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RESEARCH ARTICLE

Is this a man's world? The effect of gender diversity and gender equality on firm innovativeness

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Abstract

Gender diversity is known to have a positive effect on innovation in developed countries. However, it is unclear whether the benefits of gender diversity for innovation also apply to the particular context of developing countries, which is characterized by diverse and lower levels of gender equality. We propose that gender diversity positively impacts innovation in the developing countries participating in our study. In addition, we expect that this effect is moderated by country-specific levels of gender equality. In a cross-country study covering 18,547 firms in 15 developing countries, we find that gender diversity among a firm's owners and workforce as well as having a female top manager benefit innovation in developing countries. Yet, contradictory to our expectations, gender equality does not significantly moderate this relationship. As such, our results underline the importance of enabling and fostering gender diversity and have critical implications for firms and policy makers alike.

Introduction

Gender diversity, which refers to the balance between the two genders [1], is frequently found to have a positive effect on innovation in developed countries [1–4]. More specifically, gender diversity facilitates innovation due to a more diversified knowledge pool [5–7] and improved decision making [1,8]. Despite the importance of innovation for economic growth and poverty reduction in developing countries [9] and an increasing understanding of innovation in this specific context [10,11], gender diversity as a means to foster innovation in developing countries has thus far received no attention in the literature.

We expand existing research from developed to developing countries and expect that gender equality strongly influences the extent to which firms can reap the proposed benefits of gender diversity for innovation. Gender equality is societally engrained, manifested in country policy and laws as well as visible in practices such as access to education [12]. We propose that with increasing levels of gender equality, firms can benefit more from the advantages of gender diversity for innovation. On the one hand, and in relation to the first abovementioned benefit of gender diversity (knowledge diversification), gender equality entails whether policy and practice grant boys and girls as well as men and women equal access to education [13].

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Education is considered to be an important driver for knowledge [14] and we expect the benefit of knowledge diversification for innovation [6,15] to be limited if women are deprived from education. On the other hand, the societally engrained perception and status women are associated with is an important difference between countries. Gender is one of the observable attributes related to status beliefs that are powerful in organizing the patterns of respect and influence among individuals as they interact in decision making [16]. In a societal context where women are attributed with a low status, their contribution to the decision making process (second above referenced benefit of gender diversity) is expected to be disregarded [17].

Gender equality levels in the developing countries in Africa, the Middle East and South Asia participating in this study are much lower than in the developed countries where the positive effect of gender diversity on innovation has been previously established [9]. Given the importance of innovation in developing countries (5,6), our focus on gender diversity is relevant for both firms as well as for policy makers.

Our contributions are threefold. First, gender diversity has not been assessed as a potential firm-level mechanism to increase innovation in developing countries. Previous innovation-related studies in developing countries have focused on e.g. the types of innovation [10], the role various knowledge sources play in explaining innovation [11], as well as firm-level differences steering incremental versus radial innovation [18]. We extend knowledge on the relationship between gender diversity and innovation from developed to developing countries. Moreover, we distinguish between gender diversity at different organizational levels: gender diversity of firm owners and workforce and the gender of the highest-ranking manager. As such, our research answers the frequent request to empirically assess developing countries '[. . .] as a research context, by demonstrating how [. . .] understudied phenomena influence existing theories as well as how newly emerging phenomena have the potential to generate new theories in management research' [19].

Second, gender equality has thus far not been taken into consideration as a potential contingency factor when determining the effect of gender diversity on innovation. Our results suggest that innovation benefits from gender diversity *independent* of country-level gender equality, which further signals the importance of gender diversity for the innovative potential of firms in developing countries.

Third, our study has high managerial relevance at a firm-level and is essential for innovation-targeted policy making on a country level. The degree of a firm's gender balance is within the merits of managerial decision making and management driven strategic initiatives [20]. By contributing to an in-depth understanding of whether and how gender diversity can benefit innovation in the specific context of developing countries, our study enables informed managerial decision-making aimed at increasing innovation. Moreover, given the importance of finding ways to foster innovation in developing countries as a driver for economic growth and poverty reduction [9], our research provides interesting insights for policy makers. It points them to the importance of ratifying and enforcing policies targeted at increasing gender diversity at all hierarchical levels in the firm as a means to foster innovation.

The remainder of this article is structured as follows. We first provide an overview of the theoretical background and develop our hypotheses. Next, the empirical data and research methodology are presented. Subsequently, we describe the analysis conducted, followed by a summary of the results. Finally, we discuss our findings and provide closing remarks and conclusions.

Gender diversity and innovation

Innovation refers to the 'generation, acceptance and implementation of new ideas, processes, products or services' [21]. It is an important driver for increasing firm performance, enhancing

competitive advantage and expanding market share [4] as well as for the economic growth of countries [22]. In this study we focus on one of the five types of innovation classified by Schumpeter, namely product innovation. Product innovation is defined as the introduction of new goods or services as well as the significant improvement of existing products with regards to their characteristics and intended use [1]. Innovation in developed countries has frequently been found to benefit from gender diversity [1–4,23], which, according to the relational demography theory, is regarded upon as a compositional characteristic of groups [24]. As part of the value in diversity perspective [25], we discuss important benefits of gender diversity for innovation, stemming ‘either from each member’s unique attributes which bring different perspectives to the group or from relational and motivational processes that occur in diverse groups’ [23].

First, gender diversity expands the knowledge, which is available to a firm both internally as well as externally: Given their different experiences and career trajectories, the human and social capital of men and women [5], including their cognitive schemes and as well as systems of meaning, differ. Even though an initial investment of diverse employees to create a shared language and understanding is required, they consequently benefit from information and resources they would otherwise not have access to [26]. As such, gender diversity enriches the internally available knowledge stock. Moreover, based on the social network theory [27] and the self-categorization theory [28], people typically direct their networking strategies to individuals with similar demographics [29]. Consequently, gender diversity provides firms with access to different external networks and with that to a diversified knowledge pool outside the firm [7]. As diverse knowledge can be complementary, enables new combinations of knowledge and ultimately benefits the creation of new ideas and products, this diversified internal and external knowledge stock increases the innovation levels within a firm [6].

Second, gender diversity can benefit innovation as it is linked to improved problem solving and decision making [1]. Successful innovation requires well-founded decisions on which innovative ideas to drop and which to turn into tangible innovative outputs [8]. Cognitive conflict and expression of diverse viewpoints stemming from men’s and women’s inherently different perceptions and experiences [5] can circumvent premature consensus and thus increase the quality of decisions [30] as a driver for innovation.

We argue that the extent to which firms can take advantage of the above elaborated on benefits of gender diversity for innovation depends on the country-specific levels of gender equality. Gender equality refers to girls and women having ‘equal access to quality education, economic resources and political participation as well as equal opportunities with men and boys for employment, leadership and decision-making at all levels’ [31]. Gender equality spans across social, political, and economic dimensions in that it is manifested in country policy, deep-seated in society and culture [12] as well as visible in e.g. girls’ and women’s access to education and their social status [13]. We propose that operating in a country with higher levels of gender equality enhances a firm’s ability to reap the benefits of gender diversity among the firm owners and the workforce for innovation compared to operating in countries with little gender equality. Moreover, we expect gender equality to impact the relationship between having a female top manager and innovation. We elaborate on the three proposed interaction effects in the following sections.

Gender equality and gender diversity in the ownership structure

A firm’s owners, which can refer to single individuals, a group of individuals or a board of directors representing shareholders [32], directly influence innovation through the strategic decisions they take [33]. In the decision making process among owners, gender-related

diversity plays an important role as outlined by Hambrick and Mason's [34] upper echelon theory. Firm leaders filter and interpret the stimuli they receive during a decision challenge based on their personal and unobservable cognitive bases and values, for which demographic attributes such as gender build the foundation [35]. Despite a general preference for homogeneity [36], gender diverse owners 'can make a valuable contribution to [...] decisions by providing unique perspectives on strategic issues' [37]. Hence, by fostering cognitive dissent [8] and avoiding premature consensus [30], diversity in general [38] and gender diversity in specific are frequently found to benefit innovation [2,4] through improved problem solving and enhanced decision making [1].

