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INFORMAL COMPETITION AND INNOVATION IN SOUTHEAST ASIAN COUNTRIES: EXAMINING THE MODERATING INFLUENCE OF GENDER

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ABSTRACT

This study investigates the impact of informal competition on the innovation of Southeast Asian firms and the moderating role of female management in the informal competition–innovation nexus. In the Southeast Asian context, the informal sector employs around 78% of the working population, which is higher than the world average of 61% and the Asia-Pacific average of 68%. The analysis is based on firm-level data collected by the World Bank for eight Southeast Asian countries in 2015–2016. The quantitative analysis was conducted with the use of the multilevel mixed-effects logistic regression method to address the hierarchical/multilevel problem. Additionally, the potential endogeneity problem was taken into account with the use of the propensity score matching technique. The findings show that informal competition induces firms to increase their product and process innovations. Furthermore, female management is important in leveraging the positive effects of informal competition on innovation.

Contribution/Originality: This study is possibly the initial step toward developing the mechanisms of the moderating role of gender in the informal competition–innovation relationship. Moreover, this research advances scholarly understanding of informal competition and its impact on innovation in the Southeast Asian region.

1. INTRODUCTION

Innovation is the most important driver of inclusive growth and long-term sustainable economic development in Southeast Asia, as innovation stimulates productivity gains for businesses and expands consumption, investment, and exports (ERIA, 2018; OECD, 2019). As part of this strategy, formal firms play a key role and are encouraged to innovate as they have adequate resources (McCann & Bahl, 2017; Pérez, Yang, Bai, Flores, & Heredia, 2019). Nevertheless, formal firms are increasingly concerned about the threat posed by informal enterprises, which may disrupt their innovation strategies (Abbas, Adapa, Sheridan, & Azeem, 2022; Pérez et al., 2019). In fact, in developing nations, the informal sector is a major challenge because of inadequate institutional frameworks. As a result, the rise of informal enterprises (e.g., those that do not pay taxes) poses a severe threat to established businesses since they can take unfair advantage of a wide range of benefits.

The informal sector employs around 78% of the working population in Southeast Asia, which is higher than the world average of 61% and the Asia-Pacific average of 68% (ASEAN Secretariat, 2019; ILO, 2020). Given the

background, this first objective of this paper aims to investigate the role of informal competition in firm-level innovation in the Southeast Asian context.

Approximately 61.3 million women manage or own businesses in Southeast Asian nations (UNESCAP, 2018). More specifically, women make up 69%, 64%, and 51% of the business activities in the Philippines, Thailand, and Vietnam, respectively (UNESCAP, 2018). As women are playing an increasingly important role in firm performance and innovation in Southeast Asia, it is interesting to investigate their moderating role in formal firms' innovation under competition from the informal sector. Therefore, the second objective of this paper is to provide a better understanding of the mechanisms through which female management can moderate the informal competition–innovation relationship.

This study offers three novel contributions to the literature. First, to the best of the authors' knowledge, the role of female management in moderating the informal competition–innovation relationship has not yet been studied. Therefore, this study is possibly the initial step toward developing the mechanisms of the moderating role of gender in the informal competition–innovation relationship. This study argues that compared to males, female managers have more adaptable and democratic managerial traits, making formal firms more resilient to informal competition. This ultimately enhances formal firms' innovation in the face of informal competition (Dohse, Goel, & Nelson, 2019; Liao, Zhang, & Wang, 2019; Tian, Wang, Xie, Jiao, & Jiao, 2019).

Second, this research shows how informal rivalry affects product and process innovation in the Southeast Asian context. While there has been rich literature on this research theme in China (Pérez et al., 2019), Eastern Europe and Central Asia (McCann & Bahl, 2017), Africa and Latin America (Mendi & Costamagna, 2017), and Sub-Saharan Africa (Avenyo, Konte, & Mohnen, 2021), there has been no research on this topic in the context of Southeast Asia.

Finally, this study contributes in terms of research methods. The problem of multilevel data structure and endogeneity has not been comprehensively addressed in prior research on the role of informal competition in innovation. Only one study, by Pérez, Kunc, Durst, Flores, and Geldes (2018), has been identified that dealt with the endogeneity problem by using the propensity score matching (PSM) technique. Therefore, this study fills the methodological gap in this stream of research.

