Innovation Capabilities, Technology Adoption, and Financial Structure of New Ventures in a Border Territory: Sectoral Evidence From Cúcuta, Colombia

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Abstract

Border territories subject to abrupt closure of cross-border trade offer a natural setting for examining how new ventures build competitive capabilities under conditions of systemic disruption, yet sectoral evidence from such settings is scarce. This article characterizes the innovation capabilities, technology adoption, and financial structure of ventures created in Cúcuta, Colombia, on the border with Venezuela, following the 2015 closure of the binational border. A quantitative, analytical, non-experimental field design was applied to a probabilistic sample of 156 micro, small, and medium enterprises created between 2016 and 2018, drawn from a population of 260 registered ventures and stratified across three economic sectors: manufacturing, wholesale and retail trade, and accommodation and food services. Data were collected through an expert-validated questionnaire whose subscales attained Cronbach's alpha coefficients between .754 and .959, with an overall mean of .850. Results reveal three convergent patterns. First, innovation is predominantly incremental across all three sectors, with radical innovation virtually absent and a substantial share of trading firms reporting no product innovation at all; distinctive capabilities differ sectorally, as manufacturing concentrates on innovation while trade concentrates on customer responsiveness. Second, technology adoption is dominated by the acquisition of software and by mixed mechanical-electronic control systems rather than by automation, and it coexists with decision-making concentrated in fewer than three people per firm. Third, and most unexpectedly, public funds constitute the principal source of initial capital across all three sectors, ranging from 66% in trade to 80% in accommodation, while venture capital and bank lending are marginal, and reported financial position clusters at medium levels for manufacturing and trade and at high-to-medium levels for accommodation. The study argues that this configuration describes a subsidized survival equilibrium in which public financing sustains firm creation without generating the technological depth required for growth, and derives implications for regional entrepreneurship policy in border economies.

Keywords: Innovation Capabilities; Technology Adoption; Financial Structure; New Ventures; Border Economy; Colombia; Sectoral Analysis.

1. INTRODUCTION

Entrepreneurship research has long recognized that the environment conditions what ventures can become. Institutional arrangements, access to finance, technological infrastructure, and market access define the opportunity structure within which founders operate, and adverse environments do not merely reduce the number of ventures created but alter their type, their capability profile, and their growth trajectory. What remains comparatively underexamined is the case in which an environment deteriorates abruptly rather than gradually, and in which the deterioration is territorial in origin: border economies whose productive logic is organized around cross-border exchange and whose exchange is suddenly interrupted.

Cúcuta, capital of the department of Norte de Santander in Colombia, is such a case. Its economy was historically organized around binational commerce with Venezuela, and the closure of the border in 2015 removed that basis almost overnight. The disruption was compounded by a migratory flow of unprecedented scale, with approximately 2.3 million Venezuelans entering Colombia in the years preceding 2018 according to International Organization for Migration estimates cited in regional analyses. Local entrepreneurship in this period therefore occurs under three simultaneous pressures: the loss of the historical market, an expanded and precarious labor supply, and an institutional environment that responded with public programs of entrepreneurship promotion. The resulting ventures constitute an empirical object of considerable interest, because they were created not in spite of the crisis but within it.

The Colombian national context frames this local situation. Global Entrepreneurship Monitor data have placed Colombia among the economies with the highest entrepreneurial intention worldwide, with a reported 53% of the adult population aged 18 to 64 intending to create a firm within three years, against only 16.3% having undertaken any concrete firm-creation activity. The gap between intention and realization is the central problem of Colombian entrepreneurship policy, and it has been addressed through a dense institutional architecture — iNNpulsa, Bancóldex, the Fondo Emprender of the national training service, and the entrepreneurship promotion framework established by Law 1014 of 2006 and extended by Law 1780 of 2016. Whether this architecture produces ventures capable of accumulating capabilities, or ventures capable only of surviving, is an empirical question that requires firm-level evidence.

The Research Gap

Three bodies of literature converge on this question without resolving it. The literature on innovation in micro, small, and medium enterprises in Latin America documents low innovation intensity and a predominance of incremental change, but rarely disaggregates by sector within a single territorial economy. The literature on technology adoption in emerging economies has concentrated on determinants of adoption decisions, with less attention to what is actually adopted — a distinction

that matters, because the purchase of software and the automation of processes represent very different levels of technological deepening. The literature on the financial structure of new ventures is dominated by evidence from economies with developed capital markets, where the pecking order between internal funds, debt, and external equity is well established; its applicability to settings where public funds substitute for private capital markets is not established.

The intersection of the three is where the present study is located. Innovation capability, technological base, and financial structure are not independent dimensions of a venture: financing conditions determine what technology can be acquired, and the technological base determines what kinds of innovation are feasible. Characterizing them jointly, and sectorally, within a border economy under stress, addresses a gap that none of the three literatures fills individually.

Purpose and Research Questions

The purpose of this study is to characterize the innovation capabilities, technology adoption, and financial structure of ventures created in Cúcuta between 2016 and 2018, and to establish whether these dimensions differ across the three economic sectors in which venture creation concentrated. Four research questions guided the analysis:

RQ1. What distinctive capabilities do new ventures claim, and what type and intensity of innovation do they report, by sector?
RQ2. What technology do new ventures operate, and through which control systems and software acquisition patterns, by sector?
RQ3. What is the composition of initial financing, the reported financial position, and the magnitude of investment in innovation and development, by sector?
RQ4. What organizational and market configuration accompanies these capability and financing profiles, and what regional impact do founders attribute to their ventures?

