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Going long, going short, issue or liquidate? Corporate debt maturity of Mexican public firms

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Abstract

Purpose – This paper studies the determinants of the debt maturity of Mexican-listed companies by analysing the effects on the extensive (issuing or liquidating debt) and the intensive (debt maturity renegotiation) margins.
Design/methodology/approach – This study, using a Tobit model for panel data and measuring maturity as a time variable, shows that size, liquidity and leverage, among other firm characteristics, as well as the market interest rate, explain debt maturity. Additionally, the study employs the McDonald and Moffitt decomposition to determine whether the explanatory variables of maturity have a more significant effect on the decision to issue or liquidate debt or on debt maturity renegotiations.
Findings – The results obtained highlight that the market interest rate negatively affects debt maturity. On the other hand, variables like size, liquidity, collateral and leverage demonstrate a positive relationship with the dependent variable. In addition, the extensive margin has a higher impact on corporate debt than the intensive margin, suggesting that firms prefer to liquidate or issue new debt rather than renegotiate preexisting contracts.
Research limitations/implications – The main limitation of this study is the use of an unbalanced panel. The lack of data limits the application of specific methodologies suggested by the literature as a way to test the robustness of the estimates.
Originality/value – First of all, this study adds empirical evidence of debt maturity decisions by publicly traded firms in a middle-income country such as Mexico to the existing literature on maturity choice. Second, the study treats debt maturity as a time-censored, limited variable. Finally, the authors have used the McDonald and Moffitt (1980) methodology to decompose the effect of each independent variable into extensive and intensive margins.

Keywords Debt maturity, Tobit, Mexican firms, McDonald and Moffitt decomposition

Paper type Research paper

1. Introduction

The literature on corporate debt issuance has grown significantly in the past few years. In addition to other debt characteristics, maturity is an essential aspect of this analysis. Maturity determines the liquidity and payment capacity that companies may have, both in the short term and long term, affecting their value creation.

JEL Classification — C23, C58, G11, G32

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A broad range of theoretical and empirical literature on corporate debt maturity choice, with both cross-sectional and time-series implications, is already available. Early theories regarding this topic highlight the importance of information asymmetry and agency costs as determinants of debt maturity (Flannery, 1986, 1994; Diamond, 1991, 1993). Asymmetric information theories suggest that borrowers with favourable private data on their quality issue short-term debt and roll it over because refinancing rates will impound information about firm quality. In addition, the positive information effect outweighs the liquidity risk. Bad-quality borrowers instead resort to long-term debt to avoid the costs associated with the debt rollover. Some theoretical models also address the importance of taxes in choosing debt maturity. Firms will issue long-term debt to reduce expected tax liability in environments characterised by high market interest rates and low effective tax rates (Brick and Ravid, 1985; Kane *et al.*, 1985). The list of variables that play an essential role in debt maturity has increased by adding the institutional and financial environment of countries, such as the legal and political system and capital markets development (Demirgüç-Kunt and Maksimovic, 1999; Fan *et al.*, 2012; Kirch and Terra, 2012; Zheng *et al.*, 2012; González, 2017; Datta *et al.*, 2019). The empirical literature on maturity choice is extensive. It systematically shows that variables such as liquidity, leverage, size, cash flow risk and market interest rates, among other firm-related variables, are statistically and economically significant (Barclay and Smith, 1995; Stohs and Mauer, 1996; Guedes and Opler, 1996; Axelson *et al.*, 2013; Custódio *et al.*, 2013; Chen *et al.*, 2021).

This paper investigates the debt maturity determinants of a firm by analysing two dimensions: the *extensive* margin (the probability of issuing or liquidating debt) and the *intensive* margin (the renegotiation of current debt expiration). Most papers use the short-term to long-term debt ratio gathered from firm-level balance sheet information as a proxy of debt maturity. This research, however, defines maturity as a weighted average of the corporate debt maturity and treats it as a censored limited variable. Following McDonald and Moffitt (1980) [1], to provide strong evidence for the hypotheses, this study uses a censored Tobit model and the decomposition of its marginal effects to separate the effect on the probability of being above zero (intensive effect) from the effect conditioned to being above or below zero (extensive effect). This approach allows us to analyse whether the impact of the characteristics of a company and market factors is more significant on the probability of liquidating or reissuing debt (limit observations) or on changes in the magnitude of maturity, given that firms have already issued debt (as a positive part of the distribution).

The aim of this paper is twofold. First, it adds empirical evidence of debt maturity decisions made by publicly traded firms in a middle-income country such as Mexico to the existing literature on maturity choice. The World Bank describes the Mexican financial system as stable but relatively inefficient, shallow and with low financial inclusion. As argued by Orman and Koksal (2017), these features could lead to conflicts of interest, information asymmetry problems, expected costs of liquidation or potential tax evasion. Several studies have found that the ratio of long-term debt (with a maturity longer than one year) to total liabilities is typically lower in developing countries than in developed countries (Mayer, 1990; Caprio and Demirgüç-Kunt, 1998; Demirgüç-Kunt and Maksimovic, 1999; Giannetti, 2003; Fan *et al.*, 2012; Demirgüç-Kunt *et al.*, 2015). Therefore, studying the case of a middle-income economy is interesting, as previous research has shown that unfavourable debt maturity structures in firms may affect the macro-financial stability in developing economies (Schmukler and Vesperoni, 2006; Basel Committee on Banking Supervision, 2011).

Second, the hypothesis that firms manage their debt maturity profiles in different ways, depending on how close their maturity profiles are to zero, is tested. Choi *et al.* (2018) present a maturity choice model in which firms tradeoff between the issuance costs, the secondary market illiquidity and the rollover risk. On the one hand, if costs and illiquidity are essential, firms will choose a more concentrated debt structure. On the other hand, concentrated maturity profiles are risky if market conditions are uncertain. They also show that the choice of debt maturity depends on the preexisting maturity profile of the firm. The evidence presented by

Rauh and Sufi (2010) and Colla *et al.* (2013) establishes that small, low-rated firms have dispersed or multi-tiered debt priority structures.