The remainder of the study is organized as follows: In Section 2, the theoretical framework and hypotheses are developed; the data and empirical methods are described in Section 3; Section 4 contains the results and discussions; and Section 5 comprises the summary and implications for managers.

2. LITERATURE REVIEW

2.1. Informal Competition and Innovation

Previous literature has offered various definitions of informal firms. According to Nichter and Goldmark (2009), informal firms are "businesses that are unregistered but derive income from the production of legal goods and services". In the same vein, Pérez et al. (2018) defined the informal sector as "economic activities in the production and trade of goods and services that are conducted by unregistered firms that operate outside of government regulation and taxation systems" (Pérez et al., 2018).

Based on these definitions, even though informal firms sell legal goods and services, they are not part of the formal system. They usually do not pay taxes or follow the rules that formal businesses do, and this gives them an unfair advantage over formal businesses (Dwibedy, 2022). Informal enterprises are especially prevalent in developing economies where the economic and legal institutions are so complex that registering and operating within the domain of the law is expensive and time-consuming (McCann & Bahl, 2017).

There are conflicting theoretical arguments on the relationship between informal rivalry and innovation. While some found that rivalry from informal businesses reduces formal firms' motivation to innovate (Abbas et al., 2022; McGahan, 2012), others suggest that competition from the informal sector has a positive influence on innovation (Miocevic, Arslanagic-Kalajdzic, & Kadic-Maglajlic, 2022; Pérez et al., 2019).

Some theoretical arguments suggest that the innovative activities of formal firms are disrupted by informal activities. This negative influence of informal competition comes from different sources. First, firms in the formal and informal sectors compete for the same customers and resources. For example, regarding human capital, informal businesses provide employment prospects for low-skilled workers and skew the accumulation of skills, resulting in a scarcity of skilled workers, which is important for innovation. As a result, this worsens the innovation performance of formal firms (Abbas et al., 2022; McGahan, 2012).

Second, competition in the product market is another way in which informal enterprises might influence formal firms' innovation choices (Mendi & Costamagna, 2017). As a general rule, it costs less to start an informal business than a formal business. Consequently, a company's product has more rivals if informality is prevalent in the marketplace. This ultimately disincentivizes formal firms' innovation efforts (Abbas et al., 2022; Mendi & Costamagna, 2017).

Other theoretical arguments suggest a positive impact of informal competition on innovation. Previous research has used several theoretical frameworks, such as the resource-based view (RBV), the attention-based view (ABV), the bounded rationality view (BRV), and the theoretical "escape-competition effect" argument to examine firms' innovation performance in the context of informal competition.

First, according to the resource-based view (RBV), formal businesses need to acquire new strategic resources and competencies in order to compete with their informal counterparts. Formal businesses may raise the value of their products and the loyalty of their clients by differentiating themselves from informal businesses. This makes it easier for formal businesses to acquire new customers and maintain a competitive edge (Miocevic et al., 2022; Pérez et al., 2019).

Second, the attention-based view (ABV) claims that managers' behavior is influenced by the domains to which they devote their attention. Formal firm managers pay attention to innovation in reaction to informal rivalry because they consider innovation to be an effective answer to competition from the informal sector. As informal competitors are unlikely to follow the innovation strategy, formal firms can use their advantages in resources to further differentiate themselves from informal businesses (McCann & Bahl, 2017). Moreover, formal firms are generally reluctant to participate in corrupt practices such as lobbying or bribery. Thus, innovation offers a realistic alternative for formal firms to respond competitively. This is due to the fact that formal-sector firms tend to be more concerned about integrity reputation or using ethical methods in doing business than informal businesses, which have previously shown a propensity to operate outside of the law. Therefore, innovation provides an alternative response with no ethical concerns for formal businesses (Krishnan & Kozhikode, 2015; McCann & Bahl, 2017).

Third, based on the bounded rationality view (BRV), firms will respond strategically to the increased presence of informal rivals by introducing new goods and services. Particularly, to preserve a competitive advantage against informal enterprises, innovation will assist firms in differentiating themselves (Miocevic et al., 2022; Porter, 1985).

Finally, following the theoretical "escape-competition effect" argument, faced with intense competition, particularly from the informal sector, formal firms innovate to escape market rivalry. This is especially clear in industries with a low technological gap (Avenyo et al., 2021).

