Debt Maturity and Initial Public Offerings

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Abstract

We investigate the effect of initial public offerings (IPOs) on the evolution of debt maturity by tracking a sample of US firms that went public over the period 1998–2011. Our findings reveal a significant and permanent increase in debt maturity post-IPO. The short-term debt ratio drops by nearly a fifth in the first two years after the IPO. These findings are economically significant and robust to controlling for the endogeneity in the listing decision. However, the lengthening of the post-IPO debt maturity is only evident in small, high-growth, and highly levered firms. This finding lends greater support to asymmetric information models than theories based on the agency costs of debt. There is some support for the argument based on the agency costs of equity as the IPO effect on debt maturity is only significant for firms with a high dilution ratio. Finally, the IPO effect varies with macroeconomic conditions as the increase in debt maturity post-IPO was most pronounced during the recent financial crisis of 2007–08.

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1. Introduction

This paper investigates the effect of IPOs on the debt maturity structures of US firms, tracking these firms from when they were private to when they went public. Understanding the debt maturity choice and its evolution over the life cycle of a company is of importance to financial management because any change in debt maturity will affect real corporate behavior, including the level of investment (Aivazian et al. 2005a,b), especially in periods of credit and liquidity shocks (Almeida et al. 2011; Custódio et al. 2013). Moreover, debt maturity structure is related to other financial policies, such as leverage and cash holdings. Harford et al. (2013) show that firms with a large proportion of short-maturity debt tend to have large cash reserves in order to mitigate the refinancing risk associated with short-term debt. Studying the evolution of debt maturity in the periods pre- and post-IPO is also of great interest as it involves the IPO, one of the most important events in the life cycle of a company, and one often associated with significant changes in corporate behavior.

An IPO can be viewed as an information-releasing event that changes the information structure of a company, especially with regards to its relationship with lenders (Schenone 2010). One of the most important motives for firms to go public is to gain access to external financial markets. As a result, research has examined the impact of a firm's listing decision on its financial policies post-IPO. For example, it is well-documented that immediately after going public firms rely less on debt financing because they can raise capital in the equity markets (Pagano et al. 1998; Aslan and Kumar 2011). However, little attention has been devoted to the question of how a firm's debt maturity evolves after the IPO. This is a significant omission because debt maturity is also an important capital structure decision jointly determined with leverage (see Barclay and Smith 1995; Stohs and Mauer 1996; Johnson 2003; Datta et al. 2005; Antoniou et al. 2006; Brockman et al. 2010).

It is important for the shareholders of an IPO firm to know whether there will be a change in the debt maturity structure post-IPO for there are costs and benefits of switching between debts of different maturities. For instance, while short-term debt typically has lower interest rates, is relatively easier to negotiate, and requires less collateral than long-term debt, it exposes the firm to the refinancing and liquidity risks (Jun and Jen 2003). The refinancing risk associated with short-term debt arises when market conditions change, causing the firm to borrow at a higher interest rate (Froot et al. 1993). The liquidity risk, as highlighted by Diamond (1991), is the risk of the borrowing firm losing the control rent when lenders are reluctant to renew the debt after a downgrade to the firm. Further, firms relying heavily on short-term debt may be forced to sell important assets at fire-sale prices when they are unable to roll over their short-term debt contracts (Brunnermeier and Yogo 2009; Choi et al. 2014). According to the matching principle (Myers 1977), a firm that maintains a high proportion of short-term debt in its capital structure will tend to invest mainly in short-term projects (Ortiz-Molina and Penas 2008), which are less innovative and may affect the firm's long-term performance.

We hypothesize that the proportion of short-term debt in a firm's capital structure will decline after the firm goes public. Our hypothesis is motivated by two lines of argument based on agency theories and asymmetric information models. First, once a company goes public, its growth opportunities will be utilized, which alleviates the concern about underinvestment incentives and reduces the need for holding short-term debt as a solution to this agency problem (Myers 1977). The maturity of assets typically increases post-IPO as firms seek to invest in long-term innovative projects. This change in asset maturity structure leads to a similar shift in debt maturity toward greater reliance on long-term debt, as predicted by the matching principle (Myers 1977; Ortiz-Molina and Penas 2008). Following an IPO, managerial ownership decreases due to the dilution effect, resulting in weaker

interest alignment with shareholders. This, in turn, will create an incentive for managers to entrench themselves by eschewing short-term debt and avoiding the external monitoring that it provides (Datta et al. 2005).