However, the extent to which firms can reap the aforementioned benefits of gender diverse owners on innovation may depend on gender equality. Gender equality subsumes the socially established legal and social status of women, which determines the patterns of respect and influence among individuals as they interact and take decisions [16]. When women have low social status in a gender unequal context, 'the potential contributions of women stemming from their different values are likely to be disregarded' [17] in the decision making process. However, with increasing levels of gender equality, we expect the opinions, knowledge and experiences of both men and women to be equally taken into consideration. Thus, we infer that the positive effect of gender diversity among a firm's ownership structure on innovation will be more pronounced in countries with high levels of gender equality compared to countries with low levels of gender equality. We hypothesize the following:

Hypothesis 1a. *Gender diversity in a firm's ownership structure has a positive effect on its likelihood to innovate.*

Hypothesis 1b. *The effect of gender diversity in a firm's ownership structure on its likelihood to innovate is positively moderated by gender equality in a country.*

Gender equality and the gender of the top manager

Top managers influence firms' innovativeness [39] as they are instrumental in building an innovation-nurturing organizational climate, which includes mutual trust as well as employee involvement and accountability [40]. Particularly transformational leaders 'inspire, energize, and intellectually stimulate their employees' [41]. They rely on motivational processes which are both longer-term as well as vision-based [42] and thereby 'stir their employees to look beyond their own self-interest for the good of the group' [41]. Transformational leadership is conducive to innovation [40,42–44] and has previously been established to be more frequently exhibited by women than by men [45]. One could infer that especially women top managers have the potential to advance firms' innovation levels. Yet, studies assessing the relationship between a top manager's gender and innovation are scarce and have primarily been conducted in developed countries. Studies that have included the top manager's gender, mostly focused on CEOs (Chief Executive Officers) as the highest ranking management individual in large organizations [46]. The limited research available yields in inconsistent [46] or insignificant [47] results. As such, it is important to enhance our understanding of this relationship in the context of developing countries.

Beyond a possible direct effect, we expect that gender equality affects the extent to which female top managers can drive innovation. A study by Wolfram and colleagues [48] gives a first indication that the gender of managers and the therewith associated status can play an important role in the interaction with their followers. Their findings suggest that male followers respect female leaders less than male leaders if they believe in traditional gender roles. This lack of respect can limit a firm's innovativeness, which according to the leader member

exchange (LMX) theory [49], depends on a good relationship and quality exchange between leaders and their followers [50]. Along the same lines, Lyngsie and Foss suggest that ‘employees’ stereotyping and prejudice may negatively influence positive effects of increasing female participation in [. . . top management teams]’ [51]. Hence, we claim that gender equality moderates the relationship between a top manager’s gender and a firm’s likelihood to innovate. We formulate the following hypotheses:

Hypothesis 2a. *The gender of the top manager has a direct effect on a firm’s likelihood to innovate.*

Hypothesis 2b. *The effect of the top manager’s gender on a firm’s likelihood to innovate is positively moderated by gender equality in a country.*

Gender equality and gender diversity in the workforce

Innovation can also be initiated and driven by the employees of a firm. In bottom-up innovation processes, employees draw upon their individual pool of knowledge and experience to contribute to different activities in the innovation process [52]. Both knowledge at the level of individuals and shared knowledge at group and divisional levels are critical for innovation [53]. As explained earlier, gender diversity has been found to benefit innovation in developed countries [1,54] by diversifying the internal [6] and external knowledge pool [7]. For example, a study by Díaz-García et al. demonstrates that gender diversity within R&D teams results in high levels of radical innovation, especially in technology intensive industries [23]. Moreover, Teruel and colleagues find that ‘gender-diverse teams increase the probability of innovating, and this capacity is positively related to team size’ [3]. We also expect that this positive effect of gender diversity among the workforce on innovation can be found in developing countries. The benefits of a diverse pool of knowledge in the workforce allows for unique and novel combinations of knowledge that support firms in developing countries to unleash their innovative potential (9).

Furthermore, we expect a higher degree of gender equality, and with that enhanced access for girls and women to education [13] and knowledge, to enable a better realization of the benefits gender diversity can bring for innovation. The more women and men can contribute equal levels of inherently different knowledge and experiences to a firm’s knowledge pool, the more diverse the knowledge pool becomes, which in turn is a driver for firm innovation. Hence, we infer that the positive effect of gender diversity on innovation will be more pronounced in countries with high gender equality compared to countries with low equality between men and women. We formulate the following hypothesis:

Hypothesis 3a. *Gender diversity in a firm’s workforce has a positive effect on its likelihood to innovate.*

Hypothesis 3b. *The effect of gender diversity in a firm’s workforce on its likelihood to innovate is positively moderated by gender equality in a country.*

Data and method

Data

We test our hypotheses using a combination of the World Bank’s Enterprise Survey (ES) and the Women’s Economic Opportunity Index (WEOI) of the Economist Intelligence Unit [13]. The ES is a firm-level survey, encompassing firms in the manufacturing, retail and service industry. It covers three main components, namely firm characteristics, the business

environment as well as innovation related activities. It is stratified based on firm size, geographical location and industry sector. The ES questionnaire is answered by top managers or business owners, with the support of company accountants and human resource managers if required for specific questions. We focus on developing countries in Africa, the Middle East and South Asia. The selection of countries for this study is based on three criteria, namely: the status of being a developing country (low or lower-middle income as per World Bank definition in 2012), the period of ES data collection (2013 and 2014), and the availability of all required variables, including the measurement of gender equality (Women's Economic Opportunity Index, WOEI). As a result, 15 countries (Bangladesh, Egypt, Ghana, India, Kenya, Malawi, Morocco, Nigeria, Pakistan, Senegal, Sudan, Tanzania, Uganda, Yemen and Zambia) are included in this research. This combined data set, including in-depth insights on a high number of firms covered by the ES and a wide range of countries with information on gender equality, enables a country-based comparison of 15 countries with 18,547 firms.

Dependent variable. Our measure of innovation is based on the following ES questions: 'During the last three years, has this establishment introduced new or significantly improved products or services?'. Affirmative answers are coded one, negative replies zero. Innovation in previous gender and innovation research has been both measured by objective measures such as the number of patents [32] as well as by measures very similar to the more subjective binary response of firm-level informants used in this study [3,4]. Despite its relative subjectivity, this measure of innovation is particularly suitable in the developing country context of this study, where innovation is frequently incremental rather than radical in nature and as such rarely results in the formal registration of patents [9]. The binary nature of our dependent variable itself bears inherent limitations, which are referenced in more detail in the discussion section.

Independent variables. Blau's Index: Consistent with previous operationalization [2,3,46], we use Blau's (1977) index of heterogeneity to assess gender diversity among a firm's workforce and owners. Blau's index, originally proposed by Simpson in 1949, is also known as the Herfindahl's and the Hirschman's index and it is considered to be an appropriate measure for capturing variations within a group of people [24]. Blau's index is computed $(1 - \sum p_k^2)$, where p is the proportion of group members in each of the k categories, and it ranges from 0.00 (only one gender) to 0.50 (equal numbers of men and women).

Gender Diversity in the Workforce: More specifically, the underlying data for computing Blau's Index as a measure for gender diversity among the workforce, is based on the overall number of 'permanent, full-time individuals' and on the number of 'permanent full-time individuals that [...] were female' (ES).

Gender Diversity among the Owners: The measure of gender diversity among the owners of a firm specifically accounts for the emerging market context of this study, which is characterized primarily by small to medium sized firms without a formal board of directors. Our measure therefore differs from previous studies conducted in developed countries, which capture the percentage of women on the corporate board based on firms' widespread preference for diversified shareholder models [2,4]. Our measure (Blau's index) is based on the following two questions: 'Among the owners of the firm, are there any females?' and 'What percentage of the firm is owned by females?'

