

Article

Women at the Helm: Female Top Managers and Business Process Innovation in Ecuadorian Firms

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Abstract

Women's participation in senior management has increased, yet evidence regarding its relationship with different forms of business innovation remains inconclusive, particularly in emerging economies. This study examines whether formal Ecuadorian firms with a woman as their top manager are more likely to report business process innovation than firms led by men. A quantitative, non-experimental, cross-sectional design was applied to firm-level data from 345 enterprises included in the World Bank Enterprise Survey Ecuador; 66 firms (19.1%) reported a female top manager. Process innovation was measured from WBES item H5, which asks whether the establishment introduced a new or improved process during the preceding three years, including production or service methods, logistics/delivery/distribution, or supporting activities. Weighted logit models with firm controls and sector and region fixed effects were estimated. In the main specification ($n = 327$), female top management was associated with higher odds of process innovation (OR = 3.475; 95% CI [1.570, 7.688]; $p = 0.002$), and the direction remained positive across robustness checks. No statistically significant association was found with product innovation, R&D expenditure, or green-practice adoption. The findings therefore support a differentiated interpretation: female top management is associated with internal process change, but not uniformly with every innovation outcome. Because the data are cross-sectional and the female-manager group is comparatively small, the estimates are associational, their precision and heterogeneity are limited, and generalization is restricted to the formal non-agricultural private-sector population represented by the WBES sampling frame.

Keywords: female leadership; female top managers; process innovation; gender diversity; organizational innovation; emerging economies; Ecuador; World Bank Enterprise Survey



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1. Introduction

Research on women in corporate leadership increasingly asks not only whether representation matters, but also which managerial positions, innovation outcomes, and contextual conditions shape the association. Upper echelons theory proposes that executives' experiences and cognitive frames influence strategic attention and organizational choices (Hambrick & Mason, 1984; Hambrick, 2007). Gender-diverse leadership may therefore broaden the knowledge and perspectives available for identifying and implementing change. Systematic evidence nevertheless cautions against treating women's leadership

as a uniform input: studies variously operationalize women on boards, women owners, top-management-team diversity, or a female chief executive, even though these roles differ in authority and proximity to implementation (Alsos et al., 2013; Khushk et al., 2023; Martínez-Zarzoso, 2023).

A positive strand of the literature links women's representation in strategic roles with innovation. Female board representation has been associated with innovation investment and patent outcomes (Chen et al., 2018), and cross-country evidence connects board gender diversity with innovative output (Griffin et al., 2021). In emerging economies, the interaction of women owners and managers may support innovation and productivity (Azeem et al., 2022), while gender diversity in ownership can contribute to technological and non-technological innovation through R&D, external finance, workforce diversity, and organizational learning (Tonoyan & Boudreaux, 2023). These findings identify plausible benefits of cognitive variety and stakeholder orientation, but they do not establish that the sex of a single top manager produces the same effect across organizational settings or innovation types.

A second strand reports contingent, null, or differentiated relationships. Women in top-management teams may increase the number of innovations while narrowing search scope or reducing average impact (Lee & Chung, 2022). Women-led firms can also differ systematically in size, market orientation, financing, and accumulated resources, making selection and structural constraints central to interpretation (Ekmen-Özçelik & Gedik-Balay, 2022; Martínez-Zarzoso, 2023). Critical reviews further note that innovation research can reproduce gender stereotypes when it attributes collaborative or risk-averse styles to women as inherent traits rather than examining authority, institutions, and organizational conditions (Alsos et al., 2013). Accordingly, this study treats female top management as an observed positional characteristic, not as a proxy for an essentialized leadership style.

Ecuador is analytically relevant because it combines productive heterogeneity, a strong presence of smaller firms, uneven innovation capabilities, financing and digital constraints, and persistent under-representation of women in senior business management (World Bank Enterprise Surveys, 2025a). These features make internal, incremental innovation particularly consequential. Evidence from manufacturing firms in Pichincha identifies management capability, knowledge processes, technology, human talent, resource availability, and continuous process improvement as interdependent components of Ecuadorian innovation capacity (Ibujés-Villacís & Franco-Crespo, 2022). The country therefore provides a theoretically informative setting in which a top manager's proximity to operational decisions may matter while organizational and institutional constraints delimit what that position can accomplish.

The Ecuador-specific gender-and-innovation literature is still small and fragmented. Chávez-Rivera et al. (2024), using configurational evidence from 45 Ecuadorian women entrepreneurs, show that innovation performance arises from combinations of institutional, social, and individual conditions rather than from gender alone. Boada et al. (2023) document gender differences in reported leadership styles among firms in Loja, but do not test firm-level innovation outcomes. These studies establish the importance of context and leadership in Ecuador, yet neither compares female- and male-led formal firms nationally nor isolates process innovation from product innovation, R&D, and environmental adoption. The WBES Ecuador 2024 (World Bank Group, 2025), makes that comparison possible with a probability-based, nationally oriented firm survey and a common set of organizational controls.

Three research gaps follow from this critical review. First, most international studies concern boards, ownership, listed corporations, patents, or multicountry samples, leaving the operational role of the top manager less directly examined. Second, product and process

innovation are often combined despite their different antecedents and implementation demands (Damanpour & Gopalakrishnan, 2001; OECD/Eurostat, 2018). Third, Ecuadorian evidence has not yet tested, with recent national firm-level microdata, whether female top management is associated specifically with internal process change while accounting for firm, sectoral, regional, and sampling differences.

The study therefore asks: among formal Ecuadorian firms represented in the World Bank Enterprise Survey (WBES) Ecuador 2024 (World Bank Group, 2025), is having a female rather than a male top manager associated with a higher probability of reporting process innovation, conditional on observable firm characteristics, sector, and region? It also examines whether any association is outcome-specific by comparing process innovation with product innovation, R&D expenditure, green-practice adoption, and performance indicators. The objective is associational and theory-testing; it is not to infer that women possess a universal leadership style or that appointing a woman mechanically causes innovation.

This article contributes by connecting a clearly defined managerial position to a clearly defined innovation outcome in an underexamined national setting. It distinguishes female top management from female ownership and board diversity; distinguishes process innovation from product, R&D, and green outcomes; and explicitly states the population and causal boundaries of inference. The remainder of the article develops the theoretical framework and hypotheses, describes the data and methods, presents the results, and discusses theoretical, managerial, and policy implications.