Our second argument is based on theoretical models of debt maturity in the presence of asymmetric information. According to Flannery's (1986) signaling model, a private firm that processes favorable (private) information about its prospects should use short-term debt to signal its quality to creditors. To the extent that informational asymmetries are reduced post-IPO, the newly listed firm will have less incentive to use short-term debt as a signaling device. Reduced asymmetric information post-IPO also means that public firms become less constrained and have stronger bargaining power (Schenone 2010; Saunders and Steffen 2011), implying greater access to debt of longer maturities. In Diamond's (1991) model, firms with private information choose debt of different maturities, i.e., those with high and low risk ratings borrow short term while those with medium risk ratings borrow long term. As a private firm goes public, its default risk is likely to decrease while its credit quality improves. This implies that after an IPO, the average firm is likely to use less short-term debt.

Using data from the S&P Capital IQ database for the period 1994–2012, we document a significant shift toward longer debt maturity post-IPO, which is consistent with our central hypothesis. The mean short-term debt ratio drops significantly from the pre-IPO level of 36% to the post-IPO level of 27.5%. Controlling for changes in firm characteristics, our regression analysis shows a 2.5% permanent decrease in the short-term debt ratio post-IPO. The IPO effect on debt maturity is strongest in the first few years after the IPO. Firms reduce their short-term debt ratio by nearly 7% in the IPO and IPO+1 years, which represents a significant decrease of nearly a fifth (19%) compared to the pre-IPO level. Our results are robust to tests (1) adopting the incremental financing approach that uses a sample of new debt issues and (2) employing the difference-in-differences estimator that accounts for omitted time trends in

debt maturity, and unobserved differences in the characteristics of IPO and non-IPO firms. Overall, these findings provide strong support for our prediction that upon becoming public, firms will lengthen the maturity of their debt.

We also find that the decline in the short-term debt ratio is only observed in small and high growth firms, which is consistent with the argument based on asymmetric information. Small and high-growth firms, those that typically face greater asymmetric information, promptly switch to more long-term debt as a result of reduced informational asymmetries following the IPO. However, there is little evidence to support the argument based on the agency costs of debt as the lengthening of debt maturity post-IPO is only seen in high-growth firms, and is primarily observed in those with high leverage. High-growth firms and highly levered firms face high agency costs of debt, which they should mitigate by maintaining a high proportion of short-term debt. Our evidence does not support this prediction as we find these firms to use significantly less short-term debt after their IPOs.

Our additional tests controlling for IPO-related characteristics show that the effect of IPOs on debt maturity structures is only relevant for firms with a higher dilution ratio, i.e., those with a more severe conflict of interests between managers and shareholders. This finding is consistent with the argument based on the agency costs of equity because managers with weaker interest alignment with shareholders would prefer to reduce external monitoring associated with short-term debt. We also find that the IPO effect on debt maturity remains significant, regardless of the intended use of the IPO proceeds. This finding suggests that our results are not restricted to a group of firms that simply use the proceeds from equity capital to retire debts. This is in line with our earlier evidence obtained using the incremental financing approach.

We subject our results to a number of robustness tests and model specifications. First, one major concern about our analysis is that the IPO decision is endogenous and can be

affected by unobserved firm factors that are related to debt maturity. We deal with this endogeneity concern using a treatment regression. Our main results are robust to this model specification as we document a significant decline (7.6%) in the short-term debt ratio post-IPO. Second, we address the possibility that debt maturity and leverage, two interrelated capital structure decisions, are simultaneously determined. Using two-stage least squares regressions (2SLS) and alternative instruments for leverage, we obtain results consistent with our baseline findings. Finally, we examine whether the IPO effect on debt maturity varies with macroeconomic conditions. We find that this effect was magnified by the credit shocks associated with the recent financial crisis of 2007–2008. Since the financial crisis was a credit crunch, during which the refinancing and liquidity risks associated with short-term debt increased, IPO firms had even greater incentives to reduce their short-term debt usage.

Our study provides novel evidence of the impact of IPOs on debt maturity structures and contributes to three bodies of literature. In the IPO literature, we highlight an important impact of the listing decision on corporate financial policies. A few recent studies have documented a potential association between the IPO event and leverage (Pagano et al. 1998; Alti 2006; Lemmon et al. 2008; Aslan and Kumar 2011). However, only two non-US studies by Pagano et al. (1998) and Aslan and Kumar (2011) have formally tested the effect of IPOs on leverage. In the cash holdings literature, the association between IPOs and cash has also been observed but has not been formally examined (Von Eije 2012; Bouwman and Lowry 2012; Gao et al. 2013). To the best of our knowledge, we are the first to study the impact of the listing decision on debt maturity.

