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Economic and Financial Impacts on MSME Survival in Colombia (2016–2023): Accounting for Unobserved Heterogeneity

Impactos económicos y financieros en la supervivencia de las MIPYMES en Colombia (2016-2023): considerando la heterogeneidad no observada

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Abstract

Introduction

The survival of micro, small and medium-sized enterprises (MSMEs) is a central indicator of economic and social well-being, given its impact on employment, productivity, and business dynamics, particularly in emerging economies such as Colombia.

Objective

This study aims to determine the economic and financial variables that impact the survival of Colombian MSMEs between 2016 and 2023, with explicit treatment of unobserved heterogeneity and identification of the structural change induced by the COVID-19 pandemic.

Methodology

A discrete-time proportional hazards model with gamma-distributed unobserved heterogeneity was estimated, complemented by the non-parametric Kaplan-Meier estimator, on an unbalanced firm-year panel of 161,085 observations corresponding to 29,737 unique firms. Two multiplicative interactions between firm-level financial covariates and the 2020 indicator were incorporated to capture the structural change induced by the pandemic.

Results

The aggregate six-year survival rate reaches 73.7%, with the highest sectoral rates in real estate and agriculture (around 81%) and the lowest in transportation and human health (below 60%). Profitability and firm liquidity reduce the hazard of exit, while short-term liabilities and firm indebtedness raise it. During 2020, the effect of firm indebtedness on the hazard was approximately three times stronger than in the rest of the period, while liquidity gained relative importance as a protective mechanism.

Conclusions

Sectoral and territorial conditions emerge as substantive determinants of survival, and the design of financial support during macroeconomic shocks should account for the pre-shock leverage position of beneficiaries.

Keywords:

small and medium-sized enterprises; business survival; survival analysis; econometric models; economic statistics; microeconomics; business management; financial management; COVID-19; economic crisis; Colombia; economic development.

JEL Classification:

C41; L25; G33; O54.

Resumen

Introducción

La supervivencia de las micro, pequeñas y medianas empresas (MIPYMES) es un indicador central del bienestar económico y social, por su impacto sobre el empleo, la productividad y la dinámica empresarial, particularmente en economías emergentes como Colombia.

Objetivo

Este estudio determina las variables económicas y financieras que afectan la supervivencia de las MIPYMES colombianas entre 2016 y 2023, con tratamiento explícito de la heterogeneidad no observada e identificación del cambio estructural inducido por la pandemia de COVID-19.

Metodología

Se estimó un modelo de riesgo proporcional en tiempo discreto con heterogeneidad no observada distribuida gamma, complementado con el estimador no paramétrico de Kaplan-Meier, sobre un panel empresa-año desbalanceado de 161.085 observaciones correspondientes a 29.737 firmas únicas. Se incorporaron dos interacciones multiplicativas entre las covariables financieras y el indicador 2020 para capturar el cambio estructural inducido por la pandemia.

Resultados

La tasa de supervivencia agregada a seis años alcanza el 73,7%, con los valores sectoriales más altos en actividades inmobiliarias y agricultura (alrededor del 81%) y los más bajos en transporte y salud humana (por debajo del 60%). La rentabilidad y la liquidez reducen el riesgo de salida, mientras que los pasivos corrientes y el endeudamiento de la firma lo incrementan. Durante 2020 el efecto del endeudamiento sobre el riesgo fue aproximadamente tres veces mayor que en el resto del periodo, y la liquidez ganó importancia relativa como mecanismo protector.

Conclusiones

Las condiciones sectoriales y territoriales son determinantes sustantivos de la supervivencia, y el diseño de apoyo financiero durante shocks macroeconómicos debe considerar la posición de endeudamiento previa al shock.

Palabras clave:

pequeñas y medianas empresas; supervivencia empresarial; análisis de supervivencia; modelos econométricos; estadística económica; microeconomía; gestión empresarial; gestión financiera; COVID-19; crisis económica; Colombia; desarrollo económico.

Clasificacion JEL:

C41; L25; G33; O54.

1. Introduction

The survival of companies is an indicator of the economic and social well-being of a society, due to their impact on employment generation, competitiveness, and business dynamics. Moreover, it contributes to entrepreneurial learning in identifying signals and patterns that enable resilient and sustainable practices for business success (Chhatwani et al., 2022). Conversely, company departures can mean improvements in aggregate productivity as lower-productivity, exiting companies are replaced by higher-productivity ones (Crane et al., 2022; Decker et al., 2020). Similarly, survival produces restructuring in company activities, closing some establishments and opening others to better meet demand or to adapt to changes in supply chains (Crane et al., 2022; Fort et al., 2018).

Prior to the pandemic, Donthu and Gustafsson (2020), Engidaw (2022) and Watson and Everett (1996) found that on average 50% of businesses close in the first five years. During the pandemic in 2020, nearly 60% of companies did not last until the following year (Orlando & Rodano, 2020; Alves et al., 2020), and Giunipero et al. (2022) found that survival outcomes change depending on the region and the economic sector. In Colombia, Confecámaras (2023) documented that only 33.5% of firms created in 2017 remained operational five years later, with substantial heterogeneity across regions and city sizes, reflecting structural differences in geography, productive specialization, and local demand across the country.

Studies on firm survival in Colombia have typically relied on Probit specifications and on the Kaplan-Meier and Cox proportional hazards models. While valuable, these approaches present important limitations: Kaplan-Meier restricts the survival function to a single explanatory variable, and the Cox model assumes that the relative risk is constant over time. More importantly, neither approach explicitly accounts for unobserved heterogeneity across firms, which is likely to bias the estimation of the hazard ratios in samples that include firms with substantial differences in managerial quality, organizational culture, and market positioning.

