Corporate Debt Maturity and Future Firm Performance Volatility

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ABSTRACT

We propose a simple idea that corporate debt maturity should serve as a good indicator of future firm performance volatility. We show in a simple two-period model that the riskiness of corporate investment is a decreasing function of corporate debt maturity. If "observable" corporate debt maturity and ex ante "unobservable" corporate risk-taking is highly correlated, corporate debt maturity should be highly correlated with "ex post" realized firm performance volatility in following years. Using data on publicly listed firms in 10 developing and developed countries over the period 1991-2013, we find that future firm operating performance volatility decreases as corporate debt maturity increases and that future firm value volatility is not associated with corporate debt maturity. In addition, banking sector development and export intensity of a country play an important role in determining firm operating performance volatility.

1 Introduction

One of the main tenets in finance is that an asset's expected return is a function of risk (see e.g., Fama and French, 1993; Huang et al., 2012; Tinic and West, 1984; Watanabe and Watanabe, 2008). That is, the expected return is an increasing function of risk. In this paper, we develop a simple two-period model and show that the riskiness of corporate investment is

a decreasing function of corporate debt maturity (hereafter "debt maturity"). We relate future firm performance volatility, which is one way of "ex post" measuring "ex ante" unobservable corporate risk-taking, to debt maturity, which is conceivably a measure of financial risk. From outsiders' perspective, levels of corporate risk-taking are usually ex ante unobservable but are known to insiders (i.e., the presence of information asymmetries between insiders and outsiders). However, outsiders can indirectly infer levels of ex ante corporate risk-taking via "ex post" measures of realized firm performance volatility.

Our simple two-period model is able to capture and build on empirical evidence that (1) firms tend to have shorter debt maturity in years prior to banking/financial crises (Brockman et al., 2010; Harford et al., 2014) and (2) firms appear to have higher performance volatility in recent years (e.g., Faccio et al., 2011). Both facts are also documented in this study. When firms use debt to finance their investment, they also choose their level of short- and long-term debt. Shortening debt maturity (i.e., increasing the share of short-term debt) subjects firms to a greater level of rollover risk (Acharya et al., 2011; He and Xiong, 2012). In our model, a macro-level financial shock (e.g., a banking/financial crisis) can occur at the interim period. When short-term debt investors anticipate a financial shock to occur with high certainty, they withdraw from the debt markets by not rolling over firms' maturing short-term debt. Due to lack of the secondary market for long-term debt (or due to illiquidity of the secondary market for long-term debt), long-term debt investors cannot reverse their position at the interim period and thus are more exposed to a financial shock. Focusing on the discounted value of net profit of the success state of nature, we show that the investment's probability of success must equal or exceed a certain level (called "the investment threshold") so that the discounted value of net profit of the success state of nature is nonnegative. Focusing on the investment threshold, we find that the investment threshold decreases when the share of short-term debt in total debt increases. Lowering the investment threshold implies that riskier projects (e.g.,

projects with lower probabilities of success) become investable, allowing firms to invest in riskier projects even if financial leverage remains unaltered.

In a nutshell, three central insights obtained from our theoretical model are as follows. First, having shorter debt maturity allows or induces firms to invest in riskier projects. The larger proportion of short-term debt in total debt not only allows firms to invest in projects with smaller probability of success but also exacerbates the problem of maturity mismatch.[1] This insight supports the notion that when firms rely on short-term debt to finance their investment too excessive, the level of corporate risk-taking in the economy becomes substantially higher.

Second, investors prefer to buy short-term debt than long-term debt since short-term debt allows holders to be largely exempt from bearing bankruptcy costs prior to the onset of a financial shock and corporate default in the interim period. The demand for short-term debt results in the higher value of short-term debt and thus the lower return on short-term debt.

Third, due to lack of the secondary market for long-term debt (or the presence of illiquidity of the secondary market for long-term debt, investors require the higher return on long-term debt to compensate for bearing additional risk, relative to short-term debt.

Building from the insights obtained from our model, we argue that "observable" debt maturity contemporaneously correlates with the level of ex ante "unobservable" corporate risk-taking in investment. If ex ante corporate risk-taking in investment highly correlates with ex post realized firm performance volatility, debt maturity should be able to explain future firm performance volatility. We suggest that under certain conditions, debt maturity has a stronger or weaker effect on firm performance volatility. We test our predictions using a panel data set of publicly listed firms in 10 countries (i.e., six advanced economies, including Germany, Japan, South Korea, Switzerland, the United Kingdom, and the United States, and

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[1] See e.g., Farhi and Tirole (2012) for a detailed discussion on maturity mismatch.

four emerging markets economies, including Brazil, Indonesia, Malaysia and Thailand) during the period 1991–2013.

We use (1) firm operating performance volatility, measured as the three-year rolling standard deviation of ROA, and (2) firm value volatility, measured as the three-year rolling standard deviation of Tobin's Q, to proxy for firm performance volatility. To estimate the impact of debt maturity on future firm performance volatility, we employ panel OLS regressions as well as two-stage least squares (2SLS) regressions.

We empirically show that current firm operating performance volatility, which is observed at time t, is negatively associated with past debt maturity, which is observed at time t-3, after controlling for a large set of firm characteristics, industry conditions, and macroeconomic conditions. Our findings are also robust to controlling for unobservable time-invariant firm-specific effects, unobservable time-invariant industry-specific effects, unobservable time-invariant country-specific effects, and year effects.

We show that leverage is positively associated with future firm performance volatility in models that include both leverage and debt maturity. This result is consistent with Faccio et al. (2011) and Bruno and Shin (2014), who find that leverage is associated with firm performance volatility. We find that capital investment, firm size, the current ratio, the fixed assets ratio, and growth opportunities have a positive effect on future firm operating performance volatility. Inconsistent with prior studies such as Bruno and Shin (2014), we find that the GDP growth rate is negatively associated with firm operating performance volatility. Better industry stock price performance, which proxies for industry-level investment opportunities, is negatively associated with firm operating performance volatility. We find that firm operating performance volatility decreases as the degree of banking sector development increases.

However, we find no evidence for the effect of debt maturity on future firm value volatility, measured as the volatility of Tobin's Q. We find that capital investment, leverage, growth opportunities, and gross profit margin tend to increase future firm value volatility, while firm size, the current ratio, and the fixed asset ratio decrease it. These findings appear to suggest that corporate investment decisions, profitability and leverage play an important role in explaining future volatility of firm value.

The results of our paper provide new evidence that debt maturity and "unobservable" ex ante corporate risk-taking are more likely to be highly correlated, given that debt maturity is negatively associated with future firm operating performance. These findings can have implications for both firms and corporate debt holders. For instance, our findings, by quantifying the relationship between debt maturity and future firm performance volatility, are relevant for banks' loan officers considering loan applications. That is, when assets with long maturity are financed with shorter debt maturity, it is possible that firms are more likely to have higher corporate risk-taking. This finding is important because the effect of debt maturity on future operating performance remains evident even after controlling for growth options. Scholars such as Harford et al. (2014) note that firms with higher growth options (e.g., proxied by MBV) should have shorter debt maturity.

Our results show that the degree of banking sector development and the level of export intensity play an important role in explaining firm operating performance volatility. That is, firm operating performance volatility is negatively associated with the degree of banking sector development and is positively associated with the degree of export intensity. The magnitude of economic impact of both variables is larger that that of the GDP growth. The findings suggest that policymakers may be able to curb the firm's risk-taking by promoting the banking sector development.

The reminder of the article proceeds as follows. Section 2 provides a brief overview of related studies, our theoretical model and testable hypotheses. Next, we present our sample and methodology in Section 3. We report and discuss our empirical results in Section 4. We conclude our paper in Section 5.

2   Related literature and hypothesis development

To build arguments for the impact of debt maturity on future firm performance volatility, we primarily draw upon related studies that examine under- and over-investment problems (see e.g., Aggarwal and Samwick, 2006; Aivazian et al., 2005; Bolton et al., 2011; Butler et al., 2011; Julio and Yook, 2012; Myers, 1977; Myers and Majluf, 1984). Our theoretical arguments are also built upon prior studies related to debt maturity (see e.g., Barclay and Smith, 1995; Diamond, 1991; Fan et al., 2012; Flannery, 1986).

2.1   *Corporate debt structure and investment*

Flannery (1986) earlier agues that when the same information about a firm's prospect is shared between insiders and outsiders (e.g., outside investors), the composition of debt will be priced in a way that causes the firm to be indifference to the composition. When information asymmetries exist, better-informed insiders (e.g., managers) will attempt to choose their debt structure to maximize firm value. Brick and Ravid (1985) show in a model that when a gain from leverage exists, an increasing term structure of interest rates, which is adjusted for default risk, lead to long-term debt being optimal. Under similar conditions, a decreasing term structure of interest rates results in short-term debt being optimal. As noted by (Diamond, 1991), firms with lower credit ratings typically prefer long-term debt while firms with higher credit ratings generally prefer short-term debt. Barclay and Smith (1995)

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provide supporting empirical evidence for the contracting-cost hypothesis. That is, firms with limited growth opportunities or those that are large have more long-term debt. In addition, they show that the level of information asymmetries influences debt maturity in the sense that firms with higher levels of information asymmetries are more likely to use more short-term debt. Rauh and Sufi (2010) show that low-credit-quality firms tend to have a multi-tiered capital structure than high-credit-quality firms.

De Haan and Sterken (2006) examine the sensitivity of corporate debt structures to changes in monetary policy for a sample of firms in the Euro area and the UK and find empirical support for the broad credit view where firms that are more bank-dependent are more strongly affected by tightening monetary policy than firms that are less bank-dependent and have access to non-bank forms of external finance. Ju and Ou- Yang (2006) find that the long-run average interest rate plays an important role in determining optimal capital structure and debt maturity and that the volatility of interest rate is associated with debt maturity. Fan et al. (2012) show that country-level conditions can explain a substantial portion of the variation in leverage and debt maturity in a sample of firms in 39 countries. Leverage is higher for firms in more corrupt countries. In addition, firms in these countries are more likely to use more short-term debt. Firms in countries with explicit bankruptcy codes and deposit instance are more likely to use more long-term debt. Vig (2013) uses a sample of firms in India to show that tightening of creditor rights leads to liquidation bias and a reduction in total debt, a fall in secured debt, and a decrease in debt maturity.