Gender of the Top Manager: The third independent variable captures the gender of a firm's top manager, not gender diversity per se. The term top manager in this study refers to the firm's highest-ranking management individual and it is measured by the following question: 'Is the Top Manager female'. Positive responses are coded one, negative replies are coded zero.

Moderator: Gender equality. According to van Staveren [55], five gender indices are most widely used to measure gender equality given their reputable sources and high coverage.

One of those five indices is the Women's Economic Opportunity Index (WEOI) of the Economist Intelligence Unit [13], which we rely on in this study. The WEOI provides insights to which degree the 'set of laws, regulations, practices, customs and attitudes [. . .] allow women to participate in the workforce under conditions roughly equal to those of men' (Economist Intelligence Unit, 2012, p.5).

The WEOI is used in this research as a measure for gender equality for several reasons. First, it covers gender equality very comprehensively as it encompasses all four dimension of human development (resources, institutions, capabilities and functionings) [55]. More specifically, the WEOI incorporates insights which are particularly relevant in the context of this study, such as policies and laws discriminating against women, their social and legal status as well as their access to education [13]. Second, it is a measure, which has been successfully used in previous studies on gender equality [56,57]. Lastly, the WEOI's focus on resources and institutions is well suited for creating a better understanding of how business and economic law can be particularly restricting or discriminating against women [58] when 'social customs and institutions effectively limit or prevent women's access to most economic and political opportunities' [59].

The WEOI incorporates several national and international sources, both quantitative and qualitative in nature. It consists of 29 indicators in five categories, which are summarized in tabular form in [S1 Appendix](#). Category one, labor policy and practice, captures the degree to which governments ratify and enforce policies aimed at providing women with equal opportunities and pay. Category two, access to finance, focuses on women's access to finance related programs and services as well as their ability to build credit history. Category three captures the education and training level of women. In category four, the WEOI entails information on women's legal and social status. This includes violence against women, their citizenship and ownership rights, discrimination, political participation and fertility. The fifth category captures the regulatory quality of a country, touching upon the ease of starting a business, adequate infrastructure to do so as well as access to technology. The overall WEOI score, which ranges from 0–100 with higher values representing higher levels of gender equality, is computed from a simple average of the unweighted mean of each category's indicators [13]. [Table 1](#) encompasses an overview of the relevant WEOI values at the country level as well as a country's rank in a world-wide comparison. The information required to calculate the internal reliability of the WEOI is not available. Consequently, the internal reliability of the WEOI cannot be reported.

Control variables. Firm size: Based on prior findings indicating a positive relationship between the size of a firm and its innovation levels [1,23], we control for firm size by its number of full-time permanent employees (continuous variable, log-transformed).

Firm Type: Furthermore, we control for whether an 'Establishment is part of a larger firm' (ES) and with that in a position to benefit from economies of scale of the parent organization. If answered affirmatively, we coded establishments as one, otherwise zero.

Export: Export allows firms to 'benefit from the access they gain to knowledge that resides abroad' [60]. In line with previous research establishing a positive effect of export on innovation [3,61], we moreover control for whether a firm generates sales from export. We coded a firm zero for national sales only and one for indirect and direct export.

R&D: Given R&D's positive effect on innovation [1,3,62], we also control for whether firms 'spend on formal R&D activities, either in-house or contracted with other companies' during the last three years (ES). We coded a positive response one and a negative response zero.

Education: Preceding studies suggest a highly educated workforce to positively impact innovation [1,3]. Thus, we additionally control for employees' education level by assessing the percentage of employees who completed secondary school (ES).

Table 1. Gender equality measured by WEOI ratings and ranking for countries participating in this study.

| Country ^a | Region | WEOI Value ^b | Rank ^c |
|----------------------|----------------------------|-------------------------|-------------------|
| Egypt | Middle East & North Africa | 48.7 | 80 |
| Kenya | Sub-Saharan Africa | 47.5 | 86 |
| Morocco | Middle East & North Africa | 47.0 | 89 |
| Ghana | Sub-Saharan Africa | 46.4 | 91 |
| Tanzania | Sub-Saharan Africa | 45.4 | 95 |
| India | South Asia | 41.9 | 98 |
| Uganda | Sub-Saharan Africa | 40.4 | 102 |
| Bangladesh | South Asia | 39.2 | 105 |
| Malawi | Sub-Saharan Africa | 39.0 | 107 |
| Senegal | Sub-Saharan Africa | 38.7 | 108 |
| Zambia | Sub-Saharan Africa | 36.9 | 112 |
| Pakistan | South Asia | 35.5 | 116 |
| Nigeria | Sub-Saharan Africa | 33.4 | 119 |
| Yemen | Middle East & North Africa | 24.6 | 126 |
| Sudan ^d | Sub-Saharan Africa | 19.2 | 128 |

^a Classification World Bank for 2012: lower-middle income countries (GNI per capita of maximum US\$4,085), except for Malawi Tanzania, Uganda (low income countries, GNI per capita of US\$1,035 or less)

^b Maximum WEOI value: 100.0

^c Out of 128

^d Lowest WEOI score and rank worldwide

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Industry Sector: In line with previous research [1,61], we account for the industry sector, in which a firm operates. Manufacturing was dummy-coded one, retail two and the services (non-retail) industry three.

Ownership form: Participating firms are characterized by different ownership forms, such as shareholding companies with privately traded or no shares (dummy-coded two), firms governed by sole proprietorship (three), partnerships (four), limited partnerships (five), and all other ownership forms (six). As insights into the gender of the owners of publicly traded shares are difficult to gather and thus not sufficiently reliable, firms with shares traded publicly were excluded from this research. As sole proprietorship does not allow for gender diversity among a firm's owners, we have analysed the effect of a gender diverse ownership structure on innovation while both including and excluding firms governed by sole proprietorship. The coefficients and significance of the results remained constant to the variation in this variable specification.

To account for country specific characteristics, we additionally include the following control variables provided by the World Bank:

Income Classification: We control for the World Bank classification (2012) of countries as either being low income countries (GNI per capita US\$ 4,085 or less) or lower-middle income countries (GNI per capita of maximum US\$4,085). Firms classified as low-income countries are coded zero, lower-middle income countries are coded one.

Employment in Agriculture: We furthermore account for the percentage of a country's population, which is employed in the agricultural sector (continuous variable). A country's agricultural economic performance is critical for the reduction of extreme poverty on the one side, whilst a decreasing share of the agricultural sector in employment is a consequence of economic progress on the other side [63].

Foreign Direct Investment (FDI) net inflow: We additionally shed light on the percentage of FDI net inflow as a percentage of the overall GDP. FDI net inflow refers to the value of direct inward investment issued by investors residing outside of a particular country. It can be understood as a proxy for influence and control, which is excerpted from outside the country [64].

Rural Population: The term rural population refers to people living in rural areas [65]. The national standard for classifying areas as rural varies between countries and is determined based on population density and distance to large cities. We capture the percentage of the rural population among the total population for two primary reasons. First, the percentage of the population, which is living in rural areas, is frequently associated with higher levels of poverty [63]. Second and especially relevant for the dependent variable (product innovation), businesses operating in rural areas face pronounced operating challenges and are often prone to lower innovation levels compared to firms located in urban surroundings [66].

Statistical analysis

Given the potentially clustered nature of our data at the country-level, the commonly known regression assumption of independence can be violated [67]. Different model specifications allow to account for the risk of heteroscedasticity. To analyze our data, we rely on a binary logistic regression model with clustered standard errors [67]. We further conduct a robustness test with multi-level modeling (hierarchical linear model) [68]. If not stated otherwise, the results of both model specifications are consistent and only the results of the main analysis (binary logistic regression model with clustered standard errors) are reported.

To account for the moderating effect of gender equality, we included interaction effects in the analysis, which potentially bears the risk of high correlation with lower order terms [69]. When testing for the previously described challenge we found that, without centering the independent variables and the moderator at their mean, tolerance was at times below .2 and VIF values above 10, with an average VIF value way beyond 1 ($\overline{VIF} = 22.09$), indicating issues with multicollinearity [70]. After centering the previously mentioned variables at their respective mean, multicollinearity is of no concern: for all variables, Tolerance is above .2 and VIF values are smaller than 10 with the average VIF value not being substantially greater than 1 ($\overline{VIF} = 1.32$). Thus, the decision to mean-center the independent variables and the moderator was taken.