This paper aims to determine the impact of economic and financial variables on the survival of micro, small, and medium-sized enterprises (MSMEs) in Colombia between 2016 and 2023, with explicit treatment of unobserved heterogeneity. The methodology is quantitative and explanatory and combines two complementary techniques: the non-parametric Kaplan-Meier estimator and the discrete-time proportional hazards model of Prentice and Gloeckler (1978), extended with a gamma-distributed frailty term. The empirical strategy is applied to an unbalanced firm-year panel of 161,085 observations drawn from the Superintendence of Companies, combined with sectoral, geographic, trade, and macroeconomic information from DANE and the Banco de la República. The contribution of the paper consists of the systematic application of this framework to a nationwide sample of Colombian MSMEs and the explicit identification of the structural change induced by the COVID-19 pandemic, captured through interactions between firm-level financial covariates and the pandemic indicator.

The remainder of the paper is organized as follows. The next section develops the theoretical framework, followed by the empirical literature, methodology, results, discussion, and conclusions.

1.1 Theoretical framework

Financial factors, specifically the capital structure of the firm conditions its ability to absorb shocks and to honor its obligations. Modigliani and Miller (1958) established that, under specific market conditions, the value of the firm is independent of how it is financed; however, once frictions such as bankruptcy costs and asymmetric information are introduced, the financing mix becomes a determinant of firm continuity. Myers and Majluf (1984) extended this insight through the pecking order hypothesis, showing that firms with weaker internal financing capacity face higher costs of external funds, which raises their exposure to exit when liquidity tightens or profitability deteriorates. Together, these contributions establish

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that profitability, liquidity, and the level and structure of indebtedness are central mechanisms through which internal finances shape the hazard of firm exit.

Internal management and learning factors represent a second mechanism behind firm longevity. Penrose (2009) argued that firms grow and survive according to how productively they deploy their resources and how efficiently they coordinate factors of production. Operational efficiency, therefore, acts as a buffer against shocks and as a source of competitive durability. Complementing this view, Jovanovic (1982) modeled firm dynamics as a process of noisy selection: firms gradually learn about their own efficiency, and over time, more efficient firms expand and survive while less efficient ones contract and exit. Together, these contributions imply that operational efficiency and accumulated experience reduce the hazard of firm exit through both productive and selection channels.

Structural and sectoral factors constitute an active selection environment for businesses. Hannan and Freeman (1977; 1989) introduced the population ecology approach to organizations, in which firm survival depends on the carrying capacity of the niche, the intensity of competition within it, and the sector's exposure to environmental change. From this perspective, the sector is not a passive context but an active selection environment: niches with greater demand, lower competitive pressure, or higher financial stability sustain longer-lived firms, while niches under stress accelerate exit. The implication is that sectoral conditions influence the hazard of firm exit independently of firm-level attributes.

Geographic and territorial factors shape economic outcomes through agglomeration and spatial concentration. Krugman (1991) formalized the role of agglomeration and spatial concentration in shaping economic outcomes. Local labor markets, the size of regional demand, and the density of economic activity generate external economies that affect firm performance and survival. Firms located in regions with larger and more dynamic markets benefit from broader demand, deeper labor pools, and stronger productive linkages, all of which reduce exit risk. Conversely, regions with adverse labor conditions or limited market size expose firms to higher hazards. Geography is therefore a substantive determinant of survival, not merely a control.

External trade factors operate as a selection mechanism by exposing firms to heterogeneous risks. Melitz (2003) extended trade theory to allow for heterogeneity across firms within sectors, showing that trade exposure operates as a selection mechanism. Firms with higher productivity benefit from access to foreign markets and survive, while less productive firms are displaced by import competition. Trade exposure, therefore, has two opposing effects on survival: it lowers the hazard for firms able to exploit external demand, and it raises the hazard for firms unable to withstand foreign competition. This perspective is particularly relevant for the present study because it explicitly recognizes that firms within the same sector face heterogeneous risks, a premise that aligns with the unobserved heterogeneity modeled empirically.

Macroeconomic factors affect firm survival through two distinct channels: the level of aggregate activity and the degree of uncertainty surrounding it. Aghion and Saint-Paul (1998) modeled how business cycles influence the entry, exit, and reallocation of firms, with expansions sustaining firm continuity and recessions accelerating the exit of less efficient units. Fernández-Villaverde and Guerrón-Quintana (2020) emphasized the additional role of macroeconomic uncertainty, captured through volatility in prices and aggregate variables, which raises the option value of waiting and discourages investment, thereby increasing exit risk among financially constrained firms. The macroeconomic context, in both its level and its volatility, therefore, shapes the hazard of firm exit beyond what firm-level or sectoral conditions alone can explain.

1.2 Background

Empirical evidence consistently identifies profitability, liquidity, and capital structure as

primary survival determinants across diverse contexts. Less indebted, more profitable, and highly liquid firms survive longer, as documented in Asia (Cao, 2012; Liu & Pang, 2006; Parmonangan & Rahadi, 2020; Kristanti & Isynuwardhana, 2018; Kristanti et al., 2024), Africa (Bekele & Worku, 2008; Ayele & Derseh, 2024), and Europe (Markowicz, 2018). For Colombia, operating profitability, initial size, and financial structure remain robust predictors of microenterprise and retail firm longevity (Santana, 2017; Castro Rojas et al., 2017).

Regarding internal management, the productive use of resources and governance structures significantly influences longevity (Abdullah et al., 2019). In the Colombian context, firm continuity is heavily contingent on initial size, credit access (Jiménez Gómez, 2017), and entrepreneurial skills paired with core financial indicators (Román Ramírez, 2021).