Scholars such as Barclay and Smith (1995) and Khurana and Wang (2015) have argued that short-term debt can mitigate agency costs of debt (arising from information asymmetry and suboptimal investment problems) by constraining managerial risk-taking. Studies related to the influence of executive compensation show that managerial risk preferences are affected by executive compensation. For example, Datta et al. (2005) show that managerial stock

ownership significantly explains variation in debt maturity after controlling for factors that have been previously shown to determine debt maturity. More precisely, managerial stock ownership negatively affects debt maturity and influences the relationship between growth opportunities and debt maturity. Brockman et al. (2010) argue that large deltas (executives' portfolio sensitivities to changes in stock prices) negatively affect managerial risk-taking, whereas large vegas (executives' portfolio sensitivities to changes in stock return volatility) positively affect managerial risk-taking. They find that debt maturity positively correlates with CEO portfolio deltas and negatively correlates with CEO portfolio vegas.

Prior studies show that debt maturity has a significant effect on corporate investment decisions. For instance, Aivazian et al. (2005) find that debt maturity negatively affects investment for firm with high growth opportunities after controlling for the level of leverage but this effect is insignificant for firms with low growth opportunities. D'Mello and Miranda (2010) show that for unlevered firms, a fall in overinvestment is due to debt service obligations following the issuance of long-term debt.

2.2   *A two-period model*

In this section, we show within a simple two-period the impact that debt maturity has on corporate risk-taking. We consider a simple model of an economy with firms with limited liability and investors at three time periods, $t = 0$, 1, and 2. Firms have an investment opportunity at time 0. If this investment opportunity is taken up, it becomes an investment that has liquidation value (denoted by V) at time 1, generates no cash flows at time 1, and provides a payoff (e.g., cash flows) at time 2. In our model, investors refer to those who are interested in holding fixed-income assets such as short- and long-term bonds; hence investors can be, for example, commercial banks, insurance companies, and households.

Between time 1 and time 2, an economy-wide financial shock occurs with probability $1-\omega$. If the financial shock does not occur, the firms' investment opportunity yields R (or 0) with probability $\theta \in [0,1]$ or $(1-\theta)$ at time 2 while the liquidation value is equal to 0 at time 2. The probability θ is different for each firm and is known only by each firm. At time 0, investors do not ex ante know the success probability of any project at time 2 but know the prior distribution of θ, $G(\theta)$. By contrast, if the financial shock occurs at time 1, the firms' investment yields neither cash flows nor liquidation value (e.g., both cash flows and liquidation value are zero) at time 2. At time 1, every agent knows whether the financial shock occurs between time 1 and time 2.

Firms have their own funds or so-called equity (denoted by $\bar{I}$) but need to borrow additional funds I from investors at time 0 to take up their investment opportunities, equaling the amount $\bar{I} + I$. The ratio of $I/(\bar{I} + I)$ is viewed as financial leverage. For the purpose of this study, we assume that firms' financial leverage is exogenously given since our primary focus is on the examination of the effect of corporate debt maturity structure on corporate risk-taking. We assume that at time 0 firms use short-term (one-period) debt (e.g., short-term bonds) to finance the ratio α of I (i.e., the amount αI)[2] and use long-term (two-period) debt (e.g., long-term bonds) to finance the remaining ratio $1-\alpha$ of I (i.e., the amount $(1-\alpha)I$). The face value of the short-term debt at time 1 (at time 2) is S_1 (S_2), whereas the face value of long-term debt at time 2 is L.

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[2] While we assume that the ratio α in the model is an exogenous parameter (and is determined by firms), in practice, there is an upper bound of the ratio α, which is determined by outside investors. For example, firms cannot finance the full amount of I by issuing only short-term debt.

To simplify the analysis, we assume that $S_1 < V < S_1 + L$, $S_2 + L < R$, and $V < R/(1 + r_t)$.[3] We denote r_t the time-t discount rate (or the expected return) on corporate (risky) bond from time t to time $t + 1$. Consistent with the literature, we expect the time-t discount rate on corporate bond to be larger than the time-t risk free-rate of return ($r_{f,t}$), all else being equal. The first inequality implies that the liquidation value V can cover the claims of short-term debt holders at time 1 but cannot compensate for the sum of the claims of short-term debt (S_1) and long-term debt (L) at time 1. The second inequality guarantees that the cash flows generated by the firm's investment in case of having an investment success in the absence of the financial crisis can cover the sum of the claims of short-term (S_2) and long-term debt (L) at time 2. The final inequality ensures that the firm does not default voluntarily.

If investors provide short-term financing to the firm by buying firms' short-term bonds, they are willing to roll over short-term bonds at time 1 in the *absence* of the financial shock; however, short-term investors receive S_1 and no longer provide new short-term financing to the firm in the *presence* of the financial shock.[4] As investors discount the cash flow by the market interest rate r, the time-0 expected discounted payoff of the short-term bonds is then

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[3] Using the exogenous parameters, it follows from Equations (4)-(6) that it is equivalent to

assuming that $\dfrac{\omega E[\theta] + (1 + r_t)(1 - \omega)\kappa}{\alpha(1 + r_t)\omega E[\theta] + (1 + r_t)^2 [1 - \alpha(1 - \kappa) - \alpha\omega\kappa]} V < I$,

$I < \min\left(\dfrac{1}{\alpha(1 + r_t)} V, \dfrac{\omega E[\theta]}{(1 + r_t)^2 [1 - \alpha(1 - \kappa - \omega) - \alpha\omega\kappa]} \left[R + \dfrac{(1 + r_t)(1 - \omega)\kappa}{\omega E[\theta]} V \right] \right)$, and $V < R/(1 + r_t)$.

[4] Put it differently, at time 1, in the non-financial crisis state, firms can roll over their short-term debt by issuing new short-term debt to replace matured short-term debt. If the financial shock occurs at time 1, firms cannot roll over their short-term debt since investors do not buy their short-term debt.

$$-\alpha I + \frac{1}{1+r_t}\left[\omega\left(S_1 - S_1\right) + \left(1-\omega\right)S_1\right] + \frac{1}{\left(1+r_t\right)^2}\omega E[\theta]S_2,$$

where E is the expectation operator. Recall that $S_1 < V$ and $S_2 + L < R$.

If investors long-term financing to the firm by buying long-term bonds, in the absence of the financial shock, they receive nothing at time 1 and obtain L at time 2 when the firm succeeds, and 0 at time 2 when the firm fails. In the financial shock state of nature, long-term investors receive the residual claim $\kappa(V - S_1)$ at time 1 but do not obtain anything at time 2, where $1-\kappa \in (0,1)$ is the bankruptcy cost. This is because we assume that the firm is in default at time 1 if the financial shock is predicted to occur between time 1 and time 2 with high certainty and short-term investors no longer buy short-term bonds at time 1. In our model, short-term debt has the priority over long-term debt because short-term debt investors can withdraw their funds at time 1 prior to firms' default, and that $S_1 < V < S_1 + L$ and $S_2 + L < R$. Thus, the time-0 expected discounted payoff of the long-term bond for investors is

$$-\left(1-\alpha\right)I + \frac{1}{1+r_t}\left(1-\omega\right)\kappa\left(V - S_1\right) + \frac{1}{\left(1+r_t\right)^2}\omega E[\theta]L.$$

We assume that at time 0 investors invest in bonds as long as the expected discounted payoff is larger than or equal to zero (i.e., non-negative) given the interest rate r. Hence, at time 0, we must have

$$\frac{1}{1+r_t}\left[\omega\left(S_1 - S_1\right) + \left(1-\omega\right)S_1\right] + \frac{1}{\left(1+r_t\right)^2}\omega E[\theta]S_2 = \alpha I, \tag{1}$$

and

$$\frac{1}{1+r_t}(1-\omega)\kappa(V-S_1)+\frac{1}{(1+r_t)^2}\omega E[\theta]L=(1-\alpha)I. \tag{2}$$

In addition, when investors roll over short-term debt at time 1 in the absence of the financial shock, their expected discounted payoff must be larger than or equal to zero. Hence, the following condition must be satisfied at time 1:

$$\frac{1}{1+r_t}E[\theta]S_2=S_1, \tag{3}$$

Now, S_1, S_2, and L are simultaneously determined by Equations (1)-(3). Then, it is straightforward from (1)-(3) that we have

$$S_1=(1+r_t)\alpha I, \tag{4}$$

$$S_2=\frac{(1+r_t)^2}{E[\theta]}\alpha I, \tag{5}$$

$$L=\frac{(1+r_t)^2}{\omega E[\theta]}\left\{\left[1-\alpha+\alpha(1-\omega)\kappa\right]I-\frac{(1-\omega)\kappa V}{(1+r_t)}\right\}. \tag{6}$$

Given $\theta\in[0,1]$, we obtain $S_1<S_2$.

Because we assume that $S_1<V<S_1+L$ and $S_2+L<R$, the present discounted value of expected net profit π of the firm with success probability θ is given by

$$\pi\equiv\frac{1}{(1+r_t)^2}\omega\theta\left[R-S_2-L\right]-\bar{I} \tag{7}$$

Since we use the interest rate r_t to discount all components of the future payoff in Equation (7), the discounted expected net profit π in Equation (7) must be positive to compensate equity holders for bearing risk. It follows from (7) that the present discounted value of expected net profit of the firm with the success probability θ is nonnegative only if $\theta \geq \bar{\theta}$, where

$$\bar{\theta} \equiv \frac{(1+r_t)^2 \bar{I}}{\omega \left[R - S_2 - L \right]} > 0 \tag{8}$$

The final inequality in (8) is evident from the assumption that $S_2 + L < R$. Thus, firms with the project with the success probability $\theta \geq \bar{\theta}$ borrow additional funds from outsiders and invest in the project if the net present value of the investment is non-negative. Likewise, firms should not invest in the project with the success probability $\theta < \bar{\theta}$.[5]

Substituting (4)-(6) into (8), we characterize the investment threshold $\bar{\theta}$ more specifically as follows:

$$\bar{\theta} \equiv \frac{(1+r_t)^2 \bar{I}}{\omega \left[R - \frac{(1+r_t)^2}{\omega E[\theta]} I + \alpha \frac{(1+r_t)^2 (1-\omega)(1-\kappa)}{\omega E[\theta]} I + \frac{(1+r_t)(1-\omega)\kappa}{\omega E[\theta]} V \right]} \tag{9}$$

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[5] The threshold condition $\theta \geq \bar{\theta}$ is viewed as a minimum condition for a possible positive NPV project since, from the shareholders' perspective, Equation (7) describes the payoff of the investment. Hence, for the investment to have the time-0 positive expected net present value of the project, a necessary condition is that $\frac{1}{(1+r_t)^2} \omega \theta \left[R - S_2 - L \right] - \bar{I} > 0$.