In the debt maturity literature, most US-based research has focused on public firms (Barclay and Smith 1995; Barclay et al. 2003; Johnson 2003; Datta et al. 2005; Brockman et al. 2010). Due to the scarcity of data, Scherr and Hulburt (2001) is the only study examining the determinants of the debt maturity structures of small (private) firms. However, the authors

use a small sample of private firms collected from the National Survey of Small Business Finances (NSSBF) in only two years 1987 and 1993. Using newly available data provided by S&P Capital IQ, we analyze a much larger sample of IPO firms over the period 1994–2012, tracking them from when they were private to when they became public. Importantly, the objective of our analysis is to examine the effect of the IPO decision on the evolution of debt maturity over the life cycle of a company. Hence, our study complements the recent finding regarding the secular decrease in the debt maturity of the average public firm documented by Custódio et al. (2013).

Finally, our findings add to the recent surge of papers studying differences in the corporate financial policies of public and private firms, including leverage (Brav 2009; Huynh et al. 2012), payout ratios (Michaely and Roberts 2012), cash holdings (Gao et al. 2013), investments (Mortal and Reisel 2013; Asker et al. 2015), and innovations (Gao et al. 2014; Acharya and Xu 2015). More recently, Brav (2009) and Huynh et al. (2012) compare the capital structures of private and public firms in the UK and Canada, respectively. Although both studies document a difference in the debt maturity structures of private and public firms, the focus of their analyses is the leverage decision.[1] Our paper takes a different approach as we examine the impact of the IPO decision on debt maturity using a transition sample of US firms that were private but subsequently went public. Our study contributes to this growing research agenda by documenting the first systematic US evidence of the impact of the listing status on debt maturity structure.

The remainder of the paper proceeds as follows. We review the literature and develop our main hypothesis in the next section. We then describe our data in Section 3 and discuss the methodology in Section 4. We provide univariate and multivariate results in Section 5. We investigate what is responsible for the change in debt maturity post-IPO in Section 6. We

[1] Brav (2009) only performs a univariate analysis in which he compares the debt maturity structures of public and private firms in the UK.

deal with sample selection and endogeneity concerns in Section 7. In Section 8, we examine the IPO effect on debt maturity under different credit conditions. We conclude in Section 9.

2. Literature Review and Hypothesis Development

2.1. Literature on Debt Maturity

Most studies in the literature investigate the debt maturity choice of either private or public firms with only a few examining both types of firms. Nevertheless, there is growing international evidence that private firms tend to use more short-term debt than public firms. Using a sample of predominantly unlisted firms in Europe, Giannetti (2003) shows that listed firms have longer debt maturity than their unlisted counterparts. In a univariate analysis of the debt maturity of UK firms, Brav (2009) finds that private firms use more short-term debt and leverage than public firms. This result is consistent with Huynh et al.'s (2012) recent findings for Canadian firms. Analyzing a sample of small (private) US firms, Scherr and Hulburt (2001) show that small (private) firms have shorter debt maturity than the public firms examined by earlier studies. Similar evidence is also documented for Italian unlisted firms (Magri 2010).

The findings that private firms use more short-term debt than public firms can be explained in two ways. The first explanation is based on agency theories and concerns differences in the growth opportunities and asset maturity structures of public and private firms. The second regards differences in asymmetric information, financial constraints, bargaining power, and credit quality. First, private firms tend to have higher growth opportunities and thus face higher agency costs of debt due to the underinvestment problem (Garcia-Teruel and Martinez-Solano 2007; Heyman et al. 2008; Magri 2010). This underinvestment incentive arises because managers in high-growth firms acting in the interest of shareholders are likely to pass up positive-NPV projects as the payoffs from these projects

would partially accrue to debt-holders (Myers 1977). To mitigate this problem, private firms should use short-term debt that expires prior to the timing of investment and thus enables shareholders to gain the full payoff from the investment. Next, private and small firms tend to operate with shorter-lived assets than public and large firms (Scherr and Hulburt 2001). Based on the matching principle, assets with short lives should be financed with debt of similar maturities (Myers 1977), suggesting that private firms should have shorter debt maturity than their public counterparts. Jun and Jen (2005) find that maturity matching is beneficial to firms: those with a higher level of maturity matching are more likely to have lower return volatilities. From a different agency perspective, private firms are less likely to be known by lenders, who would prefer the discipline of external monitoring and renegotiation associated with short-term debt (Magri 2010).