2. Theoretical Framework and Hypothesis Development

2.1. Upper Echelons and Managerial Proximity to Process Change

Upper echelons theory links organizational choices to executives' boundedly rational interpretations of opportunities and constraints (Hambrick & Mason, 1984; Hambrick, 2007). The top manager is especially relevant to process innovation because production/service methods, logistics, distribution, and supporting activities require prioritization, resource allocation, coordination, and implementation across internal routines. Gender may expand the range of experience and perspectives brought to these decisions, but the observable female_manager indicator does not reveal cognition, leadership style, or decision authority. The theory therefore motivates an association at the positional level; it does not justify a deterministic or essentialist causal claim.

2.2. Critical Mass, Tokenism, and Contextual Contingency

Critical-mass research argues that the influence of women can depend on whether representation is sufficient to alter interaction patterns rather than remaining tokenistic (Torchia et al., 2011). The present dataset observes only the sex of one top manager and cannot measure the proportion of women in a management team; consequently, critical mass is used as a boundary-condition lens, not as a tested mechanism. More generally, resources, sector, region, organizational capabilities, and institutional conditions can enable or constrain the translation of managerial perspectives into innovation. This contingency logic is consistent with evidence that gender–innovation relationships vary by role, innovation type, and context (Alsos et al., 2013; Lee & Chung, 2022; Tonoyan & Boudreaux, 2023).

2.3. Why Process Innovation and Hypothesis Development

Business innovation is multidimensional. Product innovation changes goods or services offered to the market, whereas business process innovation changes how the firm produces or delivers outputs, distributes inputs or outputs, or performs supporting activities (OECD/Eurostat, 2018). Process innovation is prioritized ex ante because it is

the outcome most proximal to the top manager's operational remit and because Ecuadorian firms often build innovation capacity through management, learning, technology adoption, and continuous improvement rather than formal R&D alone (Ibujés-Villacís & Franco-Crespo, 2022). This focus was therefore theory-driven, not selected after observing statistical significance. Product innovation, R&D, and green adoption are retained as comparative outcomes to test whether the association is specific rather than universal.

H1. *Conditional on observable firm characteristics, sector, and region, formal Ecuadorian firms with a female top manager are more likely to report business process innovation than firms with a male top manager (Figure 1).*

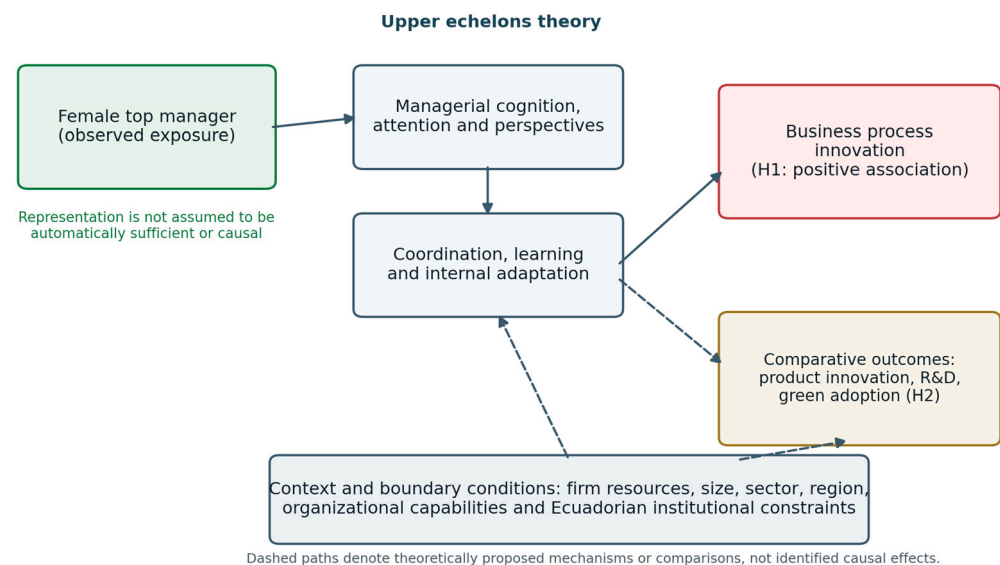


Figure 1. Conceptual framework linking female top management to business process innovation. Note: The framework states the theoretical logic and boundary conditions. Dashed paths represent mechanisms or comparisons not causally identified with the cross-sectional WBES data.

Because product innovation and formal R&D are more externally visible or resource intensive, while green adoption can depend on technologies, regulation, and capital beyond day-to-day coordination, the association need not be equal across outcomes. This argument does not predict that women-led firms outperform in every domain; it predicts outcome specificity.

H2. *The association between female top management and innovation is more evident for business process innovation than for product innovation, R&D expenditure, or green-practice adoption (Figure 2).*

3. Methodology

3.1. Design, Data Source, and Sample

This study adopts a quantitative, non-experimental, cross-sectional and associational design aimed at analyzing the relationship between female leadership in the top managerial position and process innovation in formal Ecuadorian firms. Given the cross-sectional nature of the data, the study does not seek to establish causal relationships, but rather to identify statistically significant associations between the presence of women in senior business management and innovation outcomes, controlling for observable firm characteristics.

The data source used is the Ecuador World Bank Enterprise Survey 2024 (World Bank Group, 2025), hereafter referred to as WBES Ecuador 2024 (World Bank Group, 2025). The World Bank Enterprise Surveys are firm-level surveys administered to representative sam-

ples of the formal non-agricultural private sector. They collect information on the business environment, firm performance, employment, sales, innovation, financing, infrastructure, competition, and other relevant organizational characteristics ([World Bank Enterprise Surveys, 2025b](#)).

This dataset corresponds to reference ECU_2024_WBES_v01_M. Data were collected between February 2024 and March 2025 through face-to-face interviews with establishments drawn from the formal non-agricultural private sector. The dataset was downloaded from the World Bank Microdata Library on 15 January 2026 and subsequently prepared for the statistical analyses conducted in this study. The working dataset contains 345 firms: 279 with a male top manager and 66 with a female top manager (19.1%). The main complete-case model uses 327 observations because of missing control values. The 66 female-led firms are not interpreted as a quota intended to represent half of firms; rather, their share reflects the observed sample in which women are under-represented in top management. Sampling weights support population-oriented estimates within the WBES frame, but the comparatively small female-manager group limits precision, precludes reliable fine-grained subgroup analysis, and requires cautious interpretation of wide confidence intervals and leave-one-out sensitivity. The findings are not generalized to informal, agricultural, or public-sector organizations, or to all women managers in Ecuador.

3.2. Variables

The main dependent variable, *innovation_process*, is constructed from WBES item H5: ‘During the last three years, has this establishment introduced any new or improved process?’ The questionnaire explicitly includes (i) methods of manufacturing products or offering services; (ii) logistics, delivery, or distribution methods for inputs, products, or services; and (iii) supporting activities for processes. The variable equals 1 for a ‘Yes’ response and 0 for a ‘No’ response; non-substantive or inapplicable responses are treated as missing rather than as no innovation. Thus, the measure captures whether at least one qualifying process was introduced during the three-year recall period; it does not measure novelty to the market, number of processes, expenditure, implementation quality, or economic impact. Because it is self-reported and binary, recall and common-method limitations remain possible.