Sectoral conditions independently shape firm survival. High-technology and foreign-owned sectors exhibit longer life expectancies due to knowledge spillovers (Görg & Strobl, 2000), while innovation and product differentiation lower closure rates (Salgado et al., 2012; Pérez et al., 2015). Broader evidence confirms that sector-specific covariates dictate survival outcomes, particularly during severe disruptions such as the COVID-19 pandemic (Kauermann & Tutz, 2001; Bragoli et al., 2022; Giunipero et al., 2022).

Geography is also a substantive determinant. Local labor markets, capital access, and proximity to urban centers significantly condition firm performance globally (Lee, 2016; Alcantara de Araújo et al., 2017; Puebla et al., 2018; Muhwezi & Kiliman, 2023). For Colombia, survival is positively influenced by productive clusters, local credit access, and regional labor productivity (Angulo Arboleda, 2018; Hernández, 2022; Del Carmen Rey, 2023; Mejía et al., 2023). Notably, Confecámaras (2023) documented substantial regional heterogeneity in five-year survival rates of Colombian firms, a vulnerability further amplified by the pandemic (Sepúlveda & Bustamante-Caballero, 2024).

International trade exposure operates as a dual selection mechanism: exporting generally enhances survival rates (Esteve Pérez et al., 2017), whereas intense import competition substantially raises firm exit (Fort et al., 2018).

The macroeconomic environment affects survival through aggregate activity and specific shocks (Decker et al., 2020; Engidaw, 2022). The COVID-19 pandemic vividly illustrated this severity, causing unprecedented exit rates (Alves et al., 2020; Donthu & Gustafsson, 2020; Orlando & Rodano, 2020) and establishing a structurally distinct post-pandemic macroeconomic regime where conventional distress predictors operate differently (Valaskova et al., 2023). In Latin America, MSMEs remain particularly exposed to this challenging, inflationary post-pandemic environment (OECD, 2024).

Finally, applied research increasingly addresses the challenge of unobserved heterogeneity in survival analysis. Several studies have used fixed-effects, random-effects, and discrete-time hazard models to capture unobservable firm-level differences (Kauermann & Tutz, 2001; Gupta et al., 2018; Taiwo, 2023). More recently, the explicit treatment of discrete time and frailty effects has been reaffirmed as methodologically crucial for accurately modeling SME survival (Nguyen Thi, 2022; Tripathy et al., 2025).

2. Methodology

To achieve the research objective of determining the economic and financial variables that impact the survival of micro, small, and medium-sized enterprises (MSMEs) in Colombia from 2016 to 2023, this study adopts a quantitative and explanatory empirical approach. The methodological strategy relies on duration analysis, specifically employing a discrete-time proportional hazards model with unobserved heterogeneity, complemented by the non-parametric Kaplan-Meier estimator. This analytical framework is uniquely suited to model the conditional probability of firm exits over time, as it allows for the simultaneous evaluation of firm-level financial vulnerabilities, structural sectoral conditions, and mac-

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roeconomic shocks, while explicitly accounting for unobservable idiosyncratic differences across enterprises.

The event of interest is the formal cessation of the firm's economic activity, operationalized as the non-renewal of registration before the Superintendence of Companies of Colombia. A firm is considered to have exited the market in year t if it failed to renew its registration in that year. Reactivations after a temporary absence are tracked through the corporate identifier and recorded as a new entry; a subsequent non-renewal counts as an additional exit event. Mergers and changes of corporate name are not treated as exit events, since they do not represent the cessation of activity; firms involved in such operations are followed through their identifier of record until they either fail to renew or remain registered at the end of the window. This convention is consistent with the recent Colombian survival literature (Confecámaras, 2023; Mejía et al., 2023) and with the administrative information available in the Integrated Corporate Information System (SIIS).

Right censoring arises in two cases: firms still registered at the end of the observation window (31 December 2023), whose exit time is not observed; and firms whose financial information becomes unavailable for reasons unrelated to the cessation of activity, which are censored at the last period with valid information (Kalbfleisch & Prentice, 2002).

Time is discretized in annual intervals, indexed by $t = 2016, 2017, \ldots, 2023$. The choice of an annual unit follows from the structure of the financial information reported by firms to the Superintendence of Companies, which is consolidated on an annual basis. The resulting data structure is an unbalanced firm-year panel, tracking each firm from its first valid entry until the exit event occurs or the observation is right-censored. The final dataset comprises 156,620 firm-year observations.

The empirical analysis proceeds in two complementary steps. First, the Kaplan-Meier (1958) non-parametric estimator is used to characterize the unconditional survival function of the firms in the sample and to perform descriptive comparisons across sectors, departments, and firm sizes. The estimator computes the probability of survival at each discrete period t_j as:

$$S(t_j) = \prod \left(\frac{r_j - d_j}{r_j} \right) \qquad [1]$$

Where r_j denotes the number of firms at risk at the beginning of period t_j and d_j the number of firms that experienced the event during that period. Censored observations contribute to r_j up to the moment of censoring and are removed from the risk set only in subsequent periods, which is precisely the property that allows the Kaplan-Meier estimator to use the partial information of censored firms (Kaplan & Meier, 1958; D'Arrigo et al., 2021).

Second, a discrete-time proportional hazards model is estimated to assess the relationship between the covariates derived from the theoretical framework and the conditional probability of firm exit. The model adopted is the discrete-time proportional hazards specification proposed by Prentice and Gloeckler (1978) and Meyer (1990), which expresses the discrete hazard function as:

$$h(t_j \mid x_j) = 1 - \exp[-\exp(\alpha_j + x_j'\beta)] \qquad [2]$$

Where α_j captures the baseline hazard at period t_j and x_j is the vector of covariates. The model is estimated by maximum likelihood, applying the complementary log-log link function, which is the appropriate transformation when the underlying continuous-time process satisfies the proportional hazards assumption and is observed at discrete intervals (Jenkins, 2005). In Table 1 the variables used in the model are specified.

