SCIENTIFIC CULTURE
www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 2.1, (2026), pp. 6258-6270
Open Access. Online & Print

DOI: 10.5281/zenodo.19475504

FORMALITY, SUSTAINABILITY AND STRATEGIC HETEROGENEITY IN UNIVERSITY ENTREPRENEURSHIP IN EMERGING CONTEXTS

Meneses-Quelal Orlando[1,5,6]*, Aranguren-Carrera Jesús[2], López-Goyez Juan Pablo[3] and Valverde-Obando Adrián Alexander[4]

[1]Carrera de Alimentos. Universidad Politécnica Estatal del Carchi. Tulcán, Carchi-Ecuador.
[2]Carrera de Agropecuaria. Universidad Politécnica Estatal del Carchi. Tulcán, Carchi-Ecuador.
[3]Universidad Politécnica Estatal del Carchi. Tulcán, Carchi-Ecuador.
[4]Carrera de Contabilidad y Auditoría. Universidad Politécnica Estatal del Carchi. Tulcán, Ecuador.
[5]Universidad Hipócrates. Acapulco-Estado de Guerrero, México
[6]Instituto Universitario de Innovación Ciencia y Tecnología Inudi. Perú, Puno-Perú.

Received: 21/01/2026
Accepted: 25/03/2026

Corresponding Author: Meneses Quelal Orlando (orlando.meneses@upec.edu.ec)

ABSTRACT

This study examines the determinants of formalization in ventures led by university graduates within the context of an emerging economy. Based on a census of 75 initiatives from undergraduate graduates of the State Polytechnic University of Carchi (UPEC, Ecuador), an institution that integrates a mandatory three-course entrepreneurship track into its 16 degree programs, a mixed methodology was applied, incorporating logistic regression, latent class analysis, and moderate mediation models. The results challenge linear perspectives: higher education does not guarantee formalization, as 58.7% of the ventures remain informal. The strongest predictor of formalization is a non-economic sustainability orientation (OR = 3.46), suggesting that the pursuit of institutional legitimacy, rather than immediate economic benefits, motivates formal integration. Three latent strategic profiles were identified: Institutional Entrepreneurs (hybrid, highly formal), Traditional Entrepreneurs, and Subsistence Entrepreneurs (informal, focused on the economy). A critical finding is the overrepresentation of technical graduates in the subsistence-level employment profile. The temporal analysis reveals that the longer the business has been in operation, the more the concept of sustainability influences the relationship between education and formal employment. The study contributes to the theory by proposing a contingent model that integrates human capital and institutions, with implications for the design of differentiated educational and support policies in similar contexts.

KEYWORDS: University entrepreneurship, business formality, sustainability, university graduates, strategic heterogeneity.

1. INTRODUCTION

The role of entrepreneurship as a catalyst for economic dynamism, innovation, and job creation is a cornerstone of contemporary development discourse. Within this paradigm, university graduates are frequently positioned as pivotal agents of change, possessing the human capital necessary to launch businesses that are not only economically viable but also integrated into the formal economy and aligned with the broader imperatives of sustainability (Filser et al., 2019). This expectation stems from human capital theory, which posits that education enhances cognitive abilities, technical skills, and market awareness, thereby increasing the likelihood of entrepreneurial success and formalization (López-Solís et al., 2025). Consequently, fostering graduate entrepreneurship has become a strategic priority for higher education institutions and policymakers worldwide, conceived as a conduit for translating academic knowledge into productive, formal, and sustainable economic activity.

However, this seemingly linear trajectory from university education to high-quality, formal entrepreneurship is fraught with complexities, particularly in the institutional contexts of emerging economies. A persistent and substantial informal sector coexists with formal economic structures, presenting entrepreneurs with a fundamental strategic choice: assume the costs of formal registration and regulatory compliance, or operate informally, often as a rational response to regulatory burdens, limited state capacity, and restricted access to finance (Albatran & Atikbay, 2025). While informal entrepreneurship is often associated with subsistence activities and low human capital, evidence increasingly suggests that highly educated individuals may also choose or remain in the informal sector, challenging the deterministic view of education as an automatic formalizing force (Simba et al., 2023). This phenomenon raises critical questions about the actual mechanisms through which university-level human capital interacts with institutional environments to shape entrepreneurial trajectories, suggesting that the decision to formalize is a nuanced calculation influenced by factors beyond mere technical ability.

Simultaneously, the concept of business value is undergoing a profound transformation. The traditional profit-maximization paradigm is being replaced by a more holistic conception of sustainable entrepreneurship, which seeks to harmonize economic, social, and environmental objectives (Jurgelevičius et al., 2025). For graduate entrepreneurs, this broadens the spectrum of potential business approaches. They can pursue purely commercial opportunities, adopt social or environmental missions, or navigate the hybrid space where multiple value propositions coexist (Doherty & Kittipanya-Ngam, 2021). This orientation toward sustainability is not merely an ethical choice but can be a core strategic element, influencing a company's legitimacy, its access to market niches, and its relationships with stakeholders such as impact investors, conscious consumers, and public grant agencies (Tsourela et al., 2025). However, the interplay between these sustainability orientations and the fundamental decision to formalize remains largely unexplored in theory, especially in resource-constrained environments where economic survival might be presumed to overshadow other considerations.

The theoretical frameworks for understanding these dynamics remain somewhat isolated. Institutional theory illuminates the search for legitimacy but often underestimates the role of individual agency and human capital. Human capital theory, in turn, emphasizes individual endowments while frequently treating the institutional and cognitive filters through which these endowments are deployed as a "black box." A more integrative perspective is needed, one that examines how the disciplinary imprint of university education shapes cognitive frameworks and value priorities, which in turn condition how entrepreneurs perceive and respond to institutional pressures for formality and sustainability (Erlei et al., 2022). Furthermore, the entrepreneurial process is inherently temporal (Bao et al., 2021). The relationship between formative education, initial strategic orientation, and eventual outcomes such as formalization is unlikely to be static; it can evolve through experiential learning and as businesses accumulate operational history and resources (Burch et al., 2019). This temporal dimension adds a critical layer of complexity to causal analyses.

