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Credit Rationing

The Relative Importance of Internal and External Factors

Alejandro Támara
M. Carmen Fernández Díez
Arturo Joaquín

Inter-American Development Bank
Connectivity, Markets, and Finance Division
Institutions for Development Sector

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Alejandro Támara, Consultant, Inter-American Development Bank

M. Carmen Fernández Díez, Lead Specialist, Inter-American Development Bank

Arturo Joaquín, Consultant, Inter-American Development Bank

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Abstract

Both internal and external factors can contribute to the informational frictions that drive credit rationing among firms. This study uses data from enterprise surveys and other sources to evaluate the relative contribution of internal and external variables in determining the likelihood of credit rationing. The results indicate that external factors are more important than internal ones in their association with the marginal probability of experiencing credit rationing. From these key results, we derive two policy recommendations. First, policy interventions promoting reforms to reduce inflation, decrease informality, improve firm transparency, and make judicial processes more effective are likely to reduce credit rationing. Second, while credit support programs are likely to be effective in reducing credit rationing, it is advisable to design such programs with mechanisms aimed at improving formalization and transparency.

1. Introduction

Credit rationing describes situations where there is an excess demand for credit in the market and standard price mechanisms, such as interest rates, are unable to balance supply and demand. This imbalance is largely driven by informational frictions that may affect the complex interplay between supply and demand factors within specific institutional and economic contexts. Empirical research on the determinants of credit rationing has explored factors that can be classified as internal or external to the firm. Internal factors include firm age, size, sales, and other variables that are typically proxies for informational frictions or profitability (Ang, Lin, and Tyler, 1995; Avery, Bostic, and Samolyk, 1998; Voordeckers and Steijvers, 2006), while external factors may include market structure, sector characteristics, institutional elements, and macroeconomic variables (Mc Namara, O'Donohoe, and Murro, 2020; Drakos and Giannakopoulos, 2011).

The main objective of our empirical analysis is to quantitatively establish the relative importance of internal and external factors in relation to the probability of being credit rationed. As an additional contribution to the empirical literature, we introduce two novel variables, namely *quality of information* and *truthfulness of information* reported by the firm. Our analysis yields two main findings. First, we establish a cardinal ordering of the relative importance of both external and internal factors in relation to credit rationing, indicating that the external factors contribute 17 percent more than internal factors to the marginal change in the probability of being credit rationed. Second, the quality of information and truthfulness of information provided by firms not only present a statistically significant association with the probability of experiencing credit rationing, but the quantitative relevance of other observable variables is different for firms with a high or low quality of information.

Considering each factor individually, we find that inflation rate variability and economic development display the largest (in absolute value) association with the marginal probability of being credit rationed. Credit expansions are also statistically significant, but with a smaller (in absolute value) association with rationing. At the firm level, being formally registered, the quality and truthfulness of information, the type of ownership, and the availability of internal collateral are

the most relevant factors associated with the reduction of credit rationing. At the sector level, inadequate judicial services and the presence of informal firms both increase rationing (potentially due to increasing bankruptcy and contract enforcement costs, decreased levels of credibility and transparency, and lower and riskier project returns). Operating in the manufacturing sector also increases the likelihood of rationing relative to that of firms in the service sector. Finally, a result that appears to depart from others in the literature is that firm size, measured either by number of employees or sales, is not a factor with a statistically significant association with credit rationing in our model.

2. Background, Literature Review, and Hypotheses

2.1. Credit Rationing

Credit rationing refers to a state of equilibrium excess demand in credit markets, where standard price mechanisms, such as interest rates, are insufficient to balance supply and demand. The processes leading to its emergence have been subject to study since the seminal models of the late 1970s and early 1980s. Early research explored various factors that could lead to a rationed equilibrium. Baltensperger (1978) examined the implications of a bank's risk management strategies and identified that adverse selection and moral hazard¹ could result in credit rationing. Keeton (1979) proposed another model of credit rationing, similar to Baltensperger's in several aspects (risk-return framework, borrower risk profiles, equilibrium rationing) but with a focus on the structure of loan rates. This model suggested that banks might set a uniform rate for a broad range of borrowers (and risk profiles) due to the complexities and costs associated with rate differentiation.²

Fried and Howitt (1980) offered an alternative explanation for the emergence of rationing based on implicit contracts between the banks and borrowers, emphasizing long-term relationships, borrower loyalty, bank stability, and risk sharing. Subsequently, Stiglitz and Weiss (1981) focused on adverse

¹ Adverse selection arises when lenders cannot perfectly distinguish between high-risk and low-risk borrowers, while moral hazard refers to the change in borrowers' behavior after obtaining a loan.

² This provides an early rationale for the exploration of differential levels of credit rationing conditional on firm size, if size is a relevant dimension to group borrowers.

selection and moral hazard resulting from imperfect information. In their model, higher interest rates affect the pool of borrowers and simultaneously encourage riskier projects (adverse selection and moral hazard, respectively). Given the limited effectiveness of the price mechanism, the use of non-price allocation strategies becomes pertinent.

While later studies have contested the emergence and existence of a rationed equilibrium (Besanko and Thakor, 1987; Arnold and Riley, 2009), other research continues to provide theoretical and empirical support for the existence of equilibrium rationing (Kjenstad, Su, and Zhang, 2015; Beyhaghi et al., 2020; Kallandranis, Anastasiou, and Drakos, 2023, among others).

2.2. Empirical Literature

A rationed equilibrium results from the interplay between supply and demand factors within a specific institutional and economic context. On the demand side, the empirical literature has focused on the significance of firm characteristics in the emergence of credit rationing, with most variables serving as proxies for the severity of informational frictions or indicators of profitability.

Firm size, a variable often included in econometric models of credit rationing and credit access as a categorical variable, can be interpreted as a proxy for informational frictions. Larger firms typically have more sophisticated information systems, facilitating lenders' assessments of the borrowers' risks profiles. Additionally, lenders often incur proportionally higher monitoring costs in smaller firms (Boocock and Woods, 1997). Firm size may also proxy the relevance and severity of agency problems as size increases. For instance, as a firm grows larger, there is an increasing disconnect between management and ownership, increasing the potential misalignment of incentives between these two groups, thus increasing agency problems.³ Moreover, as firms grow larger so

³ Agency problems, or principal-agent problems, arise in financial markets when one party, known as the principal, delegates authority and decision-making power to another party, known as the agent, to act on their behalf. Problems occur when the interests of the principal and the agent do not align perfectly, leading to conflicts of interest, which can result in suboptimal outcomes. Some relevant cases in the present context are the lender-borrower asymmetry (borrowers may, and typically have, better information about the underlying conditions of an investment project and have a clear understanding of objectives) and the shareholder-manager conflict (shareholders hire managers with the expectation that the latter will maximize shareholder value, but managers may

do the incentives to engage in ex post strategic behavior (moral hazard), as noted by Eslava and Freixas (2021). Alternatively, firm size is usually positively correlated with the availability of internal collateral, which can play an important role in the control and mitigation of the adverse effects of asymmetric information.⁴ The problem with the inclusion of firm size is, precisely, that it can correlate with various factors as described. As a consequence, the resulting estimation for its coefficient can be sensitive to the inclusion of other proxies.

Firm age is another commonly considered characteristic in credit access and rationing studies. It primarily serves as a proxy for the firm's profitability and market survival capabilities (Hou and Van Dijk, 2019; Cheema, Chiah, and Zhong, 2021). Empirical results often find a positive relationship between firm age and access to credit (Presbitero and Rabelotti, 2016).

The empirical literature also considers other firm characteristics such as investment in R&D and elements related to innovation, which are often correlated with greater disparities in information between borrowers and lenders, thus increasing the likelihood of rationing (Guiso, 1998; Freel, 2007; Piga and Atzeni, 2007). Type of ownership and corporate governance are also considered, as they relate to the severity of agency problems within the firm (the greater the separation between owners and managers and the weaker the corporate governance, the more severe are agency problems, thus usually leading to increased rationing) (Fama and Jensen, 1983; Claessens and Tzioumis, 2006).

The literature has also considered other factors such as market structure, sectoral classification, institutional elements, and macroeconomic conditions. Low bank competition and increased market power reduce access to credit (Leon, 2015; Grandi and Ninou Bozou, 2023). This is largely a generalization of the standard result expected as market power increases (a reduction in the level of

have their own interests and these differing interests can lead to conflicts, potentially resulting in decisions that benefit managers at the expense of shareholders).

As firms grow they may need to improve corporate governance practices and information systems to compensate for and control these problems (Von Thadden, 1990; Chu, 2011; Chi et al., 2015; Koji, Adhikary, and Tram, 2020).