Results

The descriptive statistics and bivariate correlations for all variables are outlined in [Table 2](#). The subsequent insights illustrate the general trends how and in which context the firms participating in our research operate. First, the majority are small to medium sized (75.34 percent) independent firms (79.79 percent) in the manufacturing industry (66.43 percent). Most firms, whose average percentage of employees having completed secondary school accounts for 50.12 percent, are not conducting R&D (75.66 percent) and generate their sales primarily from national transactions (81.99 percent). Second, gender diversity at all levels is rather low, expressed in a Blau's index of 0.05 among firm owners and of 0.16 among the overall workforce. In other words and more illustrative, as much as roughly 91.49 percent of the firms' owners and 84.82 percent of the firms' workforce are men. These findings are in line with previous insights that women are under-represented both in the workforce as well as particularly in management or ownership positions in developing countries [58]. This also holds true for female representation among top managers: only 8.70 percent are women. Furthermore, the mean gender equality level derived for our study (WEOI, 40.50) is well below the worldwide

Table 2. Descriptive statistics and correlation matrix (n = 18 547).

| 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 | | |
|------------------------------------|-------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|------|------|------|---|--|
| 1 Innovation | 0.43 | 0.50 | 0.00 | 1.00 | - | | | | | | | | | | | | | | | | | | | | |
| 2 Industry (Manufacturing) | 0.66 | 0.47 | 0.00 | 1.00 | -0.01 | - | | | | | | | | | | | | | | | | | | | |
| 3 Industry (Retail) | 0.13 | 0.33 | 0.00 | 1.00 | 0.03 | -0.54 | - | | | | | | | | | | | | | | | | | | |
| 4 Firm Size (log-transformed) | 89.13 | 355.59 | 1.00 | 21001 | 0.05 | 0.06 | -0.03 | - | | | | | | | | | | | | | | | | | |
| 5 Firm Type | 0.20 | 0.40 | 0.00 | 1.00 | 0.06 | -0.04 | 0.03 | 0.15 | - | | | | | | | | | | | | | | | | |
| 6 Export | 0.18 | 0.38 | 0.00 | 1.00 | 0.11 | 0.10 | -0.10 | 0.18 | 0.11 | - | | | | | | | | | | | | | | | |
| 7 R&D | 0.24 | 0.43 | 0.00 | 1.00 | 0.35 | 0.07 | -0.03 | 0.08 | 0.12 | 0.16 | - | | | | | | | | | | | | | | |
| 8 Education | 50.12 | 33.69 | 0.00 | 100.0 | 0.13 | -0.18 | 0.13 | 0.04 | 0.05 | 0.00 | 0.13 | - | | | | | | | | | | | | | |
| 9 Ownership (Shareholding) | 0.10 | 0.30 | 0.00 | 1.00 | 0.01 | 0.04 | -0.06 | 0.13 | 0.10 | 0.16 | 0.06 | 0.01 | - | | | | | | | | | | | | |
| 10 Ownership (Sole Proprietorship) | 0.55 | 0.50 | 0.00 | 100.0 | -0.06 | -0.08 | 0.10 | -0.13 | -0.18 | -0.19 | -0.16 | -0.09 | -0.37 | - | | | | | | | | | | | |
| 11 Ownership (Partnership) | 0.17 | 0.38 | 0.00 | 1.00 | -0.03 | 0.07 | -0.05 | -0.01 | 0.03 | 0.01 | 0.01 | -0.04 | -0.15 | -0.51 | - | | | | | | | | | | |
| 12 Ownership (Limited Partnership) | 0.16 | 0.36 | 0.00 | 1.00 | 0.10 | 0.00 | -0.02 | 0.08 | 0.12 | 0.10 | 0.16 | 0.15 | -0.14 | -0.47 | -0.20 | - | | | | | | | | | |
| 13 World Bank Classification | 0.86 | 0.34 | 0.00 | 1.00 | -0.03 | 0.03 | -0.04 | 0.02 | 0.02 | 0.01 | 0.06 | 0.03 | 0.04 | -0.10 | 0.05 | 0.05 | - | | | | | | | | |
| 14 Employment in Agriculture | 44.86 | 10.59 | 27.07 | 85.14 | 0.13 | -0.02 | 0.04 | -0.01 | -0.03 | -0.04 | 0.11 | 0.06 | -0.06 | 0.01 | -0.03 | 0.05 | -0.41 | - | | | | | | | |
| 15 Foreign Direct Investment | 1.88 | 1.71 | -0.15 | 7.86 | 0.11 | -0.14 | 0.06 | -0.06 | -0.06 | 0.02 | 0.02 | 0.17 | -0.01 | 0.01 | -0.07 | 0.06 | -0.01 | 0.29 | - | | | | | | |
| 16 Rural Population | 65.75 | 7.23 | 40.86 | 84.19 | 0.04 | 0.13 | -0.04 | 0.04 | -0.04 | -0.02 | 0.10 | -0.01 | 0.02 | -0.11 | 0.07 | 0.05 | -0.23 | 0.46 | -0.28 | - | | | | | |
| 17 Gender Equality (WEOI) | 40.64 | 5.88 | 19.23 | 48.65 | -0.08 | 0.20 | -0.10 | 0.04 | -0.01 | 0.02 | 0.01 | -0.02 | 0.13 | -0.19 | 0.03 | 0.11 | 0.23 | -0.20 | 0.01 | 0.13 | - | | | | |
| 18 Gender Diversity Firm Owner | 0.05 | 0.13 | 0.00 | 0.50 | 0.06 | 0.01 | -0.02 | 0.04 | 0.04 | 0.11 | 0.06 | 0.04 | 0.17 | -0.34 | 0.15 | 0.15 | 0.02 | 0.03 | 0.09 | 0.07 | 0.11 | - | | | |
| 19 Gender Top Manager | 0.09 | 0.28 | 0.00 | 1.00 | 0.07 | -0.08 | 0.06 | 0.04 | 0.04 | 0.05 | 0.07 | 0.07 | 0.01 | -0.03 | -0.02 | 0.07 | -0.02 | 0.06 | 0.09 | -0.02 | 0.01 | 0.16 | - | | |
| 20 Gender Diversity Workforce | 0.16 | 0.19 | 0.00 | 0.50 | 0.14 | -0.20 | 0.12 | 0.07 | 0.08 | 0.10 | 0.07 | 0.16 | 0.04 | -0.03 | -0.04 | 0.05 | -0.01 | 0.13 | 0.20 | 0.00 | 0.04 | 0.10 | 0.16 | - | |

Please note that the following variables are not centred at their respective mean in this table to allow for better interpretation: firm size, gender equality, gender diversity among the owners (Blau's Index), gender diversity in the workforce (Blau's Index).