Second, due to a lack of transparency and disclosure requirements, private firms have higher degrees of asymmetric information than their public counterparts. Hence, those with favorable private information about their prospects have incentives to use short-term debt as a costly and credible signaling device that cannot be mimicked by firms with unfavorable information (Flannery 1986). Additionally, as a consequence of asymmetric information, private firms tend to be financially constrained and suffer from weak bargaining power (Saunders and Steffen 2011), which force them to rely heavily on short-term borrowings. Further, private firms are generally riskier than their public counterparts. According to Diamond's (1991) model, firms with high risk ratings may be refused the option of long-term borrowings because of the resulting adverse selection problem that would see these firms choose very high-risk projects (see Scherr and Hulburt 2001; Garcia-Teruel and Martinez-Solano 2007). Peel (2000) also observes that private firms, which have low liquidity and more volatile cash flows, are susceptible to financial distress and thus rely heavily on short-term borrowings.

While prior research has focused on either listed or unlisted firms as reviewed above, it has not studied the evolution of debt maturity over the life cycle of firms. Custódio et al. (2013) are the first to investigate the evolving debt maturity structure over time. Using a sample of US public firms, they document an increase in the short-term debt ratio of the average firm over time, and find the new listings phenomenon to be responsible for this increase. The objective of our study is different from that of Custódio et al. (2013) as we examine the evolution of debt maturity over the life cycle of IPO firms, with a focus on studying the temporary and permanent effects of the IPO event on the debt maturity choice. Put differently, we are interested in examining the (time-series) change in the debt maturity of the average transition firm pre- and post-IPO, while Custódio et al. (2013) document the trend in the average debt maturity of public firms by calendar year.

2.2. Literature on IPOs and Corporate Financial Policies

Using a sample of private firms in Italy, Pagano et al. (1998) examine the reasons for firms to go public. They document three main motives related to capital structure: greater access to financial markets, an increase in bargaining power with banks, and a decrease in the cost of borrowing. The authors further study the effects of the listing decision on financial and operating variables ex post, showing that the IPO effects are significant up to three years after the IPO. Their findings indicate that firms go public to rebalance their capital structure after a period of high investment and growth. Aslan and Kumar (2011) apply a similar methodology to a sample of UK private firms, providing further support to Pagano et al.'s (1998) earlier finding that leverage drops instantly after the IPO. Neither of the two studies examines the choice of debt maturity, although it is an equally important capital structure policy (Barclay and Smith 1995; Stohs and Mauer 1996; Johnson 2003).

A few recent studies have investigated the association between IPOs and two financial policies: leverage and cash holdings. Alti (2006) examines the effect of market timing on

capital structure through analyzing the changes in the leverage ratios of market timers.[2] The results indicate that the effect of market timing on capital structure lasts for two years post-IPO.[3] Lemmon et al. (2008) study the evolution of capital structure from the year of the IPO up to 20 years after the IPO. They find that leverage is persistent over time and is significantly determined by its initial values. Lemmon et al. (2008), however, do not consider the evolution of capital structure, and, in particular, debt maturity pre-IPO.

Some recent research has also started to realize a possible association between IPOs and cash management policies (Gao et al. 2013; Von Eije 2012). Gao et al. (2013) focus on the cash holdings in private and public firms, although they also briefly study the cash policies of a sample of transition firms pre- and post-secondary IPOs.[4] According to their graphical evidence, the level of cash increases dramatically around the IPO year (i.e., from IPO−1 to IPO and from IPO to IPO+1). Using a sample of international private firms, Von Eije (2012) documents that cash holdings decline after the IPO event, although they remain even higher than the cash holdings of firms that are never listed publicly. Bouwman and Lowry (2012) also examine differences in the cash holdings of new IPO and mature firms, and among IPO firms with various financing types preceding the IPO. Their findings show extreme persistence in the level of cash in the period between IPO+3 and IPO+5, even though the growth rate, an important reason for holding a high level of cash, slows down post-IPO.

To conclude, although both theoretical and empirical studies suggest that a firm's choice of short-term versus long-term debt may evolve over its life cycle, no study has investigated the potential effect of the IPO on debt maturity structure. With a few exceptions, existing research on the evolution of corporate finance policies in general and debt maturity in particular has mainly looked at public firms. We extend the literature by examining the

[2] Market timers are firms that go public in "hot" markets, i.e., in months with above the median distribution of the (detrended) monthly moving average IPO volume.
[3] It should be noted that Alti (2006) only uses data for one-year preceding the IPO.
[4] A secondary IPO is one in which the issuer does not receive any cash proceeds.

choice of debt maturity in the periods pre- and post-IPO, which enables us to provide a comprehensive picture of the evolution of debt maturity over the life cycle of firms.