This study found that the variables significantly and positively related to the maturity of corporate debt are size, liquidity, collateral assets and leverage. In contrast, the effect of the equilibrium interbank interest rate is both negative and significant. The Tobit model decomposition shows that the extensive effect exceeds the intensive effect. In other words, the determinants of debt maturity that were relevant or significant have a greater impact on the liquidation or reissuance of debt than on the fact that companies that have already issued debt increase or decrease their maturity.

This study is structured as follows: Section 2 presents the literature review and the hypotheses; Section 3 analyses the methodology and describes the variables used to develop the estimates; Section 4 explains the results obtained from applying the corresponding models of the previous section; Section 5 discusses some critical issues and Section 6 concludes the investigation.

2. Literature review

This section proposes several hypotheses and reviews the supporting existing empirical evidence.

2.1 Hypotheses development

2.1.1 Agency costs and firm size. In an earlier paper, Smith and Warner (1979) argue that firm size is closely related to debt maturity. Conflicts of interest between creditors and shareholders develop faster in small firms, since they do not have a sufficient number of secured assets to meet their claims (Antoniou *et al.*, 2006). Therefore, the expected relationship between maturity and size is positive.

Myers (1977) indicates that if growth firms issue short-term debt before exercising their growth options, they can reduce the agency costs associated with the downside risk arising from underinvestment. If necessary, lenders and borrowers can renegotiate. Titman (1992) also supports this argument, as growing firms have a higher probability of bankruptcy and can benefit from short-term borrowing. These arguments show that growth options and maturity are inversely related.

Asset collateralization is also related to agency costs. A company with a high proportion of assets that can be pledged, reducing the conflict of interest since this fact favours the company's lenders (Körner, 2007).

H1. Firm size is positively related to debt maturity.

H2. Collateral assets are positively related to debt maturity.

H3. Growth opportunities are negatively related to debt maturity.

2.1.2 Asymmetric information, signalling and liquidity risk. Flannery (1986) states that when issuing costs are sufficiently high, good-quality companies can signal their value to the market by assuming these costs, distinguishing such firms from poor-quality companies. Therefore, high-quality firms issue a greater volume of short-term debt, which means that the relationship between company quality and maturity should be negative.

Terra (2011) argues that a combination of asymmetric information and signalling might explain why the maturity of liabilities should match the maturity of assets. Maturity matching would signal the commitment of entrepreneurs to their intentions regarding the company. Firms would also match the maturity of their liabilities to the maturity of their claims to avoid a liquidity problem that would trigger inefficient liquidation of the firm. Excess liquidity, however, is inefficient, given the high opportunity of these resources. Additionally, Morris (1992) suggested that more liquid companies can postpone the maturity of their debt to avoid certain restrictions that lenders impose on borrowers seeking longer-term debt.

Alternatively, Diamond (1993) explains the relationship between leverage and whether firms issue short-term or long-term debt. He states that leveraged companies reduce liquidity risk by issuing long-term debt. Stohs and Mauer (1996) reinforce this idea and suggest that when companies have a high level of long-term debt, this directly leads to a higher proportion of debt, establishing an automatic positive correlation between leverage and maturity.

H4. Firm quality is negatively related to debt maturity.

H5. Liquidity is positively related to debt maturity.

H6. Leverage is positively related to debt maturity.

2.1.3 Taxes. Kane *et al.* (1985) explain the relationship between taxes and corporate maturity. They develop a model implying that a firm lengthens debt maturity as the tax advantage of debt decreases to ensure that the remaining tax advantage of debt is not less than the expected flotation and bankruptcy costs. Thus, a firm's debt maturity should decrease with its effective tax rate.

H7. Effective tax rate is negatively related to debt maturity.

2.1.4 Market interest rates. Traditional financial theory states that the longer the debt term, the higher the yield demanded by an investor to compensate for the opportunity cost of the invested money. However, contrary to the expectation hypothesis, some macroeconomic conditions favour a negative relationship between time and interest rates (Campbell and Shiller, 1991; Campbell, 1995). Therefore, one of these factors can have increased, decreased or nullified the yield curves, suggesting that the relationship of the interest rate over time with the term up to maturity can be either positive or negative (McCown, 1999; Wang and Yang, 2012; Quinn *et al.*, 2022).

H8. The equilibrium interbank interest rate is positive or negative related to debt maturity.

2.1.5 Empirical evidence from developed economies. Billett *et al.* (2007) employ a simultaneous equation model to examine leverage, maturity and covenant protection as joint determinants. With a database of 15,504 debt issues from 1960 to 2003, they found that covenant protection is increasing in leverage, debt maturity and the market-to-book ratio. This evidence is consistent with the notion that firms use covenants to control shareholder–bondholder conflicts over the exercise of growth options and that debt maturity and covenants are substitutes for managing such conflicts.

Taking advantage of the long-time-series dimension analysis, Custódio *et al.* (2013) revealed a decreasing trend in the use by American firms of long-term debt from 1976 to 2008. Firms with greater growth opportunities and shorter-maturity assets rely more on short-term debt, aligning with the agency costs hypothesis and the maturity-matching principle. The relationship between debt maturity and firm size is nonmonotonic: small and large firms borrow in the short term, whereas medium-sized firms lengthen their debt maturity. These authors further demonstrate that asymmetric information constitutes an essential driver of debt maturity: research and development (R&D)-intensive firms and firms with more volatile assets rely more on short-term debt.