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Table 3. Binary logistic regression models with clustered standard errors: Effect of gender diversity and the interaction effect between gender diversity and gender equality on innovation (n = 18 547).

| Variables | Model 1 | | Model 2 | | Model 3 | |
|---|-------------------|--------|--------------------|--------|--------------------|--------|
| | B | SE | B | SE | B | SE |
| <i>Control Variables</i> | | | | | | |
| Industry (Manufacturing) | 0.10* | (0.04) | 0.20** | (0.04) | 0.20** | (0.04) |
| Industry (Retail) | 0.21** | (0.06) | 0.20** | (0.06) | 0.20** | (0.06) |
| Firm Size | 0.00 | (0.00) | 0.00 | (0.00) | 0.00 | (0.00) |
| Establishment Type | 0.08 ⁺ | (0.04) | 0.04 | (0.04) | 0.05 | (0.04) |
| Export | 0.37** | (0.04) | 0.30** | (0.04) | 0.31** | (0.04) |
| R&D | 1.60** | (0.04) | 1.60** | (0.04) | 1.60** | (0.04) |
| Education | 0.00** | (0.00) | 0.00** | (0.00) | 0.00** | (0.00) |
| Ownership (Shareholding) | 0.10 | (0.12) | 0.05 | (0.12) | 0.05 | (0.12) |
| Ownership (Sole Proprietorship) | 0.13 | (0.11) | 0.15 | (0.12) | 0.14 | (0.12) |
| Ownership (Partnership) | 0.01 | (0.12) | -0.01 | (0.12) | -0.00 | (0.12) |
| Ownership (Limited Partnership) | 0.34** | (0.12) | 0.32** | (0.12) | 0.32** | (0.12) |
| Income Classification | -0.08 | (0.05) | -0.09 ⁺ | (0.05) | -0.10 ⁺ | (0.05) |
| Employment in Agriculture | 0.01** | (0.00) | 0.00* | (0.00) | 0.01* | (0.00) |
| Foreign Direct Investment | 0.12** | (0.01) | 0.10** | (0.01) | 0.10** | (0.01) |
| Rural Population | 0.01** | (0.00) | 0.01** | (0.00) | 0.01** | (0.00) |
| Gender Equality | -0.03** | (0.00) | -0.04** | (0.00) | -0.03** | (0.00) |
| <i>Direct effects of Gender Diversity</i> | | | | | | |
| Gender Diversity Firm Owner | | | 0.52** | (0.14) | 0.37* | (0.15) |
| Gender Top Manager | | | 0.13* | (0.06) | 0.14* | (0.06) |
| Gender Diversity Workforce | | | 1.13** | (0.09) | 1.13** | (0.09) |
| <i>Interactions</i> | | | | | | |
| Gender Equality X Diversity Firm Owner | | | | | 0.08** | (0.03) |
| Gender Equality X Gender Top Manager | | | | | -0.01 | (0.01) |
| Gender Equality X Diversity Workforce | | | | | -0.02 | (0.02) |
| Constant | -2.25** | (0.23) | -2.09** | (0.23) | -2.11** | (0.23) |
| LR Chi2 | | | 192.59 | (0.00) | 202.60 | (0.00) |
| BIC (df) | 22631.4 | (17) | 22468.2 | (20) | 22487.7 | (23) |

⁺p<0.10,

* p<0.05,

** p<0.01

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average of 57.30. Nevertheless, there is still a considerable range in the gender equality values with a minimum of 19.23 for Sudan, representing the lowest WEOI worldwide, and a maximum of 48.70 for Egypt. The aforementioned results underline our initial observation that the level of gender equality in the countries participating in this study differs, however at generally lower levels compared to developed countries. Third, the dependent variable, innovation, indicates that 43 percent of the firms participating in this study introduced a new or significantly improved product or service.

Table 3 presents the main results of our analysis. Model 1 is the baseline model, which exclusively contains the control variables and serves to evaluate the added explanatory value of the independent variables. Model 2 adds the three direct effects of the independent variables, namely gender diversity in the firm ownership structure (hypothesis 1a) and the overall workforce (hypothesis 3a) as well as the gender of the top manager (hypothesis 2a). Model 3 includes the three interaction effects between our independent variables and gender equality

Table 4. Robustness test. Hierarchical linear model: effect of gender diversity and the interaction effect between gender diversity and gender equality on innovation (n = 18 547).

| <i>Fixed Effects</i> | Coefficient | S.E. | Coefficient | S.E. |
|--|-------------------|--------|-------------------|--------|
| Industry (Manufacturing) | 0.06** | (0.01) | 0.06** | (0.01) |
| Industry (Retail) | 0.04** | (0.01) | 0.04** | (0.01) |
| Firm Size | 0.00* | (0.00) | 0.00* | (0.00) |
| Establishment Type | 0.01 | (0.01) | 0.01 | (0.01) |
| Export | 0.05** | (0.01) | 0.05** | (0.01) |
| R&D | 0.36** | (0.01) | 0.36** | (0.01) |
| Education | 0.00** | (0.00) | 0.00** | (0.00) |
| Ownership (Shareholding) | 0.02 | (0.03) | 0.02 | (0.03) |
| Ownership (Sole Proprietorship) | 0.02 | (0.02) | 0.02 | (0.02) |
| Ownership (Partnership) | 0.01 | (0.03) | 0.01 | (0.03) |
| Ownership (Limited Partnership) | 0.06* | (0.02) | 0.06* | (0.02) |
| WEOI | -0.00 | (0.00) | -0.00 | (0.00) |
| Gender Diversity Ownership | 0.12* | (0.05) | 0.12* | (0.05) |
| Gender Top Manager | 0.02 ⁺ | (0.01) | 0.02 ⁺ | (0.01) |
| Gender Diversity Workforce | 0.17** | (0.05) | 0.15** | (0.04) |
| Gender Equality*Gender Diversity Ownership | | | -0.00 | (0.01) |
| Gender Equality*Gender Top Manager | | | 0.00 | (0.00) |
| Gender Equality*Gender Diversity Workforce | | | -0.01* | (0.01) |
| <i>Random Effects</i> | | | | |
| Variance intercept | 0.01 | (0.00) | 0.01 | (0.00) |
| Variance random slope Gender Diversity Ownership | 0,01 | (0.01) | 0,02 | (0,02) |
| Variance random slope Gender Top Manager | 0.00 | (0,00) | 0.00 | (0,00) |
| Variance random slope Gender Diversity Workforce | 0.02 ⁺ | (0,01) | 0.02 ⁺ | (0,01) |
| Log-likelihood | -11521,106 | | -11518,621 | |

⁺p<0.10,

* p<0.05,

** p<0.01

<https://doi.org/10.1371/journal.pone.0222443.t004>

(hypotheses 1b, 2b, 3b). Table 3 reports the results of model 1 through 3. Compared to model 1, both model 2 and 3 are significant improvements in model fit. The results of the hierarchical linear models with random intercepts and random slopes (robustness test) are summarized in Table 4.

Direct effect of gender diversity on innovation

Model 2 of the binary logistic regression analysis (see Table 3) describes the direct effect of the independent variables on innovation. The results suggest that a gender diverse ownership and workforce structure as well as a female top manager facilitate higher innovation levels. As such, the results provide strong support for hypotheses 1a, 2a and 3a. To enable a better understanding of the effect sizes, we follow the common practice of examining the marginal effects of the independent variable at one standard deviation below and above the mean [71].

Moving from one standard deviation below to one standard deviation above the mean in gender diversity among owners increases firms' likelihood to innovate by 21.42 percent. Furthermore, we find that having a female top manager increases the likelihood of firms to innovate by 2.19 percent. Finally, moving from one standard deviation below to one standard

deviation above the mean in gender diversity among a firm's workforce gives rise to its innovation likelihood by 47.24 percent.

In terms of effect magnitude, the analyses clearly show that diversity in the workforce has the largest effect on firm innovativeness. Its effect is double that of diversity in the ownership of a company and more than 20 times as big as the effect of the gender of the top manager.

Moderating effect of gender equality

Model 3 assesses the interaction effect between gender diversity and gender equality, shedding light on the three hypothesized moderation effects (Hypotheses 1b, 2b, 3b). Contrary to our expectations, the results of the binary logistic regression and the hierarchical linear regression (see [Table 4](#)) for the proposed moderation effect of gender equality are mostly non-significant as well as inconsistent. As such, our results thus do not support the hypotheses that gender equality moderates the relationship between gender diversity and innovation.

More specifically, hypothesis 1b is only partially supported. Whereas the binary logistic regression ([Table 3](#)) suggests gender equality to moderate the relationship between gender diversity among a firm's ownership structure and its likelihood to innovate, the hierarchical linear model ([Table 4](#)) yields in non-significant results. As such, we cannot infer that our results support hypothesis 1b.

Based on the results of both model specifications, hypothesis 2b is not supported. There is insufficient evidence at a 5 percent significance level to reject the claim that gender equality has no effect on the relationship between the gender of a firm's top manager and its likelihood to innovate.

