizational climate (Cropley and Cropley 2017). In addition, findings from various studies suggest that female entrepreneurs are likely to be more biased towards hiring female managers (Beugnot and Peterlé 2020). However, female managers might lack peer support and business networks in comparison to their male counterparts (McAdam et al. 2019; Rutashobya et al. 2009). Yet, such networks are critical in fostering the exchange of ideas that foster innovation. Female managers are also likely to handle a bigger proportion of family responsibilities.

Moreover, women typically face barriers in accessing education, training, and employment (Carrasco 2014). This has adverse effects on the skills and experience females gain in the labour market. Consequently, women are generally under-represented in science, technology, engineering, and mathematics (STEM) and in managerial positions (Dohse et al. 2019; Ritter-Hayashi et al. 2019; Sassler et al. 2017). As such, hiring female managers might compound the obstacles faced by female-owned enterprises e.g. accessing resources and acquiring skilled labour (Rutashobya 2001). In addition, considering that women are likely to be more risk averse, female managers might also experience bottlenecks associated with risky business ventures such as innovation. This study therefore proposes that:

H4. Female managers are positively associated with the gender gap in innovation.

3. Data and methods

3.1. Data

This study used data from the 2015 Tanzania Firm-Level Skills Survey (TFLSS). This survey was conducted from April 2015 to August 2015 by the World Bank Group. A comprehensive skills module was developed alongside a firm-level survey that collected information on innovation and innovation activities, managerial, firm, and industry characteristics. The collection of data on innovation and innovation activities was governed by the Oslo Manual guidelines (OECD 2005). The stratified random sampling technique was used to select the survey sample. Firms were stratified according to industry, firm size, and region. Two sampling frames were used. The first was the 2011/2012 Central Registry of Establishment (CRE) obtained from the National Bureau of Statistics. This sampling frame was used to select firms in mainland Tanzania. The second sampling frame comprised the 2012 CRE of the Office of Chief Government Statistician that was used to select firms located in Zanzibar (World Bank 2016).

Data from the 2015 TFLSS is suitable for investigating the gender gap in innovation for several reasons. First, the survey collects detailed information that measures the main determinants of innovation. This data includes managerial characteristics such as gender, age, experience, and education. It also includes firm-level characteristics: age, size, and industry. Second, the survey includes information on innovation activities such as R&D expenditure and innovation outcomes. Third, this is a current dataset that captures skills gaps which are likely to contribute to the gender innovation gap.

In total, 424 firms were interviewed. This study used data from 403 firms with complete information on the variables of interest. Specifically, 21 firms were dropped because they were ‘not in business’ over the period covered in the survey instrument (i.e. three fiscal years ago). The survey instrument asked whether firms introduced new or significantly improved products or processes over the last three years. Firms that were not in business over this period are likely to have had incomplete or missing data on innovation activities and innovation outcomes.

3.2. Dependent variable

Innovation was measured as the introduction of new products and processes. The survey instrument asked firms whether new or significantly improved products and services or methods of manufacturing products or offering services were introduced ‘over the last three years’. This definition and measurement of product innovation and process innovation is consistent with the guidelines found in the Oslo Manual (OECD/Eurostat 2018). Innovation was thus measured as a dummy variable taking ‘1’ if the firm introduced new or significantly improved products or processes, and ‘0’ if otherwise.

3.3. Independent variables

Female ownership

A female-owned enterprise is defined as a business that is wholly or majority female owned (i.e. at least 51 per cent ownership by women). Female ownership was measured as a dummy variable taking ‘1’ where firms reported female entrepreneur share capital holdings of not less than 51 per cent, and ‘0’ if otherwise.

Firm investment

This variable relates to the purchase of fixed assets. It encompasses the acquisition of new or used machinery, equipment, land or buildings, and vehicles. It was measured as a dummy variable taking ‘1’ if the firm reported purchasing fixed assets in 2014, and ‘0’ if otherwise.

Industry

Three industrial sectors were included in the sample: manufacturing, construction, and services. Industry was measured using a dummy variable taking ‘1’ if the industrial sector was manufacturing or construction, and ‘0’ if otherwise. The service sector was therefore the reference category.