Other studies on debt maturity associated with American companies explore novel lines of research associated with corporate culture, duration of executive compensation, political corruption and investment over the business cycles. In this study, the authors employ standard control variables associated with firm characteristics like leverage, asset maturity, firm size and the market-to-book ratio. In this sense, Datta *et al.* (2024) link corporate culture and debt maturity choice. These authors demonstrate that a superior corporate culture is associated with the choice of short-term debt, which reduces managerial agency problems and makes managers more responsive to external monitoring through the choice of short-term debt. Furthermore, the relationship between culture and debt maturity is more pronounced in firms with higher managerial equity ownership and in those with financial constraints but weakens in firms with higher CEO sensitivity to stock prices. Additionally, Fu *et al.* (2022) analyse the

relationship between the duration of executive compensation and corporate financing decisions, finding that firms with longer CEO pay duration have shorter debt maturity, which is consistent with the notion that firms shorten debt maturity to mitigate information asymmetry. This effect is stronger for firms with larger bid-ask spread, less analyst coverage, more growth options, more volatile returns and lower default risk and for firms in R&D-intensive industries. Besides, Hassan *et al.* (2022) examine the impact of local corruption on firms' debt maturity structure while exploring both demand-side and supply-side explanations. Their results support the demand-side story and demonstrate that firms in high-corruption areas employ less short-term debt to mitigate liquidity and refinancing risks. In this sense, they also find that the effect is more pronounced among firms with smaller size, lower asset redeployability and higher volatility. Finally, Poeschl (2023) explores the determinants of firms' debt maturity and the importance of firms' debt maturity for their investment and leverage dynamics. The results suggest that firms shorten debt maturity during times when default risk premiums are high and their internal funds are scarce. This behaviour is consistent with both the life cycle and business cycle dynamics of firms' debt maturity. Endogenous debt maturity helps firms to deleverage faster in response to negative shocks.

In Casino *et al.* (2019), the developed market covered is Europe. Based on two groups of listed and unlisted European companies, they measure how agency costs influence the maturity structure of the companies in the sample. Using the panel methodology to estimate the corresponding models, the study finds that asset maturity, size, leverage and liquidity are essential in determining debt maturity for the two groups of European firms. However, free cash flow and growth opportunities are not important in determining the debt maturity of listed companies. In general, the effect of these determinants on the dependent variable is consistent with the rest of the literature.

Allaya *et al.* (2022) analyse the relationship between voluntary disclosure and corporate debt maturity for 404 French-listed companies. Additionally, they include control variables such as leverage, asset maturity, firm size and the market-to-book ratio. They found that companies with higher voluntary disclosure have more long-term debt, suggesting that companies benefit from broad disclosure through greater access to long-term debt.

Besides testing the debt maturity theories, more recent papers have investigated the maturity choice of firms from a novel perspective. For instance, Choi *et al.* (2018) focus on spreading (or concentrating) maturity dates over time. Using an exogenous shock to bond rollover risks such as the GM and Ford downgrade in May 2005, they show that firms with more maturing debt to roll over immediately after the shock increase the dispersion of their maturity profile more than a control group of otherwise similar firms. Likewise, Parise (2018) tests whether the threat of entry by low-cost competitors affects financing decisions, using data on the American domestic airline industry. Parise finds that incumbents significantly increase debt maturity before entry occurs. This type of behaviour suggests that firms actively manage debt maturity to reduce the rollover risk associated with short-term debt refinancing under adverse market conditions.

2.1.6 Empirical evidence from emerging markets. Empirical tests and evidence of the debt maturity theories in emerging markets are also extensive and relatively recent. Many studies analyse corporate debt structure, using debt maturity as the dependent variable. Countries and economic areas covered and used as examples include Chile (Castañeda and Contreras, 2017), Mexico (Farfán *et al.*, 2022), African countries (Etudaiye-Muthar *et al.*, 2017), India (Kalsie and Nagpal, 2018), Vietnam (Phan, 2020), Serbia (Kuč and Kaličanin, 2021) and Eastern and Central Europe (Toader *et al.*, 2022). Based on traditional panel data and other dynamic models, these authors use independent variables such as size, growth opportunities, collateralised assets, liquidity and leverage to explain the phenomenon. Their results are generally consistent with the extensive literature already available on this subject, as they also find that firm factors explain the maturity of corporate debt to a large extent.

Some researchers empirically explore the relationship between the choice of debt maturity and firm agency costs. These authors use similar control variables such as company size,

leverage, profitability and tangibility, among others. Farhangdoust *et al.* (2020) find no tradeoff between managerial ownership and debt concerning the reduction of agency costs. Additionally, Faysal *et al.* (2020a) support the role of inside ownership in enhancing fixed performance by reducing the cost of equity, which means that managerial ownership can be a substitute for all shareholders. Moreover, Salehi *et al.* (2021a) prove that family companies and state shareholders have no significant impact on the agency costs. However, financial leverage causes a decline in agency costs, and larger companies also face higher agency costs. Likewise, Salehi *et al.* (2021b) detect that the audit committee positively impacts company performance, suggesting that effective corporate governance can minimise conflicts of interest and enhance overall performance. Finally, Faysal *et al.* (2020b) find that in the Iranian context, board size, CEO tenure and audit quality reduce the cost of equity.

Lemma *et al.* (2020) investigate the impact of climate change on corporate finance. They use a panel data model and control variables related to firm characteristics like size, profitability, tangibility and tax shield to prove the relationship between debt maturity and corporate carbon risk. The results show that the debt maturity is significantly higher, both statistically and economically, for companies with lower carbon intensity (risk). In addition, high-quality carbon disclosure accentuates the positive association between debt maturity and the inverse of carbon intensity.

