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Article

Interest rate and default risk in Mexican rural financing

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Abstract

The study aimed to analyze the structural factors that limit access to rural credit in Mexico to show how interest rates, climate risks, document formalization, and territorial location operate as institutional filters of financial exclusion. To this end, a binary logistic model was applied to a national database of 250 observations, compiled from administrative records and secondary data from 2023, including variables that identify exclusion patterns not attributable to the borrower's productive performance. The model was statistically significant and had robust explanatory power for default on rural loans. The quantitative results show that the interest rate is the factor with the greatest impact: for each additional percentage point in the rate, the probability of default increases by 21.5 percentage points. A change in climate risk category, such as going from frost to pest raises this probability by 2.23%. In addition, each additional month in the term reduces risk by 2.01%, suggesting a differentiated allocation based on the solvency profile. These findings allow us to conclude that the interest rate does not reflect the producer's productivity but rather the system's structural fragility, acting as the main driver of exclusion and that, in the rural financing system, there is a rigid architecture that penalizes structural risk without offering adaptation mechanisms for vulnerable producers.

Keywords:

borrower segmentation, credit exclusion, institutional filters, marginal effects, predicted probability.

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Introduction

In Mexico, financing for the rural sector has historically been channeled through development banking schemes such as the Trust Funds Instituted in Relation to Agriculture (FIRA), by its Spanish acronym and the now-defunct National Financial Institution for Agricultural, Rural, Forestry and Fisheries Development (FND), by its Spanish acronym. Nevertheless, international organizations such as the International Monetary Fund (IMF, 2022) and the World Bank (WB, 2021) have warned that the Mexican financial system has limited coverage in rural areas, conditioned by institutional, structural, and territorial barriers.

These restrictions do not respond to the borrower's productive performance but to frictions such as the absence of collateral, credit history, and document formalization (Beck *et al*., 2009; De Olloqui and Fernández, 2017). Various studies indicate that the interest rate on rural credit does not reflect the producer's technical efficiency but rather the fragility of the financial channel that serves producers (De la Vega *et al*., 2014; Cassimon, 2022; Yu *et al*., 2023).

In this sense, the rate operates as an instrument of financial exclusion rather than as an indicator of economic risk (Khan *et al*., 2024). These authors argue that in Mexico the interest rate has been used as a mechanism of financial discipline to compensate for the informality, territorial dispersion, and productive volatility of the rural sector, replicating urban logics without adjustment to the agricultural context.

From a more structural perspective, FAO (2020); Assairh *et al*. (2024) state that, in economies with inelastic capital supply and segmented entrepreneurs, high rates can exclude productive agents if the financial system filters by institutional frictions instead of technical efficiency. These frictions include weak governance, information problems, contractual constraints and territorial segmentation (Franjo *et al*., 2022).

Findings such as those by Madero-Salmerón and Núñez-Mora (2025) highlight that the behavior of the interest rate responds to macroeconomic factors such as expected inflation, the exchange rate, and central bank decisions, which generate distortions in the local rate curve. In rural contexts, this implies that the rate reflects not only the financial cost but also the institutional burden that producers face when trying to access formal financing schemes.

Despite the interest rate playing a central role in rural credit, empirical studies analyzing its effect as a structural variable of exclusion remain limited. Most studies focus on coverage or the operational sustainability of intermediaries, without addressing the specific impact of the rate on the default risk (Del Ángel, 2003). This omission is relevant given that in Mexico formal credit is unevenly distributed, and the rate penalizes not technical performance but rather the producer's location, formalization and documentary profile (WB, 2021).

In this framework, the present work aims to empirically analyze the impact of interest rates on the default risk of Mexican agricultural units in order to show how this variable reflects the rural financial system's structural fragility rather than the borrower's productivity.

Materials and methods

The present work was observational and employed data from secondary sources and administrative records. Because it is not possible to access the individual microdata of FIRA borrowers, we aggregated and categorized the available aggregate data into a dichotomous variable, using several (polytomous) attributes available on the microsites of the National Banking and Securities Commission (CNBV, 2025) by its Spanish initialism, the minimum risk search engine (FIRA, 2025a), and the microsite called in figures (FIRA, 2025b). The dataset used comprised 250 cross-sectional observations for 2023. The variables used in the estimated binary logistic model are shown in Table 1 .