A significant limitation in the existing literature is the tendency to treat "graduate entrepreneurs" as a homogeneous category, employing variable-centered approaches that estimate average effects. This obscures the potential existence of distinct and internally consistent strategic profiles or archetypes within the population. Latent heterogeneity may exist, where subgroups of graduates follow significantly different logics—for example, "subsistence" entrepreneurs who leverage skills for informal survival, "traditional" formal entrepreneurs focused on commercial returns, and "institutional"

entrepreneurs who use formalization as a tool to legitimize hybrid social-commercial missions (Plak, 2022). Uncovering such profiles requires person-centered analytical techniques and could explain contradictory findings in the literature, revealing that the effects of determinants such as academic discipline or location are contingent on the entrepreneur's underlying strategic configuration.

To address these interconnected gaps, this research analyzes the entrepreneurial ventures of university graduates in an emerging economy, proposing and evaluating a contingent model. This model examines the association between academic training and territorial context with formal status, highlights the role of non-economic sustainability orientations as key drivers of formalization, identifies latent strategic profiles among entrepreneurs, and unravels the dynamic mechanisms through which education influences formalization, mediated by conceptions of sustainability and moderated by time. By integrating theoretical perspectives on human capital, institutional capital, and legitimacy, and through a mixed-methods analytical strategy that combines advanced inferential models with latent class analysis, the study seeks to offer an empirically grounded and contextually rooted understanding of the phenomenon. The findings aim to enrich the theoretical discourse on entrepreneurship in developing economies and generate input for the design of differentiated and effective university policies and interventions.

2. METHODS

2.1. Institutional context and origin of the data

This study was conducted within the specific context of the State Polytechnic University of Carchi (UPEC), a public institution located in the city of Tulcán, Carchi province, in northern Ecuador. UPEC offers 16 undergraduate programs in the areas of applied sciences, engineering, and administrative and social sciences, with an undergraduate student population of 5,155 as of December 2025. During the same period, the institution registered 133 enrollments in its graduate programs. A distinctive component of its educational model is the cross-cutting integration, across all undergraduate programs, of a mandatory entrepreneurship track. This track consists of three sequential courses taught in the fourth, fifth, and sixth semesters, respectively: entrepreneurial behaviors, creativity and innovation, and entrepreneurship. The primary data for this research were officially and exclusively provided by UPEC's Community Engagement Unit and Alumni Relations Unit. These units maintain a continuous monitoring system for their graduates, using standardized instruments to collect information about their employment status and the characteristics of their businesses. For this study, only graduates of undergraduate programs were considered, excluding postgraduate students.

2.2. Study design and analytical population

An observational, cross-sectional, and quantitative design was adopted. The study population consisted of all UPEC graduates who, according to institutional records at the time of the study, declared having an active business as their primary occupation. After a data cleaning and consistency validation process, a final census database was compiled with a total of 75 businesses. Since the study included all available cases that met the criteria (a census of the accessible population), no sampling technique was applied. This eliminates sampling error but limits statistical generalization to contexts beyond this specific group of UPEC graduates.

2.3. Variables and measurement

The central dependent variable was the formal status of the business, operationalized as a dichotomous variable where 1 corresponds to "Formal" (business registered with the Internal Revenue Service -SRI- and/or the Superintendency of Companies of Ecuador) and 0 to "Informal" (without such registration). Important independent variables included academic background, categorized according to the area of knowledge of the 16 UPEC degree programs; the sustainability dimension prioritized by the business, based on the graduate's self-report; the business's age in months; the type of main offering (product or service); and the geographic location of operations. All variables were extracted and coded from the instruments administered by the institutional units.

2.4. Analytical Strategy

The analytical strategy was designed sequentially and comprehensively to address the research objectives. It began with a univariate descriptive analysis to characterize the sample. Subsequently, a bivariate inferential analysis was conducted to explore preliminary associations. The core of the quantitative approach consisted of applying three complementary multivariate techniques: a logistic regression model to identify net predictors of formality, a latent class analysis to uncover unobserved heterogeneous strategic profiles, and a

moderated mediation model to examine the underlying causal mechanisms between the variables.

2.5. Analytical construction, econometric specification, inference and validity

The construction of the analytical variables is geared towards ensuring their theoretical coherence and statistical adequacy within the framework of binary choice models. Academic seniority is defined as the number of years elapsed between the graduate's graduation date and the study's reference year, with the purpose of capturing the temporal dimension of the educational trajectory on a continuous scale compatible with maximum likelihood estimators.

Territorial location is operationalized through a set of indicator variables for each spatial level considered. This strategy allows for the identification of systematic differences associated with the geographic context within the econometric specification. The operating time of the venture is transformed from its original ordinal scale to a continuous scale expressed in months, with the aim of preserving inter-individual variability and improving the efficiency of the estimators. The orientation toward sustainability is classified into economic, social, and environmental categories, complemented by a residual category for hybrid initiatives, which allows for their incorporation into alternative specifications of the model.

The probability of formalizing the venture is modeled using a binary choice logit model. The functional relationship between the covariate vector and the dependent variable is formally expressed in Equation (1):

$$P(F_i = 1 \mid X_i) = \frac{e^{X_i\beta}}{1+e^{X_i\beta}} \qquad \text{Equation 1}$$

Where F_i denotes the observed formalization status of venture i, X_i is the vector of explanatory variables, and β is the vector of parameters to be estimated

The parameters are estimated using maximum likelihood and the coefficients are interpreted in terms of odds ratios and average marginal effects, which allows us to evaluate the relative contribution of academic and territorial determinants to the probability of formalization.

Statistical inference is based on likelihood ratio tests for the joint significance of the model and Wald tests for individual parameter comparisons. The quality of fit is assessed using the Hosmer-Lemeshow statistic and the area under the ROC curve, as indicators of calibration and discriminant capacity.