Another area of current literature related to debt maturity is addressed by Sur and Chauhan (2021). Using data from all listed Indian companies, they found that group affiliation is positively associated with corporate debt maturity, i.e. group firms use more long-term debt than similar standalone firms. However, information asymmetry and moral hazard problems weaken the impact of group affiliation on debt maturity structure. In addition, Chenari *et al.* (2023) evaluate the effect of bankruptcy risk on stock price risk, emphasising the role of debt maturity in companies listed on the Tehran Stock Exchange. They find that this effect is not statistically significant and therefore reject their research hypotheses. Finally, Zhang *et al.* (2024) analysed the influence of supplier concentration on debt maturity structure. The results suggest an inverted U-shaped relationship between supplier concentration and debt maturity structure. In the case of tight monetary policy, fewer collateral assets and higher total debt, the inverse U-shaped relationship is more significant.

Stephan *et al.* (2011) published a study related to the work described above. They analysed the determinants of debt maturity choice in Ukraine. Using a Tobit model to censor the dependent variable between zero and one, they confirm the importance of companies operating in an economy in transition. This study proves that restricted and unrestricted companies react differently to liquidity risk and follow different debt maturity strategies.

Another interesting line of research that is being widely addressed these days is that associated with environmental, social and governance (ESG) issues. Zhou *et al.* (2024) study the intricate association between ESG involvement and corporate debt maturity. They employ data from the listed Chinese firms and observe a positive correlation between ESG performance and the long-term debt ratio of enterprises. Importantly, the marginal effect of ESG on debt maturity is obvious for enterprises exhibiting higher levels of ESG performance.

3. Method

3.1 Data and variables

The dataset consists of 93 companies listed on the Mexican Stock Exchange (BMV, by its acronym in Spanish) for 18 years (2002–2019). The sample is obtained from the official BMV website, considering the non-financially listed companies. Financial data were sourced from the Capital IQ database and annual reports. The market variable, such as the interest rate, is obtained from the official website of the Central Bank of Mexico (Banxico). Since data for certain companies have been unavailable for several years for both the dependent variable and its determinants, the only option was to use an unbalanced panel.

The dependent variable "debt maturity" is defined as a weighted average of the maturity employed, which weight the contract value of each debt item over the total debt registered for each year, multiplied by the remaining time for the contract to end. This methodology provides a better representation of maturity by including time as part of the measurement:

$$\overline{m}_{i,t} = \sum_{j=1}^{J} s_{j,i,t} * m_{j,i,t} \tag{1}$$

where $s_{j,i,t} \in [0, 1]$ is understood as the proportion of each debt item "j" of the company "i" in period "t" in the total debt:

$$s_{j,i,t} = \frac{D_{j,i,t}}{\sum_{j=1}^{J} D_{j,i,t}} \tag{1a}$$

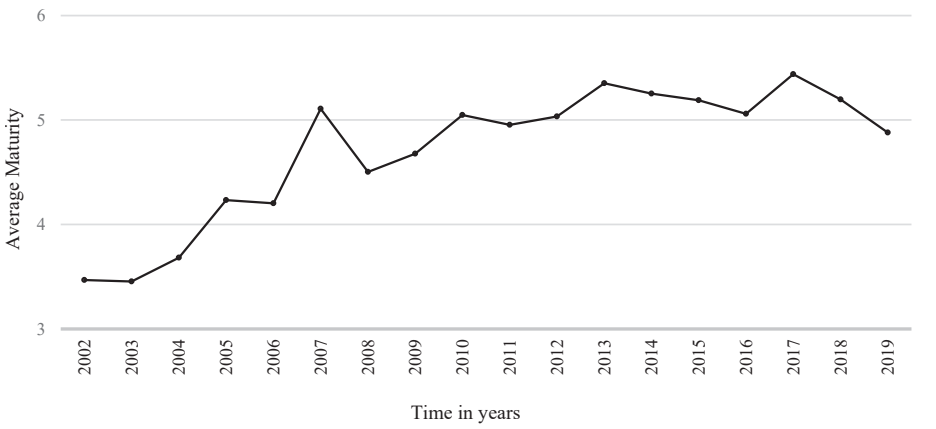
and $m_{j,i,t}$ is the current maturity of each item "j" of the company "i" in period "t":

$$m_{j,i,t} = Vt_{j,i,t} - Ac_{j,i,t} \tag{1b}$$

where Vt is the total maturity of the contract and Ac is the closing year under analysis. Figure 1 shows the behaviour of this variable.

The explanatory variables of corporate debt maturity are closely related to the firm characteristics. Size is defined as the natural logarithm of the book value of total assets. This study uses the ratio between net sales and the book value of total assets as a proxy for the quality of a firm. Liquidity of a firm is measured as the ratio between current assets and current liabilities, while tangibility is defined as the ratio between net tangible assets and the book value of the total assets. The ratio between total debt and total assets is the leverage. Taxes are computed as the proportion between the tax expenses and its taxable base (income before taxes). According to the literature, defining the growth option of a firm is vital in explaining debt maturity. The ratio of market to book value of equity is a proxy of this variable.

The study also includes a Mexican market interest rate, as an explanatory macroeconomic variable. The interbank equilibrium interest rate (TIIE) is the reference rate used in most



Source(s): Authors' own elaboration using the annual data from the Capital IQ platform

Figure 1. Annual weighted average maturity of corporate debt

commercial debt contracts signed in Mexican pesos. The annual average as a function of its daily value reflects the following factor:

$$\overline{TIIE}_t = \frac{\sum_{t=1}^{T} TIIE\ 28\ days}{T} \quad (2)$$

Sectors are the usual control variables. Table 1 shows the definition and computation of the variables under study, along with references to authors who support these variables, which are considered standards in the literature.

3.2 Descriptive statistics

Table 2 reports the descriptive statistics, except for the sector variable, to better understand the factors involved in this study.