⁴ As shown by Niinimäki (2018), collateral may generate negative incentives. Specifically, under certain conditions, the borrower might be incentivized to undertake riskier behaviors, either as a gamble for resurrection or to engage in activities that postpone liquidation in anticipation of a revaluation of the collateral.

transactions), but it has a clear correlation with the incentives to collect and process information. Sectoral variables appear in various forms. Lenders use industry classification to assess the credit quality of borrowers (Petersen and Rajan, 1994), and banks may prefer to grant loans to firms operating within growing industries. Firms operating in other industries may have trouble accessing credit in periods when their industries are in financial difficulties. Industries also differ in their intrinsic needs for external financing (Rajan and Zingales, 1998), and those with relatively larger financing needs are more likely to face increased probabilities of credit rationing. Manufacturing and infrastructure, for example, generally require large investments, leading to intrinsically higher demands for external financing. In line with these arguments, Drakos and Giannakopoulos (2011) find that firms operating in the mining sector experience greater likelihood to be credit rationed, whereas firms in real estate and hotels have the lowest probability of being credit rationed.⁵

Finally, within country-level factors, improvements in rule of law, judicial enforcement, and democracy have been shown to enhance access to credit (Ranasinghe and Restuccia, 2018; Jappelli, Pagano, and Bianco, 2005; Osei-Tutu and Weill, 2023) because these factors play a crucial role in shaping the credit market by providing a secure and predictable environment for financial transactions. Macroeconomic conditions also significantly influence credit rationing. The empirical literature has robustly demonstrated the impact on credit availability of financial crises and shifts in aggregate financial conditions (Albareto and Finaldi Russo, 2012; Kremp and Sevestre, 2013; Korab and Poměnková, 2017). In particular, during financial crises and periods of financial tightening, there is an increase in the prevalence of credit rationing.

⁵ It is worth noting that those arguments essentially point to the relative demand for external financing and not so much to information. As we shall see when presenting the theoretical framework, this increased demand can be associated with increased rationing. There are also arguments to be made about information at the sector level, such as in relation to the observability and verifiability of output or the consistent differences in rates of informality across sectors.

2.3. Theoretical Framework

An integrated credit rationing model

Our theoretical framework of reference is based on the integrated credit rationing model proposed by Kjenstad, Su, and Zhang (2015). This section presents a short overview of the model and heuristic extensions to account for implicit variables.⁶ This model encompasses two types of credit rationing. The first, based on the model of Jaffee and Russell (1976), addresses a scenario where the borrower has access to external financing but faces excess demand at the offered rate. The second type considers situations where the borrower is unable to obtain funds at any rate. Diverging slightly from the terminology used in Kjenstad, Su, and Zhang (2015), we refer to these scenarios as partial rationing (PR type) and full rationing (FR type), respectively.⁷

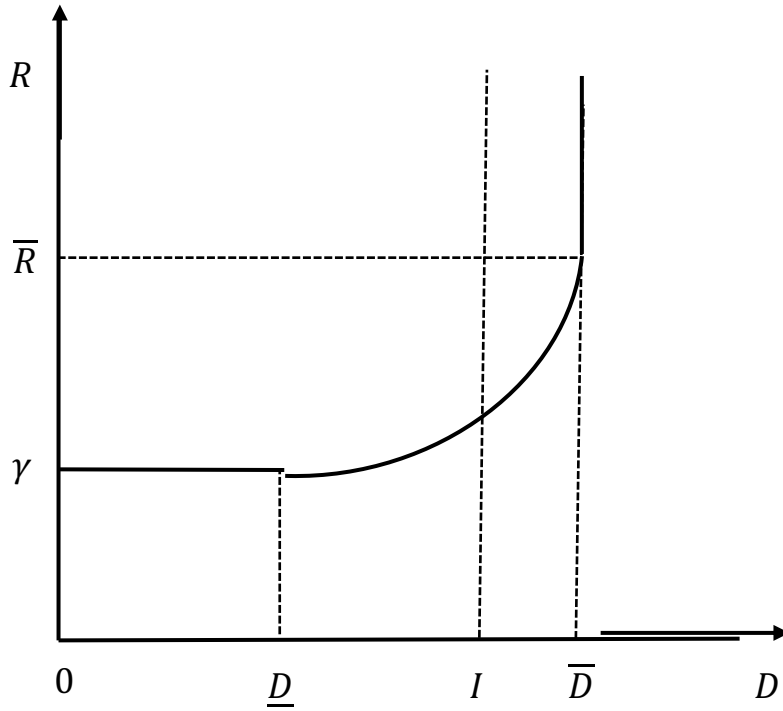
The model assumes an entrepreneur with a fixed-size investment project and a competitive credit market. The investment is financed through a loan, which can be reduced through effort. In the absence of agency problems, the marginal rate of substitution between the cost of debt and effort is determined by the tangency with the loan offer curve (determined by the zero-profit curve of the lender in the loan size-interest rate space). Given the presence of risk of default, the loan offer curve is positive sloping (without the presence of agency problems) (Figure 1).⁸

⁶ See Kjenstad, Su, and Zhang (2015) for complete details.

⁷ Kjenstad, Su, and Zhang (2015) categorize these cases as JR type and Tirole type, respectively, in reference to the base models of Jaffee and Russell (1976) and Tirole (2010).

⁸ The positive-sloping offer curve could also emerge with unlimited liability and imperfect information, as in Jaffee and Russell (1976).

Figure 1. Loan Offer Curve



Source: Adapted from Kjenstad, Su, and Zhang (2015).

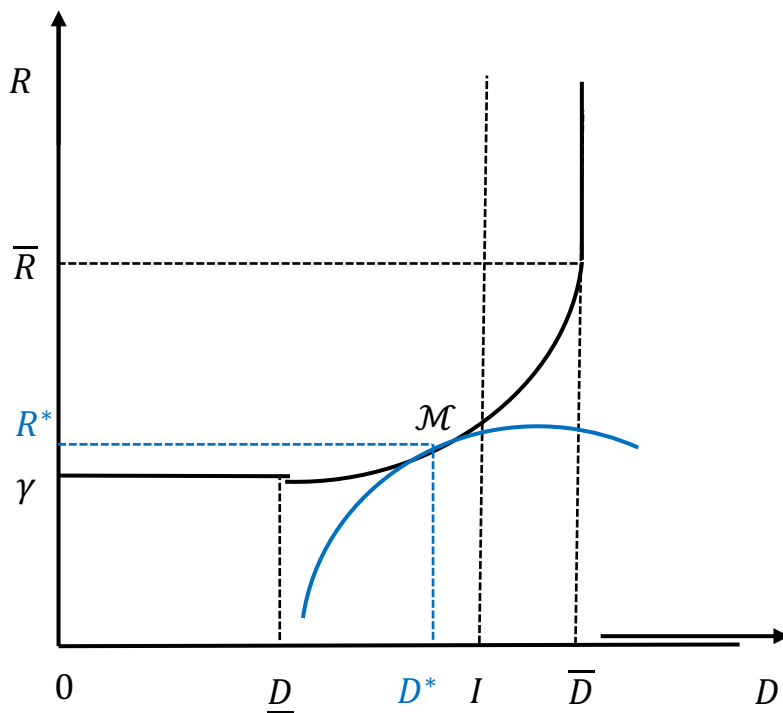
The project can yield a total positive return that can be as low as m and as high as M (i.e., the distribution of possible returns lies with the range $[m, M]$, not shown in the figures). The total investment can be financed either with debt or effort, thus $I = D + E$, where I stands for total investment, D stands for the debt used to finance the project, and E is the level of (cash-equivalent) effort made by the entrepreneur and is the argument of a convex cost function.⁹ Preferences and technical relationships are such that there is an interior solution with $D < I$ at the optimum.

Figure 2 shows a representation of an equilibrium debt contract at $\mathcal{M}$. The loan offer curve is first flat and then upward sloping, and the blue line represents the indifference curve for the entrepreneur. γ stands for the cost of loanable funds (deposit rate plus intermediation costs). The first part of the loan offer curve is flat for relatively low required returns R per unit of loan such that $DR < m$. So, there is

⁹ E includes any cost that can be reduced by effort too.