A central methodological premise of this study is the presence of unobserved heterogeneity across firms. Idiosyncratic characteristics such as managerial quality, organizational culture, or specific market positioning cannot be observed in administrative records but are likely to affect the hazard of exit. Failing to account

Table 1. Regression model variables

Category	Variable	Description	Source	Sign	Empirical reference
Profitability	Return on Assets (ROA)	Net income/Total assets	Superintendence of Companies	+	Santana (2017)
Liquidity	Current ratio	Current assets/Current liabilities	Superintendence of Companies	+	Liu and Pang (2006)
Debt	Indebtedness of assets	Total liabilities/Total assets	Superintendence of Companies	–	Santana (2017)
	Equity ratio (financial autonomy)	Equity/Total assets	Superintendence of Companies	+	Myers and Majluf (1984)
	Indebtedness of fixed assets	Total liabilities/Fixed assets	Superintendence of Companies	–	Kristanti and Isynuwardhana (2018)
Management	Leverage rate	Equity/Total assets	Superintendence of Companies	+	Myers and Majluf (1984)
	Dupont Index	Net margin × asset turnover × leverage	Superintendence of Companies	+	Drnevich and West (2023)
	Financial leverage rate	Total liabilities/Equity	Superintendence of Companies	–	Castro Rojas et al. (2017)
	Fixed-asset turnover	Operating income/Fixed assets	Superintendence of Companies	+	Cao (2012)
Sectoral	Ln sectoral employment	Ln(employed population by sector)	DANE / BANREP	+	Jovanovic (1982)
	Ln sectoral sales	Ln(total sales by sector)	DANE / BANREP	+	Hannan and Freeman (1977; 1989)
	Ln sectoral indebtedness	Ln(sectoral debt level)	DANE / BANREP	–	Hannan and Freeman (1977; 1989)
Structural	Microenterprise indicator	Dummy = 1 if microenterprise	Supersociedades	+	Angulo Arboleda (2018)
Geographic	Ln departmental population	Ln(total departmental population)	DANE / BANREP	+	Engidaw (2022)
	Ln departmental employment	Ln(employed population, dept.)	DANE / BANREP	+	Martínez (2006)
	Ln departmental unemployment	Ln(unemployed population, dept.)	DANE / BANREP	–	Meyer (1988)
	Ln departmental labour productivity	Ln(GDP / employed pop., dept.)	DANE / BANREP	+	Mejía et al. (2023)
	Departmental dummies	Atlántico, Valle, Magdalena, Caquetá	DANE / BANREP	+	Angulo Arboleda (2018)
External trade	Ln exports	Ln(national exports)	DANE / BANREP	+	Esteve Pérez et al. (2017)
	Ln imports	Ln(national imports)	DANE / BANREP	–	Fort et al. (2018)
Macroeconomic	Ln real GDP	Ln(real GDP)	DANE / BANREP	+	Decker et al. (2020)
	Ln nominal GDP	Ln(nominal GDP)	DANE / BANREP	+	Decker et al. (2020)
	Ln GDP per capita	Ln(GDP per capita)	DANE / BANREP	+	Ayele and Derseh (2024)
	Consumer price index (CPI)	CPI level	DANE / BANREP	–	Fernández-Villaverde and Guerrón-Quintana (2020)
	Ln interest rate	Ln(interest rate)	DANE / BANREP	–	Modigliani and Miller (1958)

Source: own elaboration.

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for this heterogeneity leads to biased and attenuated estimates of the coefficients (Jenkins, 2005). The model is therefore extended to incorporate a multiplicative unobserved frailty term \nu, drawn from a gamma distribution with mean one and variance \sigma^2, leading to the specification:

$$h(t_j \mid x_j, \nu) = 1 - \exp[-\exp(\alpha_j + x_j'\beta + \log \nu)] \quad [3]$$

The gamma frailty specification follows the standard formulation of Prentice and Gloeckler (1978) and Meyer (1990) and has been applied recently to SMEs in emerging economies by Nguyen Thi (2022) and revisited methodologically by Tripathy et al. (2025).

To capture the structural change introduced by the COVID-19 pandemic, three complementary specifications of the discrete-time frailty model are estimated. The first is a baseline specification incorporating the theoretical covariates without explicit pandemic controls. The second adds a 2020 dummy to capture the direct shock, alongside the logarithm of the exchange rate (TRM) to control for concurrent macroeconomic volatility. The third, and main specification, introduces multiplicative interactions between the 2020 dummy and both firm indebtedness and liquidity. These interactions test whether the pandemic redefined the financial mechanisms of firm selection by altering the relative survival impact of these variables.

A robustness check restricting the sample to the pre-pandemic period (2016–2019) verifies the stability of the main covariates, particularly sectoral indebtedness. Comparing this baseline with the full-sample estimation isolates the structural changes induced by COVID-19. Model performance across specifications is evaluated using log-likelihood, the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC). Additionally, a likelihood ratio test (Self & Liang, 1987) assesses the null hypothesis of zero variance in the gamma frailty term.

The methodological contribution of this paper does not lie in the technique itself, since the discrete-time proportional hazards model with gamma frailty is well established in the survival literature. Its contribution lies in the literature: this is, to the best of our knowledge, the first systematic application of this framework to a nationwide sample of Colombian MSMEs, combining firm-level financial data from the Superintendence of Companies with sectoral, geographic, and macroeconomic information from DANE and the Banco de la República. The analytical value of the strategy resides in its ability to identify, simultaneously and consistently, the unobserved heterogeneity across firms, sectors, and departments, which remains largely unaddressed in survival studies for Latin American economies.

3. Results

The empirical analysis is based on an unbalanced firm-year panel of Colombian MSMEs covering the period 2016–2023. The panel contains 161,085 firm-year observations and 10,909 recorded exit events, equivalent to an unconditional exit rate of 6.8% over the period.