The robustness of the results is examined by re-estimating the model under alternative specifications that consider different levels of territorial aggregation and the inclusion or exclusion of the sustainability variable as an explanatory covariate. The stability of the coefficients is assessed by comparing signs, relative magnitudes, and significance levels between models.

Computational reproducibility is ensured through the use of documented statistical environments in R and Python, with versioned scripts that allow replication of the complete cleaning, transformation, and estimation workflow. Internal validity is supported by the use of an accessible population census and the standardization of analytical procedures. External validity is limited to the institutional and territorial context of the State Polytechnic University of Carchi; therefore, generalization to other settings requires explicit assumptions of structural comparability.

2.5.1. Latent profile analysis.

To identify homogeneous subpopulations not directly observed, a Latent Class Analysis (LCA) was performed using the key categorical variables (type of offer, formal status, sustainability dimension, career, and location). The optimal number of classes was determined using information criteria (AIC, BIC) and goodness-of-fit measures (entropy). This analysis complements the regression models by capturing strategic heterogeneity within the sample.

2.5.2 Analysis of Causal Mechanisms.

To examine the mediating and moderating relationships between the variables, a moderate mediation model was specified. It was assessed whether the effect of university degree on formality was mediated by the sustainability dimension, and whether this indirect effect was moderated by the age of the business. The analyses were performed using resampling -based process regression. bootstrap (5,000 samples) to obtain robust confidence intervals.

2.5.3. Selection of the final Model.

The final specification of the logit model was derived from an iterative process that began with the inclusion of all theoretically relevant variables. Using likelihood ratio tests and parsimony criteria, predictors that did not contribute significantly to the model fit or that exhibited high collinearity were eliminated. Theoretically relevant interactions were tested, retaining only those that were statistically

significant.

2.6. Ethical and Bioethical Considerations

The study is governed by the principles of scientific integrity, respect for persons, beneficence and justice, in accordance with international guidelines for research with data of human origin and the current institutional regulations at the State Polytechnic University of Carchi.

The database used consisted of secondary information provided by institutional graduate tracking systems. All records were anonymized before analytical processing, removing direct identifiers and any attributes that could allow for individual re-identification of participants. Access to the data was restricted to the research team, and it was used exclusively for academic and scientific purposes.

From a bioethical perspective, the study adheres to the principle of non-maleficence, ensuring that the results are not used to stigmatize graduates or their businesses based on their geographical, academic, or socioeconomic background. The principle of beneficence is operationalized by orienting the analysis toward generating evidence that contributes to the design of institutional policies supporting entrepreneurship, formalization, and sustainability.

The principle of autonomy is respected through the voluntary nature of the initial provision of information by graduates in institutional instruments, as well as through transparent communication of the scientific use of the data in associated institutional reports. Finally, the principle of fairness is guaranteed by treating all records included in the analytical database equitably, without arbitrary exclusions beyond the technical criteria of consistency and completeness of the information.

3. RESULTS AND DISCUSSION

3.1. Descriptive analysis and characterization of the entrepreneurial ecosystem

The distribution of the sample (Table 1) reveals an ecosystem with distinctive features that require interpretation in light of the literature on entrepreneurship in developing economies. The predominance of product-based ventures (73.3%) over service-based ventures (26.7%) represents a significant divergence from patterns observed in advanced economies, where the service sector typically dominates the entrepreneurial landscape (Melchor-Duran & Villegas-Mateos, 2024). This productive specialization can be interpreted through the lens of regional comparative advantages and the agro-industrial heritage of the province of Carchi, where 62.7% of the cases are concentrated. As Rocha (2015) argues, regional clusters often arise from specific historical advantages and the availability of natural resources, which shape distinct patterns of business development and long-term regional trajectories.

Table 1: Descriptive statistics of the study variable.

Feature	Category	Frequency	%
Type of offer	Product	55	73.3
	Service	20	26.7
Formal status	Formal	31	41.3
	Informal	44	58.7
Sustainable dimension	Economic	53	70.7
	Social	7	9.3
	Environmental	6	8.0
	Cultural	4	5.3
	Not specified	5	6.7
University degree	Applied Sciences/Engineering	22	29.3
	Social Sciences/Management	43	57.3
	Other disciplines	10	13.3
Geographic location	Carchi Province	47	62.7
	Other provinces	28	37.3

Note: For the analysis of statistical associations, the variable "sustainable dimension" was recoded as dichotomous (economic vs. non-economic) to include the "unspecified" category in the analysis. The average tenure was 25.7 months (SD = 25.2), with a median of 24 months and a range of 2 to 180 months.

Regarding formal status, the informality rate (54.7%) significantly exceeds the formality rate (41.3%), a finding that gains theoretical relevance when considering university graduates. This result challenges the notion that higher education operates as an automatic mechanism for integration into the formal economy (Portocarrero Ramos et al., 2025), suggesting instead the persistence of institutional barriers that discourage formalization even for individuals with advanced human capital. The theory of voluntary informality (Maloney, 2004) could partially explain this phenomenon, where entrepreneurs rationally calculate that the costs of formalization outweigh its benefits in complex regulatory contexts with limited state oversight.

The prioritization of sustainability dimensions reveals a pronounced emphasis on the economic aspect (71.6%), a pattern consistent with what Muñoz and Cohen (2018) describe as "pragmatic sustainability" in contexts characterized by constrained resources. This finding aligns with research on entrepreneurship in emerging economies

that documents a hierarchy of needs where financial viability is a prerequisite for considering broader social or environmental dimensions (Aguirre Benalcázar et al., 2025). The relative marginality of non-economic dimensions (social: 9.9%, environmental: 8.5%, cultural: 5.6%) suggests opportunities for educational interventions that broaden the conception of entrepreneurial value beyond the purely economic.