Similar to hypothesis 1b, the findings of hypothesis 3b are inconsistent. Whereas our main model (binary logistic regression, [Table 3](#)) suggests that gender equality has a non-significant impact on the relationship between gender diversity among the workforce and innovation, the hierarchical linear model ([Table 4](#)) proposes a significant negative moderation effect. Based on the inconsistency across the two model specifications, there is insufficient evidence to support the hypothesis that gender equality moderates the relationship between gender diversity and innovation.

Endogeneity

The Enterprise Survey is restricted to cross-sectional observations. Therefore, unobserved heterogeneity and self-selection are a concern for our study [72]. We were able to address these concerns for two of our three independent variables. First, we performed instrumental variable probit regressions, in which we instrumented diversity among the workforce in our firms. We instrumented with the industry-specific average gender diversity in the workforce in the Netherlands. This approach of using industry averages from another country as an instrument is often used in studies on firm-level innovation as it provides highly exogenous instruments [73]. Following the procedure described by Bascle (2008), we checked whether the instrument is sufficiently strong. We did so by comparing the first-stage F statistic to Stock and Yogo's (2005) critical values. The F-statistics for model 4 and 5 (see [Table 5](#)) both pass the highest critical value (5% maximal IV relative bias) and we therefore conclude that our instruments are sufficiently strong. Importantly, the main effect of gender diversity in the workforce remains positive and highly significant indicating that our findings in this regard are not an artifact of endogeneity. Moreover, model 5 reveals a positive and statistically significant interaction effect between gender diversity in the workforce and gender equality. This effect, which is in-line with hypothesis 3b was neither present in our main analyses nor in the hierarchical linear models used as a robustness test. We take this finding as further evidence that the interaction

Table 5. Instrumental variable regressions for gender diversity in the workforce (n = 18 547).

| Variables | Model 4 | | Model 5 | |
|--|---------|-------|----------|--------|
| | B | SE | B | SE |
| Control Variables | | | | |
| Industry (Manufacturing) | 0.203** | 0.037 | 0.198** | 0.037 |
| Industry (Retail) | 0.116** | 0.035 | 0.090* | 0.038 |
| Firm Size | 0.000 | 0.000 | 0.000 | 0.000 |
| Establishment Type | 0.011 | 0.028 | 0.000 | 0.028 |
| Export | 0.124** | 0.032 | 0.104** | 0.033 |
| R&D | 0.96** | 0.025 | 0.961** | 0.025 |
| Education | 0.02** | 0.000 | 0.002** | 0.000 |
| Ownership (Shareholding) | -0.011 | 0.078 | -0.019 | 0.079 |
| Ownership (Sole Proprietorship) | 0.042 | 0.073 | 0.025 | 0.074 |
| Ownership (Partnership) | -0.034 | 0.074 | -0.043 | 0.075 |
| Ownership (Limited Partnership) | 0.173* | 0.075 | 0.150* | 0.076 |
| Income Classification | -0.09** | 0.034 | -0.030 | 0.046 |
| Employment in Agriculture | 0.000 | 0.002 | 0.002 | 0.002 |
| Foreign Direct Investment | 0.047** | 0.009 | 0.039** | 0.009 |
| Rural Population | 0.06** | 0.002 | 0.004* | 0.002 |
| Gender Equality | -0.03** | 0.002 | -0.026** | 0.002 |
| Direct effects of Gender Diversity | | | | |
| Gender Diversity Firm Owner | 0.217* | 0.086 | 0.187* | 0.088 |
| Gender Top Manager | 0.010 | 0.043 | 0.026 | 0.045 |
| Gender Diversity Workforce ^a | 1.761** | 0.348 | 1.797** | 0.350 |
| Interactions | | | | |
| Gender Equality X Diversity Workforce ^a | | | 0.135+ | 0.0690 |
| Model significance | 0.000 | | 0.000 | |
| First-stage F statistic | 179.85 | | 43.61 | |

⁺p<0.10,

* p<0.05,

** p<0.01

^a: instrumented variable

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between gender diversity and gender equality is rather sensitive to model specifications, but that the positive effect of gender diversity on innovativeness is not.

Second, we ran a propensity score matching model to deal with endogeneity for the gender of the top manager. This technique extracts ‘treatment effects’ from observational data [74]. In our case, the ‘treatment’ is a company having a female top manager. We matched companies receiving the ‘treatment’ matched to four other companies that are as similar as possible on all observed covariates used in our analyses, but that did not receive the treatment (i.e., had a male top manager) [75]. A comparison of these matched cases reveals a remaining sizeable and statistically significant effect (treatment effect = 0.045, p<0.01) of having a female top-manager of innovativeness. Again, this insight provides evidence that our findings in this regard are not an artifact of endogeneity.

Discussion

Despite the varying and generally low levels of gender equality in developing countries, we find that gender diversity among a firm’s owners and workforce, as well as a female top

manager, have a significant positive effect on innovation. Our results furthermore propose that innovation benefits from gender diversity independent of gender equality. As such, our findings broaden and refine existing knowledge on gender diversity and innovation, with both theoretical as well as practical implications.

First, we suggest a more universal applicability of gender diversity as a means to increase innovation beyond the previously set boundaries of the United States and European countries, where most diversity research has been conducted to date [29]. The results of our study put forward that gender diversity at all organizational levels as well as having a female top manager have a direct positive effect on a firm's likelihood to innovate in the developing countries participating in our study. We thus identify an important firm-level mechanism for increasing innovation in developing countries in Africa, the Middle East and South Asia as well as enhance the scholarly understanding of how 'understudied phenomena influence existing theories' [19]. Given the binary nature of our dependent variable (product innovation), future research should assess whether the effects found in this study also hold true for different types of innovation (e.g. process innovation) as well as for different forms of innovation (radical vs incremental innovation). Furthermore, a continuous measurement of innovation may provide more fine-grained insights.

Second, our study puts forward that the positive effect of gender diversity among a firm's owner and workforce as well as of having a female top manager is independent of a country's level of gender equality (contradicting hypotheses 1b, 2b, 3b). Based on the insights of this research, future studies in developing countries could assess whether the influence of female owners, employees and top managers on innovation 'may be moderated by a firm's attitudes toward' women [76] rather than by a country's level of gender equality. Support for this line of thought is provided by recent studies conducted in developed countries. For example, Reinwald and colleagues [77] suggest that a strong diversity climate can positively impact firm performance. Furthermore, also following a contingency approach, Dwyer and colleagues find that organizational culture moderates the effectiveness of gender diversity for firm performance [78]. Moreover, Wang and Kelin [79] propose that the success of women at different hierarchical levels is interdependent. It would be interesting for follow-up studies to both extend previous insights to developing countries as well as to further refine them.

Our results also have practical implications. We provide empirical evidence of the importance gender diversity has for innovation and thus economic growth in developing countries. Thereby our research channels a powerful message that supports not only the societal and ethical rationale for women's inclusion in the workplace, but also showcases the therewith associated business advantages for firms in developing countries. Our results encourage firms to actively increase their percentage of women. Effective implementation of such policies can include human resource management, such as targeted hiring, as well as equal access to training or career development for women [20]. It is important that the heterogeneity among women on the one side as well as the country-specific constraints they are faced with on the other side are taken into consideration when designing respective programs [80]. Our results also have implications for policy makers. As innovation enables economic development [9] and as gender diversity benefits innovation, policy makers are encouraged to support firms in their efforts to increase gender diversity. Efforts can include financial incentives as well as setting quota for female participation in the workforce, among firm owners as well as appointing women as top managers [81]. As the magnitude of the direct positive effect of gender diversity among the workforce on innovation is highest, we propose a special focus on increasing women's participation in the overall workforce.