Table 2 summarizes the main covariates of the model. ROA_w shows a stable distribution bounded between -0.85 and 0.86, while sectoral and macroeconomic variables exhibit lower dispersion as they vary at the sector-year or year level rather than at the firm level. The microenterprise indicator concentrates 99.9% of the observations, which is consistent with the productive structure of the Colombian MSMEs population reported by Confecámaras (2023) and justifies the explicit treatment of unobserved heterogeneity adopted in the econometric specification.

Table 3 presents the temporal distribution of observations and exit events, revealing three distinct descriptive patterns. First, the unconditional exit rate declined steadily between 2016 and 2019 (from 15.84% to 4.50%). Second, despite the onset of the COVID-19 pandemic in 2020, the exit rate remained contained at 4.65%. Third, mortality rates notably rebounded in 2021 (7.33%) and 2022 (6.89%). This delayed spike in exit events motivates the empirical strategy, which introduces interactions with the 2020 indicator to formally evaluate the structural changes induced by the pandemic.

Table 2. Descriptive statistics of the main covariates (2016–2023)

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA (winsorised, 1%–99%)	161,024	0.073	0.190	-0.852	0.856
Microenterprise (dummy)	161,085	0.999	0.04	0	1
Ln Sectoral sales	161,084	23.84	1.40	13.53	26.26
Ln Real GDP (department-sector)	161,066	9.05	1.51	1.17	10.83
Ln Sectoral labour productivity	158,514	3.89	0.98	2.08	6.18
Ln Sectoral indebtedness	161,085	0.33	1.96	-2.20	6.39
Ln Firm indebtedness	160,616	-0.91	1.34	-15.82	14.03
Ln Current ratio	159,146	0.88	1.58	-14.87	15.82
Current liabilities ratio	160,663	0.63	0.35	0.00	1.00
Ln Exchange rate (TRM)	161,085	8.19	0.14	7.99	8.37

Source: own elaboration based on Superintendence of Companies (2024), DANE (2024), and Banco de la República (2024).

Table 3. Annual distribution of observations and exit events

Year	Observations	Exit events	Exit rate (%)
2016	17,779	2,816	15.84
2017	14,679	1,938	13.20
2018	14,257	848	5.95
2019	19,173	863	4.50
2020	23,103	1,074	4.65
2021	22,749	1,668	7.33
2022	24,699	1,702	6.89
2023	24,646	0	(censored)
Total	**161,085**	**10,909**	**6.77**

Note: The 2023 cohort is right-censored at the end of the observation window.

Source: own elaboration.

Figure 1 presents the aggregate Kaplan-Meier survival curve for the panel. The survival probability declines from 92.0% at the first year to 84.1% at the third, 81.5% at the fourth, and 73.7% at the sixth year, indicating that approximately one in four Colombian MSMEs ceased operations by the end of their sixth year of activity. These figures exceed those reported by Confecámaras (2023), whose 33.5% five-year rate for the 2017 cohort reflects a more restrictive definition of survival and a single-cohort design.

Survival prospects differ across cohorts of newly registered firms, as reported in Table 4. The 2016 cohort shows a first-year survival of 89.9% that declines to 73.1% by the sixth year, while the 2017 cohort follows a steeper trajectory, from 91.3% to 64.6% by the fifth year. Cohorts registered between 2018 and 2020 display intermediate paths. The 2021 cohort exhibits a notably lower first-year survival (78.4%), coinciding with the post-pandemic macroeconomic readjustment, and the 2022 cohort is fully censored at the first year. The timing of registration thus appears as a relevant dimension of MSMEs survival, since cohorts entering the market under different macroeconomic conditions show distinct exit dynamics.

Table 5 reports the sectoral disaggregation of survival probabilities. Sixth-year survival is highest in arts and recreation (82.7%), ed-

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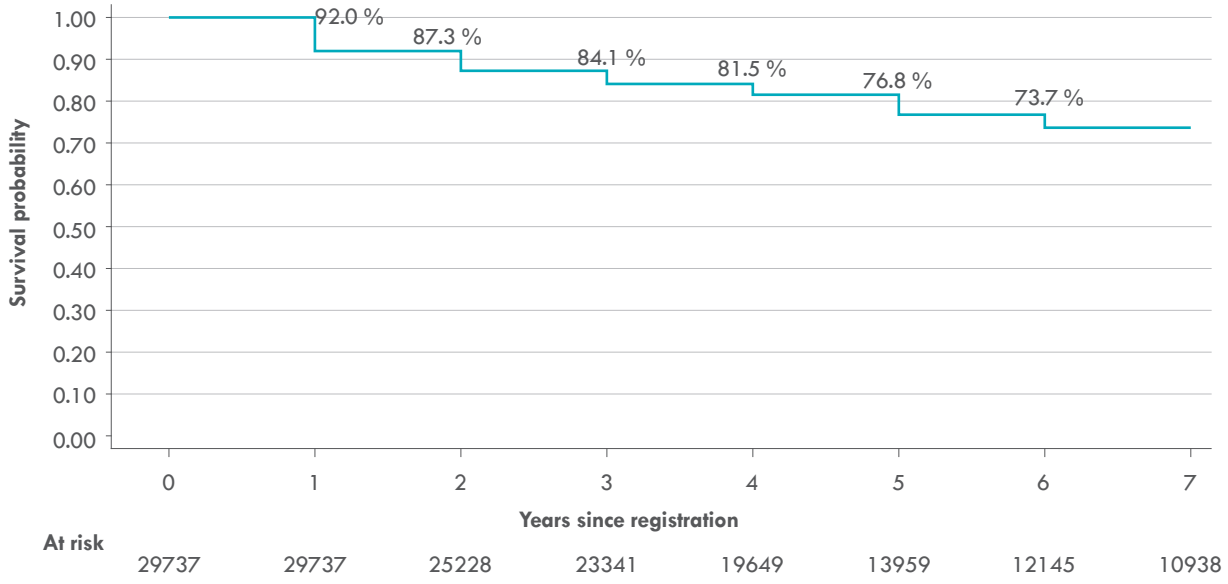
Figure 1. Kaplan-Meier curve in the survival of MSMEs in Colombia



Source: elaboration based on Superintendence of Companies (2024).