Contribution

The article contributes in three ways. Empirically, it provides firm-level sectoral evidence from a border economy in crisis, a setting for which systematic characterization is scarce. Analytically, it identifies a financing configuration in which public funds dominate initial capitalization across all sectors while private risk capital is nearly absent, and connects this configuration to the predominance of incremental innovation and to a technology base oriented to software acquisition rather than process automation. Practically, it derives implications for regional policy, arguing that instruments designed to maximize firm creation may be producing a population of ventures structurally incapable of the growth those instruments are intended to generate.

THEORETICAL BACKGROUND

Innovation Capabilities in Micro, Small, and Medium Enterprises

The conceptual foundation of innovation as the engine of economic transformation derives from Schumpeter (1934), for whom new combinations of productive factors displace established ones and generate the dynamic that sustains

development. Subsequent work refined the construct in two directions relevant here. The first distinguishes degrees of novelty: the Oslo Manual (OECD & Eurostat, 2018) differentiates product and process innovation and establishes novelty thresholds ranging from new-to-the-firm to new-to-the-world, a distinction that separates incremental adaptation from radical transformation. The second concerns the firm's capacity to innovate. Lall (1992) defined technological capabilities as the skills and knowledge required to operate, adapt, and improve technology, and argued that developing-country firms typically accumulate operational capabilities long before they develop innovative ones. Bell and Pavitt (1995) developed the same argument, distinguishing production capacity from technological capability, while Zahra and George (2002) formalized absorptive capacity as the mechanism through which firms recognize, assimilate, and exploit external knowledge. Teece (2007) situated these abilities within the dynamic capabilities framework, emphasizing sensing, seizing, and reconfiguring as the microfoundations of sustained advantage.

Applied to small firms in Latin America, this literature yields a consistent empirical picture. Crespi and Zuniga (2012), analyzing innovation surveys across several countries of the region, found that firms invest predominantly in the acquisition of embodied technology — machinery and equipment — rather than in research and development, and that the resulting innovations are overwhelmingly new to the firm rather than to the market. Álvarez and Urbano (2011) documented the institutional determinants that reproduce this pattern. The implication for the present study is that low radical innovation is the expected baseline; what requires explanation is the sectoral distribution of what innovation does occur, and its relation to financing and technology.

Distinctive Capabilities and Competitive Focus

The characterization of innovation capability in this study rests on the classical formulation of distinctive competencies, in which firms build advantage on one of four pillars: superior efficiency, superior quality, superior innovation, or superior customer responsiveness. This framework, systematized in the strategic management tradition and widely used in Latin American business research, has the analytical virtue of making the firm's strategic orientation explicit rather than inferring it from outcomes. The four pillars are not mutually exclusive in principle, but in resource-constrained firms they compete for the same scarce managerial attention, and the pillar a firm claims therefore reveals a strategic choice.

The distinction matters for sectoral comparison. Manufacturing firms transform inputs and can therefore embed advantage in the product itself, making innovation and quality plausible orientations. Trading firms intermediate between producers and consumers and cannot easily differentiate the product, which pushes them toward customer responsiveness. Accommodation and food services operate at the intersection, producing an experience in which quality and responsiveness converge. Sectoral divergence in claimed capabilities is thus theoretically expected; the empirical question is its magnitude and its consistency with the innovation activity actually reported.

Technology Adoption in Small Firms of Emerging Economies

Technology adoption has been theorized at three levels. At the individual level, the technology acceptance model (Davis, 1989) and its unified successor (Venkatesh et al., 2003) explain adoption through perceived usefulness, ease of use, social influence, and facilitating conditions. At the organizational level, the technology-organization-environment framework (Tornatzky & Fleischer, 1990) situates adoption within technological readiness, organizational characteristics, and environmental pressure. At the systemic level, Rogers (2003) models diffusion as a social process with identifiable adopter categories and a characteristic temporal shape.

For small firms in emerging economies, these frameworks require an additional distinction that the present study makes central: the difference between acquiring digital tools and transforming productive processes. A firm that purchases accounting or point-of-sale software has adopted technology in a measurable sense, but its control systems, its production logic, and its capability base may remain unchanged. The distinction corresponds to Bell and Pavitt's (1995) separation of production capacity from technological capability and has direct policy relevance, since instruments that subsidize software acquisition may register adoption without producing the deepening they intend.

Financial Structure of New Ventures

The financial structure literature originates in the trade-off and pecking order theories of capital structure. Myers and Majluf (1984) and Myers (1984) established that information asymmetry leads firms to prefer internal funds, then debt, and only lastly external equity. Applied to new ventures, where information asymmetry is extreme and collateral scarce, the pecking order predicts heavy reliance on founders' own resources and informal sources. Cassar (2004) confirmed this pattern empirically for business start-ups, showing that asset structure and growth intentions shape financing choices. Berger and Udell (1998) described the financial growth cycle in which firms progress from insider finance toward institutional debt and equity as they accumulate track record and collateral.

The applicability of this sequence to developing economies is constrained by the depth of financial markets. Beck and Demirgüç-Kunt (2006) documented that small firms in such economies face financing constraints that are not merely tighter versions of those in developed markets but qualitatively different, since the intermediate rungs of the financial growth cycle may not exist. Where formal venture capital and angel markets are thin and bank lending to new firms is rationed, public programs can become not a complement to private finance but its substitute. That possibility — public funds occupying the position that the pecking order assigns to internal funds and private debt — is a configuration with distinct consequences for the ventures that emerge, and it is directly testable in the present data.

Entrepreneurship in Crisis and Border Contexts

Two additional strands frame the territorial dimension. The first concerns entrepreneurship under crisis conditions, where the classical distinction between opportunity-driven and necessity-driven entrepreneurship (Reynolds et al., 2005)

acquires particular force: economic contraction increases necessity entrepreneurship, which is associated with lower growth expectations, lower innovation, and higher exit rates. Baumol (1990) added the crucial qualification that the allocation of entrepreneurial talent between productive, unproductive, and destructive activities depends on the reward structure institutions establish, which shifts the analytical question from how much entrepreneurship a territory produces to what kind.