3.2. Strategic configurations and their association with formalization

To examine the multivariate determinants of formality, a binary logistic regression model was estimated, the results of which are presented in Table 2. A focus on non-economic sustainability emerged as the strongest predictor (OR = 3.46, p = 0.027), a finding that substantially expands the prevailing theoretical framework on formalization. While traditional literature has primarily emphasized the economic benefits of formalization (Omri, 2020), our results highlight the importance of institutional legitimacy as a driver of formalization, particularly for ventures with social or environmental missions. This finding aligns with Suchman's theory of organizational legitimacy, which posits that organizations seek social validation to access resources and ensure their survival (Chen, 2025).

Table 2: Logistic regression model to predict formality of entrepreneurship.

Preacher	β	EE (β)	p-value	OR	95% CI for OR
Intercept	-1.02	0.48	0.033	0.36	[0.14, 0.92]
Non-economic dimension	1.24	0.56	0.027	3.46	[1.15, 10.39]
Type: Service	1.08	0.50	0.031	2.94	[1.10, 7.85]
Province: Other	0.72	0.52	0.168	2.05	[0.74, 5.70]
Interaction: Non-economic dimension × Applied career	-1.85	0.91	0.042	0.16	[0.03, 0.91]

Note: β: logistic regression coefficient; OR: odds ratio; SE(β): standard error of β; 95% CI: 95% confidence interval for OR. N = 68; χ^2 (4) = 13.28, p = 0.010; Hosmer- Lemeshow test: p = 0.793; Area under the ROC curve = 0.731 (95% CI: 0.610-0.852); Pseudo R^2 (McFadden) = 0.186; Variance inflation factors < 2.0 for all predictors.

The magnitude of the effect (a 3.46-fold greater likelihood of being formal) suggests that non-economically oriented ventures operate under different institutional logics, in which formality functions as symbolic capital that facilitates access to certifications, participation in public calls for proposals, and relationships with specialized stakeholders (Ferro-Soto et al., 2018). This pattern is consistent with research on social entrepreneurship that documents how formal legitimacy becomes a strategic resource for organizations competing in market niches where ethical credibility is fundamental (Chatterjee et al., 2021).

The significant negative interaction between non-economic dimension and applied career (OR = 0.16, p = 0.042) is a theoretically nuanced finding. This result suggests that the positive effect of non-economic sustainability on formality is considerably attenuated among graduates of technical fields, possibly due to what Karaca-Atik et al. (2024) conceptualize as "disciplinary imprinting." Training in applied sciences can foster instrumental cognitive frameworks that prioritize quantitative metrics and direct financial returns, underestimating the non-economic benefits of formal education. This finding has important implications for curriculum design, highlighting the need to integrate content on institutional management, stakeholder theory, and holistic sustainability into technical programs traditionally focused on operational skills.

3.3. Identification of latent strategic profiles and unobserved heterogeneity

To capture the non-apparent diversity in the sample, a Latent Class Analysis (LCA) was performed, the results of which are presented in Table 3. The identification of three distinct strategic profiles challenges the homogeneous treatment of the university entrepreneur that predominates in previous studies (Wang et al., 2021). Class 2, "Institutional Entrepreneurs" (29.4% of the sample), constitutes the most theoretically significant finding, as it embodies the figure of the hybrid entrepreneur who combines market logics with social or environmental missions (Zhou & Wang, 2023).

Table 3. Strategic profiles identified through Latent Class Analysis.

Feature	Class 1: Traditional (47.1%)	Class 2: Institutional (29.4%)	Class 3: Subsistence (23.5%)
Probability of formality	0.21	**0.89**	0.08
Probability of offering services	0.18	**0.67**	0.12

Probability of non-economic dimension	0.09	**0.71**	0.04
Location outside of Carchi	31%	58%	42%
Average tenure (months)	28.4	22.1	30.8
Graduates in applied sciences	42.9%	15.0%	56.3%

Model note: N = 68; BIC = 298.15; AIC = 262.84; Entropy = 0.81; Pearson goodness of fit test: χ^2 (8) = 7.23, p = 0.512.

This profile is characterized by a high probability of formality (0.89), a service orientation (0.67), and a prioritization of non-economic sustainability (0.71), configuring what Wang (2024) describes as a "composite institutional logic. These entrepreneurs appear to operate under a model where formality is not merely a legal requirement, but a strategic resource for legitimization that facilitates access to market niches that value social and environmental impact. Their relative youth (average age: 22.1 months) suggests that this strategic configuration is established early on, supporting the theory of organizational imprinting, which posits that initial conditions leave lasting imprints on organizations (Milanov & Fernhaber, 2009).

In contrast, Class 3, "Subsistence Entrepreneurs" (23.5%), shows the opposite pattern: a high probability of informality (0.08), product offerings (0.88), and an exclusive focus on economic sustainability (0.96). The overrepresentation of graduates in applied sciences in this class (56.3%) is particularly concerning from a human capital perspective, as it suggests that specialized technical skills are not translating into quality entrepreneurship. This finding aligns with research documenting how, in segmented labor market contexts, entrepreneurship can function primarily as a survival mechanism rather than a vehicle for innovation (Andersson, 2025).

The coexistence of these profiles has important implications for public and educational policies. As Jakee and Jones-Young (2021) argue, generic interventions may be ineffective when distinct subpopulations operate under different needs and institutional logics. "Institutional Entrepreneurs" could benefit from access to impact investment networks and specialized certifications, while "Subsistence Entrepreneurs" require more basic interventions that reduce the costs of formalization and connect their technical skills with market opportunities.

3.4. Temporal dynamics and mechanisms of entrepreneurial development

To examine how time, training, and strategic orientations interact, a moderate mediation model was specified, the results of which are presented in Table 4. The results show that the influence of disciplinary training on formality is mediated by the concept of sustainability, and that this mediation is significantly moderated by the age of the business. The total indirect effect is statistically significant (coefficient = 0.42, p = 0.034), but more importantly, it varies according to age: while the effect is not significant for young businesses, it is substantially strengthened for older ones (coefficient = 0.69, p = 0.028 for older businesses).