Skills gap

Skills gap was constructed from eight items used to rate the level of skills that the establishment 'needs against the skills of current permanent employees' at the firm level. The items included interpersonal and communication skills, writing skills, problem-solving skills, critical-thinking skills, work ethic, English skills, computer skills/general information technology skills, and technical skills other than computers/vocational job-specific skills. This measure was coded as '0' when a firm reported that the skills met the firm's requirements and '1' if the skills fell below the firm's requirements. The scores of the separate skills items were added for each firm. The resulting value was then divided by the total number of skills items and finally multiplied by 100 to make it a percentage. This measure reflected the degree of the skills gap in a firm. A high score on this measure was equated to a high degree of skills gap.

Female manager

This variable captured the gender of the firm's manager. It was measured as a binary variable taking a value of '1' if the firm's top manager was female and '0' if male.

3.4. Control variables

Managerial experience

This variable measures the number of years of experience the top manager has in the sector. The natural log of the years of experience in the respective sector was used in the analysis.

Firm age

The age of the firm was calculated as the difference between the year of the survey and the year that the firm began its operations. Firms were then categorized as young (≤5 years), mature (6–15 years), and old (>15 years). A dummy variable reflecting these categories was then used to measure firm age. The dummy variable took the value '1' when the firm was categorized as mature or old, and '0' if otherwise. The reference category was therefore young firms.

Firm size

Firms were categorized as a small enterprise (5–19 employees), medium-sized enterprise (20–99 employees), and a large enterprise (100 employees and more). A dummy variable was generated to reflect the firm size measures. It took the value '1' when a firm was classified as a small enterprise or medium-sized enterprise and '0' if otherwise. Large enterprises were therefore the reference category.

Formal R&D

The survey instrument asked whether the firm incurred formal R&D expenditure on activities that were either in-house or contracted. This variable was measured as a dummy taking '1' where the firm reported incurring R&D expenditure and '0' if otherwise.

Regional dummies

The 2015 TFLSS comprised five regions: Arusha, Dar es Salaam, Mbeya, Mwanza, and Zanzibar. Region was measured as a dummy variable taking '1' when a firm was situated in Arusha, Dar es Salaam, Mbeya, or Mwanza, and '0' if otherwise. Zanzibar was therefore the reference category.

3.5. Estimation model

The Blinder–Oaxaca approach was used for decomposing mean differences in innovation based on regression models in a counterfactual manner (Blinder 1973; Oaxaca 1973). This approach is generally applied in labour market outcomes to examine the gender wage gap based on group differences such as race and gender. This study applied a non-linear decomposition technique because innovation was measured as a binary variable (Yun 2004).

The Blinder–Oaxaca decomposition was used to divide the innovation differential between female-owned enterprises and male-owned enterprises into two components: the endowments effect, and the coefficients effect. The endowments effect represents the 'explained' part, which this study defines as the gender innovation gap arising from differences in resource endowments. The endowments effect is captured by observed characteristics that account for differences in innovation: managerial, firm, and industry characteristics. The coefficients effect represents the 'unexplained' part. It is the residual part that is not accounted for by the innovation determinants. It embodies the differences in returns to innovation resources. It measures the expected change in female-owned enterprise innovation outcomes if they had the coefficients of male-owned enterprises. It is essentially the gap arising from the differences in resource utilization. It captures differences in unobserved characteristics (Jann 2008).

As a first step, three separate logit regressions were estimated by enterprise ownership type. In particular, the logit regressions predicted the likelihood of innovation in male-owned enterprises, female-owned enterprises, and in the pooled sample including both male-owned and female-owned enterprises:

$$Innov_i^{male} = \beta_0^{male} + \beta_1^{male} x_i^{male} + \beta_2^{male} Controls_i^{male} + u_i^{male} \quad (1)$$

$$Innov_i^{female} = \beta_0^{female} + \beta_1^{female} x_i^{female} + \beta_2^{female} Controls_i^{female} + u_i^{female} \quad (2)$$

$$Innov_i^{pooled} = \beta_0^{pooled} + \beta_1^{pooled} x_i^{pooled} + \beta_2^{pooled} Controls_i^{pooled} + u_i^{pooled} \quad (3)$$

$$Innov_i = Innov_i^* \; if \; Innov_i^* > 0; \; Innov_i = 0 \; otherwise$$

where the superscripts $male, female, and\ pooled$ represent the separate equations for male-owned enterprises, female-owned enterprises, and the pooled sample. $Innov_i$ is a binary latent variable that represents innovation for firm i. Innovation is observed when the firm reports introducing new or significantly improved products or processes, i.e. $innov_i^*$. x_i is a vector of the determinants innovation of performance, namely firm investment, industry, skills gap, and female manager. $Controls_i$ represents the control variables including managerial experience, firm age, firm size, formal R&D, and regional dummies. u_i is the idiosyncratic error term.