The average debt maturity of the companies listed on the BMV is 4.7 years, considering this value in the medium to long term. The minimum value is zero, suggesting a debt payment and a maximum of approximately 28 years. The average liquidity is 2.48, implying that, on average, companies can cover their total obligations with their resources more than twice. However, a minimum of 0.05 exists, which means that for a particular year, a specific company had its obligations practically uncovered. Regarding collateral assets, the leverage and corporate tax rates refer to zero minimums. In the first case, a specific company at a particular moment depreciated all of its tangible assets. In the second case, a company has no recorded debt for one specific year. In the third case, a company did not pay taxes for a year because it reported financial losses. Finally, the minimum negative value recorded by the market-to-book ratio explains that, for a particular year, a specific company closed the period with negative equity, conditioned by a loss in retained earnings.

Table 1. Variable description

Variable	Description	Expected sign	References
Debt Maturity$_{i,t}$	Annual weighted average of debt contracts	N/A	Farfán *et al.* (2022)
Size$_{i,t}$	Natural logarithm of total assets of firm *i* in year *t*	+	Antoniou *et al.* (2006) and Toader *et al.* (2022)
Quality of the firm$_{i,t}$	Net sales divided by total assets of firm *i* in year *t*	−	Stephan *et al.* (2011)
Liquidity$_{i,t}$	Current assets divided by current liabilities of firm *i* in year *t*	+	Stephan *et al.* (2011)
Collateralized Assets$_{i,t}$	Net tangible assets divided by total assets of firm *i* in year *t*	+	Terra (2011) and Körner (2007)
Leverage$_{i,t}$	Total debt divided by total assets of firm *i* in year *t*	+	Diamond (1993) and Stohs and Mauer (1996)
Effective CorporateTax Rate$_{i,t}$	Tax expenses divided by Income before taxes of firm *i* in year *t*	−	Kane *et al.* (1985) and Terra (2011)
Market_to_Book$_{i,t}$	Market value of equity divided by book value of equity of firm *i* in year *t*	−	Myers (1977) and Titman (1992)
The Average 28 *days*$_t$	Annual average 28 days of the equilibrium interbank interest rate	±	Farfán *et al.* (2022) and Campbell (1995)
Sector$_{i,t}$	Dummy 0 and 1	Undetermined	Farfán *et al.* (2022)

Source(s): Authors' own elaboration using bibliographic references

Table 2. Descriptive statistics of the main study variables

Variables	Mean	Median	Std. Dev	Minimum	Maximum	Total observations
Debt maturity	4.7387	3.9577	3.7156	0	27.9346	$N = 1{,}434$
Size	9.6760	9.6784	1.4842	4.3029	14.2420	$N = 1{,}495$
Quality	0.7297	0.6823	0.4307	0.0144	2.5421	$N = 1{,}493$
Liquidity	2.4815	1.6188	5.3576	0.0526	161.9067	$N = 1{,}494$
Collateral assets	0.4100	0.4305	0.2332	0.0002	0.9735	$N = 1{,}495$
Leverage	0.2803	0.2626	0.2321	0	5.4467	$N = 1{,}493$
Tax rate	0.3135	0.2660	1.1815	0	42.5446	$N = 1{,}492$
Market_to_book	1.9502	1.4017	2.9437	−0.3154	74.1883	$N = 1{,}277$
TIIE_Average	6.3635	6.9197	1.8371	3.3167	9.6135	$N = 1{,}674$

Source(s): Authors' own elaboration using the data from the Capital IQ platform and the monthly data from the Central Bank of Mexico (Banxico)

To avoid multicollinearity problems, Table 3 presents a correlation analysis using Pearson's coefficient for measurement. This process rules out a strong relationship between determinants, avoiding overestimation of the empirical model. A correlation close to 1 or −1 suggests that two independent variables provide a similar explanation for the dependent variable, and using both would be econometrically incorrect.

The correlation analysis results indicate that, in general, there are no problematic effects. However, the relationship between debt size and maturity is approximately 41%, which, although not considered high, could be in the medium range. A test known as variance inflation factor revealed no multicollinearity. Therefore, using all variables in the econometric model estimation is empirically accurate since the range values are between 1 and 4, which is within the permissible limits.

3.3 Methodology and empirical strategy

Debt maturity is a variable that takes values in the range $[0, \infty)$. The distribution of a censored variable, debt maturity in this study, is a mixture of a continuous and a discrete distribution, with a probability accumulation at the censoring point. The existing constraint on this variable imposes the use of a Tobit-type model (Tobin, 1958) to solve these limitations.

Table 3. Correlation matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Debt Mat (1)	1.00								
TIIE_Avg (2)	−0.0760	1.00							
Size (3)	0.4129	−0.0590	1.00						
Quality (4)	−0.2276	0.0349	−0.1492	1.00					
Liquidity (5)	0.0073	0.0082	−0.0758	−0.1603	1.00				
Collateral (6)	−0.0163	0.0817	−0.1241	0.1106	−0.1471	1.00			
Leverage (7)	0.2123	−0.0650	0.1191	−0.2030	−0.1008	−0.0123	1.00		
Tax (8)	0.0148	0.0249	0.0622	0.0458	−0.0357	0.0303	−0.0297	1.00	
MtoB (9)	0.0839	−0.1218	0.1600	0.1660	−0.0239	−0.0556	0.0546	−0.0113	1.00

Source(s): Authors' own elaboration using the annual data from the Capital IQ platform and the monthly data from Banco de México

In a Tobit model, the censored variable takes the following values:

$$Y_{i,t} = \begin{cases} Y^*, if\ Y^* > 0 \\ 0, if\ Y^* \leq 0 \end{cases} \quad (3)$$

The use of panel data in this study has led the authors to propose a panel model with random effects [2] for the latent variable.

$$Y^*_{i,t} = \alpha_i + \beta_0 + \beta X'_{i,t} + u_{i,t}, u_{i,t} \Big/ X_{i,t} \sim Normal\left(0, \sigma^2\right) \quad (4)$$

where "i" and "t" correspond to each of the companies and years of the sample, respectively.