There have been varied results from empirical research on firms' innovation performance in the presence of informal rivals. While some studies show the positive impact of informal competition on innovation (Dwibedy, 2022; McCann & Bahl, 2017; Miocevic et al., 2022; Pérez et al., 2019; Qi, Zou, Xie, & Zeng, 2020), others present the opposite results (Abbas et al., 2022). It is also important to note that research on the role of information competition in innovation mainly focuses on the context of developing and emerging economies. Table 1 presents the context and results of recent studies on the influence of informal competition on innovation.

Based on the above theoretical and empirical evidence, this study argues that for formal firms, innovation is a way to lessen rivalry threats, obtain a competitive advantage, and improve performance in the face of informal competition in the Southeast Asian context. Hence, the following hypotheses are proposed:

H1: Informal competition has a positive impact on product innovation.

H2: Informal competition has a positive impact on process innovation.

Table 1. Recent studies on the impact of informal competition on innovation.

No.	Article	Context	Result
1	McCann and Bahl (2017)	Central Asia and Eastern Europe	The likelihood of developing a new product is positively correlated with the degree of informal competition.
2	Mendi and Costamagna (2017)	African and Latin American countries	An inverted-U connection exists between a company's likelihood to innovate and the competition it faces from informal sector businesses.
3	Pérez et al. (2019)	China	When confronted with informal competition, formal businesses often have a greater propensity for innovation.
4	Qi et al. (2020)	30 Eastern European and Central Asian nations	In the face of competition from informal businesses, formal firms will increase their innovation efforts in marketing and product development.
5	Avenyo et al. (2021)	Sub-Saharan Africa	Formal firms' product innovation is adversely affected by local informal competition. However, informal rivalry within the industry boosts sales of new products.
6	Abbas et al. (2022)	South Asia	Formal enterprises' product and process innovations are harmed by informal competition.
7	Dwibedy (2022)	29 nations in Central Asia, Central Europe, and Eastern Europe	Companies that are in competition with the informal sector are more likely to develop new products.
8	Miocevic et al. (2022)	EU candidate countries from Southeast Europe	Firms that face competition from informal businesses are more likely to innovate.

2.2. The Moderating Influence of Gender

In this study, the gender issue is raised to highlight the increasing importance of female leadership in business activities generally and in innovation particularly. The rich literature has emphasized that female directors are industrious and possess exceptional communication abilities. These characteristics can enhance a company's decision-making capabilities, which will have a positive impact on its success. The more diversified interests and social networks of female directors are likely to lead to insights relevant to numerous stakeholders, producing valuable resources that eventually lead to better firm performance and innovation (Eriksson, 2014; Liu, Lei, & Buttner, 2020; Monteith & Camfield, 2019). While some studies have investigated the moderating influence of female management in the corruption–innovation nexus (Wellalage, Fernandez, & Thrikawala, 2020), and the business–government–innovation nexus (Tian et al., 2019), no research has explored the influence of female managers in moderating the informal competition–innovation nexus. To fill this gap, the current research will connect different theoretical backgrounds on female leadership, informal competition, and innovation to explain the mechanism of how female management can moderate the informal competition–innovation nexus.

First, it is important to note that female managers are better at spotting non-verbal indicators of other people's emotions. This sensitivity make female managers stronger in interpersonal and communication skills (Groves, 2005). Due to their skill in situational leadership, female managers can adapt their leadership style to the demands of the environment, making firms more resilient in unpredictable settings (Ruiz-Jiménez & del Mar Fuentes-Fuentes, 2016). Hence, it is reasonable to believe that in the case of formal firms facing informal competition, those led by female managers can adapt to this competition more easily and quickly by opting for the innovation strategy (Dohse et al., 2019; Tian et al., 2019). Second, compared to males, women have more adaptable managerial traits. Their management approach is more democratic, and they are more effective at generating passion via decentralization.

This ultimately facilitates the innovation process of formal firms led by female managers when they are faced with competition from the informal sector (Liao et al., 2019; Tian et al., 2019).

Based on the above argument, the following hypothesis is proposed:

H3: Female management moderates the relationship between informal competition and product innovation positively.

H4: Female management moderates the relationship between informal competition and process innovation positively.