The Blinder–Oaxaca approach assumes that the estimated effects of observed characteristics for female-owned enterprises and male-owned enterprises are identical in the absence of a gender gap. A twofold decomposition of the mean gender innovation gap would therefore be found as follows:

$$Innov^{male} - Innov^{female} = \Delta x \beta^{male} - \Delta \beta x^{female} \quad (4)$$

where the gap between the mean outcomes in innovation between male-owned enterprises and female-owned enterprises is given by $Innov^{male} - Innov^{female}$. x represents a vector of the determinants of innovation and control variables comprising managerial, firm, and industry characteristics. The first component of the twofold decomposition $\Delta x \beta^{male}$ represents the gap in endowments. This effect arises when male-owned enterprises and female-owned enterprises differ in terms of characteristics. This study attributes the gap in endowments to the fact that female-owned enterprises are likely to have worse endowments than male-owned enterprises. The second component $\Delta \beta x^{female}$ represents the gap in coefficients; it also captures the potential effects arising from differences in unobservable factors. This gap represents effects that arise from the characteristics of male-owned enterprises and female-owned enterprises having different effects on innovation. The gap in coefficients is attributed to the fact that, theoretically, female-owned enterprises have worse coefficients than male-owned enterprises.

4. Results and discussion

4.1. Descriptive statistics

Table 1 shows the descriptive statistics and correlation matrix of the data used in the analysis[2]. About 66 per cent of the firms reported innovation. The sample therefore reported a high degree of innovation. Cirera and Muzi (2016) suggest that this is likely to be due to the subjective definition of the term innovation. The authors also suggest that it is likely that incremental innovation rather than radical innovation is reported by a majority of firms as is observed in developing countries (Cirera and Muzi 2016). Only 24 per cent of the firms were female owned. The low level of female representation in business ownership is consistent with extant literature (Ritter-Hayashi et al. 2019; Rutashobya 2001). Considering the independent variables, 51 per cent of the firms purchased fixed assets. This suggests that a majority of firms have financial capabilities that allow investment in productive assets that may improve productivity and innovation (Islam et al. 2018; Nziku and Struthers 2018). About 50 per cent of the firms were in the manufacturing industry. In contrast, only about 9 per cent of the firms were in the construction industry. A majority of construction firms in Tanzania remain undocumented because they operate in the informal sector (Ishengoma and Lokina 2017). About 26 per cent of the firms reported that employee skills did not meet the firm's requirements. This indicates the presence of skill gaps that potentially have adverse effects on innovation in Tanzania's private sector (van Uden et al. 2017). Turning to the control variables, it was noted that only 10 per cent of the firms were managed by women. This suggests that women are typically under-represented in managerial positions in the private sector (Dohse et al. 2019; Ritter-Hayashi et al. 2019). On average, the managers had about 15 years of experience, which compares well with the innovation experience by managers reported by Mohan et al. (2017). About 48 per cent of the firms were categorized as mature firms. The age of the sampled firms is consistent with that of previous studies in the context of sub-Saharan Africa (Barasa 2018; Barasa et al. 2019). In addition, 63 per cent of firms were medium-sized enterprises. This observation is supported by previous literature citing the dominance of small and medium-sized enterprises in Tanzania (Ndesaulwa and Kikula 2016). Contrastingly, only 12 per cent of the firms conducted formal R&D. The reported formal R&D is much lower than that for studies conducted in East Africa, which report an average of at least 20 per cent (Barasa et al. 2017; van Uden et al. 2017). Lastly, 52 per cent of the firms were located in Dar es Salaam, which is not surprising as this is the largest city in Tanzania.