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Table 1. Definition of the empirical model's variables.

Variable	Description	Scale of measurement
REPRIS	Loan outcome (repayment risk)	Dichotomous: 1= default, 0= repayment (dependent variable)
CLIRIS	Type of climate risk associated with the loan granted (events: hail, frost, heat wave, pests, drought, and rainy period)	Nominal, categorical
LOAM	Total value of the loan granted	Continuous, quantitative in pesos ($)
LOTER	Term to repay the loan granted	Discrete, quantitative in months
INRAT	Annual interest rate applied to the loan granted	Continuous, quantitative in percentage (%)
COL	Collateral granted by the borrower	Ordinal, dichotomous: 0= A collateral was provided, 1= no collateral was provided

Based on FIRA (2025a); FIRA (2025b); CNBV (2025).

The methodological procedure used in the research was a binary logistic model, which estimates the probability of an event (default) occurring given a set of predictor variables. The empirical model to be estimated has the following mathematical expression:

$$\ln\left(\frac{P}{1-P}\right)=\beta_0+\beta_1\text{CLIRIS}+\beta_2\text{LOAM}+\beta_3\text{LOTER}+\beta_4\text{INRAT}$$

Where: ln(•) is the logarithm of the odds ratio (odds logarithm); β0 is the constant term (intercept); β1, β2, β3, and β4, are the coefficients that weight the respective explanatory variables, which are those defined above; and e is the base of the natural logarithm (whose value is approximately 2.718). Regarding the expected signs for the model's coefficients and based on the financial logic of the default risk, it is expected that the parameter β1 will be positive, since higher climate risk tends to increase the probability of default.

As for the amount of the loan granted, an inverse relationship with default risk ($\beta_2 < 0$) is expected, assuming that larger amounts are assigned to more solvent profiles. Similarly, the repayment term is also expected to have a negative effect ($\beta_3 < 0$), as longer terms offer greater flexibility to the borrower and reduce risk. Finally, the interest rate is expected to have a positive coefficient ($\beta_4 > 0$), since higher rates increase the financial burden and, therefore, the default risk (Armendáriz and Morduch, 2010; Meki and Quinn, 2024; Khan *et al*., 2024).

Although the logistic model estimates coefficients that indicate the direction and significance of each variable, these are expressed in terms of the logarithm of the odds ratio, which makes them difficult to interpret directly; therefore, to facilitate their interpretation, the so-called marginal effects are calculated, which show how much the probability of the event (default) changes in response to a unit variation in each explanatory variable, keeping the other variables constant.

The marginal effect is estimated using the following analytic expression:

$$\frac{\partial P(Y=1)}{\partial X_j}=\beta_j P\left(1-P\right)$$

Where the right side of the equation is the marginal effect of the variable on the probability of the event; it is the estimated coefficient for the variable in the logistic model; the estimated probability that the event (default) will occur and the complementary probability (that the event will not occur).

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Results and discussion

The Table 2 presents the descriptive statistics for the discrete and continuous quantitative variables used in the research.

Table 2
Descriptive statistics of quantitative variables.

Variable	Mean	Standard deviation	Value	
			Minimum	Maximum
LOAM	266 000	67 282.3	180 000	420 000
LOTER	18.3	6.79	12	36
INRAT	14.98	1.10	13	17

The variables are described in Table 1. Based on statistical runs from Stata 15.

In the case of categorical variables, since it is not possible to obtain the above descriptive indicators, it is usual to show the frequencies and proportions of each category. The Table 3 shows these statistics for the study's categorical variables.

Table 3
Frequency and proportions of categorical variables.

Variable-categories	Frequency	Distribution	
		Percentual	Cumulative
CLIRIS			
Hail	7	2.8	2.8
Frost	18	7.2	10
Heat wave	34	13.6	23.6
Pests	76	30.4	54
Drought	86	34.4	88.4
Rainy period	29	11.6	100
Total	250	100	
REPRIS			
Default (1)	110	44	44
Repayment (0)	140	56	100
Total	250	100	
COL			
Not provided (0)	110	44	44
Provided (1)	140	56	100
Total	250	100	

Based on Stata 15 outputs.