Conclusion

To conclude, the results of our study suggest that gender diversity in developing countries in Africa, the Middle East and South Asia is not only important from an ethical perspective, but also from an economic point of view. Gender diversity can increase firms' likelihood to innovate, despite their comparably low levels of gender equality. The results of our study thus suggest that a phenomenon, which has to date been primarily studied and benefited from in developed countries, is also applicable in the context of developing countries. The implications of our findings are relevant both for firms as well as for policy makers. Firms are encouraged to aim at establishing gender balance at all levels of the firm to increase the likelihood for innovation. Ideally, this would additionally be motivated and, if required, enforced by corresponding country legislation prompting firms to create equal employment opportunities for men and women.

Supporting information

S1 Appendix. Summary of WEOI indicators.

(DOCX)

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References

1. Østergaard CR, Timmermans B, Kristinsson K. Does a different view create something new? the effect of employee diversity on innovation. *Res Policy*. 2011; 40(3):500–9.
2. Miller T, del Carmen Triana M. Demographic Diversity in the Boardroom: Mediators of the Board Diversity–Firm Performance Relationship. *J Manag Stud*. 2009; 46(5):755–86.
3. Teruel M, Parra MD, Segarra A. Gender diversity and innovation in manufacturing and service firms. *Universitat Rovira I Virgili, Working Paper*. 2013.
4. Torchia M, Calabró A, Huse M. Women Directors on Corporate Boards: From Tokenism to Critical Mass. *J Bus Ethics*. 2011; 102(2):299–317.
5. Terjesen S, Singh V. Female presence on corporate boards: A multi-country study of environmental context. *J Bus Ethics*. 2008; 83(1):55–63.
6. van der Vegt GS, Janssen O. Joint impact of interdependence and group diversity on innovation. *J Manage*. 2003; 29(5):729–51.

7. Milliken FJ, Martins LL. Searching for Common Threads: Undertanding the Multiple Effects of Diversity in Organizational Groups. *Acad Manag Rev* [Internet]. 1996; 21(2):402–33. Available from: <http://library.gcu.edu:2048/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=9605060217&site=eds-live&scope=site>
8. de Dreu CKW, West MA. Minority Dissent and Team Innovation: The Importance of Participation in Decision Making. *J Appl Psychol*. 2001; 86(6):1191–201. PMID: 11768061
9. OECD. Innovation for Development: A Discussion of the Issues and an Overview of Work of the OECD Directorate for Science, Technology and Industry [Internet]. 2012. <http://www.oecd.org/innovation/inno/50586251.pdf>
10. Bradley SW, McMullen JS, Artz K, Simiyu EM. Capital is not enough: Innovation in developing economies. *J Manag Stud*. 2012; 49(4):684–717.
11. Goedhuys M, Janz N, Mohneny P. Knowledge-based productivity in “low-tech” industries: Evidence from firms in developing countries. *Ind Corp Chang*. 2014; 23(1):1–23.
12. Eastin J, Prakash A. Economic Development and Gender Equality: Is There a Gender Kuznets Curve? *World Politics*. 2013; 65(1):156–86.
13. Economist Intelligence Unit. Women’s Economic Opportunity 2012 Index and Report. 2012.
14. Hausman A. Innovativeness among small businesses: Theory and propositions for future research. *Ind Mark Manag*. 2005; 34(8):773–82.
15. Goedhuys M. Learning, product innovation, and firm heterogeneity in developing countries; Evidence from Tanzania. *Ind Corp Chang*. 2007; 16(2):269–92.
16. Ridgeway C. Social Status and Group Structure. In: Hogg MA, Tindale RS, editors. *Blackwell Handbook of Social Psychology: Group Process*. Blackwell Publishing; 2002. p. 352–75.
17. Nielsen S, Huse M. Women directors’ contribution to board decision-making and strategic involvement: the role of equality perception. *Eur Manag Rev* [Internet]. 2010; 7(1):16–29. Available from: <http://doi.wiley.com/10.1057/emr.2009.27>
18. Robson PJA, Haugh HM, Obeng BA. Entrepreneurship and innovation in Ghana: Enterprising Africa. *Small Bus Econ*. 2009; 32(3):331–50.
19. George G, Corbishley C, Khayesi JNO, Haas MR, Tihanyi L. From the Editors. Bringing Africa in: Promising Directions for Management Research. *Acad Manag J*. 2016; 59(2):377–93.
20. Joshi A, Liao H, Roh H. Bridging Domains in Workplace Demography Research: A Review and Reconceptualization. *J Manage*. 2011; 37(2):521–52.
21. Thompson VA. Bureaucracy and innovation. *Adm Sci Q*. 1965; 10(2):1–20.
22. Fagerberg J, Verspagen B. Technology-gaps, innovation-diffusion and transformation: An evolutionary interpretation. *Res Policy*. 2002; 31(8–9):1291–304.
23. Díaz-García C, González-Moreno A, Sáez-Martínez FJ. Gender diversity within R&D teams: Its impact on radicalness of innovation. *Innov Manag Policy Pract*. 2013; 15(2):149–60.
24. Harrison DA, Klein KJ. What’s the Difference? Diversity Constructs as Separation, Variety, or Disparity in Organizations. *Acad Manag Rev*. 2007; 32(4):1199–228.
25. Cox TH, Lobel SA, Mcleod PL. Effects of Ethnic Group Cultural Differences on Cooperative and Competitive Behavior on a Group Task. *Acad Manag J*. 1991; 34(4):827–47.
26. Maurer I, Ebers M. Dynamics of Social Capital and Their Performance Implications: Lessons from Biotechnology University of Cologne Start-ups. *Adm Sci Q*. 2006; 51:262–92.
27. Granovetter M. The Strength of Weak Ties. *Am J Sociol*. 1973; 78(6):1360–80.
28. Turner JC, Hogg MA, Oakers PJ, Reicher SD, Wetherell M. Rediscovering the social group: A self-categorization theory. Cambridge, MA, US: Basil Blackwell; 1987. 1 p.
29. Zhang Y, Hou L. The romance of working together: Benefits of gender diversity on group performance in China. *Hum Relations*. 2012; 65(11):1487–508.
30. Priem RL, Harrison DA, Muir NK. Structured conflict and consensus outcomes in group decision making. *J Manage*. 1995; 21(4):691–710.
31. United Nations General Assembly. Transforming our World: the 2030 Agenda for Sustainable Development. 2015. p. 1–35.
32. Choi SB, Park B, Hong P. Does Ownership Structure Matter for Firm Technological Innovation Performance? The Case of Korean Firms. *Corp Gov*. 2012; 20(3):267–88.
33. Hoskisson RE, Hitt MA, Johnson RA, Grossman W. Conflicting Voices: The Effects of Institutional Ownership Heterogeneity and Internal Governance on Corporate Innovation Strategies. *Acad Manag J* [Internet]. 2002; 45(4):697–716. Available from: <http://www.jstor.org/stable/3069305>