Differentiating $\bar{\theta}$ with respect to α, we obtain

$$\frac{d\bar{\theta}}{d\alpha} = -\frac{(1+r_t)^2 \bar{I} \dfrac{(1+r_t)^2(1-\omega)(1-\kappa)}{\omega E[\theta]} I}{\omega\left[R - \dfrac{(1+r_t)^2}{\omega E[\theta]} I + \alpha \dfrac{(1+r_t)^2(1-\omega)(1-\kappa)}{\omega E[\theta]} I + \dfrac{(1+r_t)(1-\omega)\kappa}{\omega E[\theta]} V \right]^2} < 0. \quad (10)$$

Inequality (10) indicates that the shorter debt maturity (larger α) causes the lower success investment threshold (i.e., smaller $\bar{\theta}$). Because the lower investment threshold implies that the firm invests in riskier projects, this result shows that the riskiness of corporate investment is decreasing in the length of debt maturity.

The intuition behind (10) is that short-term debt investors can withdraw their funds before the event of firm default, whereas long-term debt investors cannot.[6] This implies that short-term debt investors do not incur any bankruptcy costs. Hence, under asymmetric information between firms and investors, if short-term debt has the priority over long-term debt in such a way that short-term debt investors are exempted from incurring bankruptcy costs ($1-\kappa > 0$) even in the presence of the financial shock ($1-\omega > 0$), firms are more likely to invest in riskier projects.[7]

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[6] We assume that there is no secondary market for long-term bonds; therefore, long-term bond investors cannot sell long-term bonds at time 1. If this assumption is relaxed, our main conclusion remains largely unaltered.

[7] This outcome is consistent with the view that under normal circumstances, investors require additional compensation for holding long-term bonds, leading to higher interest rates on long-term bonds, compared to short-term bonds. Hence, high credit-quality firms that have access to short-term bond markets prefer to issue short-term bonds to finance their (long-term)

It also follows from Equations (9) and (10) that the relationship between debt maturity and the riskiness of corporate investment is non-linear. Overall, we suggest the following proposition:

Proposition 1: Corporate investment is riskier if debt maturity is shorter. That is, the riskiness of corporate investment is a decreasing function of debt maturity. Furthermore, the relationship between debt maturity and the riskiness of corporate investment is non-linear.

Our theoretical model deserves some comments on its implications. While it is a representation of corporate debt maturity choice, it has economy-wide consequences. We discuss two primary implications in more detail below.

Implication 1: In the cross-section of firms with risky investment, a high proportion of short-term debt to total debt exposes firms to a greater level of rollover risk.

Implication 1 is a by-product consequence of the model's assumption that short-term debt investors can withdraw funds at the interim period (i.e., at $t = 1$ in our model). In anticipation of a financial shock, short-term debt investors might decide to not rollover short-term debt of firms, causing firms to default, regardless of whether a financial shock actually occurs.

Implication 2: Although our model analyses firms with one investment project (i.e., a single-project firm), Proposition 1 is applicable to multi-project firms.

investment. In this sense, the insights from our model are reminiscent of those suggested by Farhi and Tirole (2012) in the case of debt maturity for banks.

Implication 2 is a natural extension of the model's prediction for single-project firms to multi-project firms. If multi-project firms mainly finance their investment using short-term bonds (i.e., a large average value of α) and if the maturity length of short-term bonds is short on average (or many short-term bonds mature within a short period of time), a shock to the short-term debt market (e.g., investors anticipate a financial crisis and thus withdraw from the short-term debt market) would increase rollover losses of short-term debt (which are absorbed by equity) and might cause firms to run out of cash and eventually bankrupt. We observe this phenomenon happening during the recent global financial crisis when firms had great difficulties in rolling over maturing short-term debt following deteriorating liquidity in the corporate bond markets (see e.g., Dick-Nielsen et al., 2012), resulting in a shock to the real economy.

2.3   Theoretical predictions

Based on the matching principle, long-term assets should be financed using long-term debt, while short-term assets should be financed using short-term debt. Theory suggests two interrelated explanations for the prediction that firms with longer debt maturity tend to have the longer maturity of assets. First, a firm's rollover risk is a decreasing function of debt maturity, conditional on corporate capital structure.[8] For example, firms with shorter debt maturity will be more exposed to liquidity shocks to debt markets (e.g., collapses of

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[8] See, e.g., Acharya and Skeie (2011), Cheng and Milbradt (2012) and He and Xiong (2012) for a discussion of rollover risk.

commercial paper or corporate bond markets)[9] than firms with longer debt maturity. Hence, relative to firms with shorter debt maturity, firms with longer debt maturity will be able to hold longer-term assets. Second, given rollover risk of short-term debt, a firm's bankruptcy is a decreasing function of debt maturity, conditional on corporate capital structure.[10] Hence, firms that have the shorter debt maturity and consequently the higher likelihood of bankruptcy should hold more short-term assets. Thus, due to both rollover risk and bankruptcy risk, firms with shorter debt maturity should hold more short-term assets (or the shorter asset maturity).

There are two types of firms that might be able to issue short-term debt: (1) high credit-quality firms and (2) very low credit-quality firms. High credit-quality firms can issue a wide maturity range of debt (from a very short end to a very long end), while low credit-quality debt cannot have the long-term loan. As a result, low credit-quality firms are most likely forced to finance both short- and long-term assets using short-term debt.

Compared to high credit-quality firms, low credit-quality (and/or young) firms have to pay a higher cost of debt (at all range of maturity). Hence, they naturally have to invest in projects with ex ante higher expected returns (and higher risk) than the high credit-quality firms. That is, low credit-quality firms have the higher costs of debt and hence will have the upward pressure on corporate risk-taking, relative to high credit-quality firms.

Based on the above discussion, our main prediction is then that debt maturity determines the level of corporate risk-taking, which subsequently affects firm performance volatility in

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[9] See, e.g., Ericsson and Renault (2006) and Bao et al. (2011) for a discussion of illiquidity of corporate bonds and Dick-Nielsen et al. (2012) for evidence of hikes in illiquidity of corporate bonds during the global financial crisis of 2007-2009.

[10] See, e.g., Leland and Toft (1996) for a discussion of bankruptcy costs and optimal capital structure.

the future. That is, firms with shorter (longer) debt maturity have higher (lower) corporate risk-taking and subsequently higher (lower) future firm performance volatility. It should be noted that while this prediction is similar to that of our theoretical model in Section 2.2, it is based on arguments that are different from that of our theoretical model. The reason is that our theoretical argument in Section 2.2 depends on the prediction that low credit-quality firms can finance their riskier investment because the interest rate of short-term debt can be lower under asymmetric information by allowing investors to withdraw their funds in the interim period. Our theoretical prediction in Section 2.3 is based on the idea that because low credit-quality firms have the high cost of capital, they invest in riskier projects.

If agency problems are more severe for larger firms than smaller firms, the impact of debt maturity on future firm performance volatility will be larger for larger firms. That is, since larger firms have higher capacity to hold riskier assets than smaller firms, firm performance volatility will be higher for larger firms than smaller firms when the larger firms overinvest more than the smaller firms.

A competing hypothesis is that, as discussed above, because small and low-credit quality firms have the higher cost of debt at any given level of leverage than large and high-credit quality firms, the small and low-credit quality firms have to hold riskier assets with ex ante higher expected returns than large and high-credit quality firms, indicating that future performance volatility is higher for the smaller firms than for the larger firms.

It should be noted that while terms such as corporate risk-taking and firm performance volatility have often been used almost interchangeably in the empirical literature (see e.g., Faccio et al., 2011), they are subtly different. A key difference between the two is that corporate risk-taking theoretically refers to a level of risk inherent in investment that the firm takes ex ante, while firm performance volatility is an ex post "empirical and indirect" measure of a level of risk inherent in investment that the firm previously took.

So far in our theoretical analysis, we argue that debt maturity determines the current level of corporate risk-taking, which will in turn affect future firm performance volatility. In sum, we propose four testable hypotheses:

Hypothesis 1: Debt maturity negatively correlates with future firm performance volatility. Precisely, the fraction of long-term debt to total debt is negatively related to future firm performance volatility.

Hypothesis 2: The relationship between debt maturity and future firm performance volatility is non-linear. More specifically, the effect of the fraction of long-term debt to total debt on future firm operating performance volatility is non-linear.

Hypothesis 3a (Agency problems): The relationship between debt maturity and future firm performance volatility is more pronounced for larger firms than for smaller firms.

Hypothesis 3b (Costs of capital): The relationship between debt maturity and future firm performance volatility is more pronounced for smaller firms than for larger firms.

Hypothesis 4: The relationship between debt maturity and future firm performance volatility is more pronounced for firms with larger growth opportunities than for firms with smaller growth opportunities.

3 Data and methodology

3.1 Data and sample construction

Our initial sample comprises all publicly listed non-financial firms in 10 countries Brazil, Germany, Indonesia, Japan, Malaysia, South Korea, Switzerland, Thailand, the United Kingdom, and the United States over the period 1991-2013. Since we seek to ensure firms included in our final sample have a minimum of four-year observations so that a measure of a

firm's future performance volatility, which is defined as a three-year moving standard deviation of firm performance (e.g., ROA and Tobin's Q), can be computed for each firm in the sample at time $t+3$ and observations for explanatory variables at time t, the initial sample includes all non-financial firms[11] and excludes all IPOs from January 1, 2010 to December 31, 2013. In addition, we exclude observations with missing data on total assets, earnings before interest and taxes, sales, total debt and long-term debt. We retrieve firm-level and country-level data during the period 1991-2013 from Thomson Reuters Datastream.

