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# The XX factor: Female managers and innovation in a cross-country setting

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ABSTRACT

Our understanding of the link between women managers and firm-level innovation remains incomplete. Building on recent research on gender and leadership styles, we argue that there is a positive association between women managers and firm innovation. We highlight the selection process of women managers as an important underlying mechanism and discuss institutional and environmental contingencies as factors that influence this association. Specifically, we theorize and garner empirical support for the idea that in countries with legislation that promotes legally-mandated gender quotas, underqualified women may be selected for management positions, whereas in countries with voluntary gender quotas (or quotas are entirely absent), women are predominantly selected on the basis of their qualifications. The association between women and innovation is strengthened (weakened) in the latter (former) case. We also argue that this positive relationship is stronger under conditions of environmental complexity, which typically characterize innovation activities. These predictions are supported on the basis of data from the Management, Organization and Innovation (MOI) survey which covers manufacturing firms in twelve countries.

## Introduction

This decade marks the first time that women outnumber men in the US workforce (The New York Times, 2010). A mere generation ago, women were largely confined to menial jobs (Fraumeni & Christian, 2019); now, they earn more than 60% of university degrees across the US and Europe (The Economist, 2009) and head several S&P 500 companies, including General Motors, Oracle, IBM, HP and Pepsi. The increased female representation in management is of particular interest as top and middle managers control disproportionally more resources than other employees and can thus decisively influence firm-level outcomes (Bertrand & Schoar, 2003; Bloom, Sadun, & van Reenen, 2012; Finkelstein, Hambrick, & Cannella, 2009; Rosen, 1981).

Strategic leadership scholars have made significant strides in understanding the impact of women managers on corporate outcomes (Eagly & Heilman, 2016).[1] However, *innovation*—an important intermediate firm outcome and one of the main drivers of economic growth (Hasan & Tucci, 2010)—has only been examined in a handful of studies, all conducted within single-nation settings (i.e., Chen, Leung, & Evans, 2015; Deszö & Ross, 2012; Lyngsie & Foss, 2017; Quintana-García & Benavides-Velasco, 2016; Talke, Salomo, & Rost, 2010). These studies typically find a positive relationship, suggesting that there are distinct advantages to female leadership in the context of innovation. Specifically, research suggests that women tend to be associated with leadership styles that are inclusive, communicative, and aimed at knowledge sharing (e.g., Eagly & Carli, 2003; Eagly & Johnson, 1990)—all of which positively impact innovation (Deszö & Ross, 2012; Lyngsie & Foss, 2017). While the nascent literature generally finds a positive association between women managers and innovation, the nature of the association differs across studies: for instance, some studies point to critical mass effects (e.g., Lyngsie & Foss, 2017), while others do not (e.g., Deszö & Ross, 2012;). As the relevant behaviors are often unobserved, it is difficult to pinpoint which mechanisms are at work. Moreover, relevant contingencies have not been investigated. For example, complexity is a particularly important contingency because of its central and challenging role in an innovation context (Afuah & Tucci, 2012; Damanpour, 1996; Reus, Ranft, Lamont, & Adams, 2009). Decision making and problem solving under complexity often require perspective-taking,

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[1] For boards of directors, see, for example, Adams (2016), Adams and Ferreira (2009), Adams and Funk (2012), Chen, Crossland, and Huang (2016), Chizema, Kamuriwo, and Shinozawa (2015), Cumming, Leung, and Rui (2015), Knippen, Shen, and Zhu (2019) and Muller-Kahle and Schiehll (2013). For family firms, see, for example, Amore, Garofalo, and Minichilli (2014); for mandated quotas, see, for example, Matsa and Miller (2013), and for acquisition decisions, see, for example, Huang and Kisgen (2013).

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the ability to handle conflicting standpoints and criteria, and juggling different kinds of information (Sargut & McGrath, 2011). Part of the advantage to female leadership and management may be women's superior perspective-taking capability (Batson, Early, & Salvarani, 1997; Gasser & Keller, 2009) which plays an important role in complex conditions.

In this work, we delve into the still ill-understood mechanisms underlying the association between women managers and innovation. Specifically, we highlight the importance of considering the selection of qualified women for leadership positions, and how this may influence the relationship between women and innovation, including the ability of women managers to deal with complexity in an innovation context. By analyzing cross-country data from the Management, Organization and Innovation (MOI) survey (see, e.g., Bloom, Schweiger, & van Reenen, 2011), we find that having at least one woman on the management team is positively associated with the likelihood of the firm introducing a new product or service (+10.14%). Adopting a reverse causal approach (see Gelman & Imbens, 2013), we demonstrate that a plausible explanation for our findings is the selection process of women managers. Policies and institutions that seek to either directly regulate gender composition (such as those that concern boards of directors) or increase female representation in the economy may influence the proportion of women in managerial positions (Terjesen, Sealy, & Singh, 2009). However, their effect on innovation is hard to discern *a priori*. On the one hand, politically determined quotas may contribute to bringing overlooked female talent into management, which may result in more innovation. On the other hand, a shortage of *qualified* women managers in the labor market (Bertrand, Goldin, & Katz, 2010; Guiso & Rustichini, 2018) coupled with pressure to employ more women in management may lead to negative consequences for firm outcomes (Ahern & Dittmar, 2012; Kirsch, 2018). If, however, quotas are voluntary (e.g., recommendations or non-mandatory guidelines for female representation), the selection of women derives more from a nudge or a suggestion rather than from something forced, resulting in the selection of qualified female managers (Schmid & Urban, 2017). We also expect the latter kind of selection to take place in the absence of quotas.

Exploiting cross-country variation in both the presence and type of quotas, our results reveal the importance of a selection effect, tested as a mechanism through a moderator logic. We show that the relationship between female managers and the likelihood of launching new products or services is stronger (weaker) when voluntary (legally mandated) or no quotas are in place. The negative selection effect of legally-mandated quotas is more pronounced with higher quota levels. Finally, we find that complexity positively moderates the relationship between women managers and innovation, such that women (XX) may be the X factor when it comes to firm innovations in complex situations.

In sum, we build on earlier research which examines the relationship between women and innovation (i.e., Chen, Leung, & Evans, 2015; Deszö & Ross, 2012; Lyngsie & Foss, 2017; Quintana-García & Benavides-Velasco, 2016; Talke et al., 2010) and extend it by considering the selection of female managers as a mechanism underlying the association between women and innovation, by examining this mechanism in a cross-country setting, and by accounting for the environmental complexity that is inherent to innovation.

## Theory and hypotheses

### *The role of managers for innovation*

Research has shown that top and middle managers (henceforth, we use "managers" to refer to both) influence innovation processes both directly and indirectly (Finkelstein et al., 2009; Hughes, Lee, Tian, Newman, & Legood, 2018; Li, Maggitti, Smith, Tesluk, & Katila, 2013; Lyngsie & Foss, 2017). Managers may directly identify new innovative opportunities (e.g., new basic product functionalities, innovative organizational designs or management practices) and/or indirectly influence innovation processes by calling for new solutions, defining and monitoring R&D budgets, forming groups, teams and departments that are dedicated to developing R&D projects, and evaluating innovative outcomes (Barney, Foss, & Lyngsie, 2018). Additionally, managers play a critical role in shaping the firm's informal structure in ways that inspire and support innovative activities among lower-level organizational members (Hornsby, Kuratko, Shepherd, & Bott, 2009; Hornsby, Kuratko, & Zahra, 2002; Makri & Scandura, 2010). The gender of managers matters for innovation, first, because diversity may drive innovation outcomes, and, second, because women and men differ in their leadership styles, and leadership styles may have different implications for how innovation is framed and managed.

### *Gender and innovation*

*The diversity argument.* Female participation on management teams may indirectly affect innovation because increased female participation may lead to increased cognitive diversity which leads to improved problem-recognition and problem-solving capabilities (cf., e.g., Harrison & Klein, 2007; Harrison, Price, Gavin, & Florey, 2002; van Dijk, Meyer, van Engen, & Loyd, 2017; but see van Knippenberg, Dreu, & Homan, 2004, for an exploration of the conditions under which diversity may have negative consequences). As shown by Keck and Tang (2017), even a small proportion of women in groups improves the quality and the calibration of confidence judgments (see also Apesteguia, Azmat, & Iriberri, 2012; Hoogendoorn, Oosterbeek, & van Praag, 2013; Pelled, Eisenhardt, & Xin, 1999). These changes in group decision-making may translate into improved capabilities for recognizing and exploiting innovation.

*The female leadership argument.* Research suggests that leadership styles affect innovation (Makri & Scandura, 2010; Rosing, Frese, & Bosch, 2011). Female representation on management teams may influence innovation because leadership styles that are more prevalent among woman managers positively influence innovation. Leadership styles are often conceptualized along a continuum where the extremes are (i) a nurturing, considerate, and people-oriented style and (ii) a task-oriented style emphasizing structure, instructions, performance and achievement (Engen, Leeden, & Willemsen, 2001). Along that continuum, women managers typically have a less hierarchical, more inclusive and participatory leadership style (Eagly & Carli, 2003; Eagly & Johnson, 1990; Fitzsimmons & Callan, 2016). Consistent with that, women managers tend to be more cooperative than their male counterparts (e.g., Book, 2000; Helgesen, 1990). As such, they are likely to encourage participation and interaction, solicit inputs, and keep communication channels open, while their male peers tend to emphasize goal-setting (Dezsö & Ross, 2012). These behaviors facilitate innovation by supporting a diversity of perspectives and building trust that fosters the exchange of knowledge, ideas and information (Lyngsie & Foss, 2017). Existing research suggests that firms with speak-up cultures are substantially more innovative than their competitors (Hewlitt, Marshall, & Sherbin, 2013).

Female and male managers also differ in their ability to balance the requirements of different tasks and perform multiple roles (Eagly & Karau, 2002). Role congruency theorists suggest that the multiple roles played by women in their work and private lives improve their ability to multitask, ultimately enhancing their effectiveness with managerial tasks. Similarly, women's ability to commit to multiple roles is positively associated with interpersonal and task-related managerial skills (Ruderman, Ohlott, Panzer, & King, 2002). These effects go hand-in-hand with increased social support and learning opportunities, which in turn facilitate innovation processes by limiting conflicts and divergent views.

The very nature of innovation may give women an advantage. Since innovation often involves breaking away from the tried-and-true and venturing into the unknown (Pérez-Luño, Medina, Lavado, & Rodríguez, 2011), innovation may be supported by learning-oriented networking strategies (Krishnan & Park, 2005) and heterogeneous network ties, both of which are more common among women (Ibarra, 1993).[2] After all, women actively engage in organizational activities and alliances to compensate for their still limited access to power (Kanter, 1977). In a management context, this may enable women managers to draw on and infer from a large collection of experiences and resources, including navigating informal organizational structures and processes which can help women managers circumvent bureaucratic obstacles to innovation.