This temporal pattern has important theoretical implications. First, it contradicts Greiner's linear models of organizational development, which posit an automatic evolution toward greater formalization over time (Frezatti et al., 2026). Instead, it supports contingent trajectory theories (Mcmullen & Dimov, 2013), in which time functions as an amplifier of initial predispositions rather than as a direct determinant of strategic configurations.

Second, it aligns with the literature on experiential learning in entrepreneurship (Politis, 2005), which ighlights how entrepreneurs reinterpret and act upon their initial mental frameworks through accumulated practice and environmental feedback.

The strengthening of the seniority-mediated effect suggests that entrepreneurs require time to materialize their strategic orientations, possibly because formalization involves initial costs and bureaucratic complexities that are only justified once the venture has developed a degree of stability and clarity regarding its value model. From a resource-based view perspective (Barney, 1991), this time would allow for the development of the organizational capabilities necessary to navigate the formalization process effectively.

Table 4. Results of the moderate mediation analysis (Effect of career on formality via sustainable dimension).

Analyzed effect	Coefficient	Standard error	p-value	95% confidence interval
Total indirect effect	0.42	0.21	0.034	[0.03, 0.86]
With low seniority (-1 DE)	0.15	0.11	0.144	[-0.05, 0.39]

With average age	0.42	0.21	0.034	[0.03, 0.86]
With high seniority (+1 DE)	0.69	0.35	0.028	[0.08, 1.48]
Moderate mediation index	0.27	0.15	0.048	[0.01, 0.60]

Note: Analysis based on 5,000 resamples Bootstrap. Indirect effect: influence of university degree on formality, mediated by the sustainability dimension and moderated by seniority.

4. VALIDITY AND CONSISTENCY OF EMPIRICAL FINDINGS

Robustness assessment through multiple sensitivity analyses strengthens the inferential validity of the reported findings. Post-hoc power analysis for the logistic regression model (Table 2) reveals a statistical power of 78% for the observed effect size, a value slightly below the conventional threshold of 80% but adequate considering the exploratory nature of the study and the available sample size (Quach et al., 2022). This moderate power suggests interpretive caution for marginally significant effects, although it does not invalidate the main conclusions since the observed odds ratios consistently exceed 2.94, indicating associations of moderate to strong magnitude in practical terms. While the census approach (N=75) ensures complete coverage of the accessible population and eliminates sampling error, it is important to acknowledge its implications for statistical power. The post-hoc power analysis for our main logistic regression model (Table 2) indicated a statistical power of 78% for detecting the observed effect sizes, which is slightly below the conventional 80% threshold. This moderate power level suggests that our study may have limited sensitivity to detect smaller effects that could be theoretically relevant. However, this limitation is partially mitigated by the strength of the observed associations (odds ratios consistently exceeding 2.94) and the consistency of findings across multiple analytical techniques. Future research with larger samples would be valuable for confirming these patterns and exploring more nuanced subgroup effects.

Fold cross-validation (k=5) yielded an average misclassification error of 28.6% with confidence intervals between 24.1% and 33.2%, values similar to the error of the full model. This consistency indicates the absence of severe overfitting, a fundamental criterion for generalizing predictive models in moderately sized samples (Teodorescu & Obreja Braşoveanu, 2025). The stability of the estimates was maintained even after excluding the three cases identified as influential outliers (Cook's statistic > 0.5), where the odds ratio for the non-economic dimension decreased to only 2.89, maintaining statistical significance ($p = 0.045$).

Comparison with LASSO penalty regression models confirmed the selection of predictors, addressing concerns about variable selection in contexts of high relative dimensionality (Kipruto & Sauerbrei, 2025). This methodological convergence supports the theoretical relevance of the factors identified as determinants of formality. Non-response analysis suggests a random missing data mechanism (MCAR), with no systematic differences between complete and incomplete cases in key variables such as formality ($\chi^2 = 0.42$, $p = 0.52$), seniority ($t = 0.87$, $p = 0.39$), and university degree ($\chi^2 = 1.23$, $p = 0.27$).

From the perspective of causal inference, these sensitivity analyses represent stress tests that assess the robustness of conclusions against potentially violated methodological assumptions (Alfons & Schley, 2025). The consistency observed across multiple analytical specifications and techniques strengthens confidence that the findings reflect genuine patterns in the studied population rather than specific methodological artifacts.

4.1. Theoretical and practical implications and research agenda

Integrating empirical findings allows us to move toward a contingent model of university entrepreneurship that recognizes the complex interaction between disciplinary human capital, strategic orientations, and temporal context. The first theoretical contribution consists of refining the theory of specific human capital (Oltulular, 2025). While this theory predicts that the specific skills of each discipline should translate directly into related business configurations, our results show that university education primarily influences cognitive and normative frameworks (conception of sustainability) rather than direct operational decisions. This suggests, in line with Portuguez-Castro & Ramírez-Montoya (2025) that human capital acts as an "interpretive repertoire" whose materialization in strategic action depends on mediating contextual and institutional factors.

The second contribution lies in broadening the understanding of business formalization beyond purely economic frameworks. Our findings (Table 2) show that the pursuit of institutional legitimacy is a key driver of formalization, especially for socially or environmentally oriented enterprises. This connects

with organizational legitimacy theory (Suchman, 1995) and recent research on hybrid entrepreneurship (Battilana & Lee, 2014), highlighting how organizations with dual missions actively seek formal validation to access symbolic and material resources in niche markets. Formality thus emerges as a form of institutional capital that facilitates relationships with specialized stakeholders and access to certifications valued in certain organizational fields.

The third contribution is temporal and procedural. The results of the moderate mediation analysis (Table 4) reveal that entrepreneurial trajectories follow contingent logics where time amplifies initial predispositions rather than directly determining them. This supports the view of entrepreneurship as a dynamic process (McMullen et al., 2024) where strategic configurations evolve through iterations of learning and contextual adjustment. Time operates as a resource that allows entrepreneurs to calibrate their actions based on accumulated experiences and feedback from the environment (Wood et al., 2021).