34. Hambrick DC, Mason PA. Upper Echelons: The Organization as a Reflection of Its Top Managers. *Acad Manag Rev.* 1984; 9(2):193–206.
35. Carpenter MA, Geletkancz MA, Sanders WG. Upper Echelons Research Revisited: Antecedents, Elements and Consequences of Top Management Team Composition. *J Manage.* 2004; 30(6):749–78.
36. Nielsen S. Why do top management teams look the way they do? A multilevel exploration of the antecedents of TMT heterogeneity. *Strateg Organ.* 2009; 7(3):277–305.
37. van der Walt N, Ingley C. Board Dynamics and the Influence of Professional Background, Gender and Ethnic Diversity of Directors. *Corp Gov An Int Rev [Internet].* 2003; 11(3):218–34. Available from: <https://alpha2.latrobe.edu.au/validate?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=10472839&site=ehost-live&scope=site>
38. Cook A, Glass C. Do minority leaders affect corporate practice? Analyzing the effect of leadership composition on governance and product development. *Strateg Organ.* 2015; 13(2):117–40.
39. Elenkov DS, Manev IM. Top Management Leadership and Influence on Innovation: The Role of Socio-cultural Context. *J Manage [Internet].* 2005; 31(3):381–402. Available from: <http://jom.sagepub.com/cgi/doi/10.1177/0149206304272151>
40. Zuraik A, Kelly L. The role of CEO transformational leadership and innovation climate in exploration and exploitation. *Eur J Innov Manag.* 2019; 22(1):84–104.
41. Bass BM. From Transactional to Transformational Leadership: Learning to Share the Vision. *Organ Dyn.* 1990; 18(3):19–31.
42. Jung DI, Chow C, Wu A. The role of transformational leadership in enhancing organizational innovation: Hypotheses and some preliminary findings. *Leadersh Q.* 2003; 14(4–5):525–44.
43. Gumusluoglu L, Ilsev A. Transformational leadership, creativity, and organizational innovation. *J Bus Res [Internet].* 2009; 62(4):461–73. Available from: <http://dx.doi.org/10.1016/j.jbusres.2007.07.032>
44. Jung D (Don), Wu A, Chow CW. Towards understanding the direct and indirect effects of CEOs' transformational leadership on firm innovation. *Leadersh Q.* 2008; 19(5):582–94.
45. Eagly AH, Carli LL. The female leadership advantage: An evaluation of the evidence. *Leadersh Q.* 2003; 14(6):807–34.
46. Ruiz-Jiménez JM, del Mar Fuentes-Fuentes M. Management capabilities, innovation, and gender diversity in the top management team: An empirical analysis in technology-based SMEs. *BRQ Bus Res Q [Internet].* 2015; 19(2):107–21. Available from: <http://www.sciencedirect.com/science/article/pii/S2340943615000857>
47. Singhathep T, Pholphirul P. Female CEOs, Firm Performance, and Firm Development : Evidence from Thai Manufacturers. *Gend Technol Dev.* 2015; 19(3):320–45.
48. Wolfram H-J, Mohr G, Schyns B. Professional respect for female and male leaders: influential gender-relevant factors. *Women Manag Rev [Internet].* 2007; 22(1):19–32. Available from: <http://www.emeraldinsight.com/journals.htm?issn=0964-9425&volume=22&issue=1&articleid=1589180&show=html>
49. Graen GB, Uhl-Bien M. Relationship-based approach to leadership: Development of Leader-Member Exchange (LMX) Theory of Leadership over 25 years: Applying a Multi-Level Multi-Domain Perspective. *Leadersh Q.* 1995; 6(2):219–47.
50. Basu R, Green SG. Leader-Member Exchange and Transformational Leadership: An Empirical Examination of Innovative Behaviors in Leader -Member Dyads. *J Appl Soc Psychol.* 1997; 27(6):477–99.
51. Lyngsie J, Joss NJ. The more, the merrier? Women in top-management teams and entrepreneurship in established firms. *Strateg Manag J.* 2017; 38:487–505.
52. Leonard D, Sensiper S. The Role of Tacit Knowledge in Group Innovation. *Calif Manage Rev [Internet].* 1998; 40(3):112–32. Available from: <http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=738860&site=ehost-live>
53. Ipe M. Knowledge Sharing in Organizations: A Conceptual Framework. *Hum Resour Dev Rev.* 2003; 2(4):337–59.
54. Fernandes J. The impact of gender diversity in foreign subsidiaries' innovation outputs. *Int J Gend Entrep.* 2015; 7(2):148–62.
55. van Staveren I. To Measure is to Know? A Comparative Analysis of Gender Indices. *Rev Soc Econ.* 2013; 71(3):339–72.
56. Casper WJ, Harris C, Taylor-Bianco A, Wayne JH. Work-family conflict, perceived supervisor support and organizational commitment among Brazilian professionals. *J Vocat Behav [Internet].* 2011; 79(3):640–52. Available from: <http://dx.doi.org/10.1016/j.jvb.2011.04.011>
57. Kharistvalashvili N. Women's Role in Developing Economies: Case of Georgia. *Eur J Sustain Dev.* 2016; 5(1):47–52.

58. Klapper LF, Parker SC. Gender and the Business Environment for New Firm Creation. *World Bank Res Obs*. 2011; 26(2):237–57.
59. Bandiera O, Natraj A. Does Gender Inequality Hinder Development and Economic Growth? Evidence and Policy Implications. *World Bank Res Obs*. 2013; 28(1):2–21.
60. Salomon RM, York N. Spillovers to foreign market participants : assessing the impact of export strategies on innovative. 2006; 4(2):135–64.
61. Parrotta P, Pozzoli D, Pytlíková M. The nexus between labor diversity and firm's innovation. *J Popul Econ*. 2014; 27(2):303–64.
62. Quintana-García C, Benavides-Velasco CA. Innovative competence, exploration and exploitation: The influence of technological diversification. *Res Policy*. 2008; 37(3):492–507.
63. Cervantes-Godoy D, Dewbre J. Economic Importance of Agriculture for Poverty Reduction [Internet]. OECD Food, Agriculture and Fisheries Working Papers. 2010. <http://www.oecd.org/dataoecd/49/19/46341298.pdf>
64. The World Bank. Foreign Direct Investment (FDI) [Internet]. <https://datahelpdesk.worldbank.org/knowledgebase/articles/114954-what-is-the-difference-between-foreign-direct-inve>
65. The World Bank. Rural Population [Internet]. 2019. <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS>
66. Damanpour F, Schneider M. Phases of the adoption of innovation in organizations: Effects of environment, organization and top managers. *Br J Manag*. 2006; 17(3):215–36.
67. Huang FL. Alternatives to Multilevel Modeling for the Analysis of Clustered Data. *J Exp Educ*. 2016; 84(1):175–96.
68. Raudenbusch SW, Bryk AS. *Hierarchical Linear Models: Applications and Data Analysis Methods*. 2nd ed. Thousand Oaks, CA: SAGE Publications; 2002. 1–485 p.
69. Afshartous D, Preston RA. Key Results of Interaction Models With Centering. *J Stat Educ*. 2011; 19(3):1–24.
70. Field A. *Discovering Statistics Using SPSS*. London, Thousand Oaks, New Delhi: SAGE Publications; 2005.
71. Hoetker G. The Use of Logit and Probit Models in Strategic Management Research: Critical Issues. *Strateg Manag J*. 2007; 28:331–43.
72. Bascle G. Controlling for endogeneity with instrumental variables in strategic management research. *Strateg Organ*. 2008; 6:285–327.
73. Roper S, Vahter P, Love JH. Externalities of openness in innovation. *Res Policy*. 2013; 42(9):1544–54.
74. Guo S, Fraser MW. *Propensity Score Analysis: Statistical Methods and Applications*. Thousand Oaks, CA: Sage; 2015.
75. Caliendo M, Kopeinig S. Some Practical Guidance for the Implementation of Propensity Score Matching. *J Econ Surv*. 2008; 22(1):31–72.
76. Zhang YA, Qu H. The Impact of CEO Succession With Gender Change on Firm Performance and Successor Early Departure: Evidence From China's Publicly Listed Companies in 1997–2010. *Acad Manag J* [Internet]. 2016; 59(5):1845–68. <http://amj.aom.org/cgi/doi/10.5465/amj.2014.0176>
77. Reinwald M, Huettermann H, Bruch H. More Than the Average: Examining Variability in Employee Perceptions of Diversity Climate. In: *Academy of Management Proceedings*. 2018.
78. Dwyer S, Richard OC, Chadwick K. Gender diversity in management and firm performance: The influence of growth orientation and organizational culture. *J Bus Res*. 2003; 56(12):1009–19.
79. Wang M, Kelan E. The Gender Quota and Female Leadership: Effects of the Norwegian Gender Quota on Board Chairs and CEOs. *J Bus Ethics*. 2013; 117(3):449–66.
80. Buvinic Mayra, Furst-Nichols R. Promoting Women's Economic Empowerment: What Works? *World Bank Res Obs*. 2016; 31(1):59–101.
81. Ladegård G. Legitimacy, inclusion and influence: investigating women directors' board experiences. In: Machold S, Huse M, Hansen K, Brogi M, editors. *Getting Women on to Corporate Boards: A Snowball Starting in Norway*. Cheltenham, UK: Edward Elgar; 2013. p. 147–54.