3. METHODS

3.1. Sample

The World Bank's Enterprise Surveys (WBES) provided the information for the analysis. These surveys are conducted at the firm level on a representative sample of an economy's private sector. The WBES covers a wide range of topics about the business environment, firm performance, access to finance, corruption, infrastructure, competition, as well as other topics. Up to now, more than 174,000 enterprises in 151 countries have participated in the WBES following the Global Methodology, which enables cross-country analysis (World Bank, 2022).

This research obtained data from 2015 and 2016 on both innovation and informal sector practices of eight countries in Southeast Asia, namely Cambodia, East Timor, Indonesia, Laos, Malaysia, Philippines, Thailand, and Vietnam. There are 4,220 observations in 23 two-digit manufacturing sectors that follow the classification set out by the "International Standard Industrial Classification of All Economic Activities (ISIC)" of the United Nations.

3.2. Measures

3.2.1. Dependent Variable

To capture product innovation, the dependent variable *Product innovation* was generated based on the information obtained from the question "In the last three years, has this establishment introduced new products or services?". The research coded *Product innovation* as a dummy variable, which took the value of "1" if the firm introduced new products or services and "0" otherwise (McCann & Bahl, 2017; Miocevic et al., 2022).

Another dependent variable is *Process innovation*, which was constructed as a dummy variable. *Process innovation* was coded "1" if the firm answered "Yes" to any of the following three questions: "During the last three years, has this establishment introduced any new or significantly improved methods of manufacturing products or offering services?", "During the last three years, has this establishment introduced any new or significantly improved logistics, delivery, or distribution methods for inputs, products, or services?", and "During the last three years, has this establishment introduced any new or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing?". *Process innovation* was coded "0" if the firm answered "No" to all three questions (Abbas et al., 2022; Karakara & Osabuohien, 2020).

3.2.2. Independent Variable

Informal competition: Based on prior research (Abbas et al., 2022; Dwibedy, 2022; McCann & Bahl, 2017), this study relied on the following question to rate the level of informal competition: "To what degree are practices of competitors in the informal sector an obstacle to the current operations of this establishment?" The five response options are: no obstacle (0), a minor obstacle (1), a moderate obstacle (2), a major obstacle (3), a very severe obstacle (4)". Hence, *Informal competition* has five values ("0" to "4"), and the higher the value, the more severe the obstacle from the informal sector.

3.2.3. Moderating Variable

Female management: Following previous studies (Audretsch, Belitski, & Brush, 2022; Liao et al., 2019), this study used information from the question "Is the Top Manager female?" to examine the moderating effect of female

management in the informal competition–innovation nexus. *Female management* was constructed as a dummy variable, taking the value of "1" if the response was "yes" to this question, and "0" otherwise.

3.2.4. Control Variables

Following previous studies, some factors that might affect a firm's choice to innovate were controlled (Abbas et al., 2022; Dwibedy, 2022; Mendi & Costamagna, 2017; Miocevic et al., 2022).

R&D: Information for R&D activities was drawn from the question asking respondents: "During the last three years, did this establishment spend on formal research and development activities, either in-house or contracted with other companies, excluding market research surveys?". *R&D* was constructed as a dummy variable, taking the value of "1" if the response was "yes" and "0" otherwise (Dwibedy, 2022; Karakara & Osabuohien, 2020).

Training: Information for employee training activities was derived from the survey question "Did this establishment have formal training programs for its permanent, full-time employees?". *Training* was set as a dummy variable, taking the value of "1" if the response was "yes" and "0" otherwise (Abbas et al., 2022; Bu & Cuervo-Cazurra, 2020).

Exporting: This research created a dummy variable that took the value of "1" if the company exported any of its goods and "0" otherwise to control for the exporting status (Fassio, 2018; Xie & Li, 2018).

Age: The study controlled for firm age, measured by the logarithm of the number of years the firm has been in business (Abbas et al., 2022; Miocevic et al., 2022).

Size: The study also controlled for the size of the firm based on the logarithm of the number of employees working for the firm (Abbas et al., 2022; Mendi & Costamagna, 2017).

Industry: To control for industry effects, this study generated a categorical variable consisting of values for 23 two-digit manufacturing industries, which was used in the multilevel analysis as discussed below. Additionally, this research included industry dummies for the propensity score matching analysis (Miocevic et al., 2022; Pérez et al., 2019).