Considering the above and eliminating subscripts henceforth for simplicity, the expected value of the censored variable "Y" would be as follows:

$$E(Y) = Prob(censored) \times E(Y|Y = 0) + Prob(uncensored) \times E(Y|Y > 0) \quad (5)$$

Additionally, let $F(Z) = \Phi\left(\frac{\beta X'}{\sigma}\right)$ be the standard cumulative normal distribution function and $f(Z) = \phi\left(\frac{\beta X'}{\sigma}\right)$ be the standard normal density function. On the other hand, $\beta X'$ could represent the conditional expectation of $(Y|X)$ and σ the standard deviation. In this sense, the following expressions (6, 7, 8) explain the relationship between the expected value of the index variable $E(Y)$, the conditional expected value of the observations above the limit $E(Y^*)$ and the probability of being above that limit $F(Z)$:

$$E(Y) = F(Z)\beta X' + \sigma f(Z) \quad (6)$$

$$E(Y^*) = \beta X' + \sigma \frac{f(Z)}{F(Z)} \quad (7)$$

$$E(Y) = F(Z)E(Y^*) \quad (8)$$

McDonald and Moffitt find a decomposition that they obtain by considering the effect on the change of the ith variable of X in Y by partially differentiating (8):

$$\frac{\partial E(Y)}{\partial X_i} = F(Z)\frac{\partial E(Y^*)}{\partial X_i} + E(Y^*)\frac{\partial F(Z)}{\partial X_i} \quad (9)$$

Equation (9) shows the disaggregation of the total effect on Y: first, Y changes for observations above the limit, weighted by the probability of being above the limit, followed by a change in the probability of being above the limit, weighted by the expected value of Y, if above.

To better understand the estimation results and standardise the measurement units, Equation (9) can be rewritten as elasticities, following the line of discussion developed by Villezca and Moreno (2000). The unconditional expected value elasticity of maturity as time is defined as follows:

$$\eta_{E(Y)} = \left[\frac{\partial E(Y)}{\partial X_i}\right]\left[\frac{\overline{X}}{E(Y)}\right] \quad (10)$$

where

$$\eta_{E(Y)} = \eta_{E(Y^*)} + \eta_{E(Z)} \tag{11}$$

and

$$\eta_{E(Y^*)} = \left[\frac{\partial E(Y^*)}{\partial X_i}\right]\left[\frac{\overline{X}}{E(Y^*)}\right] \tag{12}$$

Finally, $\eta_{E(Z)}$ is the elasticity of the probability of liquidating or reissuing debt and is defined as follows:

$$\eta_{E(Z)} = \left[\frac{\partial F(Z)}{\partial X_i}\right]\left[\frac{\overline{X}}{F(Z)}\right] \tag{13}$$

Though originally developed for analysing demand response in censored models (like the Tobit setup), the McDonald and Moffitt's elasticity decomposition described above can be adapted to study time-related variables, such as debt maturity. In this sense, elasticities help to interpret the results in terms of how sensitive debt maturity is to changes (ceteris paribus) in the independent variables.

Notably, in terms of debt contracts, maturity refers to the time remaining until the debt is fully paid or liquidated, so it is measured by a continuous variable that might be censored in some contexts. For example, some debts may be paid off early (liquidated), resulting in a shorter-than-expected maturity. Certain debt contracts may also reach contractual maturity, but defaults or extensions could occur, effectively censoring the observation. Hence, when studying the maturity of the debt, the concepts of extensive and intensive margins can be applied and adapted.

First, the *extensive margin* relates to the likelihood that a debt reaches its contractual maturity date without being paid off early or defaulting. This analysis can help understand what factors influence the likelihood of debt being paid off early. On the other hand, the *intensive margin* would examine the magnitude of the maturity, conditional on the debt reaching this time. It helps to understand the variations in maturity among debts that are not paid off early or defaulted.

Using MM decomposition can provide a more nuanced understanding of how different factors affect debt maturity.

Following the approach by Sur and Chauhan (2021), this study implemented a two-stage simultaneous equations model (2SLS) to verify whether the potential endogeneity affects the estimates of the Tobit model, since debt maturity and leverage might be simultaneously determined. This study leads to the conclusion that the significance and positive relationship between this variable and debt maturity remain prevalent once we account for and correct leverage endogeneity. This result enables applying the MM methodology while maintaining the estimates of the Tobit model with random effects.

4. Results

The estimates obtained, following the proposed methodology, show significant results. First, the study estimates a pooled Tobit model (1) and a Tobit with random effects (2). Additionally, we estimate the 2SLS model (3) to prove that the potential endogeneity between leverage and debt maturity has no significant impact on the estimates. Table 4 illustrates the estimations for the three models.

The random-effects model has the highest log-likelihood value, making it the most effective model for explaining debt maturity.