2.3. Hypothesis Development

Our main hypothesis is that after going public, firms lengthen the maturity structure of their debt. This prediction is based on two main lines of argument drawn from existing agency theories and asymmetric information models. The first considers changes in IPO firms' growth opportunities, asset maturity, and managerial ownership. The second argument entails changes in these firms' levels of asymmetric information, financial constraints, bargaining power, and credit quality.

First, Myers' (1977) agency model suggests that firms with high growth and risky debt should shorten the maturity of their debt in order to mitigate underinvestment incentives. Since private firms have high growth options and great concerns about this incentive problem, they tend to rely heavily on short-term debt. However, when these firms go public, their growth opportunities will be utilized, reducing the need for using short-term debt as a solution for the underinvestment problem. Next, newly listed firms tend to invest in more long-term innovative projects, which should be financed with debt of longer maturities according to the matching principle (Myers 1977). From another agency perspective, when a firm goes public the managerial ownership decreases due to the dilution effect. Consequently, the conflict of interests between managers and shareholders intensifies, creating an incentive for managers to entrench themselves by avoiding short-term debt and the frequent monitoring that it provides (Rajan and Winton 1995; Stulz 2004; Datta et al. 2005; Alderson et al. 2014).

Second, under the asymmetric information framework, Flannery (1986) demonstrates how firms with favorable private information may credibly signal their prospects through short-term debt. Since going public helps firms improve transparency and disclosure while reducing the levels of asymmetric information (Schenone 2010), it is expected that listed

firms will have less incentive to use short-term debt for signaling purposes. In a related argument, private firms often face financial constraints and have limited access to long-term borrowings due to their high levels of informational asymmetries. This occurs because these firms may be unknown to lenders, who would prefer to supply short-term debt that allows for frequent monitoring and negotiation (Magri 2010). However, as asymmetric information is reduced post-IPO, newly listed firms become less constrained and have stronger bargaining power (Saunders and Steffen 2011), enabling them to use long-term borrowings. In another asymmetric information model, Diamond (1991) examines the relationship between a firm's credit quality and its choice of debt maturity in the presence of the liquidity risk associated with short-term debt. He finds that this relationship is non-monotonic, i.e., low-risk firms choose to use short-term debt while high-risk firms are forced to use it and only medium-risk firms use long-term debt. Since liquidity and default risk decrease while credit quality improves following an IPO (Pagano et al. 1998; Saunders and Steffen 2011), it is expected that the average listed firm will use more long-term debt post-IPO, especially if its credit rating is upgraded from a high-risk category to a medium one.

The above arguments suggest that subsequent to the IPO, a firm's growth opportunities, asset maturity, managerial ownership, asymmetric information, financial constraints, bargaining power, and credit quality experience material changes, thus affecting the agency costs of debt and equity, or the level of the asymmetric information facing the firm. This will in turn either reduce the firm's incentive to hold short-term debt or improve its access to long-term borrowings, both contributing to a shift toward debt of longer maturities.

In addition to these theoretical arguments, there are also several other motives for newly listed firms to switch to long-term debt and alleviate the disadvantages of short-term borrowings. Ortiz-Molina and Penas (2008) show that information-opaque and risky firms are biased toward selecting short-term debt. This bias will, in turn, affect these firms' choice of

investment, driving them toward short-term projects with a quick payoff and away from long-term innovative projects. Caprio and Demirgüç-Kunt (1998) conclude that long-term finance is associated with higher productivity and firms can grow more rapidly using long-term finance contracts than internal sources and short-term credit. Custódio et al. (2013) find that due to frequent renewal, a high level of short-term debt significantly exposes firms to external credit and liquidity shocks. In sum, all our arguments point to the prediction that after going public, firms should use less short-term debt and more long-term debt.

3. Data

We collect data on IPO firms from the S&P Capital IQ database.[5] In addition to data on public firms, this database also provides data on private firms that file Forms 10-K (annual reports), 10-Q (quarterly reports), or S-1 (securities registration) with the Securities Exchange Commission (SEC), as well as other private firms from third-party sources. According to the SEC regulations, firms with total assets of $10 million or above, and with 500 or more shareholders are required to file 10-K and 10-Q reports while firms with public debt are required to file S-1 Form (Gao et al. 2013). Further, IPO firms are required to provide two years of financial statements in their IPO prospectuses (Latham and Watkins 2013).