Finally, and somewhat counter-intuitively, a female leadership advantage may also manifest because of selection processes driven by an anti-women bias. The standards for women to be selected as leaders might be higher than those for men. As a result, if women are selected for management positions, they have to be particularly qualified, and possibly overqualified compared to their male counterparts (Eagly & Antonakis, 2015).[3]

Based on the above research, we posit the following baseline hypothesis:

H1: *The presence of women on management teams is positively associated with innovation.*

### *Selection effects*

The strength of the association posited in H1 may depend on the process through which women are selected for managerial positions. This selection process may differ depending on a country's institutional environment and government policies. While governments do not *directly* mandate quotas for women in firms' management, governments can nudge to increase female representation in firms' management or signal its desirability in many ways. For example, governments may require that firms report on female representation (e.g., in annual reports). Alternatively, an influence may be exerted through the practices of government organizations or representative institutions. Many countries establish quotas to ensure that women are represented in leadership positions in parliaments (O'Brien & Rickne, 2016) or in company boards (Hughes, Paxton, & Krook, 2017)[4] among others.

Legally-mandated quotas in politics (e.g., representation in parliament) may be established to enhance gender equality in the public, political domain as well as to send a signal to the private sector that gender equality should be the prevailing norm. In other words, politically-determined quotas may represent an attempt to redefine prevailing norms and beliefs concerning gender representation beyond the narrow political sphere, thereby legitimizing gender equality in the eyes of firms' stakeholders. In this way, the adoption of political quotas influences the business environment through institutionalizing pro-women policies (Pande & Ford, 2011; Terjesen, Aguilera, & Lorenz, 2015), increasing female representation in management and reducing discrimination against women.[5] To the extent that companies seek institutional legitimacy, their behavior will reflect attempts to increase gender parity. Indeed, research shows that the presence and influence of women in management are more likely in countries where female representation in parliament has reached a certain threshold through political quotas (Engelstad & Teigen, 2012; Fagan, González Menéndez, & Gómez Anson, 2012; Sojo, Wood, Wood, & Wheeler, 2016). The stronger the signal (e.g., quotas in parliament are mandatory rather than voluntary), the more compelled firms will feel to follow suit, and hence the more their hiring behavior may be characterized as being "forced," even if no legislation or political decision has *directly* prompted it.

These interventions may have significant influence over the selection process of women for managerial positions. The selection process is highly dependent on local conditions in managerial labor markets. For example, with a small pool of potential female managers (i.e., a shortage of qualified female managers), there is a risk that underqualified women may become managers under conditions of forced selection, that is, where governments push strongly for higher female representation (Dubbink, 2005; Gopalan & Watson, 2015; Szydlo, 2015).

In the case of board quotas, the increased entry of women on boards has been found to negatively influence short-run profits (Matsa & Miller, 2013), which may be partly explained by the selection process in a context where there are too few qualified women (Bertrand et al., 2010; Pande & Ford, 2011; Guiso & Rustichini, 2018),[6] and partly by negative perceptions about women. Regarding negative perceptions, intergroup relations scholars (e.g., McDonald, Keeves, & Westphal, 2017) argue that the appointment of a woman to the management team reduces the level of organizational identification by male managers. This behavioral response is based on biased perceptions of women (Brescoll, 2016; Hoyt & Murphy, 2016) and may translate into reduced help and cooperation between the newly appointed woman manager and the other male managers.

Under conditions where selection is forced, "femininity is seen as a comparative advantage" (Adams & Funk, 2012: 220), because there may be not enough qualified women to fulfill externally-imposed requirements. Under these circumstances, women that make it to the top face additional scrutiny from their peers, which may limit their ability to exert their leadership style. In addition to a shortage of qualified women, these new "forced-selection" managers also face suspicion from male peers and qualified women who have already made it to the top (Eagly & Carli, 2004).[7] As such, mandated quotas may result in a biased (negative) perception of women managers is likely to be reinforced (Heilman & Block, 1992).

In contrast, when female representation in management is not forced (i.e., quotas are either voluntary or absent), the selection process is more likely to be based on ability. This generates two effects. First, these qualified women managers will be able to effectively leverage their leadership style with positive implications for innovation. This is consistent with the beyond-the-glass-ceiling research which shows that the presence of women in male-dominated environments may incentivize more talented women to play and stand out in the "boys game" (Adams & Funk, 2012; Agarwal, Qian, Reeb, & Sing, 2016; Hoisl & Mariani, 2016).[8] Similarly, capital markets respond more negatively to exogenous departures of women in countries where the selection of women is more rigorous (Brinkhuis & Scholtens, 2018;

[2] As shown by Palmer and Barber (2001), this latter effect is stronger for well-networked managers who are relatively marginal with respect to social status, as women managers are in many organizations (Vial, Napier, & Brescoll, 2016).

[3] As argued by Antonakis et al. (2010: 1110): "[B]ecause of social prejudice mechanisms, stereotype threat, and self-limiting behavior, females may be less likely to be appointed to leader roles as a function of the gender typing of the context."

[4] Terjesen et al. (2015) stress the crucial role of political institutions in driving female representation on boards of directors through mimetic isomorphism.

[5] Specifically, Pande and Ford (2011: 6) argue that "[r]ather than originating from firms […] the move toward corporate quotas has been external, largely based on a realization in the public sector that political quotas have been successful in increasing female leadership."

[6] Ahern and Dittmar (2012) examine the effect of the 2003 Norwegian Law which required that forty percent of firms' directors must be women. They find that this political mandate explained large drops in stock price and Tobin's Q. One likely explanation for this effect is that legally-mandated quotas led to a negative selection of women in boards because of the limited supply of qualified women.

[7] Current women managers may even prevent other women from being appointed as managers (Derks, Van Laar, & Ellemers, 2016; Dezsö, Ross, & Uribe, 2016). Arvate, Galilea, and Todescat (2018) suggest that this does not seem to be the case in public organizations, where female leadership is associated to benevolent behaviors toward female subordinates. However, the authors find that the benevolent manner does not hold in private organizations.

[8] Siegel, Pyun, and Cheon (2018) find that women executives tend to thrive in environments that are hostile and discriminate against women (specifically, South Korean multinational firms).

**Table 1**
Descriptive statistics and pairwise correlations.

| Variable | Mean | S.D. | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) New product | 0.66 | 0.47 | 1 | | | | | | | | | | | | | | | | |
| (2) Female manager | 0.84 | 0.37 | 0.15* | 1 | | | | | | | | | | | | | | | |
| (3) Female manager % | 0.37 | 0.28 | 0.03 | 0.58* | 1 | | | | | | | | | | | | | | |
| (4) Female employee % | 0.38 | 0.28 | 0.04 | 0.34* | 0.58* | 1 | | | | | | | | | | | | | |
| (5) Firm age | 3.22 | 0.90 | 0.10* | −0.01 | −0.14* | −0.12* | 1 | | | | | | | | | | | | |
| (6) Firm size | 5.06 | 0.92 | 0.16* | 0.14* | −0.06 | −0.02 | 0.28* | 1 | | | | | | | | | | | |
| (7) Inclusive culture | 0.78 | 0.42 | 0.02 | −0.03 | −0.00 | −0.02 | −0.11* | 0.01 | 1 | | | | | | | | | | |
| (8) Organizational change | 0.14 | 0.34 | 0.11* | 0.06 | 0.00 | −0.02 | 0.09* | 0.04 | −0.06 | 1 | | | | | | | | | |
| (9) Organizational hierarchy | 3.15 | 1.43 | 0.02 | −0.09* | −0.12* | −0.19* | 0.09* | 0.29* | 0.06 | 0.07* | 1 | | | | | | | | |
| (10) Employment dismiss | 0.63 | 0.48 | 0.01 | −0.01 | 0.02 | 0.03 | −0.11* | −0.01 | 0.12* | −0.01 | −0.02 | 1 | | | | | | | |
| (11) Outsourcing | 0.31 | 0.46 | 0.14* | −0.02 | −0.09* | −0.03 | 0.02 | 0.10* | 0.02 | 0.05 | 0.01 | −0.01 | 1 | | | | | | |
| (12) Founder manager | 0.39 | 0.49 | −0.06 | −0.01* | 0.01 | −0.02 | −0.38* | −0.20* | 0.08* | −0.05 | 0.04 | 0.07* | −0.04 | 1 | | | | | |
| (13) Generic experience | 3.91 | 0.20 | −0.01 | −0.13* | −0.13* | −0.15* | 0.20* | 0.05 | −0.03 | 0.00 | 0.12* | −0.06 | −0.03 | 0.12* | 1 | | | | |
| (14) Specific experience | 2.69 | 0.75 | 0.01 | −0.15* | −0.14* | −0.14* | 0.10* | 0.03 | 0.02 | −0.04 | 0.09* | 0.00 | −0.01 | 0.19* | 0.49* | 1 | | | |
| (15) External consultant | 0.37 | 0.48 | 0.18* | −0.04 | −0.15* | −0.11* | 0.15* | 0.20* | −0.02 | 0.07* | 0.10* | 0.04 | 0.20* | −0.04 | −0.01 | 0.05 | 1 | | |
| (16) Group | 0.28 | 0.45 | 0.00 | −0.27* | −0.27* | −0.26* | 0.03 | 0.12* | −0.01 | −0.02 | 0.25* | −0.01 | −0.01 | −0.01 | 0.13* | 0.10* | 0.11* | 1 | |
| (17) International competition | 0.25 | 0.43 | 0.03 | −0.01 | −0.02 | 0.12* | 0.01 | 0.12* | −0.02 | 0.02 | −0.02 | 0.07* | 0.15* | −0.00 | −0.00 | 0.05 | 0.07* | 0.03 | 1 |
| (18) Female manager*Voluntary gender quotas | 0.22 | 0.41 | 0.13* | 0.23* | 0.02 | 0.04 | 0.07* | 0.00 | −0.09* | 0.04 | −0.03 | 0.02 | 0.17* | −0.04 | −0.01 | 0.07* | 0.14* | −0.02 | 0.22* |
| (19) Female manager %*Voluntary gender quotas | 0.08 | 0.20 | 0.04 | 0.18* | 0.29* | 0.19* | −0.09* | −0.10* | −0.03 | 0.00 | −0.03 | 0.03 | 0.12* | 0.05 | −0.04 | 0.02 | 0.02 | −0.08* | 0.21* |
| (20) Female manager*Legal gender quota | 3.30 | 9.62 | −0.09* | 0.15* | 0.02 | −0.13* | −0.02 | −0.03 | 0.07* | −0.01 | 0.11* | −0.01 | −0.13* | 0.06 | 0.07* | 0.04 | −0.02 | 0.06 | −0.08* |
| (21) Female manager %*Legal gender quota | 1.27 | 4.30 | −0.07* | 0.13* | 0.16* | −0.04 | −0.03 | −0.07* | 0.07* | −0.00 | 0.03 | −0.01 | −0.13* | 0.02 | 0.03 | 0.01 | −0.05 | 0.01 | −0.09* |
| (22) Overall complexity | 0.70 | 0.78 | 0.16* | 0.01 | −0.07* | 0.04 | 0.07* | 0.14* | −0.03 | 0.48* | 0.02 | 0.03 | 0.70* | −0.05 | −0.02 | 0.02 | 0.19* | −0.00 | 0.66* |
| (23) Female manager*Overall complexity | 0.58 | 0.76 | 0.16* | 0.34* | 0.13* | 0.13* | 0.05 | 0.17* | −0.04 | 0.46* | 0.00 | 0.02 | 0.59* | −0.06 | −0.05 | −0.02 | 0.16* | −0.07* | 0.56* |
| (24) Female manager*Overall complexity | 0.24 | 0.39 | 0.05 | 0.27* | 0.45* | 0.33* | −0.07* | 0.03 | −0.00 | 0.34* | −0.06 | 0.04 | 0.44* | 0.04 | −0.06 | −0.03 | 0.06 | −0.12* | 0.45* |

| Variable | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
|---|---|---|---|---|---|---|---|
| (18) Female manager*Voluntary gender quotas | 1 | | | | | | |
| (19) Female manager %*Voluntary gender quotas | 0.78* | 1 | | | | | |
| (20) Female manager*Legal gender quota | −0.18* | −0.14* | 1 | | | | |
| (21) Female manager %*Legal gender quota | −0.16* | −0.12* | 0.85* | 1 | | | |
| (22) Overall complexity | 0.24* | 0.18* | −0.13* | −0.13* | 1 | | |
| (23) Female manager*Overall complexity | 0.32* | 0.25* | −0.08* | −0.09* | 0.86* | 1 | |
| (24) Female manager*Overall complexity | 0.19* | 0.36* | −0.09* | −0.06 | 0.66* | 0.77* | 1 |

*$p < 0.01$.