Process innovation is the prespecified primary outcome because it maps most directly onto the top manager’s internal coordination and implementation role. The selection is also substantively appropriate for Ecuador, where innovation capabilities documented in manufacturing firms include managerial capacity, continuous improvement, knowledge management, human talent, technology, and resource recombination ([Ibujés-Villacís & Franco-Crespo, 2022](#)). Product innovation, R&D spending, and green adoption are analyzed separately as theoretically distinct comparisons, reducing the risk that a broad composite obscures outcome heterogeneity.

The key explanatory variable is *female_manager*, which takes the value of 1 if the firm reports having a woman as top manager, and 0 if it reports having a man as top manager. This variable approximates female leadership in senior business management. However, it should be recognized that it measures only the sex of the person occupying the top managerial position and does not capture leadership styles, board composition, decision-making autonomy, actual decision-making power or internal management dynamics.

The main model incorporates firm-level controls: firm size (*ln_employment*), firm age (*firm_age*), top manager’s experience (*top_manager_experience_yrs*), foreign ownership (*foreign_owned_dummy*), female ownership (*female_owner_any*), export status (*export_any*), quality certification (*quality_cert*), formal training (*formal_training*) and a digital capability index (*digital_proxy_index_v3*). Sector and regional fixed effects are also

included to control for structural differences associated with firms' economic activity and geographical location.

As complementary analyses, other business outcomes are considered: product innovation (*innovation_product*), research and development expenditure (*rd_spending*), adoption of green practices (*green_adopt*), sales (*ln_sales*), labour productivity (*ln_labor_productivity*), sales growth (*sales_cagr_3y*), employment growth (*employment_cagr_3y*) and the management practices index (*management_index_core*). The definitions and analytical roles of the main variables are summarized in Appendix A (Table A1).

3.3. Econometric Specification and Main Model

Because the main dependent variable is binary, the central specification is estimated using a logit model. The general equation is:

$$Pr(\text{Innovation Process}_i = 1) = F(\beta_0 + \beta_1 \text{Female Manager}_i + \beta_2 X_i + \delta_s + \gamma_r + \varepsilon_i)$$

where (*Innovation Process_i*) represents the probability that firm (*i*) introduces process innovation; (*FemaleManager_i*) is a dichotomous variable equal to 1 if the firm has a woman as top manager; *X_i* corresponds to the vector of firm-level controls; δ_s represents sector fixed effects; γ_r represents regional fixed effects; and ε_i is the error term. The function $F(\cdot)$ corresponds to the cumulative logistic function.

The parameter of interest is β_1 , which captures the association between female leadership and process innovation, conditional on the firm's observable characteristics. The results of the logit models are reported mainly as odds ratios (OR), which makes it possible to assess whether firms with a woman as top manager present higher or lower odds of introducing process innovation than firms with a man as top manager.

The main specification of the study corresponds to model M3. This model estimates the relationship between *Female Manager* and *Innovation Process*, incorporating firm-level controls, sector and regional fixed effects, wmedian sampling weights and standard errors clustered by stratum (strata). The use of weights allows the sampling structure of the survey to be considered, while clustering standard errors by stratum improves inference in the presence of potential correlations within sampling strata. Accordingly, model M3 is adopted as the main reference for the substantive interpretation of the results.

3.4. Robustness and Complementary Analyses

To assess the stability of the main result, several alternative specifications are estimated. First, logit models without weights, models with sector and regional fixed effects, and models with sampling weights are compared. Second, the variable *female_owner_any* is excluded to verify whether the observed association depends on the presence of female ownership in the firm. Third, additional firm-size fixed effects are incorporated. Fourth, the management practices index (*management_index_core*) is included as a complementary analysis, considering that this variable presents a high level of missing values.

In addition, probit models, linear probability models, models with alternative weights (*wstrict* and *wweak*), a survey-weighted logit estimation, and leave-one-out tests by sector and region are estimated. These strategies make it possible to evaluate whether the sign, magnitude and statistical significance of *female_manager* remain stable under different modelling decisions and after changes in the sectoral or territorial composition of the sample.

In addition to coefficients and odds ratios, predicted probabilities of process innovation are calculated based on the main model M3. This procedure allows the substantive magnitude of the estimated association to be expressed in probability terms and facili-

tates comparison between firms with a man as top manager and firms with a woman as top manager.

Finally, complementary models are estimated to assess whether the association between female leadership and innovation extends to other business dimensions. Logit models are used for product innovation, R&D expenditure and the adoption of green practices. Linear models are estimated for sales, labor productivity and business growth. These results are interpreted as complementary evidence, given that the central objective of the study focuses on process innovation.

3.5. Methodological Considerations

The study presents several relevant methodological considerations. First, the WBES 2024 (World Bank Group, 2025) is a cross-sectional dataset; therefore, the results should be interpreted as conditional associations rather than causal effects. Second, *female_manager* measures only whether the top manager is a woman, without observing leadership styles, actual decision-making power, the composition of management teams or specific forms of management. Third, the management practices index (*management_index_core*) presents a high proportion of missing values; consequently, it is used only as a complementary analysis and not as a central variable in the main model.

Fourth, labor productivity should be interpreted with caution because it is constructed from sales and employment. In logarithmic terms, the relationship can be expressed as:

$$\ln_labor_productivity = \ln_sales - \ln_employment$$

For this reason, when *ln_employment* is incorporated as a control, the coefficients of the remaining covariates may coincide algebraically with those of the sales model. To address this limitation, alternative specifications are estimated without directly including *ln_employment* as a control.

Finally, although firm-level controls, sector and regional fixed effects, sampling weights and standard errors clustered by stratum are incorporated, it is not possible to completely rule out the influence of unobserved heterogeneity or selection processes associated with the presence of women in top managerial positions.

4. Results

4.1. Sample Characteristics and Descriptive Differences

The analytical sample comprised 345 formal Ecuadorian firms. Of these, 279 reported a male top manager and 66 a female top manager. The 19.1% female-manager share is substantively consistent with the under-representation that motivates the study; it is not evidence that women should constitute half of the survey. At the same time, 66 cases constrain statistical precision and the ability to estimate sector-by-region heterogeneity. For that reason, descriptive comparisons, weighted pooled models, confidence intervals, and sensitivity tests are reported together, and no claim is made that the female-led subsample represents every type of woman-managed business in Ecuador.