The second strand concerns the environment as a determinant of entrepreneurial viability. Gnyawali and Fogel (1994) proposed an integrative framework in which government policies, socioeconomic conditions, entrepreneurial and business skills, financial assistance, and non-financial assistance jointly define entrepreneurial opportunity. Applied to a border economy whose exchange basis has been removed, the framework predicts that the environmental dimensions will not fail uniformly: public policy support may expand precisely while market conditions contract, producing ventures that are institutionally supported and commercially fragile. The sectoral evidence presented below allows this prediction to be examined directly.

Synthesis

The literature thus establishes three expectations against which the findings will be read. Innovation should be predominantly incremental and concentrated in manufacturing. Technology adoption should manifest more strongly in the acquisition of digital tools than in process transformation. Financing should depart from the classical pecking order to the extent that public programs substitute for absent private capital markets. What the literature does not establish is how these three dimensions combine within a single territorial economy under crisis, which is the contribution this study seeks to make.

METHOD

Design

The study followed a quantitative approach with an analytical level of inquiry, understood as the examination of a phenomenon through the relations among its components in order to identify the elements that compose each totality and the interconnections among them (Hurtado, 2008). The design was non-experimental, since no variable was deliberately manipulated and entrepreneurial activity was observed in its natural setting, and it was cross-sectional, since data were collected at a single point in time. It was additionally a field design, defined as the collection of data directly from the subjects investigated or from the reality in which events occur, without manipulating or controlling any variable (Arias, 2006). The research forms part of project FINU 047-2019, developed by the Research Group on Innovation and Productive Management of the Universidad Francisco de Paula Santander.

Population and Sample

The population comprised micro, small, and medium enterprises created in the city of Cúcuta between 2016 and 2018, with assets between 125 and 5,000 legal monthly minimum wages, registered in the three economic sectors in which

venture creation concentrated: manufacturing, wholesale and retail trade, and accommodation and food services. The population totaled 260 ventures.

Probabilistic sampling was applied, with a 95% confidence level, an assumed probability of occurrence of .5, and a 5% margin of error, yielding a sample of 156 ventures. Table 1 presents the sectoral distribution of the planned sample and the realized composition of responses.

Table 1:*Population, Planned Sample, and Realized Sectoral Composition*

Sector	Planned sample (firms)	Share of realized responses
Manufacturing	44	32%
Wholesale and retail trade	90	62%
Accommodation and food services	22	6%
Total	156	100%

Note. The planned stratification and the realized composition diverge, particularly for accommodation and food services. This divergence is addressed in the Limitations section, and all sectoral findings for accommodation and food services should be read as indicative rather than as precise population estimates.

Instrument and Data Collection

Two techniques were employed. Documentary review established the state of the art on entrepreneurial activity and informed the construction of the variables, using bibliographic, textual, summary, and analysis records. The principal technique was a structured survey, understood as the systematic collection of information under a previously established design that ensures the rigor of the information obtained (Tamayo y Tamayo, 2008).

The questionnaire operationalized two variable blocks. The first, characteristics of the entrepreneur, comprised demographic and psychographic dimensions and is not the object of the present article. The second, characteristics of the venture, comprised four dimensions that correspond directly to the research questions: a demographic dimension covering economic sector, activity, and firm type; a business model dimension covering the origin of the idea, value proposition, employment, research, development and innovation activity, critical competitiveness factors, and strategies; a financial dimension covering funding sources, revenue, and the share allocated to research, development, and innovation; and an environmental dimension covering entrepreneurial culture, macroeconomic context, access to financing, social context, technological context, and university and incubator support.

Financial position was measured on an ordinal, self-reported scale with three levels — high, medium, and low — applied to five items: initial seed capital, solvency index, short-term indebtedness, inventory turnover, and return on investment. This is a perceptual measure of financial position, not a set of ratios computed from financial statements, and it is reported as such throughout.

Validity and Reliability

Content validity was established through expert review of the instrument. Reliability was assessed through a pilot application and the computation of Cronbach's alpha coefficients using statistical software, disaggregated by item block and by psychographic variable. Table 2 reports the coefficients for the blocks relevant to this article together with the overall mean.

Table 2;*Internal Consistency of the Instrument (Cronbach's Alpha)*

Item block	Number of elements	Cronbach's alpha
Question 16: Funds used to create the firm	5	.754
Question 17: Financial aspects of the firm	10	.852
Question 18: Regional impact — social capital	5	.846
Mean across all instrument blocks and variables	—	.850

Note. The overall mean is computed across all thirteen blocks and variables evaluated in the original study, whose individual coefficients ranged from .754 to .959. All coefficients exceed the .70 threshold conventionally accepted for research instruments (Nunnally, 1978).

Data Analysis

Responses were tabulated and analyzed descriptively, with sectoral disaggregation as the organizing principle of the analysis. For variables in which the original study reported exact percentage distributions — funding sources, investment brackets, and regional impact — those distributions are reproduced here. For variables in which the analysis established predominant and secondary response categories without reporting full percentage distributions — distinctive capabilities, innovation type, organizational structure, decision-making, technology type, control systems, software acquisition, and market orientation — the modal and

secondary categories are reported as such. This reporting convention is stated explicitly in each results table and is revisited in the Limitations section. No inferential test of sectoral association is reported, since the disaggregated frequency distributions required to compute such tests validly are not available for all variables.

Ethical Considerations

Participation was voluntary and informed. Firms were approached through their legal representatives or owners, who were informed of the purpose of the research and of the academic use of the information. Responses are reported in aggregate and sectoral form, and no individual firm is identifiable in the results.