Table 2 shows the differences in means between female-owned enterprises and male-owned enterprises. It was observed that female-owned enterprises had a significantly higher mean value on female managers. This finding suggests that female-owned enterprises tended to prefer female managers rather than their male counterparts (Arvate et al. 2018; Beugnot and Peterlé 2020). In addition, a significantly higher mean on firm ownership in Dar es Salaam was observed for male-owned enterprises, but female-owned enterprises had a significantly higher mean on firm ownership in Mbeya. However, there were no significant differences in innovation performance, as was the case for the rest of the variables.

4.2. Determinants of innovation for female-owned and male-owned enterprises

This study modelled the likelihood of innovation using a logit regression. The results were disaggregated by ownership: female-owned enterprises, male-owned enterprises, and a pooled model including both types of ownership. These results are shown in Table 3. For female-owned enterprises, the likelihood of innovation in the construction industry was 26 percentage points lower when compared to enterprises in the service industry. This might be due to the complexities and interdependencies that surround construction processes that are likely to impede innovation (Sambasivan et al. 2017). Similarly, the likelihood of innovation was 19 percentage points lower for firms with female managers. Various studies suggest that limited access to social networks and economic networks account for the negative association between female managers and innovation (McAdam et al. 2019; Rutashobya et al. 2009). In contrast, the likelihood of innovation was 21 percentage points higher for firms with more experienced managers. Managerial experience has been associated with dynamic managerial capabilities that enhance the ability to identify and exploit opportunities for innovation (Helfat and Martin 2015; Helfat and Peteraf 2015). The likelihood of innovation was 24 percentage points lower for mature firms relative to young firms. Older firms might be less innovative due to

[2] The tales are found at the end of the paper.

inertia (Balasubramanian and Lee 2008). However, the likelihood of innovation was 68 percentage points higher for firms in Arusha relative to firms in Zanzibar.

For male-owned enterprises, Table 3 reveals that the likelihood of innovation was 22 percentage points higher for firms that purchased assets. The acquisition of fixed assets is associated with enhanced innovation (Islam et al. 2018). In contrast, the likelihood of innovation was 0.2 percentage points lower for firms reporting a high degree of skills gap (van Uden et al. 2017). As was the case with female-owned enterprises, the likelihood of innovation was 16 percentage points lower for firms with female managers and 6 percentage points higher for firms with more experienced managers. The likelihood of innovation was 19 percentage points higher for small enterprises and 23 percentage points higher for medium-sized enterprises when compared to large enterprises. Small and medium-sized enterprises are likely to be more agile in terms of adapting to market changes and embracing technological innovation as a means of enhancing competitive advantage (Bessant et al. 2002). More importantly, the likelihood of innovation was 49 percentage points higher for firms conducting formal R&D (González et al. 2016; Grimpe et al. 2017). It was also observed that the likelihood of innovation was 76 percentage points lower for firms located in Mwanza when compared to firms in Zanzibar.

Finally, the results from the pooled sample showed that most of the effects were similar to those of the two previous models. Essentially, firm investment, managerial experience, small enterprises, medium-sized enterprises, and formal R&D were positively associated with the likelihood of innovation. In contrast, skills gap, the construction industry, female managers, mature firms, and firms located in Dar es Salaam, Mbeya, and Mwanza were associated with a lower likelihood of innovation. The pooled model also included the female enterprise ownership variable, which was positively associated with innovation. This is an interesting finding given that female-owned enterprises face gender-based obstacles. The measure of female ownership (i.e. female ownership of share capital holdings of not less than 51 per cent) may partly account for this result. This measure encompasses gender diversity since business ownership is not exclusively restricted to women. Gender diversity contributes to gender equality. It is associated with enhanced innovation because it fosters knowledge sharing between women and men and improves decision making (Dai et al. 2019; Dohse et al. 2019; Ritter-Hayashi et al. 2019; Xie et al. 2020).