In the full sample, 64.1% of firms reported having introduced process innovation, 77.7% reported product innovation, 36.8% reported expenditure on research and development, and 61.6% reported the adoption of green practices. These indicators show that product innovation was more frequent than process innovation, while the adoption of green practices was reported by a substantial proportion of firms.

The comparison by the sex of the top manager reveals notable differences. The most relevant descriptive finding for this study concerns process innovation: 62.0% of firms with a male top manager reported having introduced process innovation, compared with

72.7% of firms with a female top manager (Table 1). This represents a simple difference of 10.7 percentage points in favour of female-led firms.

Table 1. Selected descriptive differences according to the sex of the top manager.

Variable	Male Top Manager	Female Top Manager	Female–Male Difference	<i>p</i> -Value
Female ownership	53.80%	89.20%	35.4 pp	<0.001
Managerial experience	27.0 years	22.0 years	−5.0 years	0.002
Quality certification	28.00%	14.30%	−13.5 pp	0.012
Sales, log	14.547	14.007	−0.54	0.041
Process innovation	62.00%	72.70%	10.7 pp	0.089
Product innovation	78.50%	74.20%	−4.3 pp	0.477
R&D expenditure	37.30%	34.80%	−2.4 pp	0.713
Green adoption	60.80%	65.20%	4.4 pp	0.51
Managerial index	0.637	0.674	0.036	0.342
Digital index	0.677	0.663	−0.014	0.603

Note: Binary variables are reported as percentages; indices are reported on a 0–1 scale. The comparison is based on a *t*-test for differences in means. Descriptive statistics are unweighted. These differences are descriptive and should not be interpreted as causal evidence. Source: Own elaboration based on WBES Ecuador 2024 (World Bank Group, 2025).

The descriptive difference in process innovation is consistent with the central hypothesis of the study. Although its statistical significance is marginal in the simple comparison, the magnitude of the difference suggests a potential association between female leadership and internal organizational innovation. By contrast, no statistically significant differences are observed in product innovation, R&D expenditure, or green adoption. This suggests that the potential association between female leadership and innovation does not appear to extend to all dimensions, but rather is concentrated mainly in process innovation (Figure 2).

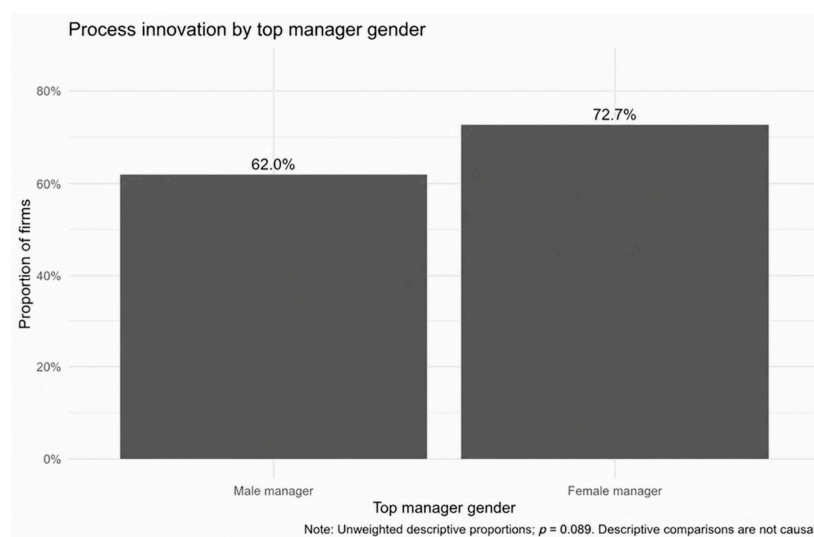


Figure 2. Process innovation by sex of the top manager. Source: Own elaboration based on WBES Ecuador 2024 (World Bank Group, 2025).

4.2. Female Top Management and Process Innovation

To assess whether the descriptive association between female leadership and process innovation persists after controlling for observable firm characteristics, logit models were estimated. The main dependent variable is a dichotomous variable equal to 1 if the firm introduced process innovation and 0 otherwise. The key explanatory variable is *female_manager*, which equals 1 if the firm reports having a female top manager.

The main model includes controls for firm size, firm age, managerial experience, foreign ownership, female ownership, exporter status, quality certification, formal training, and the digital index. It also includes sector and region fixed effects, uses wmedian sampling weights, and clusters standard errors by stratum. This specification corresponds to model M3. The results are presented in Table 2.

Table 2. Female leadership and process innovation: main model and robustness checks.

Model	Specification	n	Coef.	OR [95% CI]	p-Value
M1 Baseline	Baseline logit, without fixed effects or weights	327	0.542	1.719 [0.842; 3.508]	0.137
M2 Sector–region FE	Sector–region fixed effects, clustered standard errors	327	0.482	1.619 [0.779; 3.364]	0.196
M3 Main	Sector–region fixed effects + weights + clustered standard errors	327	1.245	3.475 [1.570; 7.688]	0.002
M4 Without female ownership	M3 excluding female_owner_any	332	1.137	3.117 [1.450; 6.700]	0.004
M5 Firm-size FE	M3 + firm-size fixed effects	327	1.245	3.473 [1.573; 7.670]	0.002
M6 Firm-size FE without female ownership	M3 + firm-size fixed effects, excluding female_owner_any	332	1.135	3.112 [1.458; 6.644]	0.003
M7 Managerial practices	M3 + managerial index	167	2.017	7.519 [1.417; 39.897]	0.018

Note: The dependent variable is process innovation. OR = odds ratio. The 95% confidence interval was calculated from the model standard errors. Model M3 is the main specification. Source: Own elaboration based on WBES Ecuador 2024 (World Bank Group, 2025).

The baseline model, without fixed effects or weights, shows a positive coefficient for female leadership, although it is not statistically significant. However, once fixed effects, sampling weights, and stratum-clustered standard errors are incorporated, the coefficient associated with female_manager increases in magnitude and becomes statistically significant.

In the main model, M3, firms with a female top manager have odds of introducing process innovation that are 3.475 times those of firms led by men. The 95% confidence interval ranges from 1.570 to 7.688, with a *p*-value of 0.002.

The positive association between female leadership and process innovation remains stable across the main robustness checks. When the female ownership variable is excluded, the OR remains at 3.117, suggesting that the result does not depend exclusively on female-led firms having a higher presence of women among firm owners. Similarly, when firm-size fixed effects are included, the OR remains virtually unchanged at 3.473. This indicates that the association between having a female top manager and process innovation is not explained solely by differences in sectoral, regional, or firm-size composition.