Table 4. Survival probability of MSMEs by year of registration (2016–2022 cohorts)

Cohort	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
2016	89.9%	86.4%	84.0%	81.2%	76.4%	73.1%
2017	91.3%	84.4%	78.8%	73.0%	64.6%	–
2018	91.5%	83.9%	76.8%	68.5%	–	–
2019	96.3%	90.3%	85.0%	–	–	–
2020	91.7%	85.1%	–	–	–	–
2021	78.4%	–	–	–	–	–
2022	(censored)	–	–	–	–	–

Source: own elaboration based on Superintendence of Companies (2024).

ucation (82.6%), agriculture, livestock, hunting, forestry and fishing (81.6%), real estate activities (80.9%), and manufacturing industries (77.6%). The lowest sixth-year survival is observed in transportation and warehousing (56.2%), human health and social work (58.6%), and construction (64.3%), while the remaining sectors lie between 66% and 76%. Wholesale and retail trade, the largest sector by volume of firms, reaches 76.3%. The sectoral heterogeneity observed is consistent with the population ecology approach of Hannan and Freeman (1977; 1989), under which the size of the niche, the level of competition, and the financial fragility of the industry condition firm survival beyond firm-level attributes.

Three nested specifications of the discrete-time proportional hazards model are estimated. Model I is the baseline with firm-level, sectoral, geographic, and macroeconomic covariates. Model II adds the 2020 indicator and the exchange rate (TRM). Model III incorporates two multiplicative interactions, between firm indebtedness and the 2020 indicator, and between firm liquidity and the 2020 indicator. Each specification is estimated with and without gamma-distributed unobserved heterogeneity. The results are reported in Table 6.

The likelihood ratio test of the null hypothesis that the variance of the gamma frailty is equal to zero is strongly rejected in all three

Table 5. Survival functions of MSMEs by economic sector

Economic sector	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Real estate activities	95.9%	91.7%	89.5%	87.8%	83.6%	80.9%
Arts, entertainment and recreation	94.3%	90.4%	89.0%	86.7%	84.7%	82.7%
Education	92.5%	90.5%	87.8%	86.3%	82.6%	82.6%
Agriculture, livestock, hunting, forestry, fishing	94.7%	91.8%	89.8%	87.4%	83.3%	81.6%
Manufacturing industries	92.6%	89.0%	86.0%	83.9%	80.9%	77.6%
Accommodation and food services	92.8%	86.9%	84.1%	82.3%	79.5%	76.0%
Wholesale and retail trade	92.1%	88.2%	85.3%	83.2%	78.8%	76.3%
Financial and insurance activities	85.2%	81.3%	79.1%	76.3%	72.6%	70.3%
Administrative and support services	89.0%	85.4%	82.1%	79.1%	73.4%	69.2%
Information and communications	88.2%	84.2%	80.0%	77.2%	71.7%	67.2%
Mining and quarrying	92.4%	83.2%	79.6%	76.5%	71.4%	67.1%
Professional, scientific, technical activities	88.9%	83.3%	79.5%	76.4%	70.5%	66.5%
Other service activities	80.0%	76.0%	72.2%	72.2%	67.8%	66.5%
Construction	92.5%	84.9%	80.0%	75.5%	68.7%	64.3%
Human health and social work	91.8%	82.2%	77.5%	73.8%	65.6%	58.6%
Transportation and warehousing	88.5%	78.7%	74.2%	71.1%	58.8%	56.2%
Sample average	**91.0%**	**86.0%**	**83.0%**	**80.0%**	**76.0%**	**73.0%**

Note: Sectors are ranked from highest to lowest survival probability at the sixth year.

Source: own elaboration based on Superintendence of Companies (2024).

Table 6. Discrete-time proportional hazards models with and without unobserved heterogeneity (2016–2023)

Variable	Model I		Model II		Model III	
	PGM	PGM + γ-frailty	PGM	PGM + γ-frailty	PGM	PGM + γ-frailty
ROA	-1.39*** (0.04)	-2.17*** (0.10)	-1.45*** (0.06)	-2.18*** (0.10)	-2.11*** (0.04)	**-2.17***** [0.114] (0.06)
Microenterprise (dummy)	-0.91*** (0.24)	-0.98*** (0.40)	-0.91*** (0.24)	-1.06*** (0.41)	-0.88*** (0.19)	**-1.05***** [0.350] (0.27)
Ln Sectoral sales	-0.32*** (0.01)	-0.36*** (0.03)	-0.17*** (0.02)	-0.25*** (0.03)	-0.15*** (0.01)	**-0.21***** [0.811] (0.02)
Ln Real GDP (dept.-sector)	0.01 (0.01)	0.03* (0.02)	-0.02* (0.01)	0.00 (0.02)	-0.01* (0.01)	**0.00** (0.01)
Ln Sectoral labor productivity	-0.49*** (0.02)	-0.61*** (0.03)	-0.39*** (0.02)	-0.53*** (0.03)	-0.38*** (0.02)	**-0.50***** [0.607] (0.02)
Ln Sectoral indebtedness	-0.19*** (0.01)	-0.19*** (0.01)	-0.22*** (0.01)	-0.18*** (0.01)	-0.20*** (0.01)	**-0.20***** [0.819] (0.01)
Ln Firm indebtedness					0.06*** (0.01)	**0.02** [1.020] (0.01)
Ln Current ratio					0.07*** (0.01)	**0.06***** [1.062] (0.01)
Firm indebtedness × 2020					0.13*** (0.03)	**0.11***** [1.116] (0.03)
Current ratio × 2020					-0.05** (0.02)	**-0.04*** [0.961] (0.02)