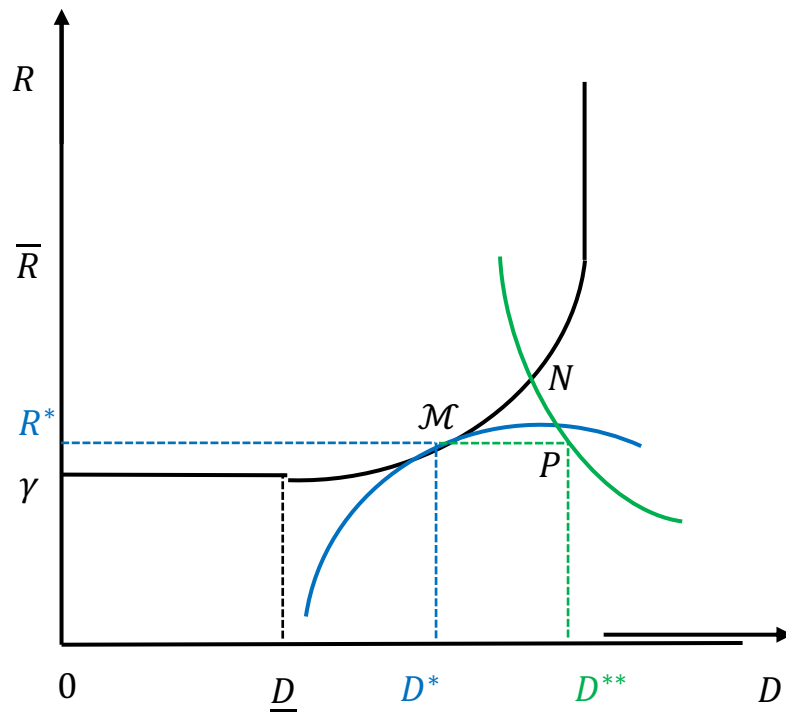
a level of debt D below which the loan offer curve is flat. Beyond this point, the required rate of return is increasing on the amount borrowed and there is an upper limit $\bar{D}$ for which there is always default and the bank takes the entirety of the project's return. Thus, at that point, the loan offer curve turns vertical, and the positive slope is the result of uncertainty and limited liability. The blue line describes results from the entrepreneur's convex cost function, where the level of effort is determined by the distance between the required investment and the loan obtained from the lender. Under suitable assumptions, there can be risky or risk-less equilibrium. We consider a situation in which there is a risky level of debt, represented by $\mathcal{M}$ resulting in a borrowing D^* . If $D < I$ and a positive sloping loan offer curve, there is PR-type equilibrium (partial rationing) since for any D such that $\underline{D} < D < I$ the borrower would prefer a slightly larger loan. This is represented in Figure 3, which now includes (in green) the demand curve that follows from an optimization over the value D by the entrepreneur. The entrepreneur gets D^* but at that cost he would want to have D^{**} .

Figure 2. Equilibrium Debt Contract



Source: Adapted from Kjenstad, Su, and Zhang (2015).

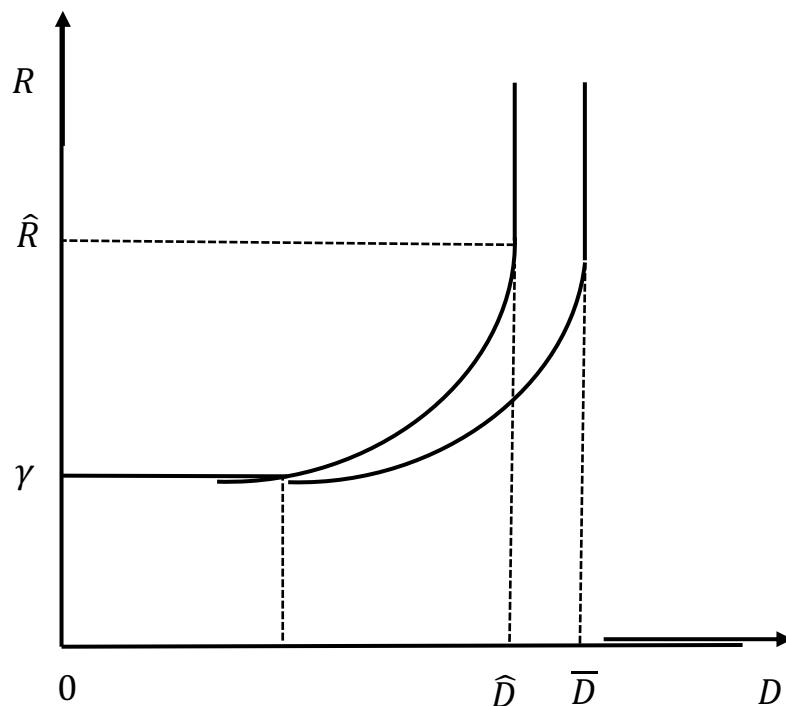
Figure 3. Equilibrium Borrowing Excess Demand (rationing)



Source: Adapted from Kjenstad, Su, and Zhang (2015).

As indicated earlier, in the baseline situation there can be a positive sloping offer curve and rationing under perfect information. Kjenstad, Su, and Zhang (2015) show that with the introduction of agency problems the maximum level of borrowing falls below $\bar{D}$ in Figure 2 to a lower level, say $\hat{D}$ in Figure 4, and, as a result, the loan offer curve shifts backwards. This situation could lead to another rationed equilibrium where there is an efficiency loss or, for sufficiently high agency problems, there may not be an equilibrium at any rate, leading to an FR-type rationing (full rationing).

Figure 4. Loan Offer Curve Shifting Inwards Due to Agency Costs



Source: Adapted from Kjenstad, Su, and Zhang (2015).

Important frictions and variations

Kjenstad, Su, and Zhang (2015) discuss various extensions to the basic setup including bankruptcy costs, costly state verification, money diversion, risk shifting, and hidden shirking. In short, in all cases, the qualitative result is the same, with the loan offer curve shifting backwards and the slope becoming steeper relative to the baseline situation, reducing the amount of lending, inducing higher levels of rationing, and, for sufficiently high costs, full rationing.

In the case of collateral, the changes are different. First, considering outside collateral (the entrepreneur's personal assets), and assuming the net effect of collateral is reducing the relevance of agency problems, the slope of the loan offer curve would be smaller, thus shifting the loan offer curve outwards.¹⁰

¹⁰ Niinimäki (2018) shows how outside collateral may generate negative incentives under certain conditions, leading the borrower to either gamble for resurrection or delay liquidation, gambling for a revaluation of the posted collateral.

Turning to inside collateral (firm's assets) can be easily incorporated as part of the minimum project return, thus extending outwards the loan offer curve, and therefore reducing rationing. Third-party collateral (say, a public guarantee) would have an effect similar to inside collateral in terms of the minimum return, thus, again, shifting the loan offer curve outwards. Interestingly, for sufficiently high levels of (inside or outside) collateral or third-party guarantees, the debt contract could end up in the risk-free region (horizontal part of the loan offer curve).

Hypotheses based on the theoretical framework

The model described in this section provides guidance about the expected signs for most of the variables considered in the empirical model presented in the subsequent sections. With reference to internal factors (firms' characteristics), we will consider firm size, formality profile, sector of operation, exporting status, the assessed quality and veracity of the provided information, type of ownership, and type of firm. Also, as part of the robustness checks, we will consider a measure of the availability of internal collateral.¹¹

Firm size serves as a proxy for both the severity of informational frictions and the potential distribution of returns, partially through the availability of internal collateral. As firms grow larger, they face both positive and negative effects. On the negative side, larger firms may encounter increased agency problems and potential gains for managers and owners from higher returns on investment (moral hazard), which could shift the loan offer curve inwards and increase rationing. On the positive side, larger firms often improve their information and management systems to counteract agency problems and the inherent increased entropy of larger and more complex organizations. Furthermore, larger firms are more likely to bear increased government oversight, which induces better accounting practices. It could be argued that the positives should outweigh the negatives, leading to an expected positive coefficient.¹²

¹¹ We do not include the availability of internal collateral in the main specification because it reduces by 62 percent the number of available observations.

¹² A priori, the positives should outweigh the negatives, otherwise the firm would go bankrupt and, thus, the expected sign is likely to be positive, with a couple of caveats. First, the larger the firm the

However, as discussed in Section 2.1 there could be countervailing forces. We address this possibility with the inclusion of a quadratic term in the empirical model.

Another firm characteristic to consider is the formality profile, which has two elements: (i) if the firm was formally registered from inception and (ii) how much time the firm has been operating formally. The rationale is that these variables would correlate with transparency, thus reducing informational frictions. Also related to transparency is the type of ownership, which is also indicative of the presence and severity of agency problems. Here we are considering a dummy variable distinguishing sole proprietorship from other types of associations. The expected result is that sole proprietorship would lead to fewer agency problems and therefore a reduction in the probability of experiencing credit rationing.