RESULTS

Firm Size and Sectoral Composition

Venture creation in the period concentrated in wholesale and retail trade, which accounted for 62% of responses, followed by manufacturing with 32% and accommodation and food services with 6%. The size profile is uniform across sectors: firms employ on average fewer than ten workers, a smaller group employs between eleven and twenty, and only a minority of manufacturing and trading firms employ between twenty-one and forty. The economy of new venture creation in Cúcuta is therefore a micro and small enterprise economy, with no meaningful presence of medium-sized employers among firms created in the period.

Innovation Capabilities

Distinctive Capabilities.

Sectoral divergence in claimed competitive focus is pronounced and consistent with theoretical expectation. Wholesale and retail trade concentrates on customer responsiveness, with only a minimal number of firms in the sector claiming innovation or high efficiency as their distinctive capability. Manufacturing concentrates on innovation, with a minimal share claiming high efficiency, and — a finding that deserves emphasis — an appreciable share of manufacturing firms reporting no distinctive capability at all. Accommodation and food services distributes across innovation and quality without a single dominant pillar.

The presence of a substantial group of manufacturing firms that claim no distinctive capability is analytically significant. In a sector whose competitive logic requires differentiation of the product itself, the absence of any claimed pillar of advantage suggests firms operating without an articulated competitive strategy, which is consistent with necessity-driven venture creation under crisis conditions.

Type and Intensity of Innovation.

Innovation activity reproduces the pattern documented for Latin American small firms. The three sectors report predominantly incremental innovations in their products. Imitative innovation appears in all three sectors at lower frequency. Radical innovation is virtually absent: only a minimal number of firms in wholesale and retail trade report having introduced innovations of this type, and none is reported in the remaining sectors. A substantial share of trading firms reports no product innovation whatsoever, and a smaller group of manufacturing firms

reports the same.

The intensity measure confirms this profile. Asked how many new or improved products they had introduced in the previous three years, accommodation and food service firms report predominantly one to two products. Manufacturing distributes across one to two, three to four, and more than four products, with an appreciable share reporting none. In wholesale and retail trade the majority report no new or improved product, with smaller groups reporting one to two, three to four, and more than four.
Table 3 synthesizes the innovation profile by sector.

Table 3:*Innovation Profile by Economic Sector*

Dimension	Manufacturing	Wholesale and retail trade	Accommodation and food services
Predominant distinctive capability	Innovation	Customer responsiveness	Innovation and quality, without a dominant pillar
Secondary pattern	Appreciable share reporting no distinctive capability	Minimal presence of innovation and efficiency	Dispersed across pillars
Predominant innovation type	Incremental	Incremental	Incremental
Presence of radical innovation	Not reported	Minimal	Not reported
Firms reporting no product innovation	Minimal share	Substantial share	Not predominant
New or improved products (3 years)	Dispersed: 1–2, 3–4 and more than 4, with an appreciable share reporting none	Majority report none	Predominantly 1–2

Note. Entries report modal and secondary categories as established in the original analysis. Exact percentage distributions were not available for these variables.

Organizational Structure and Decision-Making
Organizational structure follows sectoral logic. Wholesale and retail trade organizes predominantly by product and secondarily by department; manufacturing organizes by product and by department, with the departmental form

predominant; accommodation and food services organizes predominantly by department or through other arrangements, with product-based and matrix structures marginal. Matrix and market-based structures are minimal in all three sectors.

Decision-making is highly concentrated. In accommodation and food services, decisions are predominantly taken by two to three people, with the legal representative acting alone in a smaller proportion of firms. Manufacturing displays a similar profile, with a minimal group of firms distributing decisions among four to five people. In wholesale and retail trade the majority of decisions are taken by the legal representative alone, followed by the two-to-three configuration. Across the three sectors, fewer than three people participate in decision-making in the typical firm.

This concentration is consequential for the interpretation of the innovation findings. Innovation that requires the coordination of specialized knowledge is difficult to sustain in firms where strategic and operational decisions converge on one or two individuals who are also responsible for daily operations.

Financial Structure

Sources of Initial Capital.

The composition of initial financing is the most unexpected finding of the study. Public funds constitute the principal source of initial capital in all three sectors, and private risk capital is nearly absent. In accommodation and food services, 80% of initial investment derives from public funds and the remaining 20% from private angel capital. In manufacturing, 69% derives from public funds, 18% from private angel capital, 4% from individual private investors, and 8% from other sources. In wholesale and retail trade, 66% derives from public funds, 21% from private angel capital, 2% from individual private investors, 1% from venture capital through bank lending, and 10% from other sources.

Table 4 presents the full distribution.