Model M7 includes the managerial practices index as an additional control. Although this specification reduces the sample to 167 observations because of the high proportion of missing values in the managerial index and additional controls, the coefficient for female leadership remains positive and statistically significant. However, given the reduction in sample size, this result should be interpreted as complementary evidence rather than as the main specification.

4.3. Predicted Probabilities and Substantive Magnitude

To facilitate the substantive interpretation of the main model, predicted probabilities of process innovation were calculated from model M3. These predictions retain the structure of controls, fixed effects, sampling weights, and stratum clustering used in the main specification.

The results show that the predicted probability of process innovation is 48.9% for firms with a male top manager and 72.6% for firms with a female top manager (Figure 3). This represents an adjusted difference of 23.7 percentage points in favour of female-led firms.

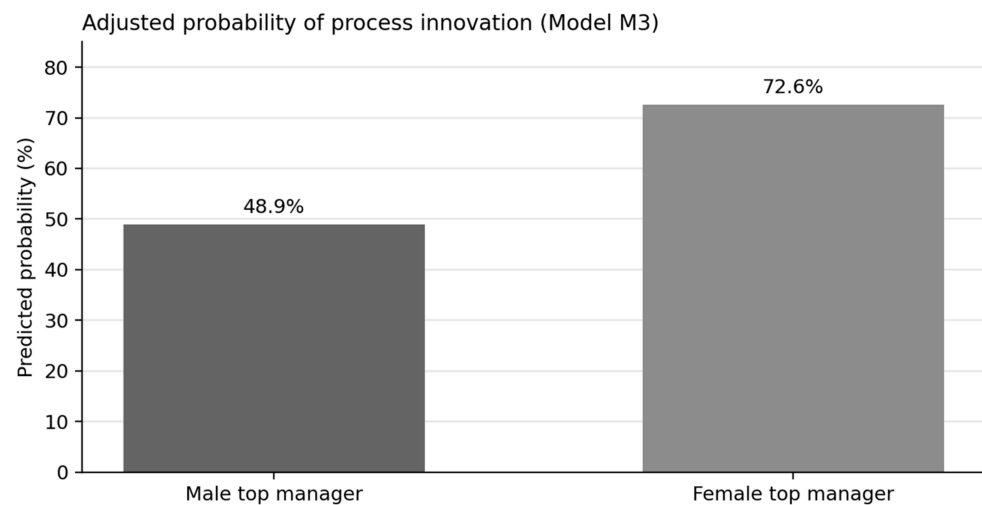


Figure 3. Predicted probability of process innovation in the main model. Source: Own elaboration based on WBES Ecuador 2024 (World Bank Group, 2025).

The difference between the descriptive gap and the adjusted gap should be interpreted with caution. The descriptive comparison captures unadjusted differences between groups, whereas the predicted probability from model M3 incorporates firm-level controls, sector and region fixed effects, sampling weights, and clustering by stratum. Therefore, the adjusted difference may differ from the simple observed difference.

This result reinforces the central interpretation of the study: female leadership is associated with a higher probability of introducing process innovations, even after controlling for observable firm characteristics and for sectoral and regional heterogeneity.

4.4. Robustness of the Main Result

To assess the stability of the main finding, several alternative specifications were estimated: a probit model, linear probability models, models using alternative weights, a survey-weighted logit specification, and leave-one-out tests by sector and region. Overall, the robustness checks support the direction of the main result. The coefficient associated with female leadership remains positive across the alternative specifications.

In the linear probability models, having a female top manager is associated with an approximate increase of 24.2 percentage points in the probability of process innovation. The models using alternative weights also support the finding: with *wstrict*, the OR is 3.042, whereas with *wweak* it increases to 4.351. The survey-weighted logit model reproduces an OR close to that of the main model, with a value of 3.475 (Table 3).

The leave-one-out tests show that the coefficient for female leadership remains positive when sectors or regions are excluded alternately. When the food, non-food manufacturing, or retail sector is excluded, the association remains positive and statistically significant. However, when the other services sector is excluded, the OR decreases to approximately 1.496 and is no longer statistically significant. Similarly, when the East region is excluded, the OR remains positive but loses statistical significance. This suggests that the result is robust in direction, although sensitive to the sectoral and regional composition of the sample. Accordingly, the evidence should be interpreted as a consistent positive association, rather than as a universal causal effect.

Table 3. Robustness of the association between female leadership and process innovation.

Model	Specification	n	Coefficient/Effect [95% CI]	OR [95% CI]	p-Value
M8	Probit with fixed effects, weights, and clustered standard errors	327	0.737 [0.264; 1.210]	Not applicable	0.002
M9	Linear probability model with fixed effects, weights, and clustered standard errors	327	0.242 [0.098; 0.387]	Not applicable	0.002
M10	Linear probability model with firm-size fixed effects	327	0.242 [0.099; 0.385]	Not applicable	0.002
M11	Logit with wstrict weight	327	1.113 [0.337; 1.888]	3.042 [1.401; 6.608]	0.005
M12	Logit with wweak weight	327	1.471 [0.686; 2.255]	4.351 [1.986; 9.533]	<0.001
M13	Survey-weighted logit	327	1.245 [0.253; 2.238]	3.475 [1.288; 9.372]	0.015

Note: LPM = linear probability model. In LPM specifications, the coefficient is interpreted in probability points. In logit models, ORs are reported. Source: Own elaboration based on WBES Ecuador 2024 (World Bank Group, 2025).

4.5. Secondary Results

After identifying the central result for process innovation, we assessed whether this association extended to other dimensions of innovation, sustainability, and firm performance. To this end, additional models were estimated for product innovation, R&D expenditure, green-practice adoption, sales, labour productivity, sales growth, employment growth, and organizational mechanisms.

The results show that female leadership is not statistically significantly associated with product innovation, R&D expenditure, or green adoption. For product innovation, the OR is below 1 and is not statistically significant. For R&D expenditure and green adoption, the OR is above 1; however, the confidence intervals include 1 and the *p*-values do not allow rejection of the null hypothesis (see Table 4).

Table 4. Female leadership in other innovation and sustainability outcomes.

Outcome	Coef.	OR [95% CI]	p-Value	Interpretation
Product innovation	−0.589	0.555 [0.242; 1.273]	0.164	Not statistically significant
R&D expenditure	0.443	1.557 [0.703; 3.448]	0.275	Not statistically significant
Green adoption	0.429	1.535 [0.578; 4.080]	0.390	Not statistically significant

Note: Logit models with sector and region fixed effects, wmedian weights, and standard errors clustered by strata. Source: Own elaboration based on WBES Ecuador 2024 (World Bank Group, 2025).