The sector of operation is a slightly difficult variable to classify because it can be seen as capturing characteristics of both the firm and its environment.¹³ Given the stylized fact of differential intrinsic needs for external financing (which has a direct counterpart in our theoretical framework), we opt to include external financing within the set of internal factors.¹⁴ The prediction is that higher intrinsic needs for external financing will correlate with higher prevalence of rationing. Following the same logic, we consider operating in the export sector as an internal factor. Exporting firms typically must meet additional informational and documentational demands to successfully operate in the segment, thus increasing transparency and reducing informational asymmetries with potential lenders. The prediction in this case is that exporting firms would experience less credit rationing relative to non-exporting firms.

Still within the set of internal variables, the model includes measures for the assessed quality of information and truthfulness of information reported by the firm. These variables can be seen as proxying the transparency and credibility

higher could be the rewards from deviations towards riskier projects and this, under certain conditions, could outweigh all previous positive effects. Second, firms do go bankrupt.

¹³ In the WBES, surveys are stratified by business sector. At a minimum, the stratification distinguishes between Manufacturing and Services firms. Additional sectors are selected for stratification in larger economies. To derive accurate conclusions, we utilize the Manufacturing and Services categories, as they encompass the entire sample in the WBES's global methodology.

¹⁴ This decision also aligns with most empirical specifications in the literature.

of the information provided by the firm and are explained in more detail in Section 3. The prediction for these variables is straightforward: because higher levels should reduce informational asymmetries between borrowers and lenders, these variables should be associated with a lower incidence of credit rationing.

In addition to the internal variables, the model also includes external factors. These comprise mostly country-level or macro-level variables, including income levels, GDP growth, inflation, informality, and institutional variables. Both GDP per capita and GDP growth are frequently included as controls in empirical studies focused on credit rationing and access to credit (Nabi and Suliman, 2011; Presbitero and Rabellotti, 2016; Drakos and Giannakopoulos, 2018; Beyhaghi et al., 2020). However, their inclusion in relation to informational frictions or other elements in a model of credit rationing is seldom clearly rationalized. Within our framework, GDP per capita can be interpreted as a proxy variable for the efficiency of financial intermediation in resources allocation. This implies a more effective generation and use of information, leading to an outward shift of the loan offer curve and a reduction in rationing.¹⁵

Another important macro factor is inflation, which is usually correlated with price dispersion and price uncertainty (Evans and Wachtel, 1993; Reinsdorf, 1994; Sheremirov, 2020). This correlation increases informational frictions (Cornand and Hubert, 2022; Singh and Bandyopadhyay, 2024), resulting in an inward shift of the loan offer curve and higher levels of rationing. Other variables considered with external factors are credit expansion (which should expand the loan offer curve and reduce rationing), informal competition (reduces transparency, increases informational frictions, and reduces profitability, contracting the loan offer curve, thus increasing rationing), and the effectiveness of courts (which would increase loan recovery and reduce transaction costs, which should expand the loan offer curve, thus reducing rationing).

¹⁵ The claim that higher GDP per capita can be a proxy for a more effective and efficient use of information follows from two accepted results. First, the cross-country variation in per capita incomes is primarily a result of variations in total factor productivity (TFP) (Maddison, 1983; Caselli, 2005). Second, TFP and productivity are influenced by financial development (Dabla-Norris, Kersting, and Verdier, 2012; Gehringer, 2014; Heil, 2019).

3. Data and Empirical Methodology

3.1. Data and Variables

Our data set contains firm-level data from the World Bank Enterprise Surveys (WBES). These surveys are stratified by sector, location, and firm size; they cover around 195,000 firms worldwide and exclude firms with less than five employees, unregistered firms, fully public firms, and the agriculture and extractive industries. There is a total of 154 countries in our sample. The first rounds of data correspond to 2006 and the last one to 2023. In addition, we include country-level data from the World Bank's World Development Indicators (WDI) and Worldwide Governance Indicators (WGI) for institutional and macroeconomic conditions from the countries included in the WBES.

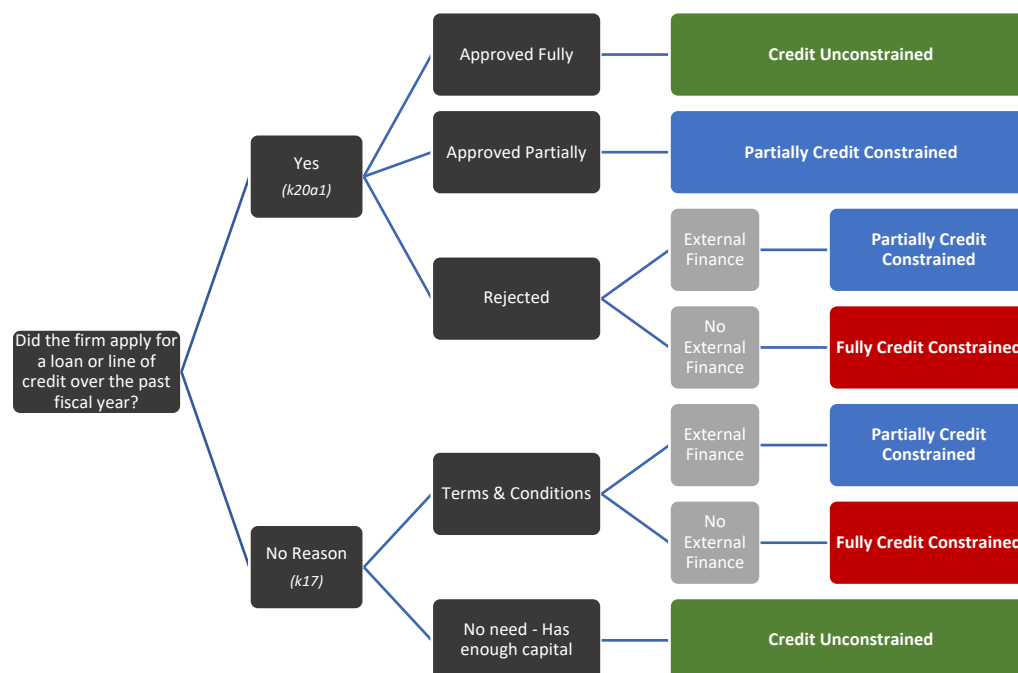
Dependent variables

Central to our analysis is the classification of the credit rationing status among firms. To categorize a firm as either credit rationed or not, we followed the strategy in Islam and Rodriguez Meza (2023). The classification is based on firm-level data from the WBES and starts with categorizing firms into three groups based on their access to finance: fully credit constrained, partially credit constrained, or credit unconstrained. A firm is classified as fully credit constrained if it lacks access to external finance and either did not apply for a loan due to reasons other than necessity or applied for a loan and was rejected, even when it has access to equity financing for investments.¹⁶ The partially credit constrained status pertains to firms that applied for a loan and had the application partially approved, applied for a loan and faced rejection while having access to external sources of finance, or possess external finance but did not apply for a loan for reasons other than the lack of necessity. Finally, credit unconstrained firms are those that either applied for a loan and had it fully approved or did not apply for a loan due to a lack of need. The classification procedure is graphically represented in Figure 5. Based on the three categories, we created two alternative

¹⁶ External finance includes borrowing for investment or working capital from banks and other financial institutions (microfinance institutions, credit cooperatives, credit unions, or finance companies). It also considers trade credit (purchases on credit from suppliers and advances from customers) and other external sources.

dichotomic variables to classify a firm as either credit constrained or not. The first one is CCD (credit constraint dummy) and it takes the value of 1 if a firm is either fully or partially credit constrained and 0 otherwise; it's our dependent variable in our baseline specification. The second one is FCC (fully credit constrained) and it equals 1 when the firm is fully credit constrained and 0 otherwise.

Figure 5. Construction of Credit Constraint Categories



Source: Authors' elaboration based on WBES Indicators and Islam and Rodriguez Meza (2023).

Notes: The codes refer to the following questions in the WBES: k20a1: What Was the Outcome of That Most Recent Application for Loan/Line of Credit? k17: Main Reason for Not Applying for New Loans or New Lines of Credit. External finance includes borrowing for investment or working capital from banks and other financial institutions (microfinance institutions, credit cooperatives, credit unions, or finance companies). It also considers trade credit (purchases on credit from suppliers and advances from customers) and other external sources (moneylenders, friends, relatives, etc.).