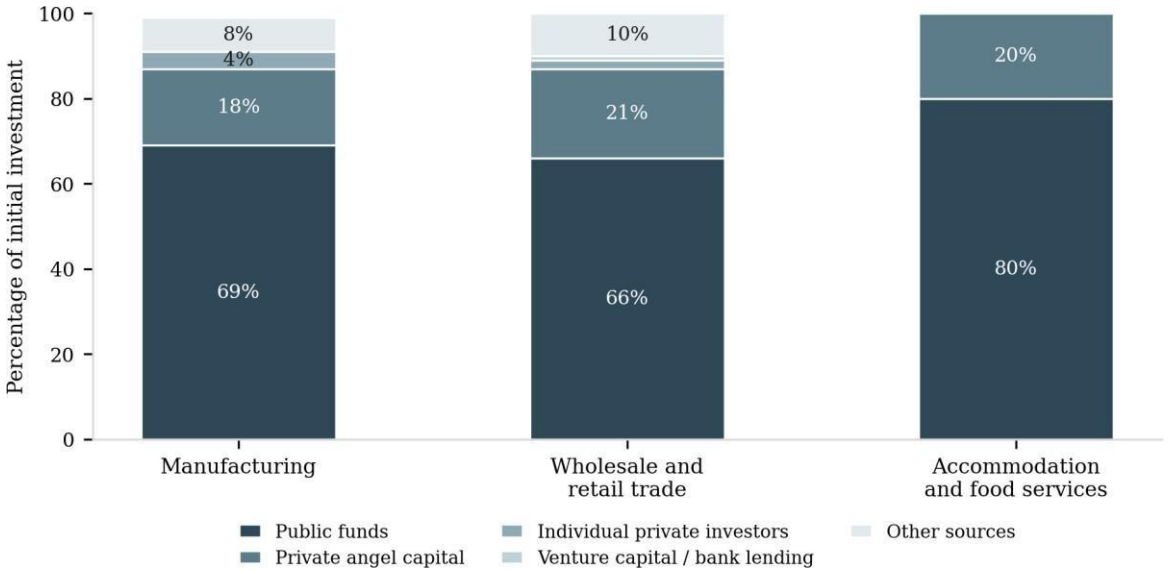
Table 4: *Sources of Initial Capital by Economic Sector (Percentage of Initial Investment)*

Source of initial capital	Manufacturing	Wholesale and retail trade	Accommodation and food services
Public funds	69	66	80
Private angel capital	18	21	20
Individual private investors	4	2	—
Venture capital	—	1	—

through bank lending			
Other sources	8	10	–

Note. Percentages as reported in the original sectoral analysis. Dashes indicate sources not reported for the sector.

Figure 1:*Sources of Initial Capital by Economic Sector*



Note. Percentages of initial investment as reported in the original sectoral analysis of project FINU 047-2019. Segments below 4% are not labelled.

The pattern departs sharply from the pecking order expectation. Bank lending, which the financial growth cycle places at the centre of early external financing, reaches 1% in a single sector and is absent elsewhere. Individual private investment is marginal. Public funds occupy the position that theory assigns to internal resources and institutional debt combined.

Reported Financial Position.

The ordinal measure of financial position yields a clear sectoral ordering. In manufacturing, seed capital, solvency index, short-term indebtedness, inventory turnover, and return on investment are predominantly medium, with a minimal number of firms at high or low levels. Wholesale and retail trade replicates this profile: medium short-term indebtedness, medium inventory turnover, medium return on investment, medium solvency, and medium initial seed capital, with a minority of firms at the extremes. Accommodation and food services is the only sector reporting a more favorable position, with seed capital, inventory turnover, and return on investment at high to medium levels and solvency high to medium, although a minimal number of firms report low solvency and indebtedness shows a high-to-medium tendency.

Table 5 summarizes the profile.

Table 5: *Reported Financial Position by Economic Sector (Modal Level on an Ordinal High–Medium–Low Scale)*

Financial dimension	Manufacturing	Wholesale and retail trade	Accommodation and food services
Initial seed capital	Medium	Medium	High to medium
Solvency index	Medium	Medium	High to medium
Short-term indebtedness	Medium	Medium	High to medium
Inventory turnover	Medium	Medium	High to medium
Return on investment	Medium	Medium	High to medium

Note. Values are modal categories of a self-reported perceptual scale, not ratios computed from financial statements. A minority of firms in each sector reported high or low levels on each dimension.

Investment in Innovation and Development.

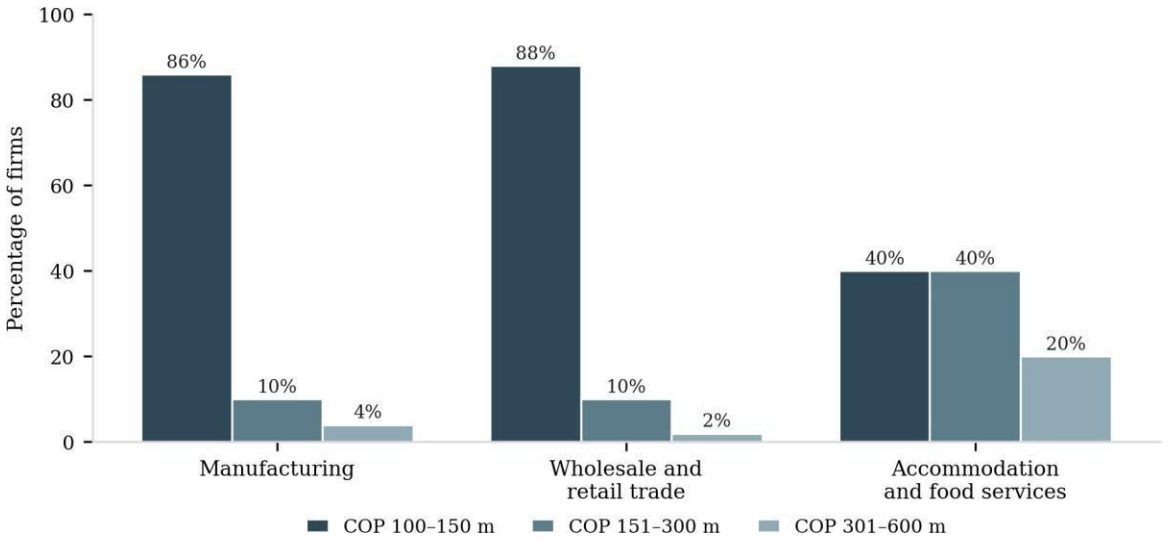
Investment magnitude concentrates in the lowest bracket in the two larger sectors and is more dispersed in accommodation and food services. In wholesale and retail trade, 88% invested between 100 and 150 million Colombian pesos in the previous three years, 10% between 151 and 300 million, and 2% between 301 and 600 million. In manufacturing, 86% invested in the lowest bracket, 10% in the second, and 4% in the third. In accommodation and food services, investment distributes evenly across the first two brackets at 40% each, with 20% in the third. Table 6 presents the distribution.