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Table 6. Discrete-time proportional hazards models with and without unobserved heterogeneity (2016–2023) (continuation)

Variable	Model I		Model II		Model III	
	PGM	PGM + γ-frailty	PGM	PGM + γ-frailty	PGM	PGM + γ-frailty
Current liabilities ratio	0.35*** (0.04)	0.51*** (0.07)	0.30*** (0.04)	0.51*** (0.06)	0.56*** (0.03)	**0.58**** [1.787] (0.04)
Ln Exchange rate (TRM)			-3.91*** (0.12)	-1.10*** (0.16)	-2.06*** (0.09)	**-1.10**** [0.333] (0.11)
2020 indicator			0.12* (0.06)	-0.60*** (0.05)	-0.33*** (0.04)	**-0.41**** [0.660] (0.04)
Constant	7.21*** (0.41)	10.91*** (1.22)	38.12*** (1.00)	29.04*** (1.31)	19.94*** (0.70)	**14.51**** (0.88)
Sector dummies	Yes	Yes	Yes	Yes	Yes	**Yes**
Department dummies	Yes	Yes	Yes	Yes	Yes	**Yes**
Gamma variance (σ^2)	–	5.36***	–	3.19***	–	**1.87****
Std. error of σ^2	–	(0.20)	–	(0.18)	–	**(0.10)**
LR test of $\sigma^2 = 0$ (χ^2_1)	–	1,547.4***	–	1,134.9***	–	**563.0****
Log-likelihood	-23,786	-22,930	-31,544	-30,984	-35,091	**-34,809**
AIC (per obs.)	0.384	0.379	0.428	0.421	0.448	**0.445**
Observations	124,062	124,062	147,497	147,497	156,620	**156,620**

Notes: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. Hazard ratios [HR = exp(β)] are reported in square brackets only for the preferred specification, Model III with γ-frailty (highlighted column). PGM denotes the discrete-time proportional hazards model of Prentice and Gloeckler (1978); PGM + γ-frailty adds a multiplicative gamma-distributed unobserved heterogeneity term. All specifications include sector dummies and department dummies (Atlántico, Valle, Magdalena, Caquetá). The LR test of $\sigma^2 = 0$ follows Self and Liang (1987) for variance components on the boundary of the parameter space; the test is strongly rejected in all three frailty specifications, validating the inclusion of unobserved heterogeneity.

Source: own elaboration.

specifications. The variance of the frailty term declines from approximately five units in Model I to less than two units in Model III. The AIC and the log-likelihood improve consistently with the inclusion of macroeconomic controls and pandemic interactions. The interpretation of the coefficients that follows refers to Model III with gamma frailty (highlighted column of Table 6).

The return on assets enters with a negative and statistically significant coefficient. The estimated hazard ratio of 0.114 indicates that a one-unit increase in ROA, reduces the instantaneous risk of exit by approximately eighty-nine percent. In more interpretable terms, a 10-percentage-point increase in profitability is associated with approximately a 20% reduction in the hazard of exit. The microenterprise indicator is associated with a hazard ratio of 0.350, indicating that microenterprises face approximately sixty-five percent lower risk of exit than firms of other sizes in the sample.

Sectoral covariates exhibit consistent signs and statistical significance. The hazard ratio of sectoral sales (0.811) implies that a unit increase in the logarithm of sectoral sales is associated with a nineteen percent reduction in the hazard of exit. Sectoral labor productivity, with a hazard ratio of 0.607, is associated with approximately a thirty-nine percent reduction in the hazard per unit increase in its logarithm. Sectoral indebtedness has a hazard ratio of 0.819 and is therefore associated with approximately an eighteen percent reduction in the hazard.

The two interactions introduced in Model III are statistically significant. The interaction be-

tween firm indebtedness and the 2020 indicator has a hazard ratio of 1.116, indicating that during 2020, a unit increase in the logarithm of firm indebtedness raised the hazard of exit by approximately 12% relative to the rest of the sample period. Combined with the baseline coefficient, the total effect of firm indebtedness during 2020 was approximately three times larger than in the rest of the period. The interaction between firm liquidity and the 2020 indicator has a hazard ratio of 0.961, marginally significant at the 10% level, indicating a slight protective effect of liquidity during the pandemic year.

The exchange rate has a hazard ratio of 0.333 in Model III, indicating that a unit increase in the logarithm of the TRM is associated with approximately a sixty-seven percent reduction in the hazard of exit. The 2020 indicator itself has a hazard ratio of 0.660, which corresponds to a thirty-four percent reduction in the hazard during that specific year, holding other covariates constant. The current liabilities ratio has a hazard ratio of 1.787, indicating that firms with a higher proportion of current liabilities face approximately seventy-nine percent higher risk of exit.

The geographic dummies for Atlántico, Valle, Magdalena, and Caquetá enter with negative coefficients, with hazard ratios ranging from 0.887 (Atlántico) to 0.329 (Magdalena). Sector dummies retain their expected signs and statistical significance, with the agricultural, manufacturing, and real estate sectors exhibiting the lowest hazard rates across the entire panel.