Schmid & Urban, 2017). Second, a non-forced selection process reduces or eliminates the negative perceptions faced by women. Indeed, peers "trust" the efficiency of this selection process since, on average, women in managerial positions are expected to be appointed because they are qualified.

Based on the above reasoning, we posit that:

H2: *The positive association of women managers and innovation is weakened (strengthened) in institutional environments where selection of women managers is (not) forced.*

### *The role of complexity*

It is not just the institutional environment that may influence the association between female managers and innovation, but also the more proximal business context. A long tradition in behavioral theory argues that complexity is likely to influence decision outcomes (e.g., March & Simon, 1958; Simon, 1959, 1973). Complexity is of particular interest in an innovation context because innovation decisions (as compared to routine decisions) are likely to be characterized by complexity; moreover, there may be gender differences when coping with complexity.

The concept of complexity is based on complex systems theory, where the most relevant distinction is the number of interacting parts and the nature of their interdependencies (Kauffman, 1993; Simon, 1973). In organizations, complexity often refers to dimensions, such as the number of activities, hierarchical levels, and geographic locations (Daft, 1992) and increases with the number of these dimensions and their relations (Levinthal, 1997). Innovations are typically characterized as complex, because they tend to involve many (possibly moving) parts that interact in non-simple ways and require the input from multiple sources across organizational and geographical firm boundaries (Crossan & Apaydin, 2010; Damanpour, 1991; Galunic & Rodan, 1998; Scalera, Perri, & Hannigan, 2018).

Complexity tends to push the bounds of the decision makers' rationality (Simon, 1959) because it tends to involve changes in many variables that may be related in multiple ways. In these situations, perspective-taking, multitasking, and networking abilities, typically associated with female managers (Kanter, 1977), may be critically important. Indeed, the relationship between the female leadership style and innovation may be enhanced when the environment is complex. First, women's superior multi-tasking capabilities (Offer & Schneider, 2011) may give them an advantage when dealing with complexity. Second, information and communication tend to be fast-paced in complex environments, as decision makers are exposed to multiple and changing stimuli that require timely responses (Hogarth & Makridakis, 1981). Female leaders may have an advantage with respect to creating favorable conditions for the development of interpersonal relations among employees and promote cross-fertilization of ideas through more frequent interaction between managers and subordinates and less formal communication channels (Eagly & Carli, 2003; Melero, 2011). Third, teams with at least one woman are better at calibrating their confidence judgments than all-male teams, enhancing the quality of judgments (Keck & Tang, 2017). This is particularly important with complexity as decision-makers tend to rely on subjective criteria and calibration of confidence judgments is fundamental to the quality of the decision. Thus, we posit the following:

H3: *The positive association of women managers and innovation is strengthened in more complex environments.*

**Table 2**
Distribution of women managers across countries and industries.

| Country | Average % female managers |
|---|---|
| Belarus | 49.37 |
| Bulgaria | 50.36 |
| Germany | 15.68 |
| India | 10.54 |
| Kazakhstan | 53.62 |
| Lithuania | 42.45 |
| Poland | 31.96 |
| Romania | 45.30 |
| Russia | 41.94 |
| Serbia | 36.98 |
| Ukraine | 48.52 |
| Uzbekistan | 39.25 |
| **Industry** | **Average % female managers** |
| Basic metals | 28.93 |
| Chemicals | 25.33 |
| Electronics | 30.73 |
| Fabricate metal products | 32.37 |
| Food | 45.68 |
| Garments | 62.80 |
| Machinery and equipment | 28.94 |
| Nonmetallic mineral products | 30.92 |
| Other manufacturing plants | 33.54 |
| Plastics and rubber | 36.88 |
| Textiles | 37.73 |

## Data and measures

### *Data*

To test our hypotheses, we use cross-sectional data from the Management, Organization and Innovation (MOI) survey developed and implemented by the World Bank and the European Bank for Reconstruction and Development (EBRD) based on the method guidelines offered by Bloom and Van Reenen (e.g., 2007). The survey was conducted between October 2008 and November 2009, and provides data for 1,777 manufacturing firms that range in size from 50 to 5,000 employees. Survey respondents were factory, production or operations managers, who were either involved in the daily operations of the establishment or were sufficiently senior to have an overview of the firm's internal practices. The surveys were implemented through face-to-face interviews (rather than by mail) that were conducted by market research companies in the respondent's native language. Standardized uniform sampling methods were used to ensure that measurement errors were minimized, information was comparable across countries, and the sample represented the distribution of the population. These methods controlled for respondents' systematic refusal to join the survey, and typical attrition problems in establishment-level surveys (e.g. stratum-level questions with missing answers). The sampling strategy was based on Bureau Van Dijk's Orbis database. All regions within a country were included, and the proportion of the sample in each region must be equal to (at least) 50% of the sample frame population in the focal region. The surveyed countries include ten transition economies (Belarus, Bulgaria, Kazakhstan, Lithuania, Poland, Romania, Russia, Serbia, Ukraine and Uzbekistan), an emerging country (India) and a Western economy (Germany). Firms may be independent or (partially or wholly) owned by other organizations, and belong to the following eleven industries: food, textiles, garments, chemicals, plastics and rubber, nonmetallic mineral products, basic metals, fabricate metal products, machinery and equipment, electronics, and other manufacturing plants.[9]

### *Measures*

***Dependent variable.*** Innovations are typically measured as new products and/or services (e.g., Lyngsie & Foss, 2017). Similarly, we

[9] The baseline industry "other manufacturing plants" includes several ISIC codes of the main output of the establishment as answered by the respondent. The vast majority of plants are in the ISIC codes 3610, 2212, 3430, 2211, 2221, 1920, 2520, 3311, 2102, 2899, 2109, 3312 (for a description of ISIC codes please see: https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf). For more details see: http://www.ebrd.com/what-we-do/economic-research-and-data/data/moi.html.

**Table 3**
Econometric results.

| | (1) New product Probit | (2) New product Two-way clustering Probit | (3) New product Two-way clustering 2SLS (second stage) | (4) Female manager Two-way clustering 2SLS (first stage) | (5) Female manager % Two-way clustering 2SLS (first stage) | (6) New product Two-way clustering Lewbel's estimator (second stage) | (7) New product Two-way clustering Lewbel's estimator with instruments (second stage) |
|---|---|---|---|---|---|---|---|
| Female manager | 0.3372* | 0.3372* | 0.8399** | | | 0.1736* | 0.1739* |
| | (0.1594) | (0.1361) | (0.2656) | | | (0.0814) | (0.0789) |
| Female manager % | −0.1867 | −0.1867 | −1.7098** | | | −0.1036 | −0.1310 |
| | (0.1832) | (0.2297) | (0.5280) | | | (0.1574) | (0.1583) |
| Female employee % | 0.5887* | 0.5887* | 0.8232** | 0.4127*** | 0.5031*** | 0.3135** | 0.3281** |
| | (0.2902) | (0.2539) | (0.2497) | (0.0511) | (0.0387) | (0.0994) | (0.0966) |
| Firm age | 0.0778 | 0.0778 | 0.0099 | −0.0221 | −0.0091 | 0.0256 | 0.0251 |
| | (0.0544) | (0.0588) | (0.0222) | (0.0137) | (0.0080) | (0.0216) | (0.0215) |
| Firm size | 0.0353 | 0.0353 | −0.0418 | 0.0841*** | −0.0062 | 0.0191 | 0.0191 |
| | (0.0470) | (0.0613) | (0.0301) | (0.0192) | (0.0093) | (0.0165) | (0.0165) |
| Inclusive culture | 0.1781† | 0.1781* | 0.0388 | 0.0232 | 0.0156 | 0.0026 | 0.0034 |
| | (0.0966) | (0.0887) | (0.0369) | (0.0298) | (0.0144) | (0.0282) | (0.0282) |
| Organizational change | 0.3268** | 0.3268* | 0.0993* | 0.0606* | 0.0325 | 0.1003* | 0.1013** |
| | (0.1029) | (0.1353) | (0.0392) | (0.0279) | (0.0198) | (0.0389) | (0.0384) |
| Organizational hierarchy | 0.0628† | 0.0628† | 0.0319* | 0.0062 | 0.0051 | 0.0191† | 0.0192† |
| | (0.0327) | (0.0334) | (0.0125) | (0.0108) | (0.0060) | (0.0106) | (0.0106) |
| Employment dismiss | 0.1155** | 0.1155 | 0.0117 | 0.0165 | 0.0088 | 0.0231 | 0.0230 |
| | (0.0425) | (0.0774) | (0.0355) | (0.0270) | (0.0120) | (0.0281) | (0.0283) |
| Outsourcing | 0.2413* | 0.2413** | 0.0926* | −0.0340 | −0.0258 | 0.1289*** | 0.1280*** |
| | (0.1138) | (0.0907) | (0.0370) | (0.0251) | (0.0170) | (0.0333) | (0.0332) |
| Founder manager | 0.1509 | 0.1509 | 0.0447 | 0.0171 | −0.0070 | 0.0465 | 0.0462 |
| | (0.1304) | (0.1094) | (0.0450) | (0.0345) | (0.0217) | (0.0382) | (0.0382) |
| Generic experience | 0.0327 | 0.0327 | 0.0108 | −0.0736 | −0.0289 | −0.0150 | −0.0155 |
| | (0.2149) | (0.2492) | (0.1204) | (0.0665) | (0.0434) | (0.0955) | (0.0957) |
| Specific experience | 0.0598 | 0.0598 | 0.0021 | 0.0140 | 0.0141 | −0.0028 | −0.0028 |
| | (0.0635) | (0.0740) | (0.0381) | (0.0221) | (0.0115) | (0.0276) | (0.0277) |
| External consultant | 0.3856*** | 0.3856*** | 0.0728* | 0.0082 | 0.0028 | 0.0952** | 0.0948** |
| | (0.0668) | (0.1000) | (0.0366) | (0.0226) | (0.0153) | (0.0325) | (0.0324) |
| Group | 0.2478* | 0.2478* | 0.0109 | −0.1251*** | −0.0635*** | 0.0236 | 0.0216 |
| | (0.1258) | (0.1145) | (0.0719) | (0.0268) | (0.0177) | (0.0385) | (0.0388) |
| International competition | −0.0586 | −0.0586 | −0.0117 | −0.0193 | 0.0065 | 0.0025 | 0.0019 |
| | (0.1567) | (0.1237) | (0.0419) | (0.0286) | (0.0173) | (0.0403) | (0.0402) |
| Job rights | | | | 0.8069*** | 0.3438*** | | |
| | | | | (0.1300) | (0.0948) | | |
| Business executives | | | | −0.4244*** | −0.2962*** | | |
| | | | | (0.0946) | (0.0706) | | |
| Number of observations | 1206 | 1206 | 909 | 909 | 909 | 909 | 909 |
| Pseudo $R^2$ | 0.1677 | 0.1677 | | | | | |
| F test on excluded instruments | | | | 22.74*** [2;80] | 9.12*** [2;80] | | |
| Sanderson-Windmeijer multivariate F test on excluded instruments | | | | 76.86*** [1;80] | 34.57*** [1;80] | | |
| Kleibergen-Paap rk Wald F | | | 17.149 | | | 27.806 | 34.271 |
| F test on excluded instruments [Female manager] | | | | | | 51.65*** [48;80] | 105.03*** [50;80] |
| Sanderson-Windmeijer multivariate F test on excluded instruments [Female manager] | | | | | | 88.69*** [47;80] | 92.89*** [49;80] |
| F test on excluded instruments [Female manager %] | | | | | | 108.08*** [48;80] | 101.14*** [50;80] |
| Sanderson-Windmeijer multivariate F test on excluded instruments [Female manager %] | | | | | | 29.45*** [47;80] | 36.77*** [49;80] |
| $\gamma^2$ robust endogeneity test | | | 9.007* [2] | | | 2.637 [2] | 1.332 [2] |
| Hansen | | | | | | 50.525 [46] | 54.804 [48] |