3.2   Methodology and key variables

We measure firm performance volatility using two measures: (1) firm operating performance volatility, which is measured as the three-year moving standard deviation of return on assets (ROA), and (2) firm value volatility, which is measured as the three-year moving standard deviation of Tobin's Q. We compute ROA as the ratio of EBIT to total assets (in %) and Tobin's Q as the sum of the market value of equity and the book value of total debt scaled by the book value of total assets. Some scholars use the country-adjusted firm performance volatility. For instance, Bruno and Shin (2014) compute the degree of corporate risk-taking as the five-year standard deviation of country-year adjusted EBITDA/assets. Debt maturity (DEBTMAT) is measured as the ratio of long-term debt to total debt (in %).

Following Aivazian et al. (2005), I measure a firm's debt maturity as the percentage of long-term debt in total debt. The high proportion of long-term debt to total debt decreases a

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[11] We exclude firms classified in the following industries: banks, financial services, life insurance, non-life insurance, and unclassified industries, according to the industry classification of Thomson Reuters Datastream.

firm's rollover risk. We include several firm-level control variables to control for firm-specific characteristics that may affect firm performance volatility. Firm size (SIZE) is computed as the natural logarithm of real total assets in million US dollars.[12] Since larger firms are more likely to have better resources and capability to take on riskier investment than smaller firms, we include firm size to control for this effect. Highly leveraged firms are more likely to investment in riskier projects. We use the ratio of total debt to total assets to control for financial leverage (LEV). To control for liquidity, we use the current asset ratio (CACL), which is measured as the ratio of current assets to current liabilities. To control for firms' growth opportunities, we use the market-to-book ratio (MBV), which is computed as the ratio of the market value of equity to the book value of equity. Firms with high profitability are under less pressure to improve their profitability and consequently are not under pressure to invest in riskier projects. To control for the profitability effect, we use return on assets (ROA), which is computed as earnings before interest and taxes scaled by total assets (in %). To control for firms' long-term investments, we use the capital investment rate, which is computed as the ratio of capital expenditures to one-year lagged total assets.

We include a number of industry-level and country-level control variables to account for industry and macroeconomic effects. Industry stock returns, which are computed as the first difference in the natural logarithm of the industry stock price index associated with a firm (i.e., the level 2 of the Datastream Global industry price index), are used as an industry-level variable to control for the industry effects (in our robustness check section, we also include industry-year interactions to control for the time-varying industry effects).

We use the GDP growth rate, banking sector development, and export intensity to control for macroeconomic effects. The GDP growth rate (ΔGDP) is the annual growth rate of GDP. Export intensity (LNEXPORT) is measured as the natural logarithm of the share of

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[12] We deflate the book value of total assets in USD by US CPI (CPI = 100 in 2010).

export to GDP while banking sector development (LNBSD) is measured as the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP.

3.3   Descriptive statistics

We report key summary statistics for all firm-level variables for the final sample of 95,240 firm-year observations in Table 1. The mean value of SDROA is 4.83, while the mean value of SDTBQ is 0.26. The mean value of DEBTMAT is 53.07, which is smaller than those reported by prior studies such as Datta et al. (2005) who find that the mean value of DEBTMAT for a sample of 6,246 firm-year observations of U.S. firms from 1992 to 1999 is 78.54. The mean value of LEV is 25.59%, which is roughly in line with prior studies. For example, Khurana and Wang (2015) report that the mean leverage for a sample of U.S. firms during the period 1985-2007 is 25.7%.

[INSERT TABLE 1 ABOUT HERE]

[INSERT TABLE 2 ABOUT HERE]

[INSERT FIGURE 1 ABOUT HERE]

Figure 1 illustrates graphically the time-series pattern of the cross-sectional average value of debt maturity (DEBTMAT), firm operating performance volatility (SDROA), and firm value volatility (SDTBQ) for firms in the final sample (N = 95,240) over the period 1993-2013. As can be seen, there is a decreasing trend of debt maturity from 1993 to 2008. That is, the average value for DEBTMAT falls about 21.78% from 63% in 1993 to 49% in 2008. Over the same time period, the average value for SDROA increases by about 69% from 3.07 in 1993 to 5.21 in 2008. In addition, the mean value for SDTBQ increases by about 38%

from 0.25 in 1993 to 0.34 in 2008. The mean values for SDROA and SDTBQ fall slightly after the onset of the global financial crisis of 2008.

We report summary statistics for small firm and large firm subsamples in Panels A and B of Table 2, respectively. We define a larger firm based on the book value of real total assets using the cross-sectional median of the book value of real total assets in a country. We find that the mean value of firm operating performance volatility (SDROA) is higher for smaller firms than for larger firm (i.e., 6.97 vs. 3.51). This difference is statistically significant at the 1% level based on *t*-test and Welch *F*-test. In addition, the difference in the mean value of firm value volatility (SDTBQ) between smaller firms and larger firms (0.35 vs. 0.21) is statistically significant. While smaller firms have higher risk than larger firms, they have lower profitability than larger firms. That is, the mean value of ROA differs significantly between smaller firms and larger firms (0.98% vs. 6.46%). Interestingly, the difference in the mean value of GPM for smaller firms and larger firms (26.32 vs. 26.91) is statistically significant at the 1% level.

The mean value of DEBTMAT is lower for the smaller firm than for the larger firm (44.34 vs. 58.42). The difference in the mean value of debt maturity for the two groups of firms is statistically significant based on *t*-test and Welch *F*-test at the 1% level. This finding indicates that the smaller firm on average has higher rollover risk (i.e., refinancing) than the larger firm. Together with the fact that the smaller firms have higher firm performance volatility, the lower mean value of risk for the smaller firms implies that firms with higher rollover risk (e.g., when firms have a smaller fraction of long-term debt to total debt) appear to have higher levels of "ex ante" corporate risk-taking. These results suggest that variation in risk (SDROA and SDTBQ) is probably driven by debt maturity. Overall, our analysis, however, does not account for potential changes in firm characteristics over time. We address this issue in Section 4 where we estimate a series of panel regressions.

Table 3 presents pair-wise correlation coefficients for the firm-level variables. As hypothesized, the correlation between SDROA and DEBTMAT is negative and highly significant (p-value < 0.01). However, the correlation between SDTBQ and DEBTMAT is positive and highly significant (p-value < 0.01). Correlation coefficients for all explanatory variables are generally below 0.30; therefore, multicollinearity is not of great concern in this study.[13] Since LNTA are LNCAP are highly correlated, we use LNTA to proxy for firm size.

4 Empirical results

4.1 Multivariate evidence on the effect of debt maturity on future firm performance volatility

To test our prediction that debt maturity positively correlates with future firm performance volatility, we estimating a series of the panel OLS regressions as follows.

$$PERFVOL_{i,j,t} = b_0 + b_1 DEBTMAT_{i,j,t-3} + \delta \mathbf{F}_{i,j,t-3} + \gamma \mathbf{C}_{j,t} + u_i + v_t + \varepsilon_{i,j,t}, \tag{11}$$

where $PERFVOL_{i,j,t}$ denotes the firm performance volatility indicator of firm i in country j at time t, which is measured as SDROA, which is the three-year rolling standard deviation of

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[13] Low correlations among the independent variables mean that the efficiency of the OLS estimation of the fixed-effects model is less likely to be affected by the correlations between the independent variables.

ROA. This measure is also known as corporate risk-taking. As a robustness check, we also use SDTBQ, which is the three-year rolling standard deviation of Tobin's Q, to measure firm value volatility. DEBTMAT$_{i,j,t-3}$ denotes debt maturity of firm i in country j at time t-3. $\mathbf{F}_{i,j,t-3}$ is a vector of firm-level control variables at time t-3; $\mathbf{C}_{j,t-1}$ is a vector of industry- and country-level control variables at time t; u_i is the firm-fixed effects; and v_t is the period-fixed effects. All firm-level explanatory variables are three-period lagged so as to control for endogeneity concerns and to establish causality running from debt maturity to future firm performance volatility. While our approach is similar in spirit to that of Faccio et al. (2011) and Bruno and Shin (2014), a key difference between ours and theirs is that their measure of firm performance volatility at time t (i.e., from time t to t+4) and explanatory variables at time t are slightly overlapped, while our measures do not (i.e., firm performance volatility at time t is estimated based on, e.g., ROA from time t-2 to t while the explanatory variables are at time t-3). Therefore, our estimation approach examines the impact of debt maturity on future firm performance volatility.

To control for unobserved firm-specific time invariant effects and unobserved time variant effects, we add firm-fixed effects and year-fixed effects in all panel OLS regressions. We cluster standard errors, which are robust to heteroskedasticity and serial correlation, at the firm level. Country-fixed effects (as well as industry-fixed effects) are included in some models to test the robustness of our results.

[INSERT TABLE 4 ABOUT HERE]

Table 4 reports the estimates of panel OLS regressions with SDROA as the dependent variable. In column (1), we include our main variable of interest, DEBTMAT, a set of firm-level control variables, firm fixed effects and period fixed effects. As mentioned earlier, to

establish the causal effect running from debt maturity to future firm performance volatility, we lag all right-hand firm-level variables three periods (i.e. at time *t*-3).

The coefficient on DEBTMAT is negative and statistically significant at the 1% level, providing empirical support to hypothesis 1. The results show that capital investment (CAPEXTA), firm size (LNTA), the current ratio (CACL), the fixed assets ratio (FATA), leverage (LEV), and growth opportunities (MBV) have a positive effect on future firm operating performance volatility. These results suggest that firms with larger capital investment, larger assets, high liquidity, larger fixed assets, high financial leverage, or larger growth options tend to have higher corporate risk-taking and subsequently have higher operating performance volatility in following years.

Consistent with prior studies such as Faccio et al. (2011) and Bruno and Shin (2014), we find that leverage is associated with future firm performance volatility. In contrary to Faccio et al. (2011), we document that ROA has a negative effect on future firm performance volatility. That is, firms with higher profitability tend to have lower future firm performance volatility. This finding implies that firms that are not under pressure to improve their profitability tend to have lower levels of corporate risk-taking with respect to investment decisions and consequently have lower future operating performance volatility.