4.3. Decomposition of the gender gap in innovation

Table 4 displays the results of the decomposition of the gender innovation gap. These results largely supported the hypotheses of this study. Gender differences were decomposed in the likelihood of innovation using female ownership as a reference point. These results revealed that female-owned enterprises faced an 18.1 percentage point lower probability of innovation. This gender gap was further divided into two parts: the endowments effect and the coefficients effect. The difference in innovation between male-owned and female-owned firms resulting from the endowments effect was positive and statistically significant. This means that male-owned enterprises had more access to innovation resources. This implies that female-owned enterprises would have had better innovation outcomes if they had possessed the same resources as their male counterparts. Table 4 also shows the decomposition of the independent variables comprising the specific resources of interest that explained the gender innovation gap. Firm investment, skills gap, and female manager significantly contributed to the endowments effect. Industry differences were non-significant. Among the control variables, managerial experience and regional differences—Mbeya and Mwanza—also accounted for the endowments effect.

The second part of the decomposition contains the coefficients effect shown in Table 4. It quantified the returns to resource utilization. The coefficients effect was negative and statistically significant. This implies that female-owned enterprises would have had a lower likelihood of innovation if the relationship between the resources and innovation was similar to that of male-owned enterprises. This means that female-owned enterprises were better able to take advantage of the resources than their male counterparts. Hence, the returns to innovation resources would be higher for female-owned enterprises if they had the same coefficients as the male-owned enterprises. This might partly reflect the unobserved differences between female-owned enterprises and male-owned enterprises that affect innovation. Innovation in male-owned enterprises can therefore be improved by better utilization of resources. This is an interesting finding that is substantiated by the previous analysis of determinants of innovation in the pooled logit regression, which revealed a positive association between female ownership and innovation. As previously discussed in relation to the positive relation between female ownership and innovation, better resource utilization by female-owned enterprises might be accounted for by the fact that the measure of female ownership is not exclusive

to women. Consequently, it is likely to be the case that this measure incorporates gender diversity. Various authors suggest that gender diversity promotes gender equality, which in turn fosters knowledge sharing and improves decision making and innovation (Dai et al. 2019; Dohse et al. 2019; Ritter-Hayashi et al. 2019). Gender diversity may play a vital role in facilitating access to social networks and economic networks, thereby promoting superior utilization of innovation resources (Dohse et al. 2019). The decomposition of the independent variables reveals that firm investment, managerial experience, and regional differences—Mwanza—significantly contributed to the coefficients effect. Industry effects were non-significant.

5. Conclusions and implications for policy and practice

The main objective of this study was to investigate the factors contributing to the gender innovation gap in Tanzania. This was done within the constraint-driven gaps and preference-driven gaps framework (Klapper and Parker 2011; Sabarwal et al. 2009). A non-linear Blinder–Oaxaca technique was applied to the 2015 TFLSS data to decompose the mean differences in innovation (Blinder 1973; Oaxaca 1973; Yun 2004). The results of the decomposition revealed that female-owned enterprises faced an 18.1 percentage point lower probability of innovation when compared to male-owned enterprises. Resource endowments seemed to favour male-owned enterprises while resource utilization favoured female-owned enterprises. Firm investment, skills gap, and female manager significantly accounted for the endowments effect contained in the gender innovation gap. In addition, firm investment significantly contributed to the coefficients effect of the gender innovation gap. These findings suggest that male-owned enterprises had better endowments than female-owned enterprises. However, despite having worse resource endowments, female-owned enterprises had better resource utilization, which led to desirable innovation outcomes relative to their male counterparts. These findings have important implications for policies aimed at reducing gender inequalities in entrepreneurship.

The findings of this study shed light on the gender inequalities that exist in the context of innovation. For example, policies that promote firm investment are likely to enhance the acquisition of assets by female-owned enterprises. This may level the playing field in terms of matching the resources that are available to female-owned enterprises to those of male-owned enterprises.

In addition, policies aimed at narrowing the skills gap by improving overall literacy and skills are bound to be beneficial for entrepreneurship. Enhancing female participation in STEM subjects is also imperative for entrepreneurial activity. STEM participation by women may play a crucial role in closing the gender innovation gap by increasing the pool of skilled female managers. In addition, private and public supported business networks that encourage female participation are also likely to be instrumental in improving the entrepreneurial environment for women. Such networks might expose female entrepreneurs and female managers to social and business networks that enhance access to economic resources.