Country and industry dummies are included in the estimates. Regressions are estimated with an intercept term. Standard errors in round brackets. Degrees of freedom in square brackets. *** p < .001, ** p < .01, * p < .05, † p < .10.

use a dummy variable (*New product*) that is coded one if the respondent answered "yes" to the following question: "In the last three years, has this establishment introduced new products or services?".[10]

***Independent variables.*** The variables related to the potential influence of women managers and their relative weight on management teams come from the following survey question: "How many of these permanent, full-time top-and-middle managers are female?". We included a dummy variable to account for the presence of at least one woman in the organization's management team to disentangle the pure "woman effect" from its critical mass. Specifically, *Female*

[10] To widen the scope of our study and ensure generality, we also use four alternative dependent variables (see the Online Supplemental Material) and our findings hold.

**Table 4**
Moderating effect of gender quotas.

| | (1) New product Probit | (2) New product Probit | (3) New product Probit | (4) New product Probit |
|---|---|---|---|---|
| Female manager | 0.1931 | 0.3473* | 0.4625* | 0.3438* |
| | (0.1265) | (0.1693) | (0.1789) | (0.1688) |
| Female manager % | −0.1568 | −0.1257 | −0.1825 | −0.1752 |
| | (0.1962) | (0.1545) | (0.1848) | (0.2067) |
| Female manager*Voluntary gender quotas | 0.3825* | | | |
| | (0.1834) | | | |
| Female manager %*Voluntary gender quotas | | −0.2974 | | |
| | | (0.7511) | | |
| Female manager*Legal gender quota | | | −0.0086 | |
| | | | (0.0054) | |
| Female manager %*Legal gender quota | | | | −0.0022 |
| | | | | (0.0101) |
| Female employee % | 0.5723* | 0.5904* | 0.5687* | 0.5847* |
| | (0.2811) | (0.2905) | (0.2814) | (0.2770) |
| Firm age | 0.0797 | 0.0767 | 0.0784 | 0.0780 |
| | (0.0545) | (0.0529) | (0.0542) | (0.0543) |
| Firm size | 0.0325 | 0.0344 | 0.0322 | 0.0349 |
| | (0.0470) | (0.0471) | (0.0469) | (0.0462) |
| Inclusive culture | 0.1741† | 0.1791† | 0.1758† | 0.1780† |
| | (0.0962) | (0.0971) | (0.0951) | (0.0965) |
| Organizational change | 0.3187** | 0.3285** | 0.3216** | 0.3260** |
| | (0.1032) | (0.1021) | (0.1013) | (0.1025) |
| Organizational hierarchy | 0.0662* | 0.0627† | 0.0646* | 0.0629† |
| | (0.0321) | (0.0331) | (0.0316) | (0.0325) |
| Employment dismiss | 0.1178* | 0.1175** | 0.1193** | 0.1161** |
| | (0.0471) | (0.0382) | (0.0460) | (0.0449) |
| Outsourcing | 0.2463* | 0.2380* | 0.2425* | 0.2412* |
| | (0.1142) | (0.1122) | (0.1129) | (0.1139) |
| Founder manager | 0.1490 | 0.1527 | 0.1524 | 0.1513 |
| | (0.1276) | (0.1320) | (0.1280) | (0.1309) |
| Generic experience | 0.0451 | 0.0292 | 0.0396 | 0.0324 |
| | (0.2158) | (0.2122) | (0.2133) | (0.2150) |
| Specific experience | 0.0535 | 0.0622 | 0.0567 | 0.0595 |
| | (0.0676) | (0.0658) | (0.0643) | (0.0640) |
| External consultant | 0.3839*** | 0.3869*** | 0.3882*** | 0.3854*** |
| | (0.0681) | (0.0665) | (0.0661) | (0.0672) |
| Group | 0.2504* | 0.2436† | 0.2430† | 0.2482* |
| | (0.1247) | (0.1291) | (0.1239) | (0.1265) |
| International competition | −0.0628 | −0.0512 | −0.0568 | −0.0589 |
| | (0.1576) | (0.1401) | (0.1589) | (0.1563) |
| Country fixed effects | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Number of observations | 1206 | 1206 | 1206 | 1206 |
| Pseudo $R^2$ | 0.1692 | 0.1681 | 0.1686 | 0.1677 |

Regressions are estimated with an intercept term. Standard errors in round brackets. *** $p < .001$, ** $p < .01$, * $p < .05$, † $p < .10$.

*manager* is a dummy that equals one if the number of permanent, full-time female top-and-middle managers the establishment employs is greater than zero. Additionally, following Lyngsie and Foss (2017), we calculate the ratio between the number of permanent, full-time female top-and-middle managers and the number of permanent, full-time top-and-middle managers (*Female manager %*).

We use a composite measure of three variables to capture business complexity (*Overall complexity*), since composite measures are substantially more reliable than individual measures (Boyd, Gove, & Hitt, 2005). First, the complexity associated with organizational change (Damanpour, 1996) is measured with a dummy variable (*Organizational change*) that equals one if the number of levels between the typical production employee and the national headquarters' top manager has changed in the last three years. Second, the complexity that is caused by relying on outsourcing, which implies coordination and integration among different actors of the value chain (Gassmann, 2006; Gilley & Rasheed, 2000), is measured by a dummy (*Outsourcing*) that equals one if the respondent answered "yes" to the following question: "Does this establishment outsource any part of the production to other companies? [excluding other establishments within the same firm]". Finally, the complexity associated with the competitive environment outside the organization (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005; Teece, 1992) is measured by whether the establishment mainly sold its products in international markets, therefore being exposed to economic, institutional and legal heterogeneity across countries and competitive pressures from international firms (Bartlett & Ghoshal, 1989). Thus, *International competition* is a dummy that is coded as one if the respondent answered "International – main product sold mostly to nations outside country where establishment is located" to the following question: "In fiscal year [insert last complete fiscal year], which of the following was the main market in which this establishment sold its main product?". Our measure of complexity is the sum of *Organizational change*, *Outsourcing*, and *International competition*.

***Control variables.*** Following the decision criteria proposed by Bernerth and Aguinis (2016), we include the following six groups of variables that allow us to control for confounding effects (e.g., management practices) that potentially bias the proper identification of the above "woman effect". The first group controls for country and industry dummies. In our model specification, the baseline country is Germany, while the baseline industry is "other manufacturing plants."

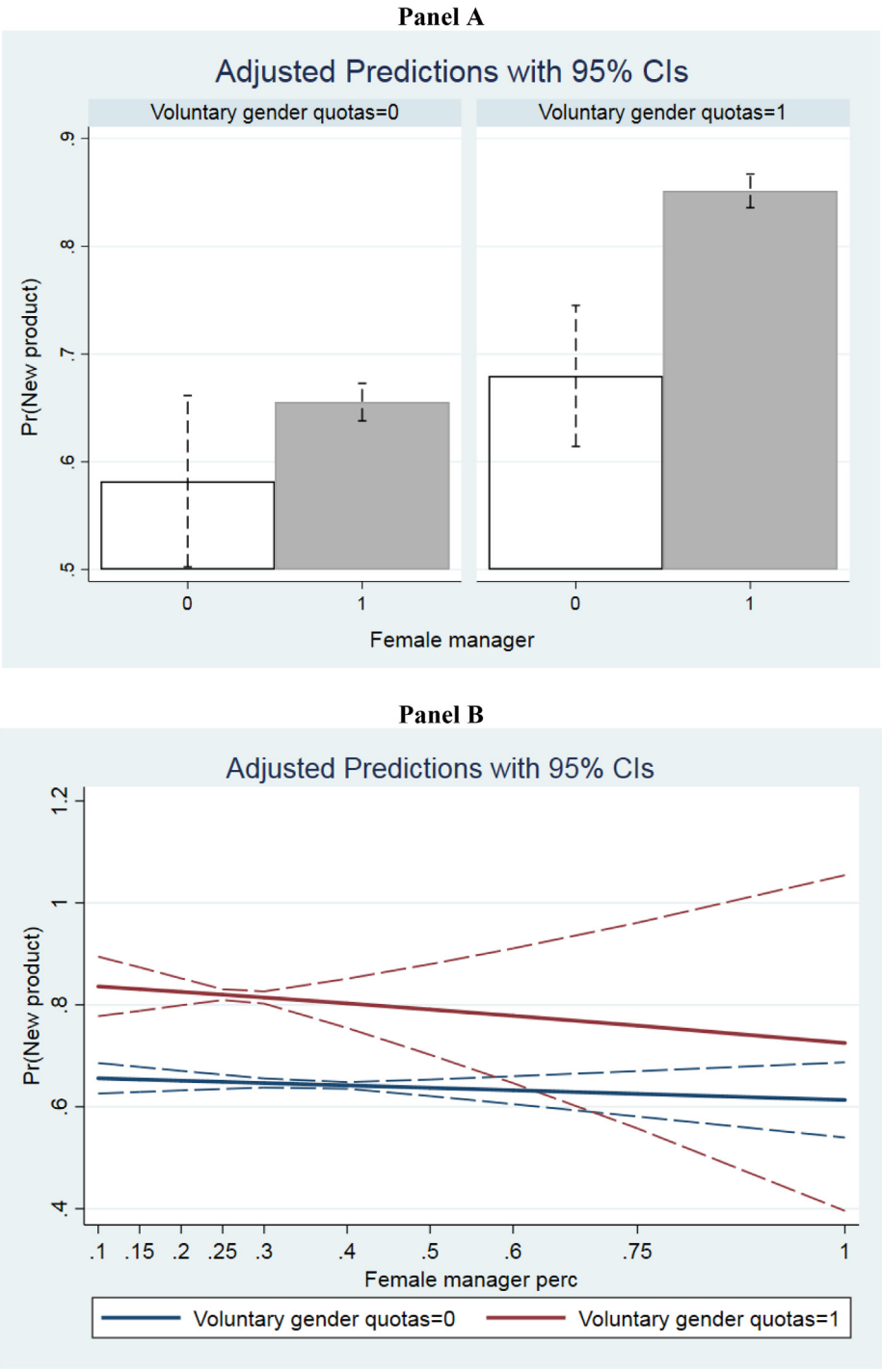


**Fig. 1.** Moderating effects of voluntary gender quotas.

The second group relates to the gender of employees, that is, the relative weight of women in the firm's workforce (Lyngsie & Foss, 2017). Specifically, *Female employee %* is the ratio between the number of female permanent full-time (production and non-production) employees and the number of permanent full-time (production and non-production) employees.