Table 6:*Investment in Innovation and Development Over Three Years by Sector (Percentage of Firms)*

Investment bracket (COP millions)	Manufacturing	Wholesale and retail trade	Accommodation and food services
100–150	86	88	40
151–300	10	10	40
301–600	4	2	20

Note. Percentages as reported in the original sectoral analysis. No firm in any sector reported investment above 600 million Colombian pesos.

Figure 2:*Investment in Innovation and Development Over Three Years by Sector*



Note. Percentage of firms in each sector by investment bracket in Colombian pesos. No firm reported investment above COP 600 million.

Technology Adoption

Technological Base.

The technology operated by these ventures is predominantly new or mixed rather than second-hand. In wholesale and retail trade the great majority of firms operate new technology or a combination of new and used equipment, with very few operating exclusively used technology. Manufacturing displays the same pattern. In accommodation and food services the majority operate new technology, a smaller group operates both, and no firm operates exclusively used equipment.

Control Systems.

Control systems reveal the limits of this technological base. In accommodation and food services, manual control and combined mechanical-electronic control predominate. In manufacturing, combined mechanical-electronic systems and purely mechanical systems predominate, with smaller groups operating exclusively electronic or exclusively manual systems. In wholesale and retail trade all system types are present, with combined mechanical-electronic control the most frequent.

The coexistence of new equipment with manual and mechanical control indicates adoption at the level of physical assets without corresponding adoption at the level of process automation. Firms have modernized what they operate more than how they control what they operate.

Software Acquisition.

The majority of firms in all three sectors invested in software for product development within the two years preceding the survey. A minimal number of firms in wholesale and retail trade and in manufacturing hold software acquired three to four years previously. Firms without any software are present in all three sectors and are proportionally most frequent in accommodation and food services. Table 7 synthesizes the technology profile.

Table 7:*Technology Adoption Profile by Economic Sector*

Dimension	Manufacturing	Wholesale and retail trade	Accommodation and food services
Predominant technological base	New and mixed new–used	New and mixed new–used	New, with a smaller group operating both
Firms operating only used technology	Very few	Very few	None
Predominant control system	Mechanical-electronic and purely mechanical	Mechanical-electronic, with all types present	Manual and mechanical-electronic
Software acquisition	Majority within the last two years	Majority within the last two years; a minimal group at three to four years	Majority within the last two years; highest share of firms without software

Note. Entries report modal and secondary categories as established in the original analysis.

Market Orientation

Commercial reach differs sharply by sector. Accommodation and food services orients principally to the local market, serving regional and international markets in smaller proportion, and reports no national market at all. Manufacturing orients principally to the regional market, also serving the national market, with minimal international presence. Wholesale and retail trade serves principally the local market with substantial regional and national activity. International orientation, although modest in absolute terms, is proportionally most representative in accommodation and food services — a finding intelligible only in a border city, where cross-border demand for lodging and food services persists independently of formal trade flows.

Perceived Regional Impact

Founders were asked to assess the incidence of their venture on four forms of regional capital, measured through an ordinal scale of detection whose reliability was verified independently. On political capital, more than 80% of firms in all three sectors report a high effect of their venture on leadership, recognition, and

prestige. On human capital, firms in all sectors report that their workforce understands what entrepreneurship is, with only 3% of manufacturing and trading firms reporting no such detection. On economic capital, more than 80% of firms in the three sectors report a clear incidence of their venture on investment, income, and profitability, with fewer than 3% reporting no detection.

Social capital yields a more differentiated result. More than 80% of firms in all three sectors attribute high incidence to connectivity. Associativity, by contrast, is recognized by 50% or fewer of firms in manufacturing and in wholesale and retail trade, while accommodation and food services does recognize its effect. Social commitment follows the same pattern as associativity, and environmental protection is clearly recognized by 60% or fewer of firms in two of the three sectors.

The asymmetry is instructive: founders readily perceive the individual returns of their ventures — economic, reputational, and connective — while collective dimensions such as associativity, social commitment, and environmental responsibility are perceived as external to the venture's impact. This is the perceptual signature of an entrepreneurial fabric composed of isolated units rather than of networks.

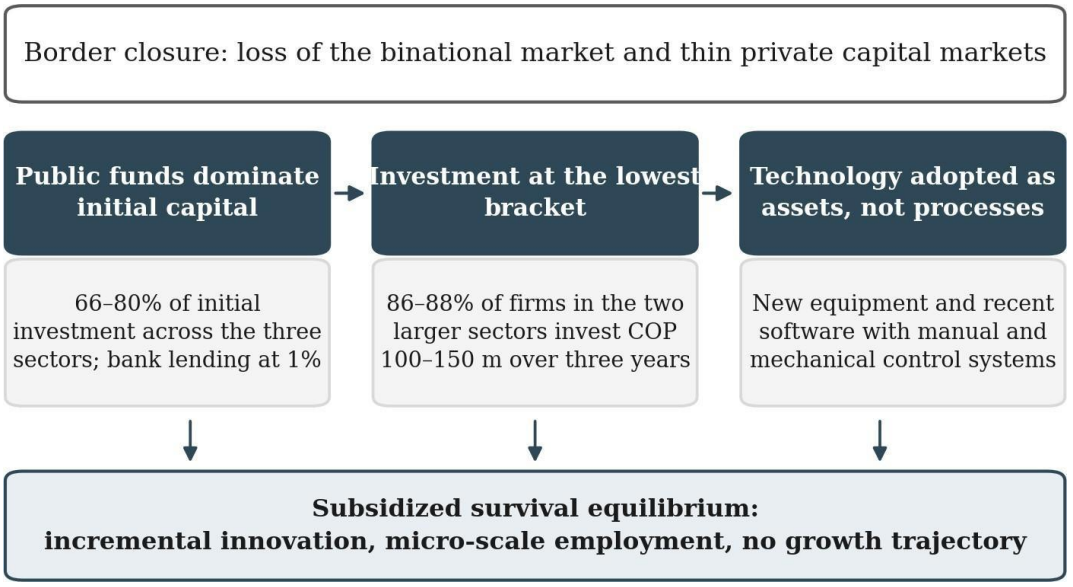
Discussion

Four interpretive claims follow from the results, each connecting the three dimensions the study set out to characterize.