In column (2), we add industry- and country-level variables to control for industry and macroeconomic effects and find that the coefficient on DEBTMAT is still negative and statistically significant at the 1% level. We do not lag the industry- and country-level variables because we want to control for the contemporaneous relation between industry- and macroeconomic factors and firm performance volatility. Inconsistent with Bruno and Shin (2014), we find that the GDP growth rate is negatively associated with firm performance volatility. The negative and significant coefficient on INDRETURN suggests that industry-level investment opportunities (proxied by the industry stock return) negatively correlate with

firm performance volatility. The coefficient on LNBSD, which is the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP, is negative and statistically significant, indicating that firm performance volatility is negatively correlated with the level of banking sector development. The coefficient on LNEXPORT is positive and statistically significant, implying that when a country performs well in terms of export performance, firms are more likely to take on riskier investment projects that result in higher degrees of firm performance volatility.

In column (3), we replace the firm fixed effects with a set of country dummies to control for unobserved time-invariant country effects. We still find the negative and significant effect of DEBTMAT. In column (4) we replace countries dummies with the firm fixed effects and the interaction between country dummies and YEAR, which is a time trend variable. The coefficient on DEBTMAT remains negative and statistically significant at the 1% level in both columns (3) and (4). The magnitude of the estimated coefficients on DEBTMAT is almost identical across four models, implying the stability of the estimations. Overall, the results in Table 4 suggest that debt maturity can significantly explain variation in future firm performance volatility.

[INSERT TABLE 5 ABOUT HERE]

To test the robustness of our result, we replace SDROA with SDTBQ as the firm performance volatility. Table 5 reports the estimates of panel OLS regressions with SDTBQ as the dependent variable. We find that the coefficient on DEBTMAT is positive but statistically insignificant in all models. As Tobin's Q measures firm value, our results in Table 5 provide no evidence for the effect of debt maturity on the volatility of future firm value, measured as the standard deviation of Tobin's Q. The results, however, suggest that

capital investment (CAPEXTA), leverage (LEV), growth opportunities (MBV), and gross profit margin (GPM) have a positive effect on future firm performance volatility. In addition, firm size (LNTA), the current ratio (CACL), and the fixed assets ratio (FATA) have a negative effect on future firm performance volatility when measured as the standard deviation of Tobin's Q.

4.2   Conditions under which debt maturity affects future firm performance volatility

To test hypotheses 2, 3a, 3b, and 4, we separately add three interaction terms in specifications.[14] In columns (1) and (4) of Table 6, we interact DEBTMAT with DEBTMAT (i.e., the squared term of DEBTMAT). The coefficient on the squared term of DEBTMAT in column (1) is significant, only at the 10% level providing weak evidence for the non-linear effect of debt maturity on firm performance volatility. In addition, the coefficient on the squared term of DEBTMAT in column (4) is positive and statistically insignificant. Our results do not suggest that the relationship between debt maturity and future firm performance volatility is non-linear, providing no empirical support to Hypothesis 2.

[INSERT TABLE 6 ABOUT HERE]

[INSERT TABLE 7 ABOUT HERE]

In columns (2) and (5) of Table 6, we interact DEBTMAT with firm size (LNTA). The estimated coefficient on DEBTMAT in column (2) is negative and statistically significant,

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[14] Since the basic findings are robust to controlling for country-fixed effects, industry-fixed effects, time-varying country effects, and time-varying industry effects, we report only specifications with firm fixed effects and year-fixed effects to conserve space.

while the estimated coefficient on the interaction term between DEBTMAT and LNTA in column (2) is positive and statistically significant.[15] These results indicate that the negative effect of debt maturity on future firm performance volatility is weaker for larger firms. The coefficient on DEBTMAT in column (5) is statistically insignificant. These results do not provide empirical support to hypothesis 3a and 3b.

In columns (3) and (6), we interact DEBTMAT with MBV. The coefficient on the interaction term in column (3) is significant, suggesting that growth opportunities moderate the impact of debt maturity on firm performance volatility. However, the coefficient on the interaction term in column (6) is positive and statistically significant, indicating that the positive effect of debt maturity on firm value volatility is stronger for firms with better growth opportunities. These findings provide some empirical support to hypothesis 4 predicting that the relationship between debt maturity and future firm performance volatility is more pronounced for firms with high growth opportunities than for firms with low growth opportunities.

4.3   The effect of debt maturity on future firm performance volatility for developing and developed countries

To test whether the effect of debt maturity on future firm performance volatility differs between firms in developed and firms in developing countries, we interact the DEBTMAT with a developed country (DEV) variable, which takes a value of one for firms listed in a

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[15] The results are very similar if we interact DEBTMAT with a large firm size (SIZEDUM) dummy variable, which takes a value of one for firm-year observations for which the book value of total assets is larger than the country-year median value of the book value of total assets, and zero otherwise.

developed country and zero otherwise. Table 7 reports the estimates of panel OLS regressions with SDROA and SDTBQ as the dependent variables, in columns (1) and (2), respectively.

The coefficient on the interaction term between DEBTMAT and DEV is statistically significant at the 10% level in column (1) and is not statistically significant in column (2). These results imply that the effect of debt maturity on future firm performance volatility does not differ between firms in developing countries and firms in developed countries.

We also estimate Equation (1) separately for both the developing country sample and the developed country sample. In untabulated results, we find that the magnitude and statistical significance of the coefficient on DEBTMAT is almost similar for the developing country sample and the developed country sample. Thus far, we find no evidence to suggest that the negative impact of debt maturity on future firm operating performance volatility differs across firms in developing countries and firms in developed countries.

[INSERT TABLE 7 ABOUT HERE]

4.4   The effect of debt maturity on future firm performance volatility for sub-periods

We now test whether the effect of debt maturity on future firm performance volatility varies over time. To this end, we divide our sample period into three periods: (1) the pre-IT bubble burst period (i.e., 1991-2000), the pre-global financial crisis period (i.e., 2001-2006), and the global financial crisis period (i.e., 2007-2013). We estimate our main specification for each period separately.

Table 8 reports the estimates of panel OLS regressions with future operating performance volatility (SDROA) in columns (1), (2), and (3) and future firm value volatility (SDTBQ) in columns (4), (5), and (6) as the dependent variables. The results show that the

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effect of debt maturity on future firm performance volatility is insignificant during the pre-20001 period and is negative during both the period 2001-2006 and the period 2007-2013. Consistent with the results in Table 5, we find the effect of debt maturity on future firm value volatility is insignificant in all three periods.

The results in Table 8 also show that the first two subperiods, firms have lower levels of future operating performance volatility when a country's GDP growth rate is higher and the level of banking sector development is higher. During the 2007-2013 period, however, both banking sector development and the GDP growth rate have a positive effect on future operating performance. Hence, there are time-varying effects of debt maturity on future firm operating performance.

[INSERT TABLE 8 ABOUT HERE]

4.5   Robustness checks

If debt maturity and corporate risk-taking are jointly determined, then OLS estimation can lead to a biased coefficient on DEBTMAT. To address this concern, I follow the literature by employing a two-stage least squares (2SLS) estimation. In the first stage, I estimate an OLS regression for debt maturity. In the second stage, I estimate an OLS regression for future firm performance volatility by using the predicted value of DEBTMAT from the first-stage regression as an explanatory variable. For the first-stage regression, I estimate the following panel OLS model:

$$DEBTMAT_{i,j,t} = c_0 + c_0 MEANDEBTMAT_{j,t-1} + \delta \mathbf{F}_{i,j,t-1} + \gamma \mathbf{C}_{j,t-1} + u_i + v_t + \varepsilon_{i,j,t}, \qquad (12)$$

where MEANDEBTMAT is the country-year mean value of debt maturity, and all variables are defined as before. All explanatory variables are one-period lagged. Firm-fixed effects and year-fixed effects are included in the model. We then use the predicted value of debt maturity obtained from Equation (12) as a measure of debt maturity in the second-stage regression as follows:

$$PERFVOL_{i,j,t} = d_0 + d_1 PREDEBTMAT_{i,j,t-3} + \delta \mathbf{F}_{i,j,t-3} + \gamma \mathbf{C}_{j,t} + u_i + v_t + \varepsilon_{i,j,t}, \tag{13}$$

where PDEBTMAT is the predicted value of debt maturity obtained from Equation (12). We include firm-fixed effects and year-fixed effects in the second-stage regressions.

Table 9 reports the second-stage results of our two-stage least squares estimation (i.e. of Equations (12) and (13)). In columns (1)-(4), firm operating performance volatility is the dependent variable. The results in columns (1)-(4) are very similar to those reported in Tables 4 and 6. The effect of debt maturity on firm operating performance volatility remains negative and statistically significant. However, we no longer find that MBV moderates the effect of debt maturity on future operating performance volatility. In columns (5)-(8), firm value volatility is the dependent variable. We still find that the effect of debt maturity on future firm value volatility is not statistically significant. Overall, the results of 2SLS regressions further indicate that debt maturity has a negative effect on future operating performance volatility.

[INSERT TABLE 9 ABOUT HERE]

Thus far, we show that our results are insensitive to the inclusion of firm-fixed effects, year-fixed effects, country-fixed effects, and/or country-year interactions (see Tables 4 and

5). In our main analysis, we use the industry stock return to control for the industry effect. We now additionally test whether industry effects drive our results by adding (1) industry dummies[16] $\times$ YEAR, which capture the annual variation in the average future firm performance volatility by industry, regardless of where firms are located, and (2) country dummies $\times$ YEAR, which capture the differential effect of business/economic cycles by country, in the same specification as those in Tables 4-8. To conserve space, we do not tabulate results. We find that our main results are largely unaltered when we include industry-year interactions and country-year interactions in the specification.

5 Conclusion

Corporate debt structure maturity has been the subject of interest in corporate finance. One issue that has received significant attention in the aftermath of financial crises (e.g., the Asian financial crisis of 1997 and the global financial crisis of 2007) is that there is a substantial mismatch between asset maturity and debt maturity. More importantly, firms tend to finance long-term assets with shorter debt maturity. In this paper, we address the question of whether debt maturity can explain variation in future firm performance volatility.