Country: This study controlled for the country effects of each country in Southeast Asia by constructing a categorical variable with values for eight Southeast Asian countries. This variable was used in the multilevel analysis. Moreover, dummy variables representing eight countries were also created for the propensity score matching analysis (Avenyo et al., 2021; McCann & Bahl, 2017).

3.3. Empirical Strategy

The dependent variable in this study has binary outcomes, thus it is common to use the logit or probit models for estimation (Cameron & Trivedi, 2009; Long & Freese, 2014). However, the standard logit or probit models cannot take into account the hierarchical/multilevel nature of a dataset. With respect to the specific dataset used in this study, a hierarchical/multilevel pattern clearly emerges. Specifically, the data structure has three levels: the first level is individual firms, the second level is industrial sectors, and the third level is countries. Particularly, firms are nested inside their respective industries, while industries are nested within their respective nations. When it comes to hierarchical/multilevel data structures, the issue is that "they violate the independence assumption required by traditional statistical analyses", which "can produce excessive Type I errors and biased parameter estimates" (Peugh, 2010). Given the nature of our dataset, a multilevel mixed-effects logit model (MELM) was utilized to account for the hierarchical/multilevel issue. This method has the advantage of considering the hierarchical nature of observations and controlling for possible variations at each level (Hetling, Kwon, & Saunders, 2015; StataCorp, 2017a). The MELM was estimated by the "melogit" command in *Stata*. The "melogit" procedure provided a likelihood ratio test evaluating the MELM in comparison with the conventional logit model. A significant test statistic suggests that a hierarchical/multilevel problem exists, and the MELM is better at estimating the dataset than the standard logit model (StataCorp, 2017a). Another problem that should be addressed is the possible endogeneity problem. It is

possible that the competition from the informal sector may be endogenous if there are unobserved firm-specific characteristics that concurrently affect the level of rivalry between businesses and innovation (Pérez et al., 2018). To control for this non-random problem, the propensity score matching (PSM) technique was utilized in this study (Chang, Chung, & Moon, 2013; Garrido et al., 2014; Rosenbaum & Rubin, 1983). PSM entails "forming matched sets of treated and untreated subjects who share a similar value of the propensity score" (Austin, 2011). The PSM technique estimates the propensity score, which is "the conditional probability of assignment to a particular treatment given a vector of observed covariates" (Rosenbaum & Rubin, 1983). To conduct the PSM, the Stata command "teffects psmatch" was used (StataCorp, 2017b). First, to calculate the propensity score, the "teffects psmatch" procedure estimated a logit model. Therefore, the categorical variable *Informal competition* was converted into a dummy variable named *Informal competition_dummy* with the value of "0" if the firm answered "no obstacle" (0) for the question "To what degree are practices of competitors in the informal sector an obstacle to the current operations of this establishment?", and "1" if the firm chose any of the other responses. Regarding the selection of covariates, following the suggestion by Caliendo and Kopeinig (2008), only the variables that simultaneously influence the participation decision and the outcome variable were included. Thus, this study included the covariates *Exporting, Training, R&D, Age (ln), Size (ln), Industry (dummies),* and *Country (dummies)* in the logit models. Second, the default 1:1 nearest neighbor matching method was used to construct a matched sample for the comparison of innovation performance of the control and treatment groups (StataCorp, 2017b). In this study, the control groups included: (i) firms that encountered no barriers from the informal sector, (ii) firms found no obstacles from the informal sector and were not managed by females. The treatment groups included: (i) firms that experienced informal competition, (ii) firms faced with informal competition and were managed by females.

Third, the current research measured the "average treatment effect on the treated" (ATT), which is "the average difference that would be found if everyone in the treated group received treatment compared with if none of these individuals in the treated group received treatment" (Li, 2013).

4. FINDINGS AND DISCUSSIONS

4.1. Summary Statistics

Table 2 shows the summary statistics for the main variables that were employed in the study. Out of all the companies, 22% of the sample engaged in product innovation, and nearly 35% of firms reported process innovation. The average rate of informal competition was 1.15, which is between "a minor obstacle (1)" and "a moderate obstacle (2)". More than 31% of firms had female top managers. Moreover, approximately 32% of firms in the sample carried out exporting activities. In addition, more than 31% of firms provided training for employees, and more than 15% of firms conducted R&D activities.