The third and fourth groups are firm-level variables. The former consists of firm-specific controls, such as age and size (Acs & Audretsch, 1987). *Firm age* is measured as the logarithm of the difference between the survey year and the year the establishment began operations. *Firm size* is measured by the logarithm of the number of permanent full-time (production and non-production) employees in the establishment. The fourth group includes firm-level measures that relate to corporate culture, organizational hierarchy, and incentives within the organization, which have been shown to affect innovative activities (e.g., Abbey & Dickson, 1983; Teece, 1996). As suggested by Teece (1996) formal and informal organizational structures influence the rate and type of corporate innovation. Specifically, the dummy variable *Inclusive culture* is coded as one if the respondent answered "All staff are rewarded" to the following question: "How do you reward this establishment's production target achievement?". *Organizational hierarchy* is the number of hierarchical levels in the firm

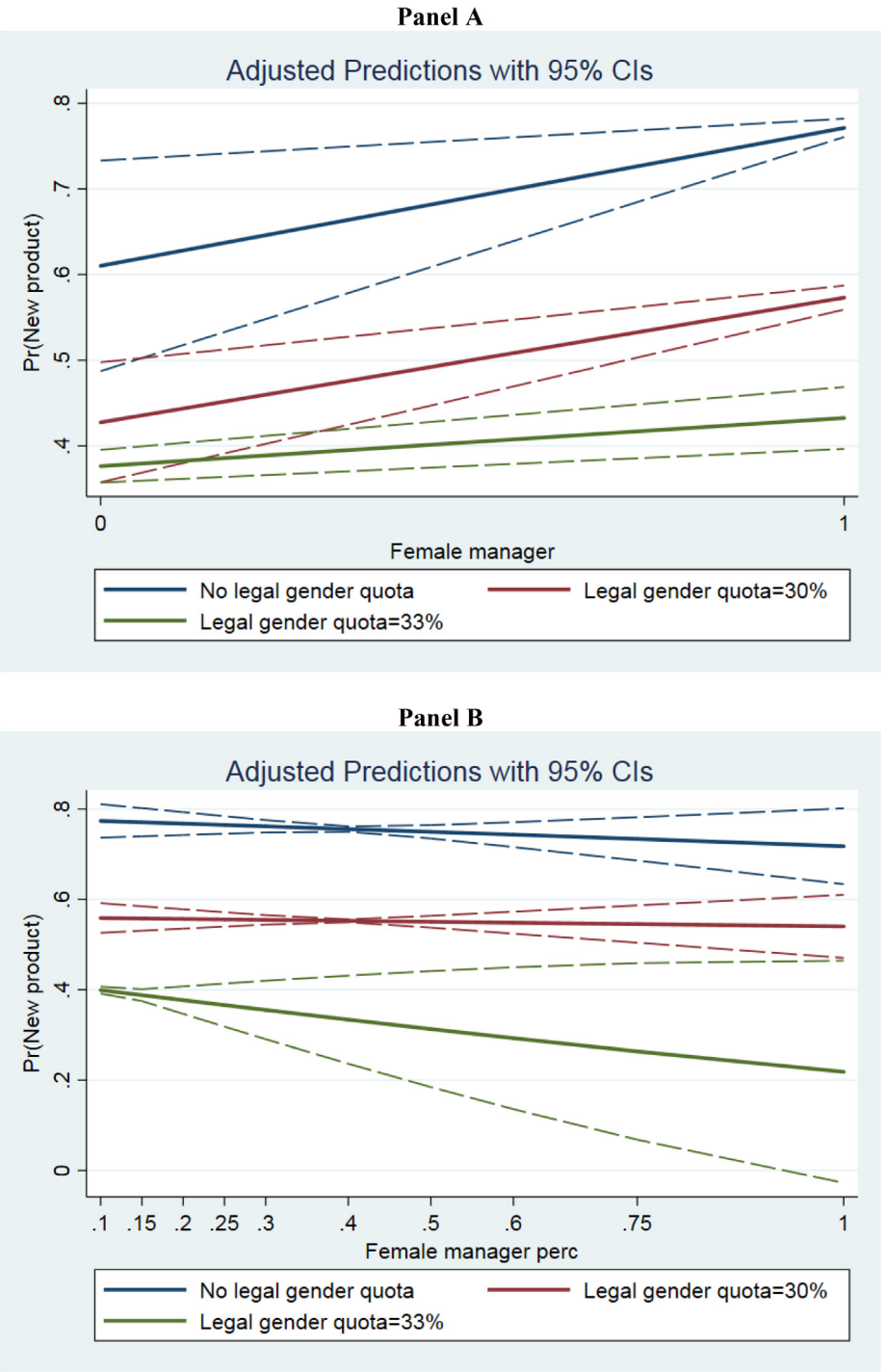


**Fig. 2.** Moderating effects of legally mandated gender quotas.

between the typical production employee and the national headquarters' top manager. *Employment dismiss* is a dummy that takes the value of one if the respondent answered "They are rapidly helped and retrained, and then dismissed if their performance does not improve" to the following question: "Which of the following best corresponds to this establishment's main policy when dealing with employees who do not meet expectations in their position?"

The fifth group relates to top management characteristics that may influence if and how organizations adopt innovation strategies (Young, Charns, & Shortell, 2001) and introduce new products (Boeker, 1997). *Founder manager* is a dummy that equals one if the respondent answered "yes" to the following question: "Is the national headquarters' Top Manager the founder of the firm?". *Generic experience* is the logarithmic age of the national headquarters' top manager. *Specific experience* is the logarithmic number of years of working experience of the establishment's top manager in the same industry as that of the firm.

The sixth group controls for the competitive environment inside the organization, such as the hiring of external consultants to help improve an area inside the organization and the affiliation to a business group. *External consultant* is a dummy that equals one if the respondent answered "yes" to the following question: "Has this estab-

**Table 5**
Moderating effect of complexity.

| | (1) New product Probit | (2) New product Probit | (3) New product Probit |
|---|---|---|---|
| Female manager | 0.3438* | 0.4307† | 0.3492* |
| | (0.1642) | (0.2340) | (0.1765) |
| Female manager % | −0.1900 | −0.1912 | 0.2800 |
| | (0.1967) | (0.1969) | (0.1979) |
| Overall complexity | 0.1588† | 0.2575** | 0.3932** |
| | (0.0849) | (0.0851) | (0.1340) |
| Female manager*Overall complexity | | −0.1228 | |
| | | (0.1152) | |
| Female manager %*Overall complexity | | | −0.6718* |
| | | | (0.2665) |
| Female employee % | 0.5461† | 0.5505† | 0.5594† |
| | (0.2929) | (0.2890) | (0.2887) |
| Firm age | 0.0847 | 0.0846 | 0.0770 |
| | (0.0567) | (0.0565) | (0.0541) |
| Firm size | 0.0214 | 0.0199 | 0.0151 |
| | (0.0507) | (0.0511) | (0.0530) |
| Inclusive culture | 0.1763† | 0.1733† | 0.1723† |
| | (0.0936) | (0.0913) | (0.0886) |
| Organizational hierarchy | 0.0670* | 0.0677* | 0.0666† |
| | (0.0337) | (0.0337) | (0.0347) |
| Employment dismiss | 0.1127** | 0.1118** | 0.1154* |
| | (0.0418) | (0.0415) | (0.0456) |
| Founder manager | 0.1518 | 0.1499 | 0.1543 |
| | (0.1276) | (0.1287) | (0.1334) |
| Generic experience | 0.0561 | 0.0619 | 0.0780 |
| | (0.1978) | (0.1982) | (0.1970) |
| Specific experience | 0.0550 | 0.0566 | 0.0610 |
| | (0.0643) | (0.0644) | (0.0643) |
| External consultant | 0.4038*** | 0.4088*** | 0.4153*** |
| | (0.0689) | (0.0712) | (0.0716) |
| Group | 0.2470† | 0.2492† | 0.2443† |
| | (0.1292) | (0.1293) | (0.1306) |
| Country fixed effects | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes |
| Number of observations | 1206 | 1206 | 1206 |
| Pseudo $R^2$ | 0.1638 | 0.1643 | 0.1720 |

Regressions are estimated with an intercept term. Standard errors in round brackets. *** p < .001, ** p < .01, * p < .05, † p < .10.

lishment ever hired an external consultant to help improve an area of its management?". Finally, *Group* is a dummy that equals one if the respondent answers "yes" to the following question: "Is this establishment part of a larger firm?".

## Results

### *Findings*

Table 1 shows descriptive statistics of dependent, independent, moderating and control variables, and pairwise correlations among them. No serious collinearity issues are present.

Table 2 shows the distribution of women managers across our sample. We report the average female managers/managers percentage ratio displayed by establishments across countries and industries. In terms of geography, Kazakhstan has the highest average proportion of women managers (almost 54%), while India ranks last with less than 11% women managers. Table 2 also reveals that the garment industry (almost 63%) has the highest average female managers/managers ratio, followed by the food industry (almost 46%) and textiles (almost 38%). The chemicals industry has the lowest ratio (around 25%).

Table 3 displays our baseline results. Column (1) shows probit results where standard errors are clustered at country-level. Our results show that the presence of at least one woman manager (variable *Female manager*) is positively associated with the likelihood of introducing new products or services; the average marginal effect is +10.14%.[11] Our results thus support H1. However, note that *Female manager %* is insignificant, which suggests that it is not necessary that women form a certain proportion of the management team before they can exert an influence on innovation. In column (2), following Cameron, Gelbach and Miller (2011), we re-estimated the model in column (1) by simultaneously clustering standard errors at country- and industry-level. Our findings are almost unaltered.

While we control for country-fixed effects, it is possible that results in column (1) are driven by the unobserved (in our model specification) correlation between the presence of women managers within firms and the institutional policies of a country and/or the cultural attitude toward women in a certain institutional environment. For instance, certain environments may be characterized by an anti-women bias, which manifests in firms setting higher standards for women to be promoted than for men. Thus, in male-oriented environments, the presence of female leaders is downward-biased; that is, only very qualified women can be observed. If this selection process were at play in our data, the association between female leadership and innovation would be overstated (Antonakis, Avolio, & Sivasubramaniam, 2003; Eagly, Johannesen-Schmidt, & van Engen, 2003). In sum, the positive relationship between women managers and innovation may be due to either their leadership style or the environment they are in.