We build a simple two-period model to analyze the effect of debt maturity on the riskiness of corporate investment. In doing so, we make a number of simplifying assumptions. Relaxing many assumptions does not alter the basic insights derived from the model. Our model suggests that the investment threshold (i.e., the investment's probability of success) is lower when the proportion of short-term debt in total debt increases, implying that

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[16] For ease of comparison, we classify each firm into a specific industry using a Level 2 classification (i.e., the business sector) of the Thomson Reuters Business Classification (TRBC) system, consisting of 28 business sectors.

corporate risk-taking (i.e., the riskiness of investment) is a decreasing function of debt maturity. We then argue that debt maturity correlates with future firm performance volatility and test our prediction empirically using a sample of firms in 10 countries over the period 1991–2013. To measure future firm performance volatility, we use (1) firm operating performance volatility and (2) firm value volatility. To measure the effect of debt maturity on future firm performance volatility, we employ the panel OLS regressions and test the robustness of our results by using the 2SLS regressions.

Our empirical results show that after controlling for a large set of firm characteristics, industry conditions, and country-level variables, debt maturity has a negative effect on future firm operating performance volatility but has no effect on future firm value volatility. The negative impact of debt maturity on future firm operating performance volatility is smaller for larger firms, compared with smaller firms. We find empirical evidence for the moderating effect of investment opportunities on the relationship between debt maturity and future firm operating performance as well as future firm value volatility.

Two macro-economic factors – the degree of banking sector development and the level of export intensity – play an important role in determining firm operating performance volatility. Firm operating performance volatility is negatively associated with the degree of banking sector development and is positively associated with the degree of export intensity. The findings suggest that as a country's banking sector further develops, firms on average reduce their risk-taking and that as a country's export performance improves, firms on average increase their risk-taking.

The results of our paper provide new evidence that debt maturity and "unobservable" ex ante corporate risk-taking are more likely to be highly correlated, given that debt maturity is negatively associated with future firm performance. These findings can have implications for both firms and corporate debt holders. For instance, our findings, by quantifying the

relationship between debt maturity and future firm performance volatility, are relevant for banks' loan officers considering loan applications as well as for central bankers.

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Table 1: Descriptive statistics for firm-level variables.

This table provides descriptive statistics for firm-level variables for the final sample during 1993-2013. We deflate the nominal value of the time series by US CPI (US CPI = 100 in 2010). All variables are winsorized at the 1st and 99th percentiles. $N = 95,240$

Variable	Definition	Description	Mean	Median	S.D.
SDROA	Firm operating performance volatility	The three-year moving standard deviation of ROA	4.83	2.51	7.18
SDTBQ	Firm value volatility	The three-year moving standard deviation of Tobin's Q	0.26	0.12	0.45
DEBTMAT	Debt maturity	Long-term debt as a percentage of total debt	53.07	55.63	33.50
CAPEXTA	Investment ratio	The ratio of capital expenditure to one-year lagged total assets (in %)	5.33	3.48	6.13
RTA	Real total assets	Total assets in million US dollars deflated by US CPI (US CPI = 100 in 2010).	3,803.55	387.82	18,036.95
RMKTCAP	Real market capitalization	Total market capitalization in million US dollars deflated by US CPI (US CPI = 100 in 2010).	96,238.14	3,802.61	341,874.19
LNTA	Firm size	The natural logarithm of real total assets in million US dollars	12.93	12.78	1.96
LNCAP	Firm market value	The natural logarithm of real market capitalization in million US dollars	8.05	8.17	3.00
CACL	Current ratio	The ratio of current assets to current liabilities	1.89	1.48	1.56
FATA	Fixed asset ratio	The ratio of non-current assets to total assets	0.51	0.50	0.21
LEV	Leverage	Total debt as a percentage of total assets	25.59	23.30	18.62
MBV	Market-to-book ratio	The ratio of the market value of equity to the book value of equity	1.79	1.18	2.39
ROA	Return on assets	Earning before interest and taxes (EBIT) as a percentage of total assets	4.38	5.52	13.34
TBQ	Tobin's Q	The sum of the market value of equity and the book value of total debt scaled by the book value of total assets	1.11	0.82	1.03
GPM	Gross profit margin	Gross profit as a percentage of sales	26.68	23.57	19.19

Table 2: Descriptive statistics for firm-level variables.
Panels A and B of this table provide descriptive statistics for firm-level variables for a small firm sample and a large firm sample, respectively, during 1993-2013. A firm size (SIZEDUM) dummy variable takes a value of one for observations for which the book value of real total assets is larger than the cross-sectional median of the book value of real total assets in a country, and zero otherwise. SDROA is measured as the three-year moving standard deviation of return on assets (ROA), which is measured as the ratio of EBIT to total assets (in %). SDTBQ is computed as the three-year moving standard deviation of Tobin's Q (TBQ), which is computed as the sum of the market value of equity and the book value of total debt scaled by the book value of total assets. Debt maturity (DEBTMAT) is measured as long-term debt as a percentage of total debt. Investment ratio (CAPEXTA) is measured as the percentage of capital expenditure to one-year lagged total assets. RTA denotes real total assets in million US dollars. Leverage (LEV) is computed as the percentage share of total debt to total assets. Current ratio (CACL) is the ratio of current assets to current liabilities. Fixed asset ratio (FATA) is computed as the ratio of non-current assets to total assets. The market-to-book ratio (MBV) is computed as the ratio of the market value of equity to the book value of equity. Gross profit margin (GPM) is the ratio of gross profit to sales (in %). We deflate the nominal value of the time series by US CPI (US CPI = 100 in 2010).

	Mean	Median	S.D.	N
Panel A: Small firms				
SDROA	6.97	3.60	9.45	36,225
SDTBQ	0.35	0.15	0.59	36,225
DEBTMAT	44.34	43.15	33.87	36,225
CAPEXTA	4.76	2.63	6.34	36,225
RTA	127.38	82.10	129.70	36,225
LNTA	11.18	11.25	1.10	36,225
CACL	2.18	1.64	1.92	36,225
FATA	0.46	0.45	0.20	36,225
LEV	23.20	19.32	19.09	36,225
MBV	1.71	1.01	2.62	36,225
ROA	0.98	4.21	18.12	36,225
TBQ	1.18	0.79	1.27	36,225
GPM	26.32	23.47	21.44	36,225
Panel B: Large firms				
SDROA	3.51	2.06	4.88	59,015
SDTBQ	0.21	0.12	0.34	59,015
DEBTMAT	58.42	62.82	32.12	59,015
CAPEXTA	5.68	3.98	5.98	59,015
RTA	6,060.08	1,083.08	22,619.34	59,015
LNTA	14.01	13.79	1.56	59,015
CACL	1.72	1.40	1.26	59,015
FATA	0.54	0.53	0.21	59,015
LEV	27.07	25.46	18.17	59,015
MBV	1.83	1.28	2.23	59,015
ROA	6.46	6.15	8.62	59,015
TBQ	1.06	0.83	0.85	59,015
GPM	26.91	23.63	17.66	59,015

Table 3: Correlation coefficient matrix of key firm-level variables.
This table presents correlation coefficients for key firm-level variables for the final sample, totaling 95,240 firm-year observations. SDROA is measured as the three-year moving standard deviation of return on assets (ROA), which is measured as the ratio of EBIT to total assets (in %). SDTBQ is computed as the three-year moving standard deviation of Tobin's Q (TBQ), which is computed as the sum of the market value of equity and the book value of total debt scaled by the book value of total assets. Debt maturity (DEBTMAT) is measured as the ratio of long-term debt to total debt (in %). Investment ratio (CAPEXTA) is measured as the ratio of capital expenditure to one-year lagged total assets (in %). Firm size (LNTA) is measured as the natural logarithm of real total assets in million US dollars. Current ratio (CACL) is the ratio of current assets to current liabilities. The fixed asset ratio (FATA) is computed as the ratio of non-current assets to total assets. Leverage (LEV) is computed as the ratio of total debt to total assets (in %). The market-to-book ratio (MBV) is computed as the ratio of the market value of equity to the book value of equity. Gross profit margin (GPM) is the ratio of gross profit to sales (in %). All variables are winsorized at the 1st and 99th percentiles. Symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. SDROA	1.00												
2. SDTBQ	0.32***	1.00											
3. DEBTMAT	-0.02***	0.05***	1.00										
4. CAPEXTA	-0.02***	0.12***	0.17***	1.00									
5. LNTA	-0.28***	-0.16***	0.35***	0.08***	1.00								
6. LNCAP	-0.24***	-0.12***	-0.08***	0.02***	0.55***	1.00							
7. CACL	0.07***	0.19***	0.10***	-0.09***	-0.14***	-0.10***	1.00						
8. FATA	-0.08***	-0.09***	0.31***	0.30***	0.26***	0.07***	-0.34***	1.00					
9. LEV	0.07***	-0.09***	0.18***	0.07***	0.12***	0.04***	-0.35***	0.30***	1.00				
10. MBV	0.09***	0.34***	0.12***	0.10***	0.08***	0.00	0.02***	-0.01***	0.00	1.00			
11. ROA	-0.44***	-0.16***	0.09***	0.13***	0.25***	0.19***	0.02***	0.04***	-0.15***	0.04***	1.00		
12. TBQ	0.18***	0.60***	0.14***	0.14***	-0.04***	-0.04***	0.15***	-0.05***	-0.01**	0.50***	0.00	1.00	
13. GPM	-0.01***	0.16***	0.18***	0.05***	0.09***	-0.03***	0.11***	0.09***	-0.09***	0.17***	0.26***	0.29***	1.00