It is worth mentioning that these first estimates reflect the relationship between the explanatory variables and the latent variables. The sign of the coefficients in this first stage of

Table 4. Debt maturity determinants of Mexican-listed companies

Dependent variable: debt maturity (time to maturity as a weighted average)						
	Pooled Tobit (1)		Tobit with random effect (2)		2sls (3)	
Variable	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
TIIE_Avg	−0.0899*	(0.052)	−0.0967**	(0.039)	−0.0750	(0.053)
Size	0.9756***	(0.074)	1.3729***	(0.121)	0.9850***	(0.075)
Quality	−0.8568***	(0.275)	0.1870	(0.399)	−0.9105***	(0.278)
Liquidity	0.0304*	(0.018)	0.0373**	(0.016)	0.0300*	(0.018)
Collateral	1.1526**	(0.493)	1.7427**	(0.734)	1.2858**	(0.497)
Leverage	2.4418***	(0.454)	1.3608***	(0.390)	2.3587***	(0.731)
Tax Rate	0.0416	(0.210)	−0.1342	(0.157)	0.0419	(0.209)
Market_to_Book	0.0474	(0.049)	−0.0382	(0.049)	0.0432	(0.050)
Constant	−3.0303***	(0.987)	−7.8366***	(1.738)	−3.0973***	(1.000)
Total Observations	1261		1261		1214	
Censored Observations	36		36			
Uncensored Observations	1225		1225			
Log−likelihood	−3278.44		−2997.81			
Probability (χ^2)	0.000		0.000			
Probability (F)					0.000	
R−square					0.2456	

Note(s): (***), (**) and (*) represents 1%, 5% and 10% significance level, respectively
Source(s): Authors' elaboration using annual data from the Capital IQ platform, monthly data from Banco de México, and the Mexican Stock Exchange information

the model estimations will prevail in the relationship between the explanatory and the dependent variables. Therefore, the determinants of debt maturity are size, collateral assets, liquidity, leverage and the TIIE. These factors are consistent with the literature in terms of significance.

Table 5 presents the decomposition proposed by McDonald and Moffitt. The results highlight that approximately 91.8% of observations have positive maturity, and the expected value of the censored variable in this positive part of the distribution is 5.39 years. Table 5 also shows the differentiated effect of the explanatory variables on the extensive, intensive and total

Table 5. Tobit model decomposition by McDonald and Moffitt

		Mean decomposition							
		$\Pr(Y>0)$	$E[Y\|Y>0]$						
		$F(Z)$	$E(Y^*)$						
		0.9181	5.3903	Extensive margin	Intensive margin	Total effect	Extensive elasticity	Intensive elasticity	Total elasticity
Variable	Mean	$\frac{\partial F(Z)}{\partial X_i}$	$\frac{\partial E(Y^*)}{\partial X_i}$	$E(Y^*)\frac{\partial F(Z)}{\partial X_i}$	$F(Z)\frac{\partial E(Y^*)}{\partial X_i}$	$\frac{\partial E(Y)}{\partial X_i}$	$\eta E(Z)$	$\eta E(Y^*)$	$\eta E(Y)$
TIIE**	6.1963	−0.0042	−0.0719	−0.0226	−0.0660	−0.0887	−0.1528	−0.0759	−0.2287
Size***	9.7942	0.0601	1.0206	0.3249	0.9370	1.2610	3.4553	1.7032	5.1585
Quality	0.7419	0.0082	0.139	0.0442	0.1276	0.1718	0.0357	0.0176	0.0533
Liquidity**	2.5042	0.0016	0.0277	0.0086	0.0254	0.0341	0.0235	0.0118	0.0353
Collateral**	0.4034	0.0762	1.2954	0.4107	1.1893	1.6001	0.1804	0.0890	0.2695
Leverage***	0.2736	0.0595	1.0116	0.3207	0.9288	1.2495	0.0956	0.0472	0.1427
Tax rate	0.2866	−0.0059	−0.0998	−0.0318	−0.0916	−0.1234	−0.0099	−0.0049	−0.0148
MtoB	1.8746	−0.0017	−0.0284	−0.0092	−0.0261	−0.0352	−0.0187	−0.0091	−0.0278

Note(s): (***), (**) and (*) represents 1%, 5% and 10% significance level, respectively
Source(s): Authors' own elaboration using the estimates obtained using the annual data from the Capital IQ platform, the monthly data from Banco de México and information from the Mexican Stock Exchange

elasticities. The absolute value of the elasticity needs to be compared to determine which of the effects is more important.

Previous literature displays that firm size positively affects corporate debt maturity. With the expected positive sign (consistent with Hypothesis 1), larger firms tend to increase the maturity of their obligations, since, as Antoniou *et al.* (2006) state, larger firms tend to have more assets to offer to their creditors in case of a conflict of interest between themselves and their shareholders. The dependent variable is highly sensitive to changes in firm size, since its elasticity is 5.1585, which is greater than one. This relationship implies that a marginal increase in firm size raises the debt maturity average more than proportionally, and the most significant impact is in the extensive margin, with a value of 3.4553. It shows that company size has a greater scope in the observations of the sample that are on the limit, implying that its marginal variation increases the probability of companies issuing debt to a greater extent than the increase in the debt maturity for companies that already had a debt portfolio.

Collateral assets also show positive significance in explaining the weighted average maturity of the firm (consistent with Hypothesis 2). A marginal change in this factor triggers a less-than-proportional maturity shift due to the total elasticity value of 0.2695. The extensive elasticity takes a value of 0.1804, which means that its incidence is higher with an increase in the probability of liquidating or debt issuance than in the case where companies increase debt maturity in the positive part of the distribution, with an intensive elasticity of 0.0890.

Another relevant variable that predicts the debt maturity of Mexican companies is liquidity, which has a significant and positive coefficient (consistent with Hypothesis 5). Liquidity has a total elasticity of 0.0353 and is considered an inelastic variable. When analysing the effects, it becomes clear that the extensive variable has a value of 0.0235, while the intensive variable has a value of 0.0118. This suggests that liquidity has a positive and more significant influence on the probability of liquidating or debt issuance than on the increase in maturity, given that firms have a previous debt issued.