Table 2. Summary statistics.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Product innovation	4,156	0.220	0.414	0	1
Process innovation	4,220	0.348	0.477	0	1
Informal competition	4,114	1.155	1.188	0	4
Female management	4,187	0.311	0.463	0	1
Exporting	4,194	0.319	0.466	0	1
Training	4,173	0.312	0.463	0	1
R&D	4,144	0.152	0.359	0	1
Age (ln)	4,220	2.767	0.622	0	4.234
Size (ln)	4,220	3.951	1.459	0.693	9.741

Table 3 displays the correlations between the independent and control variables utilized in the study. Multicollinearity is not a concern for our investigation because the correlation coefficients between the independent and control variables are less than 0.5 (Kennedy, 2008).

Table 3. Correlation matrix.

Variables	1	2	3	4	5	6
Informal competition	1					
Female management	-0.087***	1				
Exporting	-0.070***	0.042***	1			
Training	-0.089***	0.057***	0.254***	1		
R&D	0.012	0.002	0.173***	0.257***	1	
Age (ln)	-0.041***	0.016	0.075***	0.126***	0.044***	1
Size (ln)	-0.064***	-0.028*	0.422***	0.340***	0.248***	1

Notes: *** and * denote significance at 1% and 10%, respectively.

4.2. Empirical Results

Table 4 shows the results of a multilevel mixed-effects logistic regression. Four models were estimated to evaluate the hypothesized relationships. In Models 1 and 2, we investigated how informal competition affected the development of new products/processes, and the moderating role of female management in the informal competition–product/process innovation nexus was examined in Models 3 and 4.

Table 4. Estimation results.

Variables	Model 1	Model 2	Model 3	Model 4
	Product innovation	Product innovation	Process innovation	Process innovation
Informal competition	0.146***	0.127***	0.212***	0.159***
	(0.038)	(0.044)	(0.035)	(0.040)
Female management	0.147	0.006	0.062	-0.184
	(0.103)	(0.148)	(0.093)	(0.132)
Informal competition x Female management		0.142***		0.194***
		(0.083)		(0.073)
Exporting	0.308***	0.303***	0.247***	0.243**
	(0.104)	(0.104)	(0.094)	(0.094)
Training	0.271***	0.271***	0.442***	0.446***
	(0.103)	(0.104)	(0.094)	(0.094)
R&D	1.624***	1.627***	2.078***	2.082***
	(0.111)	(0.111)	(0.122)	(0.122)
Age (ln)	0.307***	0.300***	0.072	0.070
	(0.077)	(0.077)	(0.069)	(0.069)
Size (ln)	0.088**	0.090**	0.137***	0.139***
	(0.035)	(0.035)	(0.032)	(0.032)
Constant	-3.303***	-3.258***	-2.259***	-2.196***
	(0.341)	(0.343)	(0.300)	(0.298)
Country (var(_con)	0.451	0.451	0.343	0.328
	(0.244)	(0.245)	(0.195)	(0.188)
Country > Industry (var(_con)	0.051	0.051	0.026	0.029
	(0.035)	(0.035)	(0.023)	(0.024)
Wald χ^2	357.54	360.59	475.66	479.95
Prob > χ^2	0.0000	0.0000	0.0000	0.0000
LR test versus logit model	$\chi^2 = 202.56$ Prob > χ^2 = 0.0000	$\chi^2 = 196.45$ Prob > χ^2 = 0.0000	$\chi^2 = 165.18$ Prob > χ^2 = 0.0000	$\chi^2 = 152.79$ Prob > χ^2 = 0.0000
Observations	3,912	3,912	3,952	3,952

Notes: Standard errors in parenthesis. *** and ** denote significance at 1% and 5%, respectively.

The likelihood ratio test indicates that the multilevel mixed-effects logistic regression is better at estimating the dataset than the conventional logistic regression in all four models. In terms of the first and second hypotheses, the results indicate that threat from informal competitors has a positive effect on a firm's propensity to engage in product/process innovation. This supports hypotheses 1 and 2 significantly. The results are similar to those found in previous studies (Dwibedy, 2022; McCann & Bahl, 2017; Miocevic et al., 2022; Pérez et al., 2019; Qi et al., 2020). The

findings provide evidence to support the idea that formal firms follow an innovation strategy differentiate themselves from informal businesses, and innovation acts as an effective answer to competition from informal competitors (Krishnan & Kozhikode, 2015; McCann & Bahl, 2017; Pérez et al., 2019). Moreover, innovation allows formal firms to address market rivalry from informal firms more effectively, especially in industries with a low technological gap (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005; Avenyo et al., 2021). Hence, following the innovation strategy, formal firms in the Southeast Asian region can preserve a competitive advantage over informal businesses (Miocevic et al., 2022; Porter, 1985).