Control variables

Following the previous discussion, we incorporate two levels of information in our specifications, namely internal (or firm-level) variables and external variables. Internal (firm-level) variables include the number of employees, value of sales, duration of operation as a formally registered firm, an indicator variable for firms that were formally registered since inception, four variables indicating the firm's

legal status (sole proprietorship, partnership, shareholding company, and other legal forms), and dummy variables indicating the sector of operation and exporting status. Within the set of internal variables, we also include quality of information and truthfulness of information, sourced from the WBES. Quality of information is a categorical variable that assesses the quality of the quantitative information associated with and provided by the firm; going from low to high quality the levels are arbitrary and unreliable, estimated with some precision, estimated and taken from books, and establishment records. The second variable, truthfulness of information, is also a categorical variable; this one indicates the perceived truthfulness of the rest of the information associated with and provided by the firm and the categories considered are not truthful, somewhat truthful, and truthful.¹⁷

Given the novelty of these last two variables, it's worth discussing them in more detail. These variables come from the post-interview section of the WBES questionnaire and the data is provided by the interviewer. Quality of information indicates the sources for answers to questions about figures. The interviewer is given four options to describe whether the figures are arbitrary and unreliable, estimated with some precision, a mix of record data and estimations, or taken directly from establishment records. Truthfulness of information evaluates the perceived truthfulness of qualitative data (opinions and perceptions) categorized as not truthful, somewhat truthful, and truthful. Thus, these variables report the assessed quality and veracity, respectively, of the firms' records and information.¹⁸

Finally, the external variables included in the model are the change in inflation rate,¹⁹ the log of GDP per capita PPP, the rate of growth of domestic credit, and two additional variables (courts and informal competition) that convey information about the environment in which the firm operates, which

¹⁷ Truthfulness of information would cover the credibility of variables such as the importance of informal competition. Quality of information would refer to variables like sales or the number of employees.

¹⁸ Because the variables included in the empirical model are meant to approximate the information involved in the assessment of a lending operation, one could also assume that these two variables are proxies for screening activities by lenders, who need to judge the ex ante veracity and credibility of the application.

¹⁹ The rate of change in inflation would be the second derivative of prices with respect to time and is likely to convey a better measure of the disruption that inflation causes in the informational content of the price system and the subsequent allocation inefficiencies.

may vary from firm to firm. The former is a categorical variable capturing the perception of the courts as an obstacle for the operation of the firm, while the latter is a measure of market informality affecting the firm's operation.

3.2. Empirical Model

Our main empirical strategy is to model the probability of a firm being credit rationed, $\pi_{c,i,t}$, using a logistic specification as in equation 1, where $X_{f,c,i,t}$ stand for internal (firm-level) variables, $Z_{s,c,i,t}$ represent the external variables reported by the firm (courts and informal competition), $A_{c,i,t}$ are country-level external variables, and $\xi_{c,i,t}$ is an error term. For the baseline specification, we use the dummy variable of credit rationing $ccd_{c,i,t}$ as previously defined.

$$\ln\left(\frac{\pi_{c,i,t}}{1-\pi_{c,i,t}}\right) = \alpha_0 + \sum_{f=1}^F \beta_f X_{f,c,i,t} + \sum_{s=1}^S \gamma_s Z_{s,c,i,t} + \sum_{k=1}^K \delta_k A_{c,i,t} + \xi_{c,i,t} \quad (1)$$

4. Empirical Evidence

4.1. Descriptive Statistics

Tables 1A and 1B report the summary statistics. Table 1A presents the means and standard deviations in the sample, while Table 1B presents the mean values and number of observations for the three classifications of rationing status (credit unconstrained, partially credit constrained, and fully credit constrained).

Table 1A. Descriptive Statistics (means and standard deviations)

Level	Variable	Mean	SD
	Credit Constrained Dummy (1=Unconstrained, 0=Otherwise)	1.38	0.67
Firm	(log) Number of Employees	2.65	1.03
	(log) Number of Employees Squared	8.10	7.15
	(log) Value of Sales	15.68	2.85
	(log) Values of Sales Squared	253.87	98.21
	(log) Years Formally Registered	2.64	0.76
	Registered Day 1 (1=Yes, 0=No)	0.91	0.28
	Partnership as Legal Status (1=Yes, 0=No)	0.36	0.48
	Public or Private Shareholding Company as Legal Status (1=Yes, 0=No)	0.33	0.47
	Other, as Legal Status (1=Yes, 0=No)	0.30	0.46
	Sole Proprietorship (1=Yes, 0=No)	0.01	0.10
Sector	Courts (0=No Obstacle, 4=Very Severe Obstacle)	0.89	1.15
	Informal Competition (1=Yes, 0=No)	0.38	0.48
	Export Sector (1=Yes, 0=No)	0.11	0.31
	Manufacturing Sector (1=Yes, 0=No)	0.28	0.45
Country	(log) GDP per Capita PPP	9.84	0.74
	Inflation Rate Variability	-0.68	2.40
	Credit Expansion	-1.17	10.35
Screening	Truthfulness of Information Dummy (1=Truthful, 0=Otherwise)	0.68	0.47
	Quality of Information Dummy (1=From Firm Records, 0=Otherwise)	0.26	0.44

Source: Authors' calculations based on WBES and WDI.

Table 1B. Descriptive Statistics (means by credit rationing status)

Level	Variable	Credit Unconstrained		Partially Credit Constrained		Fully Credit Constrained	
		N	Mean	N	Mean	N	Mean
Firm	(log) Number of Employees	8,083,496	2.62	1,707,194	2.65	1,525,146	2.56
	(log) Number of Employees Squared	8,083,496	7.91	1,707,194	7.88	1,525,146	7.42
	(log) Value of Sales	7,080,637	15.58	1,581,059	16.14	1,345,480	16.02
	(log) Values of Sales Squared	7,080,637	248.62	1,581,059	267.03	1,345,480	262.40
	(log) Years Formally Registered	7,175,291	2.74	1,513,043	2.63	1,113,434	2.49
	Registered Day 1 (1=Yes, 0=No)	5,336,286	0.93	1,135,570	0.86	1,224,480	0.81
	Partnership as Legal Status (1=Yes, 0=No)	8,067,937	0.31	1,697,190	0.26	1,541,125	0.24
	Public or Private Shareholding Company, as Legal Status (1=Yes, 0=No)	8,067,937	0.27	1,697,190	0.27	1,541,125	0.22
	Other, as Legal Status (1=Yes, 0=No)	8,067,937	0.01	1,697,190	0.01	1,541,125	0.01
	Sole Proprietorship (1=Yes, 0=No)	8,067,937	0.41	1,697,190	0.47	1,541,125	0.53
Sector	Courts (0=No Obstacle, 4=Very Severe Obstacle)	7,646,814	0.80	1,601,007	0.97	1,395,827	0.90
	Courts Dummy (1=Moderate to Major Obstacle, 0=Otherwise)	7,646,814	0.24	1,601,007	0.30	1,395,827	0.27
	Informal Competition (1=Yes, 0=No)	7,934,384	0.35	1,674,486	0.43	1,525,686	0.43
	Export Sector (1=Yes, 0=No)	8,036,210	0.10	1,677,417	0.10	1,504,767	0.06
	Manufacturing Sector (1=Yes, 0=No)	8,135,525	0.31	1,709,190	0.39	1,550,079	0.41
Country	(log) GDP per Capita PPP	8,117,883	9.86	1,703,372	9.51	1,541,428	9.38
	Inflation Rate Variability	8,071,687	1.06	1,682,679	0.48	1,524,992	-0.01
	Credit Expansion	7,765,919	-1.05	1,620,991	-3.04	1,331,304	-2.51
Screening	Perception of Survey Truthfulness (1=Not Truthful, ..., 3=Truthful)	8,033,311	2.75	1,676,065	2.66	1,527,721	2.54
	Truthfulness of Information Dummy (1=Truthful, 0=Otherwise)	8,033,311	0.76	1,676,065	0.68	1,527,721	0.60
	Quality of Information (1=Arbitrary/Unreliable, 2=Estimates, 3=Some Precision, 4=Books)	8,130,807	2.70	1,708,449	2.61	1,548,743	2.49
	Quality of Information Dummy (1=From Firm Records, 0=Otherwise)	8,130,807	0.31	1,708,449	0.30	1,548,743	0.26

Source: Authors' calculations based on WBES and WDI.

4.2. Main Estimations

Non-standardized variables results

Column 1 in Table 2 presents the results of the baseline model and shows a first apparent departure from standard results in the empirical literature of credit rationing, in that neither measure of size (*number of employees* and *value of*

sales) deliver a statistically significant coefficient.²⁰ Next are the variables relating to the firm's formality profile: the logarithm of the number of years a firm has been formally registered (*years formally registered*) and a dummy variable indicating if the firm has been formally registered since its creation (*registered day 1*). Consistent with the model predictions, both variables show a statistically significant negative association with the probability of being credit rationed.