To tackle this potential endogeneity issue, we use an instrumental variables (IV) approach. We use two variables that act as instruments, namely *Job rights* and *Business executives*. Both variables are sourced from the World Values Survey (WVS)[12] and represent the national cultural environment for women in labor markets and their *perceived* ability in managerial positions. *Job rights* is the country-level average of answers to the statement "When jobs are scarce, men should have more right to a job than women", where the scale is: 1 "Agree", 2 "Neither" and 3 "Disagree". *Business executives* is the country-level average of answers to the statement "On the whole, men make better business executives than women do", where the scale is: 1 "Strongly agree", 2 "Agree", 3 "Disagree", and 4 "Strongly disagree." While these cultural traits should influence the access of women into the corporate realm (Terjesen et al., 2009), they are unlikely to directly influence firm-level innovative activities. Specifically, even though a country's cultural traits may influence the innovative performance of the domestic firms, we expect that this effect is neutral across domestic firms. *A priori*, we cannot predict the expected sign of correlation between these two exclusion restrictions and our allegedly endogenous variables (*Female manager* and *Female manager %*). In fact, in countries that favor gender equality, the presence of women in management positions is more likely. Nonetheless, the beyond-the-glass-ceiling theory (Adams & Funk, 2012) calls for higher incentives for women in male-dominated environments in order to challenge male managers' negative stereotypes about women managers (McDonald et al., 2017).

The estimation is composed of two steps. In the first step, the dependent variables are *Female manager* and *Female manager %*. In these two first-step equations we include the above exclusion restric-

[11] We also calculated the average marginal effect at the means of the independent variables, which is very close.

[12] WVS is the most comprehensive and non-commercial data source that provides cross-country information about individual values and beliefs, collected through nationally representative surveys on around the 90% of the world's population. WVS data have been widely used across different research fields such as political science, social psychology, economics and management (e.g., Alesina, Giuliano, & Nunn, 2013; Brechin, 1999). For more details, see: http://www.worldvaluessurvey.org/wvs.jsp. Unfortunately, the two above exclusion restrictions are not available for three countries included in our sample: Kazakhstan, Lithuania and Uzbekistan. Thus, these three countries are excluded from our robustness analysis.

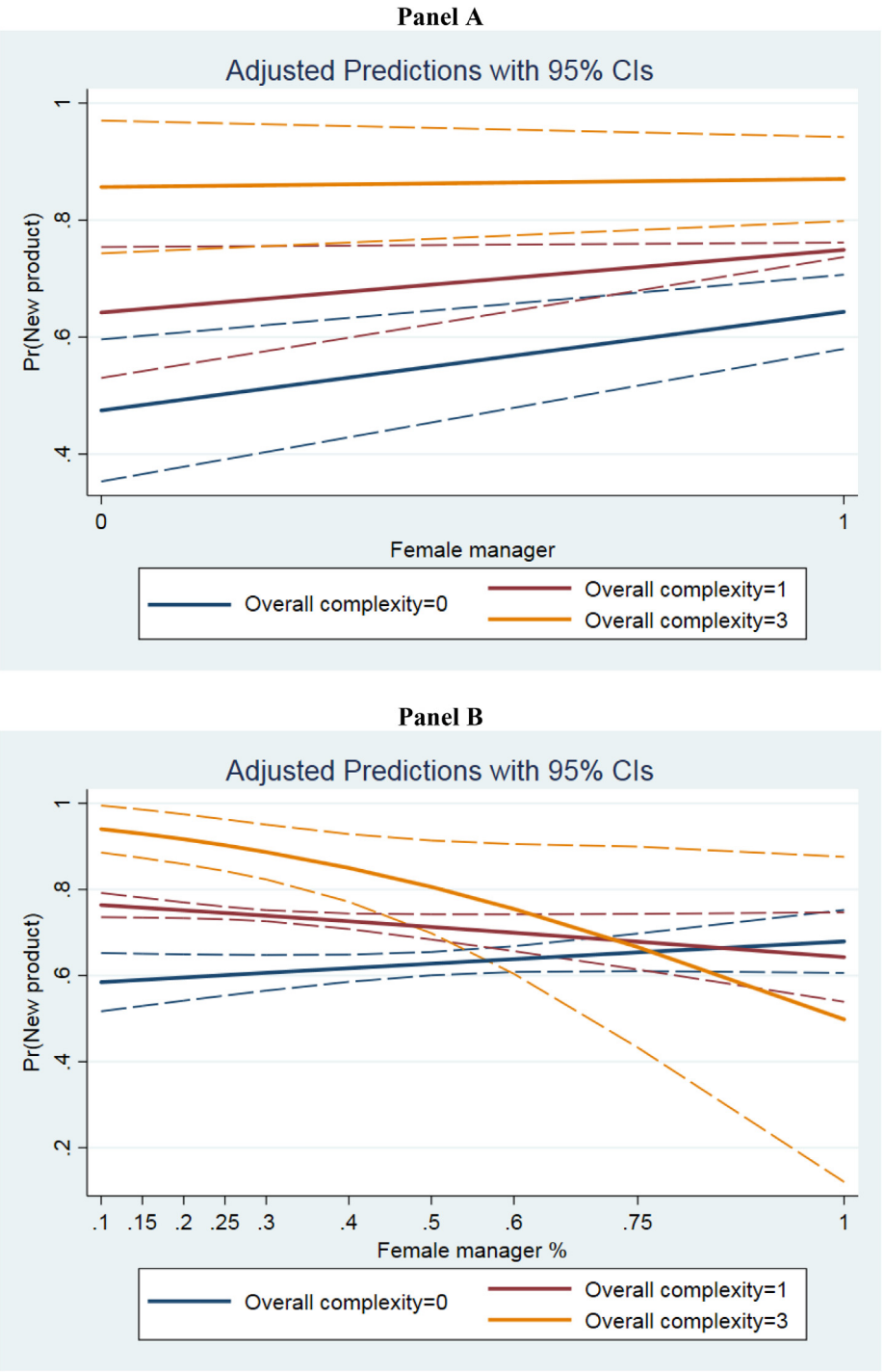


**Fig. 3.** Moderating effect of complexity.

tions among the regressors and we estimate both first-step regressions by means of linear models to avoid the "forbidden regression" bias (Angrist & Pischke, 2008: 190).[13] Using standard econometrics notation, where the subscripts *i* and *j* indicate firm- and country-level variables, respectively, we estimate the following system of equations where *X* is the vector of exogenous variables:

$$New\ product_i = \beta_0 + \beta_1 * Female\ manager_i + \beta_2 * Female\ manager\%_i + \beta_3 * X_i + \varepsilon_1 \quad (1)$$

$$Female\ manager_i = \gamma_0 + \gamma_1 * X_i + \gamma_2 * Job\ rights_j + \gamma_3 * Business\ executives_j + \varepsilon_2 \quad (2a)$$

$$Female\ manager\%_i = \delta_0 + \delta_1 * X_i + \delta_2 * Job\ rights_j + \delta_3 * Business\ executives_j + \varepsilon_3 \quad (2b)$$

[13] When dependent variables in the first step are dichotomous, their conditional expectation functions are nonlinear. The "forbidden regression" bias happens when using a nonlinear model to estimate the first step and then plugging-in the first step predicted value in the second step equation. In principle, there is no guarantee that first step residuals are uncorrelated with predicted values and covariates.

We ran three different estimations. First, in columns (3)-(5) of Table 3 we estimated a standard linear two stage least squares (2SLS) methodology.[14] It is worth noting that clustering standard errors at country-level made the estimated covariance matrix of moment conditions not of full rank; thus, we still used the above two-way clustering procedure at country-industry level. Second, in column (6) we used the Lewbel (2012)'s estimator. Using again the above standard econometrics notation, and assuming that we do not have available excluded instruments, we have:

$$New\ product_i = \beta_0 + \beta_1 * Female\ manager_i + \beta_2 * Female\ manager_i\% + \beta_3 * X_i + \varepsilon_1 \quad (3)$$

$$Female\ manager_i = \gamma_0 + \gamma_1 * X_i + \varepsilon_2 \quad (4a)$$

$$Female\ manager\%_i = \delta_0 + \delta_1 * X_i + \varepsilon_3 \quad (4b)$$

The identifying assumption behind this estimator is that the correlations between $\varepsilon_2$ and $X$ and between $\varepsilon_3$ and $X$ are not null. This assumption typically holds in many models: the above first stage regressions (4a) and (4b) are in fact not motivated by any theory, but are just linear projections of *Female manager* and *Female manager %* on the vector $X$ , respectively. The estimation of Eq. (3) is a 2SLS regression using $X$ , $[Z - \widehat{E(Z)}]\varepsilon_2$ and $[Z - \widehat{E(Z)}]\varepsilon_3$ as instruments, where $Z$ is a subset of $X$. Third, in column (7) we augmented the Lewbel's estimator with our two excluded instruments *Job rights* and *Business executives*, so to improve the estimation efficiency. One of the advantages of the two estimators in columns (6) and (7) of Table 3 is the possibility to test the validity of our two excluded instruments, and not only their strength as in the case of the standard 2SLS estimation: indeed, the system of equations estimated via standard 2SLS is exactly identified (i.e., non-overidentified).

In columns (3)-(7) of Table 3, we report several tests for the three IV-type estimates. It is worth noting that the endogeneity tests (robust in the presence of clustered standard errors) reported at the bottom of Table 3 do not clearly indicate that *Female manager* and *Female manager %* are endogenous. All first stage F tests on excluded instruments (Sanderson & Windmeijer, 2016) reject (at 1‰ confidence level) the null hypothesis that excluded instruments (*Job rights* and *Business executives* for the standard 2SLS estimator in columns (3)-(5), heteroscedasticity-based generated instruments for the Lewbel's estimator in column (6), both sets of instruments for the augmented Lewbel's estimator in column (7)) are not statistically correlated with the two assumed endogenous variables *Female manager* and *Female manager %*, thus reassuring us about the strength of our instrument set (for more details see Sajons, 2020). However, 2SLS findings should be interpreted with caution because the F test on excluded instruments in the first stage equation where the dependent variable is *Female manager %* is below the threshold value of 10 (Staiger & Stock, 1997). In columns (6) and (7) Hansen tests do not reject the null hypothesis that our instrument sets are valid.

With regard to the two excluded instruments *Job rights* and *Business executives*, their coefficients have opposite signs, namely, positive and negative, respectively. This suggests that a country's non-discriminating attitude toward women is positively correlated with the presence (and proportion) of women in managerial positions; however, women are more likely to be in executive roles in countries characterized by the stereotype that men are better executives than women. This result is consistent with the main argument of the beyond-the-glass-ceiling theory, which posits that women have "stronger incentives to play the boys' game" in male-dominated environments.

Our results in columns (3)-(7) provide support to our findings in columns (1) and (2). IV-2SLS results are still in line with those reported in column (1); however, the coefficient of *Female manager %* is statistically significant. Even though, as explained above, 2SLS findings should be interpreted with caution this latter finding even strengthens our claim that the relationship between women managers and firm innovation is driven by a selection effect, while no critical mass effects are at play.