However, it is important to point out that while female-owned enterprises were disadvantaged in terms of resource endowments, they seemed to have an advantage with regards to resource utilization. Indeed, while female-owned enterprises require support in acquiring resources, male-owned enterprises might benefit from training programmes aimed at enhancing resource use. Policy makers thus need to strike a balance between enhancing resource acquisition by female-owned enterprises and improving resource utilization by their male counterparts to avoid reversals in the gender innovation gaps. These reversals might occur when policies result in imbalances in resource ownership in the event female-owned enterprises end up with more resources than their male counterparts, and imbalances in resources utilization if male-owned enterprises ultimately utilize resources better than their female-owned counterparts.

Ultimately, the results of this study provide policy insights that can guide policy makers on how to close the gender innovation gap. This is critical for promoting growth-enhancing female entrepreneurs' participation in private sector development. Policies that advance ownership of innovation resources by female-owned enterprises are vital for the achievement of Tanzania's Development Vision 2025, Africa's common policy goal of industrialization, and the global development agenda comprising SDGs.

5.1. Avenues for future research

The availability of panel data would be useful in establishing causality of the hypothesized relationships. In addition, the data used typically focused on innovation and innovation activities and skills gaps. As such, key variables such as access to credit, and innovation outcomes reporting the number of new products and processes introduced were not contained in the 2015 TFLSS. Hence, future studies might examine the link between access to credit, quantitative innovation outcomes, and the gender innovation gap. Furthermore, examining the role of cultural norms and stereotypes might improve the understanding of gender innovation gaps. Moreover, measuring innovation in terms of the rate of commercialization of innovative output might provide useful insights as to whether gender effects determine how firms profit from innovation. Lastly, examining other measures of innovation such as business processes and organizational and marketing innovation might enhance our understanding of gender gaps in innovation.

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Tables

Table 1: Descriptive statistics and correlation matrix (n=403)

No.	Variable	Mean	Std Dev	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Innovation	0.66	0.47	0.00	1.00	1.00																			
2	Female ownership	0.24	0.43	0.00	1.00	0.04	1.00																		
3	Firm investment	0.51	0.50	0.00	1.00	0.22	-0.04	1.00																	
4	Manufacturing industry	0.50	0.50	0.00	1.00	0.05	-0.02	0.04	1.00																
5	Service industry	0.40	0.49	0.00	1.00	-0.02	0.03	-0.02	-0.83	1.00															
6	Construction industry	0.09	0.29	0.00	1.00	-0.06	-0.02	-0.03	-0.32	-0.26	1.00														
7	Skills gap	25.62	24.84	0.00	100.00	-0.19	0.05	-0.06	0.19	-0.09	-0.18	1.00													
8	Female manager	0.10	0.31	0.00	1.00	-0.01	0.45	-0.12	0.01	0.03	-0.08	0.06	1.00												
9	Managerial experience (years)	15.27	9.88	1.00	60.00	0.12	-0.06	0.11	0.08	-0.16	0.13	-0.03	-0.10	1.00											
10	Young firm	0.06	0.25	0.00	1.00	0.02	0.02	0.00	-0.02	0.03	-0.01	0.03	-0.02	-0.13	1.00										
11	Mature firm	0.48	0.50	0.00	1.00	0.02	-0.01	0.02	0.06	-0.06	0.00	-0.05	-0.02	-0.32	-0.25	1.00									
12	Old firm	0.46	0.50	0.00	1.00	-0.03	0.00	-0.02	-0.05	0.05	0.00	0.03	0.03	0.38	-0.24	-0.88	1.00								
13	Small enterprise	0.63	0.48	0.00	1.00	-0.04	-0.08	-0.19	0.07	-0.01	-0.11	0.16	0.16	-0.15	0.10	0.12	-0.17	1.00							
14	Medium-sized enterprise	0.24	0.43	0.00	1.00	0.06	0.06	0.11	-0.03	-0.03	0.10	-0.08	-0.12	0.16	-0.05	-0.10	0.12	-0.73	1.00						