Table 4: The effect of debt maturity on future firm operating performance volatility.
This table presents the results of panel OLS regressions of future firm operating performance volatility on debt maturity for a sample of non-financial firms. We measure firm operating performance volatility (SDROA) using the three-year moving standard deviation of ROA. All firm-level explanatory variables are three-period lagged. ΔGDP denotes the GDP growth rate (in %); LNBSD is the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP. LNEXPORT is the natural logarithm of the percentage share of export to GDP; INDRETURN denotes the industry-level stock return (in %), measured as the first difference in the natural logarithm of the industry price index. YEAR is a time trend variable. All other variables are defined as in Table 1. Standard errors, which are robust to heteroskedasticity and serial correlation, are clustered at the firm level. We report standard errors in parentheses. Symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Intercept	-0.694*	5.295***	6.374***	142.054***
	(0.385)	(1.269)	(1.751)	(53.871)
DEBTMAT$_{t-3}$	-0.008***	-0.008***	-0.006***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
CAPEXTA$_{t-3}$	0.012***	0.010**	0.044***	0.008*
	(0.004)	(0.004)	(0.005)	(0.004)
LNTA$_{t-3}$	0.902***	1.028***	-0.530***	1.087***
	(0.060)	(0.061)	(0.021)	(0.063)
CACL$_{t-3}$	0.116***	0.112***	0.230***	0.098***
	(0.028)	(0.028)	(0.025)	(0.028)
FATA$_{t-3}$	0.649**	0.494	-1.141***	0.380
	(0.306)	(0.305)	(0.195)	(0.306)
LEV$_{t-3}$	0.008***	0.007***	0.017***	0.008***
	(0.003)	(0.002)	(0.002)	(0.003)
MBV$_{t-3}$	-0.004	0.005	0.166***	0.007
	(0.011)	(0.011)	(0.012)	(0.011)
ROA$_{t-3}$	-0.025***	-0.026***	-0.156***	-0.026***
	(0.002)	(0.002)	(0.002)	(0.002)
GPM$_{t-3}$	-0.021***	-0.021***	0.013***	-0.021***
	(0.003)	(0.003)	(0.002)	(0.003)
INDRETURN$_{t}$		-0.003***	-0.003***	-0.003***
		(0.001)	(0.001)	(0.001)
LNBSD$_{t}$		-1.934***	-0.695***	-0.667***
		(0.180)	(0.194)	(0.248)
LNEXPORT$_{t}$		0.744***	0.910***	1.709***
		(0.250)	(0.272)	(0.362)
ΔGDP$_{t}$		-0.066***	-0.110***	-0.061***
		(0.014)	(0.016)	(0.014)
Firm fixed effects	Yes	Yes	No	Yes
Period fixed effects	Yes	Yes	Yes	Yes
Country dummies	No	No	Yes	No
Country dummies $\times$ YEAR	No	No	No	Yes
Adjusted R^2	0.462	0.464	0.184	0.466
F-statistic	9.089***	9.154***	446.426***	9.196***
Firms included	8,593	8,593	8,593	8,593
Observations	81,120	81,120	81,120	81,120

Table 5: The effect of debt maturity on future firm value volatility.
This table presents the results of panel OLS regressions of future firm value volatility on debt maturity for a sample of non-financial firms. We measure firm value volatility (SDTBQ) using the three-year moving standard deviation of Tobin's Q. All firm-level explanatory variables are three-period lagged. INDRETURN denotes the industry-level stock return (in %), measured as the first difference in the natural logarithm of the industry price index. ΔGDP denotes the GDP growth rate (in %); LNBSD is the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP. LNEXPORT is the natural logarithm of the percentage share of export to GDP. YEAR is a time trend variable. All other variables are defined as in Table 1. Standard errors, which are robust to heteroskedasticity and serial correlation, are clustered at the firm level. We report standard errors in parentheses. Symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Intercept	1.098***	0.681***	-0.241**	-20.496***
	(0.022)	(0.073)	(0.109)	(3.092)
DEBTMAT$_{t-3}$	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
CAPEXTA$_{t-3}$	0.002***	0.002***	0.005***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
LNTA$_{t-3}$	-0.119***	-0.122***	-0.030***	-0.123***
	(0.003)	(0.004)	(0.001)	(0.004)
CACL$_{t-3}$	-0.011***	-0.010***	0.019***	-0.010***
	(0.002)	(0.002)	(0.001)	(0.002)
FATA$_{t-3}$	-0.227***	-0.227***	-0.163***	-0.217***
	(0.017)	(0.017)	(0.012)	(0.017)
LEV$_{t-3}$	0.000***	0.000***	-0.001***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
MBV$_{t-3}$	0.009***	0.008***	0.038***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
ROA$_{t-3}$	0.000*	0.000	-0.006***	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
GPM$_{t-3}$	0.000***	0.000***	0.003***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
INDRETURN$_t$		0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)
LNBSD$_t$		0.063***	0.040***	0.030**
		(0.011)	(0.012)	(0.014)
LNEXPORT$_t$		0.050***	0.072***	-0.026
		(0.015)	(0.017)	(0.020)
ΔGDP$_t$		0.001	0.005***	0.000
		(0.001)	(0.001)	(0.001)
Firm fixed effects	Yes	Yes	No	No
Period fixed effects	Yes	Yes	Yes	Yes
Country dummies	No	No	Yes	No
Country dummies $\times$ YEAR	No	No	No	Yes
Adjusted R^2	0.500	0.501	0.219	0.502
F-statistic	10.424***	10.438***	554.626***	10.462***
Firms included	8,593	8,593	8,593	8,593
Observations	81,120	81,120	81,120	81,120

Table 6: The effect of debt maturity on future firm operating performance volatility and future firm value volatility.
This table presents the results of panel OLS regressions of future firm performance volatility on debt maturity for a sample of non-financial firms. We measure firm performance volatility using two measures: (1) firm operating performance volatility, measured as the three-year moving standard deviation of ROA (in columns (1)-(3)) and (2) firm value volatility, measured as the three-year rolling standard deviation of Tobin's Q (in columns (4)-(6)). All firm-level explanatory variables are three-period lagged. INDRETURN denotes the industry-level stock return (in %), measured as the first difference in the natural logarithm of the industry price index. ΔGDP denotes the GDP growth rate (in %); LNBSD is the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP. LNEXPORT is the natural logarithm of the percentage share of export to GDP. All other variables are defined as in Table 1. Standard errors, which are robust to heteroskedasticity and serial correlation, are clustered at the firm level. We report standard errors in parentheses. Symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) |
	SDROA	SDROA	SDROA	SDTBQ	SDTBQ	SDTBQ
Intercept	5.263***	5.975***	5.403***	0.676***	0.691***	0.673***
	(1.273)	(1.286)	(1.269)	(0.073)	(0.074)	(0.073)
DEBTMAT$_{t-3}$	-0.007*	-0.018***	-0.010***	0.000	0.000	0.000**
	(0.003)	(0.004)	(0.001)	(0.000)	(0.000)	(0.000)
Squared DEBTMAT$_{t-3}$	0.000			0.000		
	(0.000)			(0.000)		
DEBTMAT$_{t-3}$ × LNTA$_{t-3}$		0.002***			0.000	
		(0.001)			(0.000)	
DEBTMAT$_{t-3}$ × MBV$_{t-3}$			0.001***			0.000***
			(0.000)			(0.000)
CAPEXTA$_{t-3}$	0.010**	0.010**	0.010**	0.002***	0.002***	0.002***
	(0.004)	(0.004)	(0.004)	(0.000)	(0.000)	(0.000)
LNTA$_{t-3}$	1.027***	0.912***	1.028***	-0.122***	-0.124***	-0.122***
	(0.061)	(0.070)	(0.061)	(0.004)	(0.004)	(0.004)
CACL$_{t-3}$	0.113***	0.114***	0.110***	-0.010***	-0.010***	-0.010***
	(0.028)	(0.028)	(0.028)	(0.002)	(0.002)	(0.002)
FATA$_{t-3}$	0.498	0.486	0.479	-0.226***	-0.227***	-0.225***
	(0.305)	(0.305)	(0.305)	(0.017)	(0.017)	(0.017)

LEV$_{t-3}$	0.007***	0.007***	0.007***	0.000***	0.000***	0.000***
	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)
MBV$_{t-3}$	0.005	0.005	-0.060***	0.008***	0.008***	0.013***
	(0.011)	(0.011)	(0.020)	(0.001)	(0.001)	(0.001)
ROA$_{t-3}$	-0.026***	-0.026***	-0.026***	0.000*	0.000	0.000*
	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)
GPM$_{t-3}$	-0.021***	-0.021***	-0.021***	0.000***	0.000***	0.000***
	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)
INDRETURN$_t$	-0.003***	-0.003***	-0.003***	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
LNBSD$_t$	-1.932***	-1.949***	-1.925***	0.063***	0.062***	0.062***
	(0.180)	(0.180)	(0.180)	(0.011)	(0.011)	(0.011)
LNEXPORT$_t$	0.746***	0.749***	0.741***	0.050***	0.050***	0.050***
	(0.250)	(0.250)	(0.250)	(0.015)	(0.015)	(0.015)
ΔGDP$_t$	-0.066***	-0.066***	-0.066***	0.001	0.001	0.001
	(0.014)	(0.014)	(0.014)	(0.001)	(0.001)	(0.001)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.464	0.464	0.464	0.501	0.501	0.501
F-statistic	9.153***	9.157***	9.158***	10.437***	10.437***	10.444***
Firms included	8,593	8,593	8,593	8,593	8,593	8,593
Observations	81,120	81,120	81,120	81,120	81,120	81,120

Table 7: The effect of debt maturity on future firm performance volatility.
This table presents the results of panel OLS regressions of future firm performance volatility on debt maturity for a sample of non-financial firms. We measure firm performance volatility using two measures: (1) firm operating performance volatility, measured as the three-year moving standard deviation of ROA (in columns (1)) and (2) firm value volatility, measured as the three-year rolling standard deviation of Tobin's Q (in columns (2)). A developed country (DEV) variable takes a value of one for firms listed in a developed country and zero otherwise. All firm-level explanatory variables are three-period lagged. INDRETURN denotes the industry-level stock return (in %), measured as the first difference in the natural logarithm of the industry price index. ΔGDP denotes the GDP growth rate (in %); LNBSD is the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP. LNEXPORT is the natural logarithm of the percentage share of export to GDP. All other variables are defined as in Table 1. Standard errors, which are robust to heteroskedasticity and serial correlation, are clustered at the firm level. We report standard errors in parentheses. Symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1) SDROA	(2) SDTBQ
Intercept	5.335***	0.680***
	(1.269)	(0.073)
DEBTMAT$_{t-3}$	-0.012***	0.000
	(0.003)	(0.000)
DEBTMAT$_{t-3}$ × DEV$_{t-3}$	0.005*	0.000
	(0.003)	(0.000)
CAPEXTA$_{t-3}$	0.010**	0.002***
	(0.004)	(0.000)
LNTA$_{t-3}$	1.026***	-0.122***
	(0.061)	(0.004)
CACL$_{t-3}$	0.114***	-0.010***
	(0.028)	(0.002)
FATA$_{t-3}$	0.507*	-0.227***
	(0.305)	(0.017)
LEV$_{t-3}$	0.007***	0.000***
	(0.002)	(0.000)
MBV$_{t-3}$	0.005	0.008***
	(0.011)	(0.001)
ROA$_{t-3}$	-0.026***	0.000*
	(0.002)	(0.000)
GPM$_{t-3}$	-0.021***	0.000***
	(0.003)	(0.000)
INDRETURN$_{t}$	-0.003***	0.000
	(0.001)	(0.000)
LNBSD$_{t}$	-1.942***	0.063***
	(0.180)	(0.011)
LNEXPORT$_{t}$	0.736***	0.050***
	(0.250)	(0.015)
ΔGDP$_{t}$	-0.066***	0.001
	(0.014)	(0.001)
Firm fixed effects	Yes	Yes
Period fixed effects	Yes	Yes

Adjusted R^2	0.464	0.501
F-statistic	9.154***	10.437***
Firms included	8,593	8,593
Observations	81,120	81,120

Table 8: The effect of debt maturity on future firm performance volatility: Different sample periods.