²⁰ Specifications that contained only one measure (not shown) also delivered statistically insignificant coefficients. It is worth noting here that, quite often, empirical specifications consider categorical variables for size and not continuous variables. However, we do not follow such categorization here for the following reasons. First, there are no objective and universally accepted cutoff points to establish firm size categories. Although it is commonplace to have size categories—quite often officially sanctioned—there is substantial heterogeneity in their definitions. For instance, considering the number of employees, a firm of 50 employees can be classified as small, medium, or large according to varying country-specific classifications. Second, such size categorizations involve more than one dimension for many countries, and we do not have such information. For example, Argentina classifies firm size based on the number of employees, sales, sector, assets, and other variables. Third, such size classifications are not established with reference to the level of access to external financing. Instead, they are typically implemented for fiscal and regulatory purposes.

Table 2. Regression Results

VARIABLES	C1	C2	C3	C4	C5 +	C6 +
(log) Number of Employees	0.0921 (0.258)	0.0807 (0.246)	0.00905 (0.0432)	0.0147 (0.0441)	0.0202 (0.0608)	0.0125 (0.0596)
(log) Number of Employees Squared	-0.0282 (0.0343)	-0.0262 (0.0325)	-0.00402 (0.00535)	-0.00475 (0.00573)	-0.0520 (0.0627)	-0.0440 (0.0585)
(log) Value of Sales	0.131 (0.165)	0.149 (0.172)	0.0358 (0.0353)	0.0271 (0.0318)	0.0831 (0.0976)	0.110 (0.108)
(log) Value of Sales Squared	-0.00360 (0.00523)	-0.00410 (0.00535)	-0.000998 (0.00109)	-0.000746 (0.000986)	-0.0800 (0.106)	-0.107 (0.117)
(log) Years Formally Registered	-0.241*** (0.0634)	-0.244*** (0.0699)	-0.0462*** (0.0129)	-0.0444*** (0.0119)	-0.0368*** (0.00984)	-0.0382*** (0.0107)
Registered Day 1 (1=Yes, 0=No)	-0.394*** (0.151)	-0.394** (0.154)	-0.0813** (0.0395)	-0.0716** (0.0306)	-0.0716** (0.0306)	-0.0813** (0.0395)
Partnership as Legal Status (1=Yes, 0=No)	0.372* (0.210)					
Public or Private Shareholding Company as Legal Status (1=Yes, 0=No)	0.253*** (0.0910)					
Other as Legal Status (1=Yes, 0=No)	0.584** (0.272)					
Courts (0=No Obstacle, 4=Very Severe Obstacle)	0.115*** (0.0337)					
Informal Competition (1=Yes, 0=No)	0.203** (0.0923)	0.203** (0.0882)	0.0383** (0.0149)	0.0368** (0.0149)	0.0368** (0.0149)	0.0383** (0.0149)
Export Sector (1=Yes, 0=No)	-0.257 (0.178)	-0.249 (0.176)	-0.0413 (0.0287)	-0.0452 (0.0318)	-0.0452 (0.0318)	-0.0413 (0.0287)
Manufacturing Sector (1=Yes, 0=No)	0.213*** (0.0707)	0.209*** (0.0741)	0.0389*** (0.0149)	0.0380*** (0.0144)	0.0380*** (0.0144)	0.0389*** (0.0149)
(log) GDP per Capita PPP	-0.525*** (0.165)	-0.534*** (0.157)	-0.101*** (0.0278)	-0.0971*** (0.0248)	-0.115*** (0.0294)	-0.120*** (0.0330)
Inflation Rate Variability	0.183*** (0.0709)	0.182** (0.0718)	0.0129*** (0.00341)	0.0332** (0.0135)	0.352** (0.144)	0.137*** (0.0362)
Credit Expansion	-0.0147* (0.00794)	-0.0147* (0.00874)	-0.00283* (0.00167)	-0.00268* (0.00154)	-0.0452* (0.0259)	-0.0476* (0.0282)
Truthfulness of Information (1=Not Truthful, 3=Truthful)	-0.354** (0.167)					
Quality of Information (1=Arbitrary/Unreliable, 2=Estimates, 3=Some Precision, 4=Books)	-0.127** (0.0603)					
Sole Proprietorship (1=Yes, 0=No)		-0.314*** (0.115)	-0.0554** (0.0221)	-0.0570*** (0.0205)	-0.0570*** (0.0205)	-0.0554** (0.0221)
Courts Dummy (1=Moderate to Major Obstacle, 0=Otherwise)		0.307*** (0.0736)	0.0582*** (0.0133)	0.0558*** (0.0125)	0.0558*** (0.0125)	0.0582*** (0.0133)
Truthfulness of Information Dummy (1=Truthful, 0=Otherwise)		-0.366** (0.171)	-0.0739** (0.0318)	-0.0665** (0.0316)	-0.0665** (0.0316)	-0.0739** (0.0318)
Quality of Information Dummy (1=From Firm Records, 0=Otherwise)		-0.324*** (0.114)	-0.0546** (0.0216)	-0.0589*** (0.0219)	-0.0589*** (0.0219)	-0.0546** (0.0216)
Constant	4.874** (1.907)	4.228** (1.821)	1.226*** (0.337)			0.443*** (0.0564)
Observations	67,718	67,718	67,718	67,718	67,718	67,718
R-squared			0.086			0.086

Source: Authors' calculations.

Note: Column 1 presents the logit model over the specification with categorical variables; column 2 presents the logit model with categorical variables transformed into dummy variables; column 3 presents the Linear Probability Model (LPM); column 4 displays the average marginal effects of the logit model of column 2; column 5 presents the average marginal effects of the logit model using standardized variables; and column 6 presents the LPM using standardized variables. Robust standard errors in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Next are the dummies for alternative legal status of the firm (*partnership, shareholding company, other*), with *sole proprietorship* as the base category. The results align with the interpretation that these categories are associated with increased coordination and informational problems (heightened agency problems) and thus associated with a higher probability of being credit rationed.

Manufacturing sector is a dummy indicating the sector of operation, which differentiates between manufacturing and services. The estimation finds a positive and statistically significant coefficient, which indicates a higher prevalence of rationing in the manufacturing sector, a result that is consistent with the model given the intrinsically higher demands for external financing for these types of firms.

Next is the dummy variable *export sector*. In this case, there are two opposing forces affecting the relationship with credit rationing. On the one hand, international trade is very demanding in terms of documentation, transparency, (business) sustainability, and reputation. As such, we would expect exporting activities to be associated with a lower prevalence of rationing. On the other hand, there is an increased demand for external financing relative to comparable firms with no international trade operations, which, according to the model, would lead to more credit rationing. In this case, the estimation delivers a negative coefficient but is not statistically significant at conventional levels.

The remaining internal variables are *truthfulness of information* and *quality of information*. The results show a decreased incidence of credit rationing in firms deemed to be more truthful in their representation of their situation and in firms that provided higher-quality information. These results are aligned with the model's predictions under the interpretation that these variables are proxies for informational transparency.

The remaining variables correspond to external factors. First, (log) GDP per capita PPP is the (logarithm) of per capita GDP in constant PPP dollars. As previously discussed, we expect this variable to be associated with lower rates of rationing, and the result is confirmed in the data. *Inflation rate variability* shows a positive and statistically significant association with rationing, which is the expected result. *Credit expansion*, which measures the rate of change in the aggregated levels of domestic credit and is aimed at representing an outward

movement in the loan offer curve, also shows the expected coefficient sign and it's statistically significant, confirming that credit expansions are associated with a decreased incidence of credit rationing.

Lastly, and still within the set of external factors, are those variables related to sector conditions relevant for each firm. Given the importance of courts in resolving credit frictions, from the model we can predict a positive association of *courts dummy* with credit rationing, which is indeed observed in regression results. *Informal competition*, as discussed, is expected to be associated with increased informational asymmetries and deteriorated project returns, both of which would be associated with higher probabilities of being credit rationed—a result that is observed in the data as reflected by the statistically significant positive coefficient in the regression.

Overall, these results are in line with our theoretical framework, both in terms of the direction of the associations and their multifactorial nature. However, they are still not indicative of the relative importance of the factors considered in the model. For this, we need to estimate the average marginal effects and use standardized scales for all variables.

Marginal effects and standardized variables

The results of the logistic regression indicate only the direction of the associations. One way to gain insight on the relative importance of each variable is to compute marginal effects, which indicate the expected change in the probability of being credit rationed given a one-unit change in a variable of interest.