No.	Variable	Mean	Std Dev	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
15	Large enterprise	0.13	0.34	0.00	1.00	-0.03	0.03	0.12	-0.06	0.05	0.03	-0.13	-0.09	0.00	-0.07	-0.04	0.08	-0.51	-0.22	1.00					
16	Formal R&D	0.12	0.32	0.00	1.00	0.20	0.07	0.08	-0.09	0.09	-0.01	-0.07	0.08	-0.10	-0.10	0.10	-0.05	-0.12	0.07	0.08	1.00				
17	Arusha	0.11	0.32	0.00	1.00	0.13	0.04	-0.08	0.01	-0.06	0.08	-0.18	0.03	-0.02	0.03	0.00	-0.02	-0.08	0.04	0.07	-0.01	1.00			
18	Dar es Salaam	0.52	0.50	0.00	1.00	0.04	-0.12	0.15	-0.13	0.18	-0.09	0.07	-0.05	-0.02	-0.01	-0.06	0.06	0.05	-0.05	0.00	0.05	-0.37	1.00		
19	Mbeya	0.12	0.33	0.00	1.00	-0.06	0.12	-0.22	0.03	-0.02	-0.02	0.09	0.09	-0.01	-0.04	0.00	0.02	0.23	-0.18	-0.10	0.00	-0.14	-0.39	1.00	
20	Mwanza	0.11	0.32	0.00	1.00	-0.24	-0.04	-0.19	0.09	-0.11	0.02	0.02	0.01	-0.04	-0.03	0.03	-0.02	-0.11	0.13	0.00	0.02	-0.13	-0.37	-0.14	1.00
21	Zanzibar	0.13	0.33	0.00	1.00	0.12	0.07	0.25	0.06	-0.10	0.06	-0.05	-0.06	0.09	0.05	0.05	-0.08	-0.12	0.10	0.05	-0.09	-0.14	-0.40	-0.14	-0.14

Source: author's calculations based on TFLSS data.

Table 2: Differences in means between female-owned enterprises and male-owned enterprises

No.	Variables	Mean male ownership (n=306)	Mean female ownership (n=97)	Mean difference
1	Innovation	0.65	0.69	-0.040
2	Firm investment	0.52	0.47	0.045
3	Manufacturing industry	0.51	0.49	0.025
4	Construction industry	0.10	0.08	0.012
5	Skills gap	24.88	27.96	-3.086
6	Female manager	0.03	0.35	-0.324***
7	Managerial experience (years)	2.50	2.43	0.077
8	Mature firm	0.48	0.47	0.006
9	Old firm	0.46	0.45	0.004
10	Medium-sized enterprise	0.65	0.56	0.090
11	Large enterprise	0.23	0.29	-0.063
12	Formal R&D	0.11	0.16	-0.050
13	Arusha	0.11	0.13	-0.026
14	Dar es Salaam	0.56	0.41	0.143**
15	Mbeya	0.10	0.20	-0.095**
16	Mwanza	0.12	0.09	0.028

Note: t-test on equality of means. * p<0.10, ** p<0.05, *** p<0.01.

Source: author's calculations based on TFLSS data.