## The effect of political gender quotas: A test of the selection effect

The extent to which women are qualified for managerial positions is partly dependent on prevailing institutions, policies, and political initiatives aimed at increasing female representation on management teams. Thus, the findings in Table 3 need to be examined in the light of the institutional and political context (Terjesen & Singh, 2008), which may reflect selection effects enabled by policies such as legally-mandated or voluntary quotas, representing the mechanisms we test through a moderator logic (Jacoby & Sassenberg, 2011; Spencer, Zanna, & Fong, 2005).

As mentioned in H2, we posit that the positive or negative effects associated with gender quotas depend on the *type* of quota. Thus, we need to examine a context that allows for variation in relevant policies. In our sample of countries, we have both *voluntary* and *legal* (legally-mandated) gender quotas adopted by parties in parliament (at the level of Single/Lower House or Upper House, or at Sub-National Level). While legal gender quotas impose certain minimum levels of female representation, voluntary quotas do not impose a forced level of female representation.

To estimate the moderating effect of the two types of quotas on the relationship between women managers and innovation, we use voluntary gender quotas adopted by parties in parliament (*Voluntary gender quotas*) and legal gender quotas (in percentages) in parliament (*Legal gender quota*) – if introduced before the period of our analysis. The data are collected from the Global Database of Quotas for Women (source: www.quotaproject.org), and OECD statistics.[15]

To test the effects of the different types of quotas, we interacted the two types of quotas separately with *Female manager* and *Female manager %*. This represents an indirect test of the selection of female managers. It builds on the assumption that the supply of (qualified) women managers in the local labor market may be limited (as shown by, for instance, Bertrand et al., 2010; and Guiso & Rustichini, 2018). While legally-mandated quotas require that firms hire a certain number of women, even under a condition of shortage of qualified women. Voluntary quotas allow more freedom to firms, so that women are hired if considered to be qualified.

If the interaction term between *Female manager* and the presence of legal (voluntary) quotas is negative (positive), this may suggest that the female leadership advantage in presence of legal (voluntary) quotas is lower (higher) than in the case of no quotas. Further, with the

[14] We avoided using an IV probit estimation because both the dependent variable and one of our endogenous variables are dichotomous. In this type of settings, IV probit models likely produce biased estimates (Wooldridge, 2010; for empirical applications see, for instance, Cumming, Grilli, & Murtinu, 2017; Grilli et al., 2018; and Mrkajic, Murtinu, & Scalera, 2019).

[15] Among the countries included in our sample, Germany, Lithuania and Romania adopted voluntary quotas. India and Uzbekistan implemented legally mandated quotas of, respectively, 33% and 30% of female representation. Even though Serbia introduced a 30% quota for the Single/Lower House and at the sub-national level in 2004, we do not detect the presence of a legally mandated quota. As reported by the Global Database of Quotas for Women, this quota does not seem binding as testified by the use of the word "should". Namely, "In 2004, amendments to the law of parliamentary elections were adopted, including a gender quota at the national and sub-national levels. The law specified that lists of candidates should include at least 30 percent of the under-represented gender, and that for every four candidates at least one should be of the under-represented gender" (source: https://www.idea.int/data-tools/data/gender-quotas/country-view/253/35). We re-classified Serbia as a country with legal quotas, and estimated results in Table A8 and the corresponding Fig. A3 in the Online Supplemental Material section are fully in line with our findings in Table 5 and Fig. 2.

interaction between *Female manager %* and the presence of legal (voluntary) quotas, we aim at testing whether and how the female leadership advantage changes at certain values of *Female manager %*. Results are reported in Table 4.[16]

To show the effect of the interaction terms, we report the marginal effects graphically. This is required because our dependent variable is binary (Ai & Norton, 2003; Greene, 2010; Hoetker, 2007; Zelner, 2009). In nonlinear models the coefficients of interaction terms are not directly interpretable. For instance, when graphically represented, a statistically insignificant coefficient may instead reveal a statistically significant moderation effect (at least over a partial range of the covariates).[17] Figs. 1 and 2 depict the marginal effects of the interaction terms of voluntary and legal quotas, respectively. Our results seem to suggest that, on average, the presence of voluntary quotas positively moderates the relationship between female managers and the likelihood to launch new products or services (Fig. 1, Panel A). In contrast, legal quotas seem to negatively moderate this relationship (and the moderation effect is stronger for higher levels of the quota) (Fig. 2, Panel A). Further, while the finding about legal quotas holds over the full range of *Female manager %* (Fig. 2, Panel B), the moderating effect of voluntary quotas holds only up to a certain threshold (Fig. 1, Panel B). Overall, these findings seem to support H2, pointing to a "selection argument" and suggesting that the type of quota introduced affects the selection of women managers differently.

## The effect of complexity

The female leadership advantage indicated in Table 3 may not be only influenced by policy-driven selection effects, but also by the business environment. Thus, we need to test whether our findings in Table 3 are affected by complexity, as hypothesized in H3.

We first test whether our results in Table 3 change when we use the variable *Overall complexity* as regressor. As shown in Table 5 (column (1)) our main findings hold. Further, the coefficient of *Overall complexity* is positive and statistically significant (at 10% confidence level). Thus, complexity influences the relationship between female managers and the likelihood of launching new products or services. One explanation for this result may be that complexity is a proxy for innovative opportunities stemming from both inside and outside the company. In fact, under conditions of high complexity, firms are motivated to find new solutions (Byström & Järvelin, 1995), which may prompt innovative products or services so positively affecting firm innovation (Aiken & Hage, 1971).

Then, to estimate the potential moderating effect of complexity, we interacted *Overall complexity* separately with *Female manager* and *Female manager %*, respectively. Results are reported in Table 5 (second and third column) and Fig. 3.[18]

Like Table 4, we report the marginal effects graphically to be able to correctly interpret, and show, the effect of the interaction terms. To ease the interpretation of the marginal effects we report the baseline situation of no complexity and the situations where complexity takes the minimum (*Overall complexity* = 1) and the maximum value (*Overall complexity* = 3). Fig. 3 shows that complexity positively moderates the relationship between female managers and the likelihood to launch new products or services, confirming H3. In other words, the "woman effect" is larger in complex environments (Panel A). This suggests that in complex environments, women's multitasking capabilities and attitude toward inclusion and collaboration may help them spur innovative activities. Interestingly, the moderation effect is stronger for higher levels of complexity. Further, the positive moderation holds until a threshold level of about 50% of female representation on management teams (Panel B). Thus, the moderating role of complexity on the relationship between women and innovation is stronger for lower levels of female representation of management teams, and when gender diversity is at the maximum (i.e., 50:50) the moderation effect becomes weak (and the innovation outcome is not maximized). Finally, the results suggest that, when there is a predominance of female representation on management teams, the degree of complexity does not affect the outcome of innovative activities.

### *Robustness checks*[19]

We performed several checks to test the robustness of our results. The first set of robustness checks relates to the baseline model specification presented in Table 3. The detailed description of each procedure and their results are provided in the Online Supplemental Material. Our results may be limited because: our dependent variable (i) only captures the outcome of the innovation process, and not the process itself; and (ii) comprises a three-year span prior to the measurement of the independent variables of interest. Thus, we replicated our baseline model by using four alternative dependent variables measuring different phases of the innovation process, which do not suffer from non-theory-based timing lags (Fischer, Dietz, & Antonakis, 2017). Results in Table A1 fully confirmed our main findings in Table 3. Second, we implemented three empirical strategies to address the inability, due to data constraints, to distinguish between top and middle managers. Results in Table A2 leveraged the information on the number of hierarchical levels between production employees and both top managers and factory managers, and the proportion of employees that report directly to the top manager. We found confirmation that the inclusion of middle managers in our main independent variables does not drive our results. Third, we checked for potential issues in our model specifications derived from the choice and operationalization of control variables, issues about clustering standard errors, and the fact that one of our key independent variables, *Female manager %*, is a ratio (thus, it is not clear whether the influence of *Female man-*

[16] Our results hold when re-estimating models in Table 4 by means of Wooldridge (2010)'s method for endogenous interactions. In formulas: $\text{Newproduct}_i = \beta_0 + \beta_1 * \textit{Femalemanager}_i + \beta_2 * \text{Femalemanager}\%_i + \beta_3 * \text{X}_i + \beta_4 * \textit{Femalemanager}_i * \text{Voluntarygenderquotas}_j + \varepsilon_1$ (5) $\textit{Femalemanager}_i = \gamma_0 + \gamma_1 * \text{X}_i + \gamma_2 * \text{Jobrights}_j + \gamma_3 * \text{Businessexecutives}_j + \gamma_4 * \text{Jobrights}_j * \text{Voluntarygenderquotas}_j + \gamma_5 * \textit{Businessexecutives}_j * \text{Voluntarygenderquotas}_j + \varepsilon_2$ (6a) $\textit{Femalemanager}\%_i = \delta_0 + \delta_1 * \text{X}_i + \delta_2 * \text{Jobrights}_j + \delta_3 * \text{Businessexecutives}_j + \delta_4 * \text{Jobrights}_j * \text{Voluntarygenderquotas}_j + \delta_5 * \textit{Businessexecutives}_j * \text{Voluntarygenderquotas}_j + \varepsilon_3$ (6b) - $\textit{Femalemanager}_i * \textit{Voluntarygenderquotas}_j = \theta_0 + \theta_1 * \text{X}_i + \theta_2 * \textit{Jobrights}_j + \theta_3 * \text{Businessexecutives}_j + \theta_4 * \text{Jobrights}_j * \text{Voluntarygenderquotas}_j + \theta_5 * \textit{Businessexecutives}_j * \text{Voluntarygenderquotas}_j + \varepsilon_4$ (6c) where *X* is the vector of exogenous variables. The above system of equations represents the model specification in column (1) of Table 4. Then, it needs to be adjusted for re-estimating the model specifications in columns (2)-(4). Results are available upon request from the authors.

[17] In nonlinear models, the interpretation of the statistical significance of the estimated coefficients of interaction terms is not straightforward. For example, consider the following case: $y = f(A)$, where $A = b_1x_1 + b_2x_2 + b_3x_1x_2$, and $b_1$, $b_2$ and $b_3$ are the estimated coefficients. The effect of $x_1$ on y is given by $\delta y/\delta x_1 = (b_1 + b_3x_2) * \delta f/\delta A$. Thus, not only the statistical significance of $\delta y/\delta x_1$ is a function of the sample (given that f changes with the different values of $x_1$ and $x_2$), but the sign of the coefficient can change at different values of $x_1$ and $x_2$, potentially crossing zero for some values of $x_2$.

[18] The pairwise correlation between our composite measure of complexity and our main dependent variable is 0.16 (statistically significant at the 1% confidence level). *Overall complexity* captures both the complexity within the firm (internal complexity, as proxied by *Organizational change*) and the complexity beyond firm boundaries (external complexity, as proxied by *Outsourcing* and *International competition*). As expected from a theoretical point of view, the two measures of external complexity are significantly correlated (0.15, at 1% confidence level), while these two measures are not significantly correlated (at conventional levels) with *Organizational change*, namely 0.05 and 0.02 in the case of *Outsourcing* and *International competition*, respectively. However, from a mere statistical point of view, one may call into question whether the above three sub-measures capture the same phenomenon. For the sake of prudence, we re-estimated our models in Table 5 by using a two-item measure of complexity that is the sum of *Outsourcing* and *International competition* (and adding *Organizational change* as a regressor). Results are fully in line with those shown in Table 5 and are available upon request from the authors.