As a first step in this direction, and in order to obtain a simpler interpretation of the results for policy use, we first transform the categorical variables (*courts*, *truthfulness of information*, and *quality of information*) into dichotomic variables, which now stand as follows:²¹ *courts dummy* is equal to 0 if courts are deemed as being not an obstacle or a minor obstacle and 1 when they

²¹ This transformation is not strictly necessary, but it simply makes for an easier interpretation and mapping of the results to the underlying concepts. If we were to maintain the categorical nature of, say, Quality of Information, estimating the marginal effects would require treating each category as a dummy variable, for which the marginal effect would be estimated. Thus, we would have 3 marginal effects associated with that variable. Although this is certainly not a problem, we consider that is better to maintain clearer mapping between concepts and estimated coefficients.

are a moderate to major obstacle; *truthfulness of information dummy* is equal to 0 if not truthful or somewhat truthful and 1 if truthful; and *quality of information dummy* is equal to 0 if other than taken from firm records and 1 if taken from firm records. Furthermore, instead of alternatively considering three legal statuses other than sole proprietorship, we revert to that simpler distinction in which the dummy variable *sole proprietorship* takes the value 1 when the firm is under sole proprietorship and 0 for any other legal status. The estimation of the logistic model after these transformations can be seen in column 2 of Table 2. A comparison with the first column reveals that these changes do not significantly alter the initial results. Column 3 of Table 2 presents the average marginal probabilities from the main specification using a linear probability model (LPM). Column 4 presents the average marginal probabilities corresponding to the proper logit specification. These coefficients indicate the average change in the probability of being credit rationed for a one-unit change in the corresponding variable, holding other variables constant.

Although these results are informative regarding the expected marginal change in the probability of being credit rationed, because variables are measured on different scales we still cannot say that one factor has a relatively larger association than another with the probability of interest. One way to circumvent this limitation is to use standardized variables.

Standardizing variables according to the expression $Z_i = (X_i - \mu_{X_i})/\sigma_{X_i}$ puts them on a common scale (with mean of 0 and standard deviation of 1). This removes the influence of differing scales or units of measurement, allowing for a more direct comparison of the magnitudes of their coefficients or marginal effects. After standardization, a one-unit change in any continuous variable corresponds to a one standard deviation change in that variable (there is no standardization for dummy variables, as they remain a one-unit change). The marginal effect then reflects the change in the probability of the outcome for a one standard deviation change (or one-unit change if it is a dummy) in the predictor. Column 5 of Table 2 presents the marginal probabilities based on the logit model using standardized variables, and column 6 shows the marginal probabilities from the LPM (also using standardized variables).

With standardization, if the marginal effect of one variable is larger than another, it could be argued that the former has a stronger association with the change in probability than the latter, all else being equal. We cannot, however, add up the marginal coefficients derived from a logistic regression because this would require assuming both independence and linearity (the independence assumption could be maintained or argued, but the logistic regression is nonlinear in nature). Looking at individual marginal effects we can rank the variables in decreasing order according to the (absolute) value of the coefficient and its statistical significance. From that ranking, we can identify which variables have a stronger association with the probability of being credit rationed.²² This is shown in the second column of Table 3.

Table 3. Ranked Average Marginal Effects of Standardized Variables

Independent variables	Logit model			LPM		
	dy/dx	dy/dx	P> z	dy/dx	dy/dx	P> t
Inflation Rate Variability	0.352	0.352	0.014	0.137	0.137	0.000
(log) GDP per Capita PPP	-0.115	0.115	0.000	-0.120	0.120	0.000
(log) Value of Sales	0.083	0.083	0.395	0.110	0.110	0.313
(log) Value of Sales Squared	-0.080	0.080	0.449	-0.107	0.107	0.363
Registered Day 1 (1=Yes, 0=No)	-0.072	0.072	0.019	-0.081	0.081	0.041
Truthfulness of Information Dummy (1=Truthful, 0=Otherwise)	-0.067	0.067	0.035	-0.074	0.074	0.021
Quality of Information Dummy (1=From Firm Records, 0=Otherwise)	-0.059	0.059	0.007	-0.055	0.055	0.012
Sole Proprietorship (1=Yes, 0=No)	-0.057	0.057	0.005	-0.055	0.055	0.013
Courts Dummy (1=Moderate to Major Obstacle, 0=Otherwise)	0.056	0.056	0.000	0.058	0.058	0.000
(log) Number of Employees Squared	-0.052	0.052	0.407	-0.044	0.044	0.453
Export Sector (1=Yes, 0=No)	-0.045	0.045	0.155	-0.041	0.041	0.153
Credit Expansion	-0.045	0.045	0.081	-0.048	0.048	0.092
Manufacturing Sector (1= Yes, 0=No)	0.038	0.038	0.008	0.039	0.039	0.010
Informal Competition (1=Yes, 0=No)	0.037	0.037	0.013	0.038	0.038	0.011
(log) Years Formally Registered	-0.037	0.037	0.000	-0.038	0.038	0.000
(log) Number of Employees	0.020	0.020	0.739	0.012	0.012	0.834

Source: Authors' calculations.

According to these results, changes in inflation have the strongest association with the probability of being credit rationed, followed by the level of economic development. Next, with rather similar marginal effects, are being formally

²² Such ranking and claims could be argued only in the specification using the standardized variables. It is important to keep in mind that the marginal effects refer to the marginal change in the accumulated probability. So, if a coefficient is 0.10, this means that one standard deviation in the corresponding variables changes the probability of being credit rationed by 10 percent. Thus, if the corresponding accumulated probability is 0.10, then, after the marginal change, it would be 0.11 (and not 0.2). To reinforce the example, if the initial accumulated probability is 0.5, then, after the marginal change, it would be 0.55 (and not 0.6).

registered from day one, the perceived truthfulness of information, the quality of the information, sole proprietorship, and courts. The presence of a general credit expansion is the next statistically significant factor, followed by the manufacturing sector dummy, the presence of significant competition from informal firms, and, last, the number of years formally registered.

We can expand these results further relying on the marginal effects estimated by an LPM. As indicated before, because the logistic model is nonlinear in nature, we cannot add up coefficients without violating the model's assumptions. However, the LPM makes the opposite assumption, so we can add up coefficients to approximate the relevance of a group of factors—with a few caveats. First, the LPM would typically violate the assumption of homoskedasticity, although this problem is mitigated in our specifications because we are computing robust clustered standard errors (which provide a way to obtain more reliable standard errors in the presence of heteroskedasticity or clustering). Second, the combined marginal effects assume that there is a simultaneous change in the corresponding variables. Third, the comparison doesn't say anything about the likelihood of observing a variation over time in the corresponding variables (this observation is valid for any interpretation of marginal effects). Fourth, there can be significant differences between the marginal effects under both models. In this case, the average difference in marginal effects between the two models is approximately 2 percent, with a median difference of 3.9 percent, and with the largest difference being 61.1 percent for *inflation rate variability* (the coefficient in the logistic regression is 61.1 percent larger than the estimated coefficient from the LPM).

With these considerations in mind, the combined statistically significant marginal effects by type of factor can be seen in Table 4, which shows that a simultaneous variation of one standard deviation in all statistically significant external variables in the model would be associated with a change in the probability of being credit rationed of 40.1 percent, which is 591 basis points higher than the combined marginal effects for internal variables, which stands at 34.2 percent. The implications of these results, particularly for policy design, will be discussed in Section 5.

Table 4. Combined Average Marginal Effects of Standardized Variables from LPM

Grouped factors	 dy/dx
External factors: Σ dy/dx 	0.401
Inflation Rate Variability	0.137
(log) GDP per Capita PPP	0.120
Credit Expansion	0.048
Courts Dummy (1=Moderate to Major Obstacle, 0=Otherwise)	0.058
Informal Competition	0.038
Internal factors (firm level): Σ dy/dx 	0.342
Registered Day 1 (1=Yes, 0=No)	0.081
Truthfulness of Information Dummy (1=Truthful, 0=Otherwise)	0.074
Quality of Information Dummy (1=From Firm Records, 0=Otherwise)	0.055
Sole Proprietorship (1=Yes, 0=No)	0.055
(log) Years Formally Registered	0.038
Manufacturing Sector (1=Yes, 0=No)	0.039
Size, by sales*	-
Size, by number of employees*	-
Exporting Firm*	-

Source: Authors' calculations.

4.3. Robustness Checks and Subsamples

Two concerns about the results correspond to the estimation of standard errors and the computation of the dichotomic variable for credit rationing. In the main estimation, we computed robust standard errors clustered by country-year as shown in Table 2. Table 5 repeats the estimation of the marginal effects from the logistic regression using standardized variables but using, respectively in columns 1 and 2, robust standard errors clustered only by country and robust standard errors without clustering. As can be seen from columns 1 and 2 of Table 5, the statistical significance of the estimated coefficients does not change substantially with these modifications. In addition, we re-estimated the main specification (column 5 in Table 2) using a stricter classification of credit rationing (now the dichotomic variable takes the value of 0 if a firm is classified as credit unconstrained or partially credit constrained and 1 if it is fully credit constrained).

As can be seen in column 3 of Table 5, the main results survive this change in classification.