The identification of latent profiles (Table 3) constitutes a fourth methodological and theoretical contribution. By revealing subpopulations with distinct strategic logics, the study challenges the homogeneous treatment of university entrepreneurship in the literature (Mouton et al., 2023). The coexistence of "Institutional," "Traditional," and "Subsistence" Entrepreneurs suggests that one-size-fits-all policies may be ineffective or even counterproductive, supporting arguments in favor of differentiated interventions based on strategic profiles (Autio et al., 2014).

The practical implications are multifaceted. For educational institutions, the results point to the need for curricular reforms that integrate entrepreneurial skills, knowledge of the institutional ecosystem, and the development of social capital into traditionally technical programs. The overrepresentation of applied science graduates in subsistence-level businesses suggests that technical universities may be producing human capital that, due to a lack of complementary skills in business management and institutional understanding, remains confined to low-productivity and informal initiatives.

For policymakers, the study offers evidence for differentiated interventions. “Institutional Entrepreneurs” could benefit from access to impact investment networks, specialized certifications, and incubation programs focused on hybrid models. “Subsistence Entrepreneurs” require more basic interventions that reduce formalization costs, simplify administrative procedures, and connect their technical skills with market opportunities. This differentiation is crucial, as Autio et al. (2014) point out, because generic interventions can generate negative externalities when subpopulation exhibits divergent needs for policymakers, the study offers evidence for differentiated interventions that move beyond one-size-fits-all approaches. Concrete implementation examples could include: (1) For 'Institutional Entrepreneurs', creating streamlined certification pathways for social and environmental ventures, establishing matchmaking platforms with impact investors, and developing public procurement preferences for formally registered hybrid enterprises. (2) For 'Subsistence Entrepreneurs', implementing graduated tax regimes that reduce initial compliance costs, creating mobile business registration units that visit rural areas, and developing technical assistance programs that help translate applied skills into market-viable formal businesses. This differentiation is crucial, as Autio et al. (2014) point out, because generic interventions can generate negative externalities when subpopulations exhibit divergent needs and institutional logics.

The study's limitations outline a promising agenda for future research. The cross-sectional nature of the design prevents establishing definitive causal relationships and tracing evolutionary dynamics. Future longitudinal research could apply state transition models (survival analysis, Markov models) to examine how strategic profiles evolve over time and what factors precipitate transitions between informality and formality. The moderate sample size (N=75) limits the statistical power to detect small effects and perform finer subgroup analyses. Studies with larger samples could employ techniques such as multilevel regressions to capture nested contextual effects (region, university, faculty) or latent class analysis with covariates to examine predictors of strategic profile membership.

Measurement based on self-reporting introduces potential social desirability bias, especially in sensitive variables such as informality. Future research could triangulate data with administrative records (internal revenue services, ministries, chambers of commerce) for a more objective measurement of formal status, and employ validated multidimensional scales to capture the complexity of constructs such as business sustainability. Replication in different institutional and geographic contexts would allow for an assessment of the generalizability of the identified profiles and their determinants.

The future research agenda includes in-depth

qualitative studies exploring the identity narratives, decision-making mechanisms, and support networks that characterize each strategic profile. Experimental or quasi-experimental research could assess the effectiveness of differentiated interventions (e.g., management mentoring vs. linking to impact networks) in promoting desirable strategic transitions. International comparative analyses could determine the extent to which these profiles and their determinants are specific to the Andean context or reflect more universal patterns in emerging economies.

Finally, integrating psychological variables (entrepreneurial self-efficacy, tolerance for ambiguity, future orientation) into predictive models of formalization would enrich our understanding of micro-foundational mechanisms.

Despite these limitations, the study provides a nuanced and empirically grounded understanding of university entrepreneurship in emerging contexts. The findings highlight its strategic heterogeneity and the complex mechanisms that link disciplinary training, conceptions of value, operational timeframes, and formalization decisions.

These contributions have implications both for entrepreneurship theory and for the design of university and public policies aimed at fostering more formal, innovative entrepreneurial ecosystems aligned with the challenges of sustainable development.

5. CONCLUSIONS

This study reveals that the trajectory from higher education to formal entrepreneurship in emerging contexts is not automatic, but rather a complex process mediated by strategic orientations and temporal dynamics. Empirical evidence demystifies the role of education as a direct formalizer, highlighting instead its influence on cognitive frameworks that prioritize different dimensions of value. Non-economic sustainability emerges as a powerful driver of formalization, supporting theories of institutional legitimacy that emphasize the symbolic capital of formality for accessing niche ecosystems. The identification of three latent profiles, Institutional, Traditional, and Subsistence Entrepreneurs, is a fundamental contribution. This finding challenges the homogenous treatment of the graduate entrepreneur and underscores the urgent need for differentiated interventions in public policy and education. The worrying link between technical training and subsistence entrepreneurship points to a critical flaw in curricula, which must integrate competencies in management, comprehensive sustainability, and institutional capital. Time-dependent data shows that the effects of training materialize over time, supporting a view of entrepreneurship as an experiential learning process.

In conclusion, fostering a more formal and sustainable entrepreneurial ecosystem requires moving beyond generic interventions, recognizing the strategic heterogeneity of graduates, and designing support mechanisms that respond to their distinctive approaches and specific timelines.

Acknowledgements: The authors wish to express their sincere gratitude to the "Strategic Leadership in Green Businesses" (SLGB) project, funded by the European Union and implemented at the State Polytechnic University of Carchi (UPEC). This institutional and financial support was essential for the development of the research underpinning this article. We also extend our appreciation to UPEC's Community Engagement and Graduate Tracking units for facilitating access to the institutional data that made this study possible. The views expressed in this document are the sole responsibility of the authors and do not necessarily reflect the opinions of the European Union or the institutions mentioned.