These findings indicate that the relationship between female leadership and innovation is not homogeneous across all dimensions. The strongest evidence is concentrated in process innovation, rather than in product innovation or formal investment in R&D. This pattern suggests that female leadership is more closely related to internal transformations within the firm, such as working methods, operations, logistics, internal coordination, or service delivery, than to visible product innovations, formal R&D expenditure, or environmental adoption.

In the case of firm performance, a negative association is observed between female leadership and sales in logarithms. However, this result should be interpreted with caution, as the cross-sectional design does not make it possible to distinguish whether differences in sales reflect current leadership, prior firm trajectories, scale constraints, or unobserved firm characteristics. Nor is robust evidence found of a significant relationship with sales

growth or employment growth. Accordingly, the performance results should be treated as complementary and not as the central focus of the article.

The exploratory analyses of organizational mechanisms also do not show a statistically significant association between female leadership and the managerial index, formal training, or quality certification. Therefore, there is no evidence that these observed mechanisms directly explain the association between female leadership and process innovation. Nevertheless, other unobserved mechanisms cannot be ruled out, such as leadership styles, orientation towards change, internal culture, or forms of operational coordination.

4.6. Diagnostics and Scope of the Evidence

The methodological diagnostics support the use of model M3 as the main specification. Most of the variables used in the main model show low levels of missing values. The main exception is `management_index_core`, with 49.3% missing values; for this reason, the managerial index is used only as a complementary analysis and not as a central variable in the study. Likewise, the collinearity diagnosis does not indicate severe problems: the adjusted GVIF values remain at moderate levels. Appendix A (Table A2) summarizes the effective sample sizes, robustness checks, and basic diagnostic findings.

The labour productivity variable should also be interpreted with caution, as $\ln_labor_productivity = \ln_sales - \ln_employment$. When $\ln_employment$ is included as a control, the coefficients of the remaining covariates coincide algebraically with the sales model. For this reason, the productivity results are reported only as complementary evidence.

Finally, given the cross-sectional nature of the WBES 2024 (World Bank Group, 2025), the results should be interpreted as conditional associations and not as causal evidence. The empirical design allows the identification of statistically significant differences associated with female leadership, controlling for observable firm characteristics, sector and region fixed effects, sampling weights, and standard errors clustered by stratum. However, it does not allow the influence of unobserved heterogeneity, prior firm trajectories, or selection into the presence of women in top management to be completely ruled out.

5. Discussion

The main finding is an adjusted association, not a causal effect: formal Ecuadorian firms with a female top manager show higher odds of reporting process innovation in model M3 (OR = 3.475; 95% CI [1.570, 7.688]; $p = 0.002$). The positive direction persists across alternative specifications, but the interval is broad and leave-one-out significance weakens when other services or the East region are removed. The appropriate conclusion is therefore that the full WBES sample contains a robust positive conditional association whose magnitude and cross-context stability remain uncertain.

The result is compatible with upper echelons theory because the top manager can shape strategic attention, resource allocation, and implementation priorities (Hambrick & Mason, 1984; Hambrick, 2007). It also aligns with studies connecting women in strategic positions to innovation (Chen et al., 2018; Griffin et al., 2021; Kong et al., 2024). However, those studies frequently examine boards, teams, or patents. The present evidence is narrower and more operational: it links the sex of one top manager to a self-reported indicator of internal process change. It cannot demonstrate that cognition, collaboration, or stakeholder orientation mediates the relationship, because these mechanisms are not observed.

This distinction addresses a recurrent problem in the literature: women on boards, women owners, women in top-management teams, and female chief executives are analytically different constructs (Alsos et al., 2013; Martínez-Zarzoso, 2023). The result should not be interpreted as proof of an inherently ‘female’ style. Rather, women’s access to a position with operational authority may introduce experiences and perspectives that matter under

some organizational conditions, while the realized outcome still depends on resources, authority, sector, and institutions.

The Ecuadorian evidence strengthens this contextual interpretation. [Chávez-Rivera et al. \(2024\)](#) find that innovation among Ecuadorian women entrepreneurs emerges from configurations of institutional, social, and individual conditions. [Ibujés-Villacís and Franco-Crespo \(2022\)](#) identify managerial capacity, knowledge, technology, talent, resources, and continuous improvement as interacting elements of innovation management in Pichincha manufacturing firms. The current national firm-level result complements those studies: it shows an association with process innovation after observable controls, but it does not reduce innovation to the manager's sex or identify which contextual configuration generated the outcome.

The contrast across outcomes is theoretically informative. Process and product innovation have distinct adoption dynamics ([Damanpour & Gopalakrishnan, 2001](#)), and process innovation is closer to routines, logistics, delivery, and supporting activities. No statistically significant association appears for product innovation, R&D expenditure, or green adoption. This pattern supports H2 only in a comparative evidentiary sense: the data reveal statistical evidence for process innovation and not for the alternative outcomes, but they do not establish that the coefficients differ significantly from one another unless formally tested in a joint framework.

The absence of a significant association with product innovation and R&D expenditure may also be interpreted in light of the constraints faced by many female-led firms. [Ekmen-Özçelik and Gedik-Balay \(2022\)](#) show that firms with women in senior management positions may differ from male-led firms in size, market orientation, and available resources. From this perspective, process innovation may constitute a more feasible form of innovation for firms facing constraints in scale, financing, or access to networks, as it may depend less on formal R&D investment and more on coordination capabilities, internal reorganization, and operational learning.

This result also connects with [Tonoyan and Boudreaux \(2023\)](#), who show that gender diversity in ownership and management is associated with general innovativeness, technological innovation, and non-technological innovation in emerging economies, and that this relationship operates partly through R&D investment and access to external capital. In the Ecuadorian case, the finding for process innovation may be capturing a dimension of non-technological or organizational innovation, more closely linked to internal changes than to formal R&D expenditure. However, since the present study does not find a significant association with R&D expenditure, the most cautious interpretation is that female leadership appears to be related to internal processes of organizational change, but not necessarily to formal investment in research and development.

Complementing this perspective, [Wu and Liu \(2025\)](#) find a positive relationship between gender diversity in top management and firm-level digital transformation in Chinese firms, identifying digital innovation and the alleviation of financial constraints as potential mechanisms. Although their study focuses on management team composition and digital transformation, rather than the gender of a single top manager and business process innovation, it provides complementary evidence on the relationship between gender diversity in leadership and organizational change.

The secondary results reinforce this differentiated interpretation and partially support H2. Female top management does not show a statistically significant association with product innovation, R&D expenditure, or green-practice adoption. This pattern suggests that the relationship between female leadership and innovation should not be interpreted as a generalized effect on any firm-level outcome. In the case of green adoption, the result partially contrasts with studies that find links between gender diversity and environmental

performance or climate commitment, particularly in boards and top management teams. For example, [Xie et al. \(2020\)](#) associate gender diversity on boards with corporate environmental strategy, while [Caby and Coron \(2022\)](#) link gender diversity in top management teams to climate commitment. The difference may be explained by the fact that these studies focus on boards, corporate sustainability, or environmental disclosure, whereas the present study analyses top management and green adoption in formal Ecuadorian firms.