Table 5. Robustness Checks

VARIABLES	(1) C1	(2) C2	(3) C3	(4) C4	(5) C5
(log) Number of Employees	0.0147 (0.0438)	0.0147 (0.0264)	-0.0282* (0.0149)	0.0606 (0.0912)	-0.00757 (0.0596)
(log) Number of Employees Squared	-0.00475 (0.00562)	-0.00475 (0.00340)	0.00246 (0.00222)	-0.104 (0.0883)	-0.0184 (0.0678)
(log) Value of Sales	0.0271 (0.0343)	0.0271 (0.0198)	0.0186 (0.0183)	-0.0249 (0.134)	0.146 (0.0953)
(log) Value of Sales Squared	-0.000746 (0.00105)	-0.000746 (0.000548)	-0.000615 (0.000511)	0.0247 (0.128)	-0.142 (0.107)
(log) Years Formally Registered	-0.0444*** (0.0114)	-0.0444*** (0.00952)	-0.0217*** (0.00645)	-0.0215 (0.0140)	-0.0445*** (0.00881)
Registered Day 1 (1=Yes, 0=No)	-0.0716** (0.0310)	-0.0716*** (0.0226)	-0.00532 (0.0110)	-0.0404* (0.0232)	-0.0878** (0.0365)
Sole Proprietorship (1=Yes, 0=No)	-0.0570*** (0.0213)	-0.0570*** (0.0170)	-0.0221** (0.0102)	-0.0780*** (0.0295)	-0.0404* (0.0233)
Courts Dummy (1=Moderate to Major Obstacle, 0=Otherwise)	0.0558*** (0.00960)	0.0558*** (0.0173)	0.0198* (0.0107)	0.0432** (0.0216)	0.0621*** (0.0200)
Informal Competition (1=Yes, 0=No)	0.0368*** (0.0141)	0.0368** (0.0151)	0.000211 (0.00957)	0.0413*** (0.0158)	0.0330* (0.0189)
Export Sector (1=Yes, 0=No)	-0.0452 (0.0304)	-0.0452** (0.0190)	-0.0303** (0.0145)	-0.0379 (0.0392)	-0.0520* (0.0309)
Manufacturing Sector (1=Yes, 0=No)	0.0380** (0.0150)	0.0380*** (0.0123)	-5.44e-05 (0.0100)	0.0645*** (0.0209)	0.0227 (0.0225)
(log) GDP per Capita PPP	-0.0971*** (0.0264)	-0.0971*** (0.00756)	-0.0589*** (0.00993)	-0.101*** (0.0275)	-0.113*** (0.0325)
Inflation Rate Variability	0.0332** (0.0135)	0.0332*** (0.00355)	0.0111 (0.00800)	0.472*** (0.157)	0.263* (0.152)
Credit Expansion	-0.00268 (0.00190)	-0.00268*** (0.000418)	-0.00134* (0.000783)	-0.0210 (0.0197)	-0.0649** (0.0327)
Truthfulness of Information Dummy (1=Truthful, 0=Otherwise)	-0.0665** (0.0332)	-0.0665*** (0.0148)	-0.0391*** (0.0133)	-0.0581 (0.0453)	-0.0832*** (0.0299)
Quality of Information Dummy (1=From Firm Records, 0=Otherwise)	-0.0589*** (0.0211)	-0.0589*** (0.0170)	-0.00410 (0.0110)		
Observations	67,718	67,718	67,718	30,309	37,409

Source: Authors' calculations.

Notes: Robust standard errors in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

In addition to the alternative computation of standard errors and definition of the dependent variable, we explore the estimation results for the subsamples of firms with high- and low-quality information. Column 4 in Table 5 estimates the main

specification over a sample of firms with high-quality quantitative information.²³ In this case, the most notable differences are that *years formally registered*, *credit expansion*, and *truthfulness of information* are no longer statistically significant, while at the same time there are some differences in the size of the estimated coefficients. Column 5 presents the results when estimating the model over a sample of firms with low-quality information. The estimated coefficients for the low-quality information firms are qualitatively similar to the main specification. These results suggest that high-quality information firms are less affected, in terms of credit rationing, by changes in aggregate credit expansions or contractions than low-quality information firms.

5. Discussion and Policy Implications

Our research makes two contributions to the empirical literature on credit rationing. First, it offers a consistent quantitative assessment of the relative association of various individual and grouped factors to credit rationing. In this area, the empirical model establishes that the aggregate marginal effect of external variables on the probability of being credit rationed is larger than the aggregate marginal effect of internal factors (40.1 percent and 30.3 percent respectively). Among all factors (internal and external), inflation and income levels display the largest (absolute) marginal effects. The subsequent largest individual (absolute) marginal effects correspond to being formally registered from inception, the quality and truthfulness of information provided by the firm, and the type of ownership.

Within the set of internal factors, firm size, measured by number of employees and sales, fails to show a statistically significant association with the probability of being credit rationed. Although this may appear to run contrary to common results in the literature, there are a few observations to be made both at the theoretical and empirical level. To begin with, in theoretical models of credit rationing, firm size is not typically a relevant factor if not for its association with other variables. For example, in the integrated model of Kjenstad, Su, and

²³ We consider quantitative information to be high quality if it is based on records or a combination of estimations and books' information.

Zhang (2015), adopted here as the underlying theoretical framework, firm size by itself is not a relevant variable.²⁴ Furthermore, when it comes to empirical models, firm size is typically included as a proxy variable for other, more fundamental, factors (such as the severity of agency problems, quality of information, firm profitability, and availability of collateral, among others).²⁵ Moreover, when firm size turns out to be statistically significant in empirical models, it typically enters the specifications in categorical or dichotomic form, which can induce an inference error because such aggregations may create an apparent strong relationship at the group levels that fails to emerge at the individual level (ecological fallacy).²⁶

The second contribution of this work is the introduction of two innovative variables in the empirical examination of credit rationing: quality of information and truthfulness of information. The estimated coefficients for those variables are statistically significant and have the expected signs. Firms that are assessed as having higher-quality information and deemed as being more truthful about the qualitative information they provide experience a lower incidence of credit rationing.²⁷ Moreover, the marginal effects of the individual variables are somewhat different between firms of high- and low-quality information. Probably the most interesting difference is that the estimated coefficient for the variable *credit expansions* is not statistically significant for high-quality

²⁴ This is illustrated by the fact that all the alternative situations regarding rationing emerge for the same given level of investment or project size (the closest metric assimilable to firm size).

²⁵ Thus, size may be a proxy for variables with countervailing effects and the estimated coefficient would be affected by the partial inclusion of some of those variables.

²⁶ We explored this possibility by computing a sequential unequal variances t-test for the prevalence of credit rationing for firms grouped by size of n and $n+1$ employees. That is, we started comparing the prevalence of credit rationing for the group of firms of size 5 against the group of size 6, then for the group of 6 against the group of 7, and so on until size 100. When considering increments of one employee, only in 6 percent of the cases we rejected the null hypothesis of equality of means in favor of the alternative hypothesis that the prevalence of rationing among the larger firms was lower. However, when we increased, arbitrarily, the distance between the groups to 50 percent of the base size group, we rejected the null hypothesis in favor of the alternative hypothesis in 25 percent of the cases. Thus, increasing the distance between the groups increases the likelihood of finding statistically significant differences in means, even when such differences are statistically insignificant for marginal changes.

As indicated previously, we also considered specifications with dichotomic variables for firm size, which also fail to deliver statistically significant coefficients in our sample when including all other control variables.

²⁷ It is worth noting that these variables do not assess if the information provided is positive or negative in terms of profitability or financial conditions, only whether the information is derived from reliable sources and it is perceived to be truthful.

information firms but it is statistically significant for firms with low-quality information. This can be interpreted as high-quality information firms enjoying more stable access to credit over periods of expansion and contraction.

The results that appear most relevant for policy makers are the following. First, external factors appear to be quantitatively more relevant than internal ones when it comes to credit rationing. Second, the most important internal factors are formality and transparency. Third, firm size (measured either by sales or number of employees) does not appear to be a relevant factor when controlling for other variables. Fourth, credit expansions do appear to reduce credit rationing, but mostly for low-quality information firms. Fifth, the quality of courts and the prevalence of informality affect the level of credit rationing experienced by firms.

From these key results we can derive two policy recommendations. First, policy interventions promoting reforms to reduce inflation, decrease informality, improve firm transparency, and make judicial processes more effective are likely to have meaningful and lasting effects on the incidence of credit rationing. Second, while credit support programs aiming to increase lending to alleviate credit rationing are likely to be effective, they should not be targeted based on firm size but rather made conditional on improving formalization and transparency.

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