[19] We are grateful to the anonymous reviewers for prompting us to conduct these additional tests, and for, in some cases, suggesting specific tests.

*ager %* is driven by the numerator, number of women managers, or the denominator, the total number of managers). The tests reported in Table A3 confirmed our model specification. Fourth, we performed a falsification test to check whether our main results were driven by potential spurious correlations between gender variables and innovation. This test in Table A4 reassured us about the absence of spurious correlation. Fifth, we tested a potential inverted U-shaped relationship in the relationship between women managers and innovation. Using the procedure suggested by Haans, Pieters, and He (2016), we removed from the model in Table 3 (column (1)) the variable *Female manager* and inserted the squared term of *Female manager %* (*(Female manager %)*$^2$). As explained in the Online Supplemental Material and shown in Table A5, our results (and tests on the extreme values of *Female manager %*) do not suggest the presence of an inverted U-shaped relationship between the proportion of female managers and firm innovation. Finally, even though we control for country-specific effects in our model specifications, in Table A6 we tested whether our findings were driven by the presence of two non-transition economies: our results in Table 3 hold.

The second set of robustness checks attempts to rule out possible alternative explanations for our findings related to the selection effect under different institutional environments. Namely, companies that voluntarily employ a higher number of women in their management teams may simply be more open to diverse ideas and value diversity more (Ely & Thomas, 2001). These companies are less likely to be embedded in an institutional environment promoting legal quotas and may not be comparable to other companies. As a result, comparing companies under legal (voluntary) quotas with all other companies, and in particular with those located in countries with voluntary (legal) quotas, may be imprecise and does not allow to distinguish whether the selection effect comes from the features of the country (type of quotas) or of the company (openness to diversity). Thus, to more precisely test whether different types of quotas are related to the selection of (under)qualified women, we used two propensity score matching methodologies. In this way, we compare companies embedded in institutional environments with legal or voluntary quotas with similar firms (in terms of characteristics like firm age, firm size, and industry) that operate in countries where quotas are absent (the detailed description of the matching procedure is provided in the Online Supplemental Material). The results on the matched samples fully confirm our findings in Table 4 and Figs. 1 and 2.

In addition to the matching procedure, we ran tests to confirm that the female leadership advantage shown in Table 3 and the moderating effect of voluntary vis-à-vis legal quotas shown in Table 4 are not driven by a firm's openness to diversity. We ran the model specifications in Table 3 (column (1)) and Table 4 by adding three regressors that capture a firm's openness to diversity. The augmented models described in the Online Supplemental Material and shown in Table A7 and in Figs. A1 and A2 confirm our findings in Tables 3 and 4 and in Figs. 1 and 2.

Another alternative explanation for our findings in Table 4 is that in male-stereotypical settings the most qualified women may be selected via corporate selection processes driven by an anti-women bias. That is, a male-stereotypical environment represents a confounding factor behind our findings about quotas. Indeed, male-stereotypical settings are typically present in masculine societies, which are more likely to openly categorize individuals by their gender than feminine societies. Thus, observed differences between female and male managers may be driven by a biased selection process that makes women managers overqualified when compared to their male peers. Using Hofstede's masculinity data, in unreported regressions (available upon request) we re-estimated our model specifications in Table 4 by interacting *Female manager* and *Female manager %* with the masculinity measure. We did not detect any moderation effects exerted by masculinity. These findings suggest that the masculinity of the environment is not likely to explain our findings.

## Concluding discussion

### *Contributions of this study*

Over the last few decades, the global economy has experienced both increasing participation of women in the global workforce (The Guardian, 2015) and the growing importance of innovation as a source of competitive advantage (ECB, 2017). Although these two phenomena may be related, strategic management and leadership research on the relationship between women and innovation remains in its infancy (e.g., Chen et al., 2015; Eagly & Heilman, 2016; Lyngsie & Foss, 2017). Notably, our understanding of the phenomenon is still scant with respect to examining the relation between women managers and innovation under the effect of key contingencies and the role of country-specific factors (e.g., institutions and policies). Going beyond the single-country focus of the existing literature, our analysis of a cross-national survey allows us to capture the effect of different institutions and policies, thus responding to the call by Cook and Glass (2014: 91) for more inquiry into the "institutional-level mechanisms that may increase women's ascension to top positions."

Our findings may be cautiously taken to support claims that management teams with female representation are better at handling innovation processes, and this effect seems particularly important in complex business environments. Our findings in support of H1 to H3 support the notion that a selection effect helps explain the positive association between female managers and innovation. That is, we find evidence for the overarching argument that when women are likely to be selected based of their skills and capabilities in an innovation context, their association with innovation is so strong that critical mass effects are not salient. The positive association between women managers and innovation is positively moderated by complexity. This positive moderating effect holds only up to about 50% of female representation, but its strength becomes weaker with increasing female representation on management teams.

Selection arguments may also account for this finding: The supply of qualified women managers may be limited for a variety of reasons including women dropping out the labor market once they have children (Bertrand et al., 2010) or cultural traits that limit the supply (Guiso & Rustichini, 2018). Thus, the fact that the positive influence of having a woman manager holds only up to about 50% of female representation may be related to the mechanism that the first women to join the management team are the most qualified and capable, endowed with better skills to spur innovation under complexity; while, the additional women are likely to be "less selected", and thus underqualified, diluting the positive contribution of the more qualified managers already in the team.

We have bolstered our findings with a series of robustness tests (reported in the Online Supplemental Material), for example, running the models with alternative dependent variables, instrumenting for our predictor variables, and taking into account possible alternative explanations.

All in all, our findings provide partial support for the beyond-the-glass-ceiling theory (Adams & Funk, 2012; Agarwal et al., 2016). The direct and indirect dynamics of the selection effect - including peers' perception -, in combination with scant availability of qualified women mangers in the labor market, suggest that greater female representation on management teams may attenuate the effect of women who have broken the glass ceiling. On the other hand, our findings suggest important contingences associated to the tokenism phenomenon, which predicts that minority members (e.g., women on management teams) are more likely to be perceived as tokens by their colleagues and respond by keeping a low profile with marginal influence on decisions (Kanter, 1977; King, Hebl, George, & Matusik, 2010; Izraeli, 1983). Given an efficient selection process, women who make it to the management team are able to maximize their influ-

ence on the innovation process when they are a consistent minority within the management team.

*Policy implications*

Our findings have implications for institutional policies with regard to legally-mandated and voluntary quotas, and how the implementation of these policies might indirectly influence firm behavior and (innovation) performance. Specifically, our study suggests that in institutional environments without legally-mandate quotas, the selection process of women managers tends to lead to better innovation outcomes. In contrast, legally-mandated quotas may lead to the selection of underqualified women managers and potentially negative firm consequences, particularly when there is a limited supply of qualify women managers in the labor pool (Bertrand et al., 2010; Guiso & Rustichini, 2018). Optimistically, as the beginning of our study alludes, women outnumber men in the US labor force and are earning graduate degrees in greater numbers. Indeed, it seems that there may currently be a healthy pipeline of women in middle management. This suggests that the selection effect of less qualified women being brought into leadership positions, reducing innovation performance, may peter out over time.

*Future research*

Our research may be extended in several ways. Due to data limitations, we are unable to rule out alternative explanations that may support our findings. For example, future research may offer different explanations for our results related to the female leadership advantage and the selection process. An anti-women corporate environment may bias the selection process, so that women that make it to the management team are overqualified compared to their male peers (Antonakis, Bendahan, Jacquart, & Lalive, 2010; Eagly & Antonakis, 2015). Therefore, the female leadership advantage may be attributed to the biased selection process that establishes a comparison between overqualified women managers and (average) qualified men peers. Even if in our analysis we do account for firm-level characteristics related to this potential bias in the selection process, like inclusive culture and openness to diversity, future studies should complement the current results with specific information on corporate discrimination policies against women, and the actual qualifications of women and men managers, so as to clearly distinguish between the effects of gender and qualification.

Further, upper-echelons research (Carpenter, Geletkanycz, & Sanders, 2004; Hambrick, 2007; Hambrick & Mason, 1984) may suggest an alternative explanation for our results about the female leadership advantage under complexity. This stream of literature has begun exploring the negative effects of a heterogeneous workforce, suggesting that diversity leads to conflicts driven by differences in values, beliefs, and attitudes (e.g., Campbell & Mínguez-Vera, 2008; Jehn, Northcraft, & Neale, 1999; cf. also, van Knippenberg, De Dreu, & Homan, 2004). Because innovations often require timely responses, such differences may generate barriers for cooperation, communication and interactions, which may tilt the organizational balance and negatively impact innovations. Extending that argument, gender diversity may increase conflicts and reduce the likelihood that management teams will agree on risky investments, such as those related to innovative activities. Additionally, the literature on leadership effectiveness has connected individual-specific features, values and practices to effective leadership (e.g., Reave, 2005). For those features that do not systematically differ across gender, future studies should shed more light on whether these features strengthen or weaken the investigated female leadership advantage in innovation contexts. Our study shows that having women within the firm's management team is but half of the equation. Future studies should devote more attention to identify, explore and test the micro-level mechanisms associated with the different types of quotas, in relation to the motivations, processes and practices adopted either by women managers to effectively transfer their management style across the different layers of the organization or by male managers to work with female managers. Additionally, future research needs to address the spillover effects or interaction effects of women on men's behaviors and reactions within management teams. For instance, women and men may use different heuristics in their decision-making processes, but interaction may produce convergence over time in the use of such heuristics. Future researchers should disentangle behavioral and prospective uncertainty and between sensation-seeking and overconfidence in investment-related decisions (Grinblatt & Keloharju, 2009). Furthermore, men may react differently, and develop different perception regarding their female peers, depending on the type of decision (e.g., one-shot vs repeated), the type of information set (e.g., probability to face incomplete information), the level of information disclosure (Dufwenberg & Gneezy, 2002), and the reputation formation mechanisms (for non-gender-related see Brandts & Figueras, 2003).

Another limitation of our analysis is that our data set only includes manufacturing industries, which are typically male-dominated environments. The effectiveness of a woman's leadership may be influenced by informal and social networks within the industry that are a function of the identity of the dominant gender (Mayer & Puller, 2008), so likely hindering women leaders' outcomes (Heilman, Wallen, Fuchs, & Tamkins, 2004). Further, as argued by, for instance, Price (2012) and Grossman (2013) dominant gender leaders may be perceived as more capable in those industries by relevant stakeholders, such as other managers and employees. The above stereotypes may pressure women leaders when making decisions (Lyngsie & Foss, 2017). This may give rise to two possible outcomes with women being hampered in their leadership role (as explained above) or, by contrast, with women mimicking the leadership style of the dominant gender to build a tough reputation of being able to play the "boys game" (Agarwal et al., 2016).

## Conclusions

Research on women managers and innovation remain in its nascent stages, and many issues in this domain remain open and ill understood. We contribute to the emerging literature by examining a cross-country dataset that allows us to grapple with the relation between women and innovation and some of the key contextual variables that may influence this relation. Our findings suggest that there may be an XX factor with regard to firm innovation and cast new light on the relationship, pointing to the role of the institutional and political environment and complexity as important moderating forces.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.leaqua.2021.101537.

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