4. Discussion

The empirical results confirm that MSME survival in Colombia is determined by a layered structure of internal financial vulnerabilities, structural sectoral conditions, and spatial heterogeneity. The negative association between profitability and the hazard of exit aligns with the financial mechanisms emphasized by Modigliani and Miller (1958) and the pecking-order hypothesis (Myers & Majluf, 1984). Firms with robust internal resource generation face lower external financing constraints and accumulate a cash-flow buffer to absorb shocks. The magnitude of this protective effect is consistent with evidence reported by Santana (2017) and Ben Jabeur et al. (2023). Correspondingly, the positive coefficient of the current liabilities ratio reinforces this interpretation, confirming that heavy reliance on short-term obligations severely amplifies exit risk.

Sectoral conditions emerge as substantive determinants rather than mere controls. The protective effect of sectoral sales is consistent with the carrying capacity argument (Hannan & Freeman, 1977; 1989), as firms in larger sectors enjoy broader demand and lower exposure to idiosyncratic shocks. Similarly, the role of sectoral labor productivity aligns with Penrose's (2009) resource-based logic and regional evidence by Mejía et al. (2023). The stark differences in survival rates—with real estate and agriculture outperforming transportation and construction—demonstrate that uniform macroeconomic shocks produce substantially divergent mortality rates across sectors.

Crucially, the interaction terms reveal the structural change induced by the COVID-19 pandemic. During 2020, the effect of indebtedness on the hazard of exit tripled, while liquidity buffers gained relative importance as a protective shield. This pattern supports the macroeconomic-uncertainty mechanism (Fernández-Villaverde & Guerrón-Quintana, 2020) and the business-cycle reallocation argument (Aghion & Saint-Paul, 1998): under heightened uncertainty, leverage operates as a risk amplifier, whereas liquidity acts as a shield. Furthermore, the negative coefficient of the 2020 indicator reflects the unconditional, temporary protection provided by broad public relief programs, a dynamic that explains the delayed rebound in exit rates in 2021 and 2022 after these measures were withdrawn.

The territorial dimension confirms that geography is a substantive determinant of MSME survival. The lower exit hazards estimated for Atlántico, Valle, Magdalena, and Caquetá are consistent with Krugman's (1991) agglomeration arguments, where local demand size and

productive linkages generate protective external economies. As Hernández (2022) suggests, local conditions, rather than national averages, dictate the relevant scale for understanding firm survival in Colombia.

These findings carry three direct implications for public policy design. First, the protective effect of liquidity during the pandemic confirms that interventions targeting short-term financial constraints (e.g., credit guarantees and tax deferrals) effectively sustain firm continuity during shocks. Second, the differential effect of leverage indicates that financial support designs must explicitly account for the pre-shock capital structure of beneficiaries, as identical credit expansions can produce opposite effects on firms with divergent financial profiles. Third, the profound sectoral and territorial heterogeneity suggests that uniform national policies underperform; policymakers must transition towards sector- and region-specific schemes tailored to the unique structural vulnerabilities of MSMEs outside the main agglomeration centers.

5. Conclusions

This paper estimated a discrete-time proportional hazards model with gamma-distributed unobserved heterogeneity to identify the economic and financial determinants of the survival of Colombian MSMEs between 2016 and 2023. The empirical strategy combines firm-level financial information from the Superintendence of Companies (2024) with sectoral, geographic, trade, and macroeconomic information from DANE (2024) and the Banco de la República (2024), on an unbalanced firm-year panel of 161,085 observations corresponding to 29,737 unique firms and 10,909 recorded exit events.

Four findings emerge from the analysis. First, firm-level profitability and the position of short-term liabilities are robust determinants of the hazard of exit, consistent with the financial mechanisms emphasized by the theoretical framework. Second, sectoral conditions exert a substantive influence on firm survival, independent from firm-level attributes, in line with the population ecology view of organizations. Third, the territorial dimension is a non-trivial determinant of survival, with the departments of Atlántico, Valle, Magdalena, and Caquetá showing distinct hazard rates consistent with the agglomeration mechanisms of the economic geography literature. Fourth, and most importantly, the COVID-19 pandemic operated as a structural change in the financial mechanisms of selection between firms: during 2020, the effect of firm indebtedness on the hazard of exit was approximately three times stronger than in the rest of the period, while firm liquidity gained relative importance as a mechanism of protection. The reversal of the sign of sectoral indebtedness with respect to its pre-pandemic value is interpreted as evidence that the public credit support programs implemented during the pandemic were disproportionately accessed by firms operating in financially exposed sectors, a reading reinforced by the unconditional containment of the exit rate during 2020 and its rebound in 2021 and 2022.

The findings have three implications for public policy. First, programs that relax short-term financial constraints, such as credit guarantees, tax deferrals, and working capital lines, are effective in containing firm exit during macroeconomic shocks. Second, the differential effect of indebtedness across the pandemic regime indicates that financial support programs should explicitly account for the pre-shock leverage position of beneficiaries, since the same policy can produce opposite effects across firms with different financial profiles. Third, the sectoral and territorial heterogeneity documented in the results suggests that uniform national policies underperform relative to sector-specific and region-specific schemes, particularly for sectors with low average productivity and for departments outside the main agglomeration centers.

Finally, this study faces three limitations that outline avenues for future research. First, the overwhelming dominance of microenterprises constrains the variability of the size indicator; future work could address this by utilizing a continuous measure of scale. Second, the dataset cannot identify which firms effectively accessed public credit support programs; matching this panel with administrative support records would refine the interpretation of pandemic policy ef-

fects. Lastly, while the current analysis uses dummy variables for sectoral and territorial heterogeneity, future studies could employ multilevel models to explicitly capture the nested hierarchy of firms within sectors and departments.

Contribuciones de los autores

Elcira Solano Benavides: conceptualization, research, methodology, project management, supervision, writing (review and editing).

Nelson Alandete: data curation, formal analysis, validation, visualization, writing (original draft).

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The authors declare no conflicts of interest regarding this article's writing and publication.

Ethical Implications

The authors have no ethical implications that need to be declared in the writing and publication of this article.

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