A Subsidized Survival Equilibrium

The central finding is the combination of three elements that individually would be unremarkable and jointly describe a specific configuration. Public funds finance between 66% and 80% of initial capital across all sectors; investment in innovation and development concentrates in the lowest available bracket for 86% to 88% of firms in the two larger sectors; and innovation is overwhelmingly incremental, with radical innovation reported by only a minimal number of firms in a single sector. Public capital is therefore sustaining the creation of firms that do not subsequently accumulate the technological depth associated with growth.

Figure 3: *The Subsidized Survival Equilibrium of New Ventures in a Border Economy*



Note. Synthesis of the three converging findings and their joint outcome, derived from the sectoral results reported above.

This configuration is not the pecking order described by Myers and Majluf (1984). In that model, firms exhaust internal funds before seeking external finance, and external equity is the last resort precisely because it is costly under information asymmetry. Here, the most external of all sources — public programs, which involve no ownership dilution and no repayment obligation of the kind banks impose — occupies the first position. The intermediate rungs of the financial growth cycle described by Berger and Udell (1998) are effectively missing: bank lending reaches 1% in a single sector, and individual private investment does not exceed 4%. This is consistent with Beck and Demirgüç-Kunt's (2006) argument that financing constraints in developing economies are qualitatively distinct rather than merely tighter, and it extends that argument by documenting what fills the resulting vacuum.

The consequences are structural. Public entrepreneurship funds are typically awarded on the basis of a business plan and are calibrated to the creation of a viable micro-enterprise rather than to the scaling of a growth venture. A financing system organized around such instruments will therefore produce many firms and few growing firms, which is precisely the pattern Colombian entrepreneurship data have long registered at the national level in the gap between entrepreneurial intention and realized firm creation. The present study locates the mechanism of that gap at the level of the individual venture's balance sheet.

Technology Adopted at the Level of Assets, Not of Processes

The second claim concerns what technology adoption means in this population. By conventional measures, adoption is high: most firms operate new or mixed new-and-used equipment, almost none operates exclusively second-hand technology, and the majority purchased software within the two years preceding the survey. Yet

control systems remain manual or mechanical-electronic, with purely electronic control confined to minority groups within manufacturing and trade.

This is the distinction between production capacity and technological capability formulated by Bell and Pavitt (1995), observable here in a single cross-section. Firms have acquired the physical and digital artifacts of modernization without reorganizing the processes those artifacts are meant to transform. The finding matters for measurement as much as for policy: an adoption indicator built on equipment age or software purchase would classify these ventures as technologically advancing, while an indicator built on process control would classify them as largely unchanged. Zahra and George's (2002) absorptive capacity framework suggests why the gap persists: assimilation and exploitation of new technology require prior knowledge and organizational routines that firms of fewer than ten employees, with decisions concentrated in one or two people, are poorly positioned to develop.

The decision-making finding reinforces this reading. Where fewer than three people participate in decisions and the legal representative alone decides in the majority of trading firms, the organizational precondition for exploiting acquired technology — distributed specialized attention — is absent. Technology enters the firm as an asset and remains one.

Sectoral Divergence and Its Limits

The third claim concerns sectoral structure. The three sectors differ in ways the literature predicts: manufacturing claims innovation as its distinctive capability and shows the widest dispersion in new-product intensity; trade claims customer responsiveness, reports the highest proportion of firms with no product innovation, and concentrates decision-making most tightly; accommodation and food services reports the most favorable financial position, the most dispersed investment profile, and the only clear recognition of associativity as a dimension of impact.

Yet the divergence has a ceiling. All three sectors converge on public funds as the dominant source of capital, on incremental innovation as the dominant innovation type, on fewer than ten employees as the dominant size, and on the lowest investment bracket as the dominant magnitude in the two larger sectors. Sectoral logic differentiates competitive orientation but not structural condition. This suggests that the binding constraint operates at the territorial and institutional level rather than at the sectoral one, which is consistent with Gnyawali and Fogel's (1994) framework: when several environmental dimensions fail simultaneously, sectoral strategy cannot compensate.

The manufacturing firms that report no distinctive capability at all deserve separate mention. In Baumol's (1990) terms, the allocation of entrepreneurial effort responds to the reward structure institutions establish; a reward structure that pays for firm creation rather than for firm growth will produce founders who have satisfied the requirement without having formulated a competitive position. The appreciable share of manufacturing firms without a claimed pillar of advantage is

the observable trace of that incentive.

The Border as Market Structure

The fourth claim concerns the territorial dimension. The market orientation results describe an economy turned inward: accommodation and food services serves the local market and reports no national market at all; manufacturing reaches the regional and national markets with minimal international presence; trade operates locally with regional and national extension. The single counterintuitive result — that international orientation is proportionally most representative in accommodation and food services — is intelligible only in the border setting, where demand for lodging and food arises from cross-border movement of people even when the movement of goods has been interrupted. The border, having ceased to be a commercial market, persists as a flow of persons.