This table presents the results of panel OLS regressions of future firm performance volatility on debt maturity for a sample of non-financial firms. We measure firm performance volatility using two measures: (1) firm operating performance volatility, measured as the three-year moving standard deviation of ROA (in columns (1)-(3)) and (2) firm value volatility, measured as the three-year rolling standard deviation of Tobin's Q (in columns (4)-(6)). A developed country (DEV) variable takes a value of one for firms listed in a developed country and zero otherwise. All firm-level explanatory variables are three-period lagged. INDRETURN denotes the industry-level stock return (in %), measured as the first difference in the natural logarithm of the industry price index. ΔGDP denotes the GDP growth rate (in %); LNBSD is the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP. LNEXPORT is the natural logarithm of the percentage share of export to GDP. All other variables are defined as in Table 1. Standard errors, which are robust to heteroskedasticity and serial correlation, are clustered at the firm level. We report standard errors in parentheses. Symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	SDROA	SDROA	SDROA	SDTBQ	SDTBQ	SDTBQ
	Pre-2001	2001-2006	2007-2013	Pre-2001	2001-2006	2007-2013
Intercept	-3.894	25.928***	-8.799**	1.242***	1.647***	-0.602***
	(3.936)	(5.630)	(4.156)	(0.306)	(0.353)	(0.200)
DEBTMAT$_{t-3}$	-0.005*	-0.008***	-0.008***	0.000	0.000*	0.000
	(0.003)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)
CAPEXTA$_{t-3}$	0.019**	0.022**	-0.019***	0.001*	0.001	0.000
	(0.009)	(0.009)	(0.006)	(0.001)	(0.001)	(0.000)
LNTA$_{t-3}$	1.253***	2.329***	2.029***	-0.082***	-0.228***	-0.146***
	(0.188)	(0.173)	(0.119)	(0.013)	(0.011)	(0.006)
CACL$_{t-3}$	-0.122	0.052	0.093**	0.003	-0.025***	-0.014***
	(0.078)	(0.058)	(0.040)	(0.006)	(0.004)	(0.002)
FATA$_{t-3}$	-1.906**	2.929***	4.229***	0.036	-0.241***	-0.195***
	(0.902)	(0.673)	(0.474)	(0.064)	(0.044)	(0.024)
LEV$_{t-3}$	0.024***	0.002	-0.017***	-0.001	0.000	0.000
	(0.007)	(0.005)	(0.004)	(0.000)	(0.000)	(0.000)
MBV$_{t-3}$	0.006	0.013	-0.042***	-0.002	0.003*	0.001*
	(0.028)	(0.020)	(0.016)	(0.002)	(0.001)	(0.001)

ROA$_{t-3}$	0.003	0.028***	0.030***	0.000	0.001***	0.000
	(0.008)	(0.004)	(0.003)	(0.001)	(0.000)	(0.000)
GPM$_{t-3}$	-0.004	-0.019***	-0.021***	-0.001**	0.000	-0.001***
	(0.008)	(0.005)	(0.004)	(0.001)	(0.000)	(0.000)
INDRETURN$_t$	-0.002	-0.002	-0.004***	0.000**	0.000***	0.000***
	(0.002)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)
LNBSD$_t$	-2.330***	-8.398***	1.257*	0.134***	-0.013	0.267***
	(0.605)	(0.958)	(0.648)	(0.047)	(0.062)	(0.032)
LNEXPORT$_t$	3.863***	0.296	-1.710***	-0.354***	0.074	0.202***
	(0.795)	(0.777)	(0.547)	(0.056)	(0.050)	(0.027)
ΔGDP$_t$	-0.026	-0.077	0.057***	-0.002	0.005	-0.001
	(0.019)	(0.048)	(0.021)	(0.002)	(0.003)	(0.001)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.621	0.590	0.568	0.568	0.603	0.598
F-statistic	8.130***	7.118***	8.082***	6.724***	7.456***	9.020***
Firms included	2,893	5,655	8,221	2,893	5,655	8,221
Observations	12,656	24,085	44,379	12,656	24,085	44,379

Table 9: Two-stage least squares regressions: The effect of debt maturity on future firm performance volatility.

This table presents the second-stage results of two-stage least squares (2SLS) regressions. In the first-stage regression, debt maturity is the dependent variable and the one-year lagged country-year average debt maturity and a set of lagged firm-level variables, industry stock returns, and country-level variables are the independent variables. The predicted value of debt maturity (PDEBTMAT) from the first-stage regression is used as an explanatory variable in the second-stage regression. Firm operating performance volatility, measured as the three-year moving standard deviation of ROA (in columns (1)-(4)), and (2) firm value volatility, measured as the three-year rolling standard deviation of Tobin's Q (in columns (5)-(8)), are the dependent variable in the second-stage regression. All firm-level explanatory variables in the second-stage regressions are three-period lagged. INDRETURN denotes the industry-level stock return (in %), measured as the first difference in the natural logarithm of the industry price index. ΔGDP denotes the GDP growth rate (in %); LNBSD is the natural logarithm of the percentage share of domestic credit to private sector by banks to GDP. LNEXPORT is the natural logarithm of the percentage share of export to GDP. All other variables are defined as in Table 1. Standard errors, which are robust to heteroskedasticity and serial correlation, are clustered at the firm level. We report standard errors in parentheses. Symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	SDROA	SDROA	SDROA	SDROA	SDTBQ	SDTBQ	SDTBQ	SDTBQ
Intercept	5.290***	4.349***	4.436***	5.363***	0.673***	0.696***	0.686***	0.661***
	(1.425)	(1.490)	(1.559)	(1.426)	(0.081)	(0.084)	(0.088)	(0.081)
PDEBTMAT$_{t-3}$	-0.029***	0.000	-0.015	-0.030***	0.000	-0.001	-0.001	0.000
	(0.007)	(0.015)	(0.012)	(0.007)	(0.000)	(0.001)	(0.001)	(0.000)
Squared PDEBTMAT$_{t-3}$		0.000**				0.000		
		(0.000)				(0.000)		
PDEBTMAT$_{t-3}$ × LNTA$_{t-3}$			-0.002				0.000	
							(0.000)	
PDEBTMAT$_{t-3}$ × MBV$_{t-3}$			(0.002)	0.001				0.000***
				(0.000)				(0.000)
CAPEXTA$_{t-3}$	0.005	0.005	0.004	0.004	0.002***	0.002***	0.002***	0.002***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)
LNTA$_{t-3}$	1.255***	1.268***	1.405***	1.255***	-0.118***	-0.118***	-0.120***	-0.118***
	(0.067)	(0.068)	(0.132)	(0.067)	(0.004)	(0.004)	(0.007)	(0.004)
CACL$_{t-3}$	0.088***	0.091***	0.088***	0.087***	-0.008***	-0.008***	-0.008***	-0.008***
	(0.029)	(0.029)	(0.029)	(0.029)	(0.002)	(0.002)	(0.002)	(0.002)

FATA$_{t-3}$	0.748**	0.746**	0.761**	0.741**	-0.208***	-0.208***	-0.208***	-0.207***
	(0.325)	(0.325)	(0.326)	(0.325)	(0.018)	(0.018)	(0.018)	(0.018)
LEV$_{t-3}$	0.007**	0.007**	0.007**	0.007**	0.000*	0.000*	0.000*	0.000*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
MBV$_{t-3}$	-0.011	-0.011	-0.011	-0.050*	0.007***	0.007***	0.007***	0.014***
	(0.012)	(0.012)	(0.012)	(0.029)	(0.001)	(0.001)	(0.001)	(0.002)
ROA$_{t-3}$	-0.022***	-0.022***	-0.022***	-0.022***	0.000	0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
GPM$_{t-3}$	-0.020***	-0.020***	-0.020***	-0.020***	0.000***	0.000***	0.000***	0.000***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
INDRETURN$_t$	-0.004***	-0.004***	-0.004***	-0.004***	0.000*	0.000*	0.000*	0.000*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
LNBSD$_t$	-2.016***	-1.992***	-2.005***	-2.012***	0.061***	0.060***	0.061***	0.060***
	(0.202)	(0.202)	(0.202)	(0.202)	(0.012)	(0.012)	(0.012)	(0.012)
LNEXPORT$_t$	0.682**	0.715***	0.668**	0.681**	0.052***	0.051***	0.052***	0.052***
	(0.271)	(0.271)	(0.271)	(0.271)	(0.016)	(0.016)	(0.016)	(0.016)
ΔGDP$_t$	-0.049***	-0.051***	-0.049***	-0.049***	0.000	0.000	0.000	0.000
	(0.015)	(0.015)	(0.015)	(0.015)	(0.001)	(0.001)	(0.001)	(0.001)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.468	0.468	0.468	0.468	0.514	0.514	0.514	0.514
F-statistic	8.720***	8.721***	8.720***	8.720***	10.287***	10.286***	10.286***	10.293***
Firms included	8,219	8,219	9,547	8,219	8,219	8,219	8,219	8,219
Observations	72,487	72,487	105,492	72,487	72,487	72,487	72,487	72,487

Figure 1: Debt maturity, firm operating performance volatility and firm value volatility.
This figure presents the average values for debt maturity (DEBTMAT), firm operating performance volatility (SDROA), and firm value volatility (SDTBQ) based on a sample of 95,240 firm-year observations. For ease of presentation, we divide the values for DEBTMAT and SDROA by 100.