The evidence on firm performance should also be interpreted with caution. In the complementary models, a negative association is observed between female leadership and sales in logarithms, but no robust evidence is found of a significant relationship with sales growth or employment growth. This result relates to the literature warning that female-led firms may face structural constraints in terms of size, capitalization, access to markets, and financing. [Martínez-Zarzoso \(2023\)](#) shows that the relationship between female management and productivity is not uniform, and that a distinction must be made between female management, female ownership, and the combination of both. Consequently, the negative result for sales should not be interpreted as evidence of lower managerial capacity, but rather as a possible indication that firms with a female manager operate under different structural conditions, prior trajectories, or unobserved constraints.

The exploratory analyses of organizational mechanisms also provide no evidence that the managerial index, formal training, or quality certification directly explain the association between female leadership and process innovation. This result has two possible interpretations. On the one hand, it may indicate that the mechanisms observed in the WBES do not adequately capture the channels through which female management is linked to internal innovations. On the other hand, it may reflect measurement limitations, especially because the managerial practices index has a high proportion of missing values and reduces the effective sample. In this sense, the absence of statistical significance in the observed mechanisms does not allow unobserved mechanisms to be ruled out, such as leadership styles, organizational culture, team coordination, orientation towards change, informal learning, or internal adaptation processes.

The theoretical contribution is therefore a conditional, non-essentialist extension of upper echelons reasoning. Executive characteristics can be associated with organizational choices, but the influence of a top manager is filtered through decision authority, resources, capabilities, and context. Critical-mass theory cannot be tested because the WBES does not observe the gender composition of the management team. Its value here is to clarify why the presence of one woman should not automatically be equated with transformed group dynamics ([Torchia et al., 2011](#)). The conceptual framework accordingly separates the observed association from unobserved mechanisms and contextual moderators.

This sectoral and regional sensitivity deserves attention. The leave-one-out tests show that the sign of the coefficient associated with female leadership remains positive when sectors or regions are excluded alternately, but significance weakens when certain groups, such as other services or the East region, are excluded. This does not invalidate the main finding, but it does suggest that the relationship between female leadership and process innovation may depend on the productive and territorial structure of the sample. Accordingly, the estimated association should be understood as a consistent empirical regularity in the full sample, but not necessarily as homogeneous across all sectors or regions.

Empirically, the study fills a circumscribed gap. Earlier Ecuadorian work has examined women entrepreneurs' configurations of innovation performance ([Chávez-Rivera et al., 2024](#)), local leadership styles ([Boada et al., 2023](#)), and innovation-management capabilities in manufacturing ([Ibujés-Villacís & Franco-Crespo, 2022](#)). This study instead uses recent WBES microdata to compare female- and male-led formal firms nationally, focuses on the top-

manager position, and distinguishes process innovation from other outcomes. Its contribution is incremental and context-specific rather than a universal test of women's leadership.

Managerial implications should focus on organizational design rather than symbolic appointments. Firms can widen transparent promotion pipelines, provide women managers with genuine budgetary and operational authority, and pair leadership development with process-mapping, digitalization, employee problem-solving systems, and cross-functional teams. Because the study does not identify mechanisms, these actions are evidence-informed propositions, not interventions proven by the model. Firms should evaluate them with sex-disaggregated process metrics, implementation timelines, and before–after or pilot comparisons.

Policy implications are similarly bounded. Public agencies, chambers, universities, and financial institutions could integrate women's leadership programs with technical assistance for process redesign, digital adoption, quality systems, managerial training, innovation networks, and appropriately structured finance. Targeting should recognize differences by firm size, sector, and region rather than treating women-led firms as homogeneous. Evaluation designs should track access, implementation, and process outcomes and should avoid interpreting the present cross-sectional association as the expected causal return to a particular program.

6. Conclusions

Using the WBES Ecuador 2024 (World Bank Group, 2025), this study examined whether the sex of the top manager is associated with business process innovation among formal non-agricultural private-sector firms. Process innovation was explicitly measured through item H5 as the introduction, during the prior three years, of new or improved production/service methods, logistics/delivery/distribution methods, or supporting activities.

The results show that firms with a female top manager have a higher probability of introducing process innovation than firms led by men. In the main model, which includes firm-level controls, sector and region fixed effects, sampling weights, and standard errors clustered by stratum, female leadership is associated with odds of introducing process innovation that are 3.475 times higher, with a 95% CI [1.570; 7.688] and $p = 0.002$. This result remains positive across several robustness checks, including specifications excluding female ownership, firm-size fixed effects, probit models, linear probability models, alternative weights, and survey-weighted estimates.

The results support H1 as an associational hypothesis within the analyzed survey population. They do not establish that female top management causes process innovation, that the estimated magnitude applies to every Ecuadorian sector or region, or that women share a uniform managerial style.

H2 receives partial support because statistical evidence is concentrated in process innovation, whereas product innovation, R&D expenditure, and green-practice adoption are not significantly associated with female top management. This is evidence of outcome specificity, but not a formal proof that all cross-outcome coefficients differ.

The main contribution of the study is not to claim that female leadership improves all aspects of firm performance, but rather to show that it is associated with a specific dimension of innovation: process innovation. This finding is relevant because it qualifies the literature on gender and innovation by showing that the relationship depends on the type of leadership analyzed, the type of innovation studied, and the business context in which it occurs.

For the Ecuadorian case, the study provides recent micro-firm evidence on an under-explored relationship: the presence of women in top management and its association with internal processes of organizational transformation. In an environment characterized by

productive heterogeneity, financing constraints, sectoral differences, and gender gaps in managerial positions, the results suggest that female management may be more closely linked to internal and organizational changes than to formal technological innovation, R&D expenditure, or general financial performance.

Finally, the results should be interpreted as conditional associations and not as causal evidence. The WBES 2024 (World Bank Group, 2025) is a cross-sectional dataset and therefore does not allow prior trajectories to be observed or establish whether the presence of a female manager directly causes process innovation. In addition, the *female_manager* variable identifies the sex of the top manager, but does not measure leadership styles, decision-making autonomy, management team composition, or actual decision-making power within the firm.

At the firm level, the findings justify testing integrated initiatives that combine equitable access to top-management roles with real decision authority and capabilities for operational improvement. Relevant supports include process mapping, digital tools, quality management, employee suggestion systems, cross-functional coordination, and leadership development. Organizations should monitor whether these initiatives change concrete process outcomes rather than assuming benefits from representation alone.