The perceived-impact findings complete this picture. Founders report high incidence of their ventures on economic, political, and connective dimensions, and markedly lower recognition of associativity, social commitment, and environmental protection. An entrepreneurial fabric in which half or fewer of the firms in the two largest sectors recognize associativity as a dimension of their impact is one in which the collective infrastructure that sustains growth — supplier networks, shared services, joint market access — is neither present nor perceived as relevant. In a territory that has lost its external market, that absence is a second-order constraint compounding the first.

Implications for Policy and Practice

Four implications follow. First, regional entrepreneurship instruments should be evaluated on survival and growth at three and five years rather than on firms created, since the present evidence suggests the two indicators diverge. Second, financing instruments should address the missing rungs of the financial growth cycle explicitly, through guarantee schemes or graduated credit products that allow ventures to transition from public seed funding toward institutional debt rather than remaining dependent on successive public calls. Third, technology support should shift from subsidizing acquisition to financing implementation — process redesign, control system upgrading, and the training required to exploit what has already been purchased. Fourth, the associativity deficit should be treated as a policy object in its own right, since sectoral business networks are the mechanism through which micro-enterprises access markets that individually they cannot reach.

Limitations

Five limitations bound the claims made here. First, and most consequentially for interpretation, the original sectoral analysis reported exact percentage distributions for some variables — funding sources, investment brackets, and regional impact — and modal categories without full distributions for others, including distinctive capabilities, innovation type, organizational structure, technology, and market orientation. The present article reproduces each variable at the level of precision available and labels the distinction in every table. This precludes inferential testing of sectoral association, which is why no such test is reported.

Second, the planned sectoral stratification (44 manufacturing, 90 trade, 22 accommodation) and the realized composition of responses (32%, 62%, and 6%) diverge, most sharply for accommodation and food services. Findings for that sector rest on a small number of firms and should be read as indicative.

Third, financial position was captured through a self-reported ordinal scale rather than through ratios computed from financial statements. The measure reflects founders' perception of their financial condition, which is informative in its own right but is not equivalent to audited financial structure.

Fourth, the study is cross-sectional and confined to a single city, so no causal inference and no generalization beyond comparable border economies is warranted. Fifth, the ventures studied were created between 2016 and 2018, and the instrument includes items referring to investment in the period surrounding the COVID-19 pandemic; readers should therefore situate the findings within the sequence of two successive shocks — the 2015 border closure and the subsequent pandemic — rather than attributing the observed configuration to either alone.

Future Research

Three lines follow. A longitudinal follow-up of the same cohort would establish survival and growth rates and test the subsidized survival hypothesis directly, which the cross-sectional design cannot. A study with access to firm-level financial statements would allow the perceptual financial measure to be validated against computed ratios and would permit the inferential analysis this study could not undertake. Finally, a comparative design across two or more border economies — for instance, other Colombian border departments or comparable frontier cities in Latin America — would establish whether the configuration documented here is specific to the Cúcuta disruption or constitutes a general pattern of entrepreneurship in territories that have lost their exchange basis.

CONCLUSIONS

This study characterized the innovation capabilities, technology adoption, and financial structure of 156 ventures created in Cúcuta between 2016 and 2018, following the closure of the Colombian-Venezuelan border, disaggregating the analysis across manufacturing, wholesale and retail trade, and accommodation and food services.

On innovation capabilities, the ventures display a predominantly incremental profile in all three sectors, with radical innovation virtually absent and a substantial share of trading firms reporting no product innovation. Distinctive capabilities diverge sectorally — innovation in manufacturing, customer responsiveness in trade — but an appreciable group of manufacturing firms reports no articulated competitive position at all.

On technology adoption, firms operate predominantly new or mixed equipment and have acquired software recently, yet their control systems remain manual or mechanical-electronic. Adoption has occurred at the level of assets rather than of

processes, and it coexists with decision-making concentrated in fewer than three people per firm.

On financial structure, public funds finance between 66% and 80% of initial capital across the three sectors, private risk capital and bank lending are marginal, investment in innovation and development concentrates in the lowest bracket for the overwhelming majority of firms in the two larger sectors, and reported financial position clusters at medium levels except in accommodation and food services.

Taken together, these findings describe a subsidized survival equilibrium: public financing sustains the creation of micro-enterprises that acquire technological assets without transforming processes and that innovate incrementally without accumulating the capability base that growth requires. The configuration is not a failure of the ventures but a predictable outcome of an opportunity structure in which the external market has disappeared, private capital markets are thin, and public instruments reward creation rather than consolidation. For border economies facing comparable disruption, the policy conclusion is that the number of ventures created is the wrong measure of success, and that financing, technological, and associative instruments must be designed as a sequence rather than as a single entry point.

Declarations

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Conflicts of interest. The authors declare no conflicts of interest.

Ethical approval and consent. Participation was voluntary and informed. Firms were approached through their legal representatives, who were informed of the academic purpose of the research. Results are reported in aggregate form and no individual firm is identifiable.

Data availability. The data supporting the findings derive from the final report of project FINU 047-2019 and may be requested from the corresponding author.

Relation to previous outputs of the project. The project previously produced two articles addressing different objectives of the same research: one on internal and external factors affecting the development and sustainability of small and medium enterprises (Aglala, 2021) and one on the socioeconomic impact of COVID-19 on micro and small service-sector firms on the Colombian-Venezuelan border (Conocimiento Global, 2021). The present article reports the venture-characterization objective — innovation activity, technological advancement, business structure, and entrepreneurship costs — which was not the object of either previous publication.

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Delgado: investigation, data curation, formal analysis, writing – review and editing. R. I. Laguado Ramírez: methodology, validation, writing – review and editing. All authors read and approved the final manuscript.

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