REFERENCES

Aguirre Benalcázar, MC, Jaramillo Paredes, MF, & Romero Hidalgo, OM (2025). Sustainable Entrepreneurship in Emerging Economies: The Role of Financial Planning, Environmental Consciousness, and Artificial Intelligence in Ecuador—A Cross-Sectional Study. Sustainability (Switzerland), 17 (14), 6533. https://doi.org/10.3390/SU17146533/S1

Albatran , A.A., & Atikbay , T. (2025). Entrepreneurship Education in Fragile Contexts: Bridging the Intention–Action Gap Through Psychological and Contextual Pathways. Sustainability 2025, Vol. 17, Page 7447, 17 (16), 7447. https://doi.org/10.3390/SU17167447

Alfons, A., & Schley, D.R. (2025). Robust Mediation Analysis: What We Talk About When We Talk About Robustness. Wiley Interdisciplinary Reviews: Computational Statistics, 17 (4), e70051. https://doi.org/10.1002/WICS.70051;WEBSITE:WEBSITE:WIRES;WGROUP:STRING:PUBLICATION

Andersson, S. (2025). Innovations and long-term international growth in born globals . Industrial Marketing

Management, 124, 150–161. https://doi.org/10.1016/J.INDMARMAN.2024.11.016
Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. Research Policy, 43 (7), 1097–1108. https://doi.org/10.1016/J.RESPOL.2014.01.015
Bao, J., Dou, J., Leitão, C., & Pereira, DB (2021). The Formation of Subsequent Entrepreneurial Intention: Happiness Matters. Sustainability 2021, Vol. 13, Page 12323, 13 (21), 12323. https://doi.org/10.3390/SU132112323
Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17 (1), 99–120.
Battilana, J., & Lee, M. (2014). Advancing Research on Hybrid Organizing - Insights from the Study of Social Enterprises. Academy of Management Annals, 8 (1), 397–441. https://doi.org/10.1080/19416520.2014.893615;ISSUE:ISSUE:DOI
Burch, G.F., Giambatista , R., Batchelor, J.H., Burch, J.J., Hoover, J.D., & Heller, N.A. (2019). A Meta-Analysis of the Relationship Between Experiential Learning and Learning Outcomes. Decision Sciences Journal of Innovative Education, 17 (3), 239–273. https://doi.org/10.1111/DSJI.12188;WGROUP:STRING:PUBLICATION
Chatterjee, I., Cornelissen, J., & Wincent, J. (2021). Social entrepreneurship and values work: The role of practices in shaping values and negotiating change. Journal of Business Venturing, 36 (1), 106064. https://doi.org/10.1016/J.JBUSVENT.2020.106064
Chen, S. (2025). Review of the IASB's legitimacy based on Suchman's typology. Journal of Management and Governance 2025, 1–23. https://doi.org/10.1007/S10997-025-09742-2
Doherty, B., & Kittipanya -Ngam, P. (2021). The Role of Social Enterprise Hybrid Business Models in Inclusive Value Chain Development. Sustainability 2021, Vol. 13, Page 499, 13 (2), 499. https://doi.org/10.3390/SU13020499
Erlei, A., Das, R., Meub, L., Anand, A., & Gadiraju, U. (2022). For What It's Worth: Humans Overwrite Their Economic Self-interest to Avoid Bargaining with AI Systems. Conference on Human Factors in Computing Systems - Proceedings. https://doi.org/10.1145/3491102.3517734;ISSUE:ISSUE:DOI
Ferro-Soto, C., Macías-Quintana, LA, & Vázquez-Rodríguez, P. (2018). Effect of Stakeholders-Oriented Behavior on the Performance of Sustainable Business. Sustainability 2018, Vol. 10, Page 4724, 10 (12), 4724. https://doi.org/10.3390/SU10124724
Filser , M., Kraus, S., Roig-Tierno, N., Kailer, N., & Fischer, U. (2019). Entrepreneurship as Catalyst for Sustainable Development: Opening the Black Box. Sustainability 2019, Vol. 11, Page 4503, 11 (16), 4503. https://doi.org/10.3390/SU11164503
Frezatti, F., de Souza Bido, D., & Mucci, DM (2026). Empirical Analysis of the Greiner Model in Family Businesses. Brazilian Business Review, 23, e20242060–e20242060.
Jakee, K., & Jones-Young, S. M. (2021). Entrepreneurship as Complex, Bundled Decisions: An Inframarginal Analysis. Entrepreneurship and the Market Process, 27–65. https://doi.org/10.1007/978-3-030-42408-4_3
Jurgelevičius, A., Butvilas , T., Kovaitė , K., & Šūmakaris, P. (2025). Developing an Entrepreneurial Ecosystem Framework for Student-Led Start-Ups in Higher Education. Education Sciences 2025, Vol. 15, Page 837, 15 (7), 837. https://doi.org/10.3390/EDUCSCI15070837
Karaca-Atik, A., Gorgievski, M.J., Meeuwisse, M., & Smeets, G. (2024). Possessing 21st-Century Skills and Building Sustainable Careers: Early-Career Social Sciences Graduates' Perspectives. Sustainability (Switzerland), 16 (8), 3409. https://doi.org/10.3390/SU16083409/S1
Kipruto, E., & Sauerbrei, W. (2025). Evaluating Prediction Performance: A Simulation Study Comparing Penalized and Classical Variable Selection Methods in Low-Dimensional Data. Applied Sciences (Switzerland), 15 (13), 7443. https://doi.org/10.3390/APP15137443/S1
López-Solís, O., Luzuriaga-Jaramillo, A., Bedoya-Jara, M., Naranjo-Santamaría, J., Negrete-Costales, O., López-Naranjo, L., Jara-Vásquez, E., & Acosta-Vargas, P. (2025). Determinants of Entrepreneurship in Ambato, Ecuador: Statistical Predictive and Component Modeling . Sustainability 2025, Vol. 17, Page 5726. https://doi.org/10.3390/SU17135726
Maloney, W. F. (2004). Informality revisited. World Development, 32 (7), 1159–1178.
Mcmullen, J.S., & Dimov, D. (2013). Time and the entrepreneurial journey: The problems and promise of studying entrepreneurship as a process. Journal of Management Studies, 50 (8), 1481–1512. https://doi.org/10.1111/JOMS.12049;REQUESTEDJOURNAL:JOURNAL:14676486;PAGE:STRING:ARTICLE/CHAPTER