Nevertheless, female presence in management should not be understood as a sufficient condition for innovation. The evidence from the study shows a positive association with process innovation, but this relationship requires organizational conditions that allow managerial potential to be translated into concrete outcomes. Therefore, the inclusion of women in decision-making positions should be accompanied by managerial training, the strengthening of digital capabilities, team training, access to business networks, financing, and improvements in internal processes.

At the policy level, support for women's business leadership can be linked to innovation extension services, digital transformation, mentoring networks, procurement opportunities, and finance for process upgrading, especially for smaller firms. Programs should be differentiated by sector and region and evaluated with longitudinal or quasi-experimental designs. More generally, the study shows why gender-inclusive innovation policy should address both representation and the complementary resources that allow managerial authority to translate into implementation.

Business support institutions, chambers of commerce, universities, and public agencies could also promote training and mentoring spaces for women in managerial positions. Since process innovation is linked to internal changes in working methods, organization, logistics, and coordination, interventions should not focus solely on R&D or advanced technology, but also on operational management, basic digitalization, process improvement, internal productivity, and organizational culture.

Academically, the study recommends avoiding general approaches that assume that female leadership relates in the same way to all firm-level outcomes. The evidence shows the need to distinguish between process innovation, product innovation, R&D expenditure, sustainability, and financial performance. This distinction allows more precise hypotheses to be constructed and helps avoid overgeneralized conclusions about gender, leadership, and firm-level innovation.

The first limitation is temporal and causal: the cross-sectional WBES cannot establish sequencing or rule out unobserved selection. The second is statistical: only 66 of 345 firms report a female top manager, which yields meaningful pooled evidence but limited precision and insufficient support for detailed intersectional, sectoral, or regional estimates. The third is construct validity: *female_manager* records the sex of one officeholder, not leadership behavior, authority, management-team composition, or critical mass. The fourth

is measurement: process innovation is a binary self-report over three years and does not capture novelty, intensity, implementation quality, or economic impact.

Future research should combine longitudinal firm panels with executive transitions, richer measures of managerial authority and team composition, and direct indicators of process-innovation intensity and performance. Matched designs, instrumental strategies where defensible, and natural experiments could improve causal identification. Qualitative comparative work across Ecuadorian sectors and regions could test the proposed mechanisms—attention, coordination, learning, and internal adaptation—without presuming that they are inherently gendered.

Research should also examine intersectionality and organizational context, including ethnicity, age, education, ownership, firm size, informality, and access to finance and networks. Larger samples are needed to test whether female top management interacts with managerial critical mass or whether benefits depend on complementary digital, human-capital, and knowledge-management capabilities.

Finally, comparative Latin American studies using harmonized WBES measures could assess whether Ecuador represents a broader regional pattern or a context-specific association. Such work should pre-register primary outcomes, formally compare coefficients across innovation types, and report design-based uncertainty so that theoretical claims do not outrun the evidence.

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Data Availability Statement: The data supporting the findings of this study are available from the World Bank Microdata Library, specifically the Ecuador—World Bank Enterprise Survey 2024 (World Bank Group, 2025) dataset. Access to the microdata is subject to the terms and conditions established by the World Bank Microdata Library. The cleaned analytical dataset, variable construction procedures, and statistical code used in this study are available from the corresponding author upon reasonable request, subject to compliance with the World Bank’s data access and use policies. The World Bank describes the Enterprise Survey as a firm-level survey of a representative sample of the formal private sector, covering topics related to the business environment and firm performance.

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Abbreviations

The following abbreviations are used in this manuscript:

Abbreviation	Definition
CI	Confidence interval
FE	Fixed effects
GVIF	Generalized variance inflation factor
LPM	Linear probability model
OECD	Organization for Economic Co-operation and Development
OR	Odds ratio
PP	Percentage points
R&D	Research and development
WBES	World Bank Enterprise Survey

Appendix A. Variables, Effective Sample, and Basic Diagnostic

Table A1. Main variables used in the analysis.

Variable	Description	Use in the Study
innovation_process	Takes the value of 1 if the firm introduced a process innovation; 0 otherwise.	Main dependent variable
female_manager	Takes the value of 1 if the firm reports having a female top manager; 0 if the top manager is male.	Central explanatory variable
ln_employment	Natural logarithm of the current number of employees.	Firm-size control
firm_age	Age of the firm in years.	Control
top_manager_experience_yrs	Years of experience of the top manager.	Control
foreign_owned_dummy	Takes the value of 1 if the firm has foreign ownership participation.	Control
female_owner_any	Takes the value of 1 if there is female ownership in the firm.	Control/robustness check
export_any	Takes the value of 1 if the firm exports directly or indirectly.	Control
quality_cert	Takes the value of 1 if the firm holds a quality certification.	Control
formal_training	Takes the value of 1 if the firm offers formal training.	Control
digital_proxy_index_v3	Index of digital capabilities constructed from proxies available in the WBES.	Control

Table A1. *Cont.*

Variable	Description	Use in the Study
management_index_core	Index of managerial practices.	Exploratory robustness check
wmedian	Main sampling weight from the WBES.	Weighting of the main model
strata	Sampling stratum.	Clustering of standard errors

Source: Author's own elaboration based on WBES Ecuador 2024 ([World Bank Group, 2025](#)).

Table A2. Effective sample, robustness checks, and basic diagnostics.

Item	Result
Total sample	345 firms
Main model M3	327 observations
Model with managerial practices	167 observations
Main specification	Logit model with sector and region fixed effects, wmedian weights, and standard errors clustered by strata
Main result	OR = 3.475; 95% CI [1.570, 7.688]; $p = 0.002$
Without female ownership	OR = 3.117; $p = 0.004$
With firm-size fixed effects	OR = 3.473; $p = 0.002$
Probit	Positive and statistically significant coefficient
Linear probability model	Approximate association of +24.2 percentage points; $p = 0.002$
Alternative weights	wstrict: OR = 3.042; wweak: OR = 4.351
Survey-weighted logit	OR = 3.475; $p = 0.015$
Sectoral/regional sensitivity	The sign remains positive; statistical significance weakens when other services or the Eastern region are excluded
Highest missingness	management_index_core: 49.3% missing values
Collinearity	Moderate adjusted GVIFs; no evidence of severe collinearity
Labour productivity	Interpreted with caution because $\ln_labor_productivity = \ln_sales - \ln_employment$
Causal scope	Conditional association; no causality due to the cross-sectional design

Source: Author's own elaboration based on WBES Ecuador 2024 ([World Bank Group, 2025](#)).

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