As with the previous variables, the total elasticity of leverage takes a positive value of 0.1427, which is smaller than 1. Once again, the extensive elasticity exceeds the intensive elasticity, this time by 0.0484. Marginal increases in this factor result in more significant increases in the probability of liquidating or debt issuance than increases in debt maturity for firms that had already issued debt previously. The positive relationship between leverage and debt maturity is consistent with Hypothesis 6.

The variable that reflects the reference rate for debt contracts in Mexican pesos indicates that when this factor increases, the debt maturity tends to decrease (consistent with Hypothesis 8) but less than proportionally. The TIIE has a total elasticity of −0.2287. The extensive effect with a value of −0.1528 is the most important component of the total elasticity. This result suggests that this variable has a significant impact, as it decreases the probability of reissuing debt if the short-term interest rate increases.

Factors such as the market-to-book ratio, firm quality and the effective corporate tax rate, associated with Hypotheses 3, 4 and 7, respectively, do not explain the corporate debt maturity of Mexican public companies, and thus, they are statistically rejected.

5. Discussion

5.1 Theoretical implications

The results of this research suggest evidence in line with the hypothesis stated in the previous literature by revealing that determinants associated with company characteristics are highly relevant to explaining debt maturity.

This study uses a Tobit-censored response analysis to study the determinants of the debt maturity choice of Mexican public firms and identifies the marginal effect of each independent variable both at the intensive and the extensive margins. The study introduces a refinement proposed by McDonald and Moffitt to decompose the effects of the independent variables into two parts: one associated with the change in the probability of liquidating or reissuing debt

from a previous total liquidation (debts exiting and re-entering the debt market) and the other related to variations in the debt maturity of firms that had already issued debt contracts.

According to this methodology, the relevant and significant variables that explain debt maturity are TIIE, firm size, collateral assets, liquidity and leverage. Most of these factors reflect a positive relationship with the dependent variable, which is consistent with the literature reviewed and discussed in the previous sections. With each increase, debt maturity tends to increase, implying that companies choose longer-term issues. The TIIE market interest rate negatively affects debt maturity. Finally, public Mexican firms tend to choose shorter-term debt when market interest rates increase, which may refer to an economy in a recession stage.

Therefore, one of the main conclusions derived from the estimations presented in this study is that the higher extensive margin over intensive margin elasticities suggests that changes in the determinants of debt maturity, when measured as "time to expiration," have a higher impact on the probability of issuing or liquidating debt than in the expected time of debt already issued.

5.2 Managerial/policy implications

In the context of this research, since debt maturity is highly sensitive to company size and positively related to it, it can serve as an incentive to increase investments and thus achieve higher growth. In this sense, if a small or medium-sized company becomes large, it can count on more favourable conditions to request financing or to renegotiate its debt.

Additionally, the findings suggest that extensive margins are more relevant for Mexican-listed companies than intensive margins, which is why firms are more interested in liquidating their debt early than in renegotiating it. According to the results, companies with higher liquidity, collateral and leverage will try to liquidate their debt early instead of renegotiating or restructuring it, thus reducing the cost of their debt.

5.3 Limitations and future research agenda

Despite its consistent results, this research has certain limitations. Firstly, the study uses an unbalanced panel, which causes information loss and makes it impossible to apply specific models suggested by the literature to test the robustness of the estimates. Secondly, the choice of a Tobit model crucially depends on the assumptions of normality and homoscedasticity of the error term. These assumptions are made about the latent variable because it is unusual in these studies for the observed variable to follow a normal distribution. If any of the assumptions fail, the estimation and the inference are invalid, as it is unknown what the maximum likelihood estimator is solving. This model also uses an identical mechanism to determine the probability of censoring, as well as the expected value of the uncensored observations. The determinants of these two effects may be unrelated because the same explanatory variables could have a different impact on the dependent variable.

Future research may consider extending this analysis to the most important emerging economies in Latin America, using the construction of the dependent variable as proposed, since it is a more precise way to calculate corporate debt maturity. In addition, the methodology presented by MM can provide an idea of how emerging Latin American economies manage their debt portfolio, controlled by macroeconomic variables associated with each specific country. On the other hand, adding the COVID-19 pandemic period to the dataset can help determine if this adverse situation faced by the world has, to some extent, changed the debt management patterns of Latin American companies.

6. Conclusions

This paper analyses determinants of debt maturity when measured as a time-censored limited-dependent variable. The relevance of this approach relies upon proposing an alternative

methodology to study the effects over maturity using a Tobit model and the McDonald and Moffitt decomposition, identifying the effects over the *extensive* margin (the probability of issuing or liquidating) and the *intensive* margin (the renegotiation of current debt contracts). The observations at the lower limit of the sample, though they are a small number in relation to the whole, have a great scope to explain the phenomenon of liquidation and debt issuance against changes in the magnitude of the maturity.

This new approach to analysing maturity allows for a better understanding of what is behind debt issuance and debt maturity. Relevant variables, except company size, have a total elasticity between 0 and 1 in absolute value. In this sense, the effects of these independent variables are considered inelastic, as corporate debt maturity undergoes less than proportional changes for small variations in each factor. The decomposition of the elasticity shows that the extensive effect outweighs the intensive effect in all of the variables. This result means that the explanatory variables have a more significant impact on the probability that firms liquidate and reissue debt than on changes in maturity magnitude, given that they have already issued debt.

The results are robust, showing that Mexican companies prefer early debt liquidation rather than holding and refinancing by adjusting the magnitude of their maturity. This holds true only when the firm's liquidity permits.

Notes

1. From this point forward, we will refer to McDonald and Moffitt as authors interchangeably, using either their full surnames or their initials, MM.
2. It is essential to clarify that using a Tobit model with fixed effects is not empirically sound. There is no sufficient statistic that allows the fixed effects to be conditioned out of the likelihood, due to the incidental parameter problem (Greene, 2004).

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Further reading

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