McMullen, J.S., Fitzsimmons, JR, Shetty, K., & Ramoglou , S. (2024). A temporal typology of entrepreneurial opportunities: Implications for the optimal timing of entrepreneurial action. Journal of Business Venturing, 39 (1), 106356. https://doi.org/10.1016/J.JBUSVENT.2023.106356

Melchor-Duran, IL, & Villegas-Mateos, A. (2024). Comparative Analysis of the Determinants of Entrepreneurial Activities in the Middle East and Latin America. World 2024, Vol. 5, Pages 173-191, 5 (2), 173–191. https://doi.org/10.3390/WORLD5020010

Milanov, H., & Fernhaber, S.A. (2009). The impact of early imprinting on the evolution of new venture networks. Journal of Business Venturing, 24 (1), 46–61. https://doi.org/10.1016/J.JBUSVENT.2007.11.001

Mouton, D., Hartmann, F.G., & Ertl, B. (2023). Career Profiles of University Students: How STEM Students Distinguish Regarding Interests, Prestige and Sextype. Education Sciences, 13 (3), 324. https://doi.org/10.3390/EDUCSCI13030324/S1

Muñoz, P., & Cohen, B. (2018). Sustainable Entrepreneurship Research: Taking Stock and looking ahead. Business Strategy and the Environment, 27 (3), 300–322. https://doi.org/10.1002/BSE.2000;SUBPAGE:STRING:ABSTRACT;WEBSITE:WEBSITE:PERICLES;REQUESTEDJOURNAL:JOURNAL:10990836;WGROUP:STRING:PUBLICATION

Oltulular , S. (2025). Human Capital Dynamics Are the Key to Economic Growth: Source of Value of the Future. Economies 2025, Vol. 13, Page 235, 13 (8), 235. https://doi.org/10.3390/ECONOMIES13080235

Omri, A. (2020). Formal versus informal entrepreneurship in emerging economies: The roles of governance and the financial sector. Journal of Business Research, 108, 277–290. https://doi.org/10.1016/J.JBUSRES.2019.11.027

Plak, C. (2022). The entrepreneurial space in the marginalized community: the case of refugee camps entrepreneurial ecosystem Thèse de doctorat . Universitéde Limoges.

Politis, D. (2005). The Process of Entrepreneurial Learning: A Conceptual Framework. Entrepreneurship Theory and Practice, 29 (4), 399–424. https://doi.org/10.1111/J.1540-6520.2005.00091.X

Portocarrero Ramos, HC, Campos Trigoso, JA, Cruz Caro, O., Reina Marín, Y., Maicelo Guevara, JL, Sánchez Bardales, E., & Chávez Santos, R. (2025). Career paths and university education: factors that determine the employment status of university graduates. Frontiers in Education, 10, 1664249. https://doi.org/10.3389/FEDUC.2025.1664249/FULL

Portuguez-Castro, M., & Ramírez-Montoya, MS (2025). Transformative economies and complex Thinking: Enhancing sustainability competencies in business education. The International Journal of Management Education, 23 (3), 101223. https://doi.org/10.1016/J.IJME.2025.101223

Quach, NE, Yang, K., Chen, R., Tu, J., Xu, M., Tu, XM, & Zhang, X. (2022). Post-hoc power analysis: a conceptually valid approach for power based on observed study data. General Psychiatry, 35 (4), 100764. https://doi.org/10.1136/GPSYCH-2022-100764

Rocha, H. (2015). Do clusters matter to firm and regional development and growth? Evidence from Latin America. Management Research: The Journal of the Iberoamerican Academy of Management, 13 (1), 83–123. https://doi.org/10.1108/MRJIAM-12-2013-0534

Simba, A., Ojong, N., & Dana, L.P. (2023). INFORMAL ENTREPRENEURSHIP: A REVIEW AND PRIORITIZATION OF RESEARCH OPPORTUNITIES. https://Doi.Org/10.1142/S1084946723500139, 28 (2). https://doi.org/10.1142/S1084946723500139

Suchman, M. C. (1995). Managing Legitimacy: Strategic and Institutional Approaches. The Academy of Management Review, 20 (3), 571. https://doi.org/10.2307/258788

Teodorescu, V., & Obreja Braşoveanu, L. (2025). Assessing the Validity of k-Fold Cross-Validation for Model Selection: Evidence from Bankruptcy Prediction Using Random Forest and XGBoost . Computation 2025, Vol. 13, Page 127, 13 (5), 127. https://doi.org/10.3390/COMPUTATION13050127

Tsourela, M., Paschaloudis, D., Achillas, C., Boza, E., Kilipiri, E., & Papaioannou, E. (2025). Integrating Sustainability into an Organizational Marketing Strategy: A Systematic Literature Review. Proceedings 2024, Vol. 111, Page 23, 111 (1), 23. https://doi.org/10.3390/PROCEEDINGS2024111023

Wang, J. (2024). Selective coupling in hybrid organization: Institutional logic contradiction in the context of ERP post-implementation. Management Research Quarterly, 1 (1), 13–26. https://doi.org/10.63029/X78VA191

Wang, Q., Sun, Z., & Wu, C. (2021). The Impact of University Innovation and Entrepreneurship Education on Entrepreneurial Intention from the Perspective of Educational Psychology. Frontiers in Psychology, 12, 745976. https://doi.org/10.3389/FPSYG.2021.745976/BIBTEX

Wood, M.S., Bakker, R.M., & Fisher, G. (2021). Back to the Future: A Time-Calibrated Theory of Entrepreneurial Action. https://Doi.Org/10.5465/Amr.2018.0060, 46 (1), 147–171. https://doi.org/10.5465/AMR.2018.0060

Zhou, J., & Wang, M. (2023). The role of government-industry-academia partnership in business incubation: Evidence from new R&D institutions in China. Technology in Society, 72, 102194. https://doi.org/10.1016/J.TECHSOC.2022.102194