Regarding the moderating role of female management in the informal competition–innovation nexus, the coefficients of the interaction terms *Informal competition* x *Female management* are positive and significant in Models 3 and 4, indicating that female management moderates the informal competition–product/process innovation relationship positively. These results provide strong support for hypotheses 3 and 4. The finding supports this study's argument that female managers are more adaptive and democratic in their management style, making formal businesses more resistant to informal competition. Thus, the ability of formal enterprises to innovate in the face of informal competition is greatly enhanced (Dohse et al., 2019; Liao et al., 2019; Tian et al., 2019).

4.3. Robustness Test

As a robustness check of the main results, the PSM technique is utilized. Table 5 shows the logit regression results used to calculate the propensity scores for the matching process.

Table 5. Logit regression to calculate the propensity score.

Variables	Model 5	Model 6	Model 7	Model 8
	Product innovation		Process innovation	
	Informal competition_dummy	Informal competition_dummy x Female management	Informal competition_dummy	Informal competition_dummy x Female management
Exporting	–0.217**	–0.219***	0.174	0.170
	(0.088)	(0.087)	(0.110)	(0.109)
Training	–0.015	–0.025	0.042	0.045
	(0.089)	(0.088)	(0.110)	(0.110)
R&D	0.335***	0.327***	0.583***	0.578***
	(0.108)	(0.107)	(0.128)	(0.127)
Age (ln)	–0.058	–0.058	0.113	0.110
	(0.061)	(0.061)	(0.081)	(0.080)
Size (ln)	–0.077***	–0.076***	–0.138***	–0.137***
	(0.029)	(0.029)	(0.037)	(0.036)
Country fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Constant	–0.993**	–1.001**	–2.917***	–2.906***
	(0.500)	(0.500)	(0.766)	(0.766)
LR χ2	601.51	605.26	247.84	249.94
Prob > χ2	0.0000	0.0000	0.0000	0.0000
Observations	3,934	3,978	3,912	3,952

Notes: Standard errors in parentheses. *** and ** denote significance at 1% and 5%, respectively.

The results of the PSM estimation in Table 6 show the significantly positive ATTs for all concerned treatment statuses, suggesting that informal competition increases the possibility of innovation. Furthermore, firms that face informal rivalry, when led by female managers, are more likely to develop new products and processes. These results confirm those presented in Table 4.

Table 6. PSM estimation.

Variable	ATT	
	Product innovation	**Process innovation**
Informal competition_dummy	0.066***	0.100***
	(0.017)	(0.021)
Informal competition_dummy x Female management	0.048**	0.104***
	(0.024)	(0.027)

Notes: Standard errors in parentheses. *** and ** denote significance at 1% and 5%, respectively.

5. CONCLUSIONS AND IMPLICATIONS

This study aims to understand firms' innovation performance when facing competition from informal firms. Moreover, the moderating role of female management in the informal competition–innovation nexus is also examined. The analysis was performed using a large dataset of Southeast Asia firms sourced from WBES. Multilevel mixed-effects logistic regression and propensity score matching methods were employed to address the multilevel issue of the dataset and the potential endogeneity problem, respectively. The empirical findings show that rivalry from the informal sector has a positive impact on the innovation process in terms of both product and process innovations. Additionally, female management has a positive moderating impact on the informal competition–innovation relationship. This result has significant practical implications that can assist business leaders in developing markets when they put efforts into innovation. First, evidence from this study shows that product and process innovations are an effective countermeasure to distinguish formal companies from informal companies. Therefore, informal enterprises' rivalry should not be underestimated from a management standpoint. Moreover, firms should create a working environment that encourages continuous learning and innovation among employees to support firms' innovation efforts. Second, evidence from this study shows that in firms where the top executives are women, informal rivalry has a more positive influence on innovation. This shows the importance of female managers in the business operation of formal firms. Hence, Southeast Asian governments should support female entrepreneurs in terms of management skills and access to new technologies and knowledge so that they can manage their businesses better and have more capability for following innovation strategies.

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