Table 3: Logit models predicting the likelihood of innovation

Variables	Female ownership				Male ownership				Pooled sample			
	Logit coefficients		Marginal effects		Logit coefficients		Marginal effects		Logit coefficients		Marginal effects	
Firm investment	-1.799	(1.873)	-0.206	(0.161)	1.574***	(0.286)	0.219***	(0.038)	0.804***	(0.266)	0.127***	(0.049)
Manufacturing industry	0.541	(0.446)	0.062	(0.056)	0.137	(0.392)	0.019	(0.052)	0.285	(0.323)	0.045	(0.048)
Construction industry	-2.265**	(1.003)	-0.259**	(0.117)	-0.221	(0.187)	-0.031	(0.028)	-0.740***	(0.172)	-0.117***	(0.025)
Skills gap	-0.019	(0.017)	-0.002	(0.001)	-0.017*	(0.010)	-0.002*	(0.001)	-0.013***	(0.004)	-0.002***	(0.001)
Female manager	-1.696***	(0.497)	-0.194***	(0.072)	-1.110*	(0.631)	-0.155*	(0.077)	-0.881***	(0.276)	-0.139***	(0.043)
Managerial experience (log)	1.852**	(0.866)	0.212**	(0.050)	0.434***	(0.168)	0.061***	(0.021)	0.629***	(0.201)	0.100***	(0.026)
Mature firm	-2.112***	(0.668)	-0.242***	(0.057)	-0.853	(1.017)	-0.119	(0.126)	-0.743*	(0.383)	-0.118*	(0.052)
Old firm	-2.692	(1.731)	-0.308	(0.112)	-0.132	(0.662)	-0.018	(0.090)	-0.562	(0.518)	-0.089	(0.075)
Small enterprise	2.159	(1.342)	0.247	(0.086)	1.377**	(0.561)	0.192**	(0.054)	1.641**	(0.698)	0.260**	(0.089)
Medium-sized enterprise	1.917	(1.350)	0.220	(0.099)	1.626**	(0.723)	0.227**	(0.086)	1.692**	(0.665)	0.268**	(0.089)
Formal R&D	1.746	(3.330)	0.200	(0.332)	3.503***	(1.086)	0.488***	(0.083)	2.402***	(0.481)	0.380***	(0.068)
Arusha	5.974*	(3.195)	0.684*	(0.236)	1.074	(1.573)	0.150	(0.207)	1.621	(1.277)	0.257	(0.187)
Dar es Salaam	0.682	(1.082)	0.078	(0.109)	-1.404	(1.057)	-0.196	(0.140)	-1.020*	(0.600)	-0.162*	(0.090)
Mbeya	-2.658	(1.700)	-0.304	(0.136)	-1.262	(1.010)	-0.176	(0.136)	-1.615***	(0.583)	-0.256***	(0.079)
Mwanza	0.338	(1.078)	0.039	(0.121)	-5.558**	(2.636)	-0.775**	(0.255)	-3.146***	(0.658)	-0.498***	(0.072)
Female ownership									0.684***	(0.150)	0.108***	(0.020)
Constant	-1.304	(1.782)			-0.229	(1.005)			-0.904**	(0.657)		
Pseudo R-squared	0.46				0.33				0.26			
No. of observations	97				306				403			

Note: robust clustered standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Source: author's calculations based on TFLSS data.

Table 4: Non-linear decomposition of gender innovation gap

Differential		
Prediction (male)	0.665***	(0.032)
Prediction (female)	0.595***	(0.061)
Difference	0.070**	(0.035)
Decomposition		
Endowments	0.181***	(0.042)
Coefficients	-0.111***	(0.025)
Endowments		
Independent variables		
Firm investment	0.021*	(0.012)
Manufacturing industry	0.001	(0.007)
Construction industry	-0.004	(0.004)
Skills gap	0.027**	(0.014)
Female manager	0.084***	(0.026)
Control variables		
Managerial experience (log)	0.027***	(0.009)
Mature firm	-0.002	(0.007)
Old firm	0.005	(0.009)
Small enterprise	-0.001	(0.017)
Medium-sized enterprise	0.005	(0.016)
Formal R&D	-0.005	(0.009)
Arusha	-0.007	(0.007)
Dar es Salaam	-0.011	(0.014)
Mbeya	0.028**	(0.014)
Mwanza	0.011***	(0.004)
Coefficients		
Independent variables		
Firm investment	0.184***	(0.047)
Manufacturing industry	-0.017	(0.029)
Construction industry	0.011	(0.014)
Skills gap	-0.009	(0.140)
Female manager	0.064	(0.046)
Control variables		
Managerial experience (log)	-0.436**	(0.182)
Mature firm	0.081	(0.070)
Old firm	0.170**	(0.068)
Small enterprise	-0.090	(0.090)
Medium-sized enterprise	-0.006	(0.017)
Formal R&D	0.023	(0.051)
Arusha	-0.054	(0.038)
Dar es Salaam	-0.166	(0.170)
Mbeya	0.031	(0.042)
Mwanza	-0.075*	(0.041)
Constant	0.179	(0.463)
No. of observations	403	

Note: robust clustered standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Source: author's calculations based on TFLSS data.

Contacts

Dar es Salaam
Plot No. 100
1 Magogoni Street, Kivukoni
P.O. Box 105753
Tel: +255 (0) 22 211 0372/3
Fax: +255 (0) 22 211 0374

Dodoma
NHIF Building, 2nd Floor
18 Jakaya Kikwete Road
P.O. Box 1081
Tel: +255 (0) 26 269 3882/3

Email: info@uongozi.or.tz
Website: www.uongozi.or.tz