The results of the empirical logistic model, in which the response variable is the repayment risk (REPRIS), are shown in Table 4 .

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Table 4. Estimated parameters of the empirical logistic model.

Variable	Parameter	Standard error	z	P>|z|
Intercept	-156.9097	28.89789	-5.43	0
CLIRIS	1.241496	0.4827	2.57	0.01
LOAM	-0.0000372	0.0001	-3.31	0.001
LOTERM	-1.124856	0.2552	-4.41	0
INRAT	11.98603	2.2032	5.44	0

Based on Stata 15 outputs.

There is an inverse relationship between the amount of loan granted (LOAM) and the repayment risk (REPRIS), which is consistent with the logic of credit selection, in which more favorable contractual conditions tend to be assigned to borrowers with better solvency profiles and lower default risk (Meki and Quinn, 2024; Khan *et al*., 2024). Table 5 shows the goodness-of-fit statistics of the empirical model.

Table 5. Goodness of fit statistics of the empirical model.

Observations	Log-likelihood	Chi-square likelihood ratio	Probability associated with chi-square	Pseudo R^2
n	L(#)	LRX^2(4)	Prob> X^2	R^2McFadden
250	-17.3579	308.25	0	0.8988

Based on Stata 15 outputs.

The chi-square likelihood ratio statistic (308.25 with four degrees of freedom) and its associated probability (0) indicate that the model with explanatory variables is highly significant and substantially improves the fit compared to a model without predictors.

This result implies that at least one of the independent variables has a relevant effect on the probability of default on rural loans. In addition, the pseudo-R^2value (0.8988) indicates that the model achieves a notable improvement in the fit to the observed data, reinforcing its explanatory power (Menar, 2000). The average marginal effects of the empirical model are shown in Table 6 .

Table 6. Average marginal effects of the empirical logistic model.

	Delta method	z	P> |z|	
	#Y#X	Standard error		
CLIRIS	0.0222695	0.0085895	2.59	0.01
LOAM	-6.68e-07	1.62e-07	-4.12	0
LOTER	-0.0201772	0.0039901	-5.06	0
INRAT	0.2150008	0.0349705	6.1	0

Based on Stata 15 outputs.

The interpretation of the average marginal effects is the key point in the logistic model, as it allows the estimated coefficients to be expressed in terms of probability. In the case of climate risk (CLIRIS), it can be stated that a change of one category in the type of climate risk; for example, from 'frost' to 'pests', is associated with a 2.23% increase in the probability of default, keeping the other variables constant.

Additionally, for each 1-unit increase in the loan amount (LOAM), the probability of default decreases by 0.000067%. For the loan term (LOTER), the probability of default increases by 2.02% per additional month in the loan term. According to the results, for each 1-percentage point increase in the interest rate (INRAT), the probability of default would increase by 21.5 percentage points.

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Before discussing the results, it is necessary to note that the application of logistic models or other approaches, such as generalized linear models and multivariate methods, to obtain the probability of default risk among borrowers is scarce, and those that could be consulted, such as Meky and Quinn (2024) , do not use average marginal effects to interpret the parameters estimated with the logistic model.

The problem with interpreting these coefficients is that it is done in terms of the odds ratio; for example, as stated in Assairh *et al*. (2021) , if the logistic model parameter for the gender variable (woman= 0, man= 1) is -0.29, then its odds ratio is 0.75.

This result can be interpreted as meaning that men have a 24.2% lower default odds ratio than women, holding the other variables in the model constant. It is obvious that this way of analyzing logistic regression results is not intuitive and straightforward as in the classical linear regression model. However, the use of average marginal effects derived from the estimated parameters does allow a direct interpretation, as is done in the classic linear regression model, but in terms of probabilities when the explanatory variable in question changes by one unit.

On the other hand, the work by Korkulu and Akan (2024) aimed to identify the factors influencing the demand for subsidized (low-interest) agricultural loans among agricultural producers in the province of Erzurum, Turkey, using the binary logistic regression approach.

The said research determined the predicted probabilities of the variables that define the demand for credit in that country; although the present research estimated the probability of default on the loan received by rural borrowers, in both works, the use of the average marginal effects of the parameters of the logistic model directly provided the predicted probability of the demand for loan and the probability of default on the loan, respectively.

For example, Korkulu and Akan (2024) found that producers located near the center of one of the ten districts in which they conducted their survey had an 80% probability of applying for credit, whereas those farther away only reached a 60% probability. This 20% difference in predicted probability, derived from a single change in geographic location, illustrates how marginal effects can offer a more direct and useful reading for decision-making.

For example, the present research found that for each additional percentage point in the interest rate, the probability of default increases by 21.5%. The apparently unrelated results for Turkey and Mexico in the previous paragraph provide empirical support for this research proposal: access to rural credit is determined not by the producer's technical efficiency but by an institutional architecture that filters applicants based on their geographical location, level of formalization, and documentary traceability. Using logit regression for agricultural loans in China, Yin *et al*. (2020) also reported a significant effect of the base interest rate on default, a result consistent with the findings of the present research.

In this way, it can be said that exclusion in the granting of rural credit manifests not only in explicit rejection but also in invisible filters that condition access through institutional design.

Additionally, in Mexico, climate risk acts as a structural factor that directly affects default, since according to the results of the logistic model, a change in the category of the type of risk, such as moving from drought to pests, increases the probability of default by 2.23%. This effect reveals that the financial system does not absorb natural risk but instead transfers it to the producer, also making it a criterion of institutional exclusion beyond technical performance.

Korkulu and Akan (2024) also found that producers without formal collateral have an 18.7% lower probability of applying for loans than those with documentary support, even though both groups express the real need for financing.

This finding provides empirical support for the fact that Turkey's financial system filters access not by productive viability but by the level of formalization. Finally, it is necessary to highlight that the vast majority of studies that address the analysis of financial exclusion, the structural penalization of climate risk, territorial segmentation in access to credit, and documentary informality as institutional barriers, all articulated by a financial architecture that reproduces inequalities under

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criteria unrelated to technical efficiency, do so through qualitative or descriptive analytical analysis, as is done in Muñoz-Rodríguez *et al* . (2002); FAO (2020) .

In Amanullah and Chana (2020); Nyebar *et al*. (2023) following a similar approach, it is noted that in rural economies with imperfect markets, access to credit will be conditioned by structural factors such as the lack of collateral, productive informality, and institutional segmentation. These studies point out that the poorest households face severe restrictions in accessing financing, which will perpetuate cycles of low investment and productive vulnerability, and conclude that exclusion does not respond to technical efficiency but to systemic failures in the rural financial architecture.

Conclusions

Based on the results of the logistics model estimated in this research, it is possible to assert that they confirm that rural financing in Mexico presents structural conditions that go beyond the producer's mere technical performance and efficiency. Variables such as climate risk, document formalization, and territorial location operate as institutional filters that penalize conditions external to the productive subject.

In particular, the marginal effect of climate risk (2.23%) and the exclusion due to lack of collateral (up to 18.7% in comparative studies) show that inequalities are reproduced in the rural financial system under exclusionary financial architecture. It is possible to point out that territorial segmentation and the absence of compensatory mechanisms (for example, complementary guarantee funds, subsidized agricultural insurance, income stabilization funds, among others) reinforce this logic, turning credit into a privilege conditioned by criteria of formalization and location rather than by productive viability.

Based on these findings, it is possible to generalize that, in rural contexts with incomplete markets, the institutional design of financing functions as a filtering mechanism rather than an inclusion mechanism, and that the prevailing financial architecture neither assesses productive capacities nor cushions structural vulnerabilities; rather, it reproduces patterns of exclusion that penalize producers for their environment rather than for their performance.

In this way, it is concluded that any rural financial inclusion policy must be based on recognizing these structural distortions, and that any regulatory and operational reconfiguration of the system must incorporate criteria of institutional co-responsibility, mechanisms for hedging against climate risk, and evaluation models that recognize the territorial and productive diversity of the Mexican rural sector. Only in this way can credit become an instrument of inclusion and not a mechanism for systematic exclusion from access to financing for rural productive activity.

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