S&P Capital IQ has been used by many recent empirical studies (Colla et al. 2013; Gao et al. 2013; Garcia-Appendini and Montoriol-Garriga 2013) and, importantly, its quality of data has been verified by such studies. For instance, the quality of S&P Capital IQ data on public firms is comparable to that of Compustat data (Colla et al. 2013).

Our sample covers the period 1994–2012 as only company data from 1994 are available in S&P Capital IQ. We consider firms that did an IPO during the period 1998–2011 as S&P Capital IQ only provides comprehensive information about IPO transactions for the

[5] All our data are from S&P Capital IQ, with the exception of the term structure of interest rates, which we retrieve from the Federal Reserve Bank of St. Louis website.

period post-1998. As standard in the literature, we exclude financial and utilities firms. Note that S&P Capital IQ does not remove dead companies so our sample is not affected by survivorship bias. Consistent with the IPO literature (e.g., Lowry 2003), we exclude firm-year observations with an offer price of less than $5, REITs, and unit offerings. We further drop firm-year observations with negative equity values. Our final sample consists of 1,712 firms and 9,562 firm-year observations.

4. Methodology

4.1. Empirical Models

The main objective of our study is to examine the effect of a firm's IPO on its choice of debt maturity. Prior literature typically investigates the IPO effects on corporate financial policies for a number of years subsequent to the IPO. Pagano et al. (1998), for example, argue that the impacts of the IPO event on financial and operating variables may remain significant for up to three years post-IPO. Gao et al. (2013) graphically show that the effect of the listing decision on cash holdings is significant for three years after the IPO. Thus, to examine the (short-term) effect of the IPO decision on the evolution of debt maturity in the years immediately after the IPO, we estimate the following model:

$$ST_{it} = \beta_0 + \beta_1 D_{IPO} + \beta_2 D_{IPO+1} + \beta_3 D_{IPO+2} + \beta_4 D_{IPO+3} + \boldsymbol{\theta}' \boldsymbol{X}_{it} + \varepsilon_{it}. \quad (1)$$

In this model, the dependent variable, ST_{it}, is the short-term debt ratio, measured as debt maturing within one year (i.e., short-term borrowings plus the current portion of long-term debt) divided by total debt.[6] D_{IPO} takes the value of 1 in the IPO year, and 0 otherwise. D_{IPO+i} with *i*=1..3 takes the value of 1 in the IPO+*i* year, and 0 otherwise. $\boldsymbol{X}_{it}$ is a vector of

[6] Our measure of debt maturity is consistent with previous studies of private firms that typically define short-term debt as debt maturing within one year (Scherr and Hulbert 2001; Giannetti 2003; García-Teruel and Martínez-Solano 2007; Brav 2009; Magri 2010). Note that studies of public firms often consider several measures of short-term debt, such as debt maturing within one, three, and five years (e.g., Harford et al. 2013). However, the private firms in our sample have the majority of their debt maturing within five years. Thus, considering debt maturing within three and five years as short-term debt is inappropriate for our analysis, as it would overestimate the short-term debt ratio.

the control variables, which we will discuss in detail in Section 4.2. Note that Model (1), which includes four IPO dummies, considers a test window between the pre-IPO years and the IPO+3 year. Pagano et al. (1998) employ a comparable model, although they do not include any control variables. The exclusion of the control variables may give rise to an omitted variables bias. We alleviate this potential bias by including the commonly known determinants of debt maturity. According to our main hypothesis, we expect the coefficients on the IPO dummies to be negative and significant.

Next, we estimate the following model to examine the long-term, permanent effect of the IPO event on debt maturity:

$$ST_{it} = \beta_0 + \beta_1 D_{Post\_IPO} + \boldsymbol{\theta}' \boldsymbol{X}_{it} + \varepsilon_{it}, \quad (2)$$

where D_{Post_IPO} is a dummy variable that takes the value of 1 in the IPO year and the years post-IPO, and 0 otherwise. Schenone (2010) uses a comparable model to test the effect of a firm's IPO on its cost of borrowing measured by the loan spread. Since we predict a decline in the short-term debt ratio post-IPO, we expect the coefficient on D_{Post_IPO} to be negative.

4.2. Control Variables

Consistent with the debt maturity literature, we consider the following control variables: asset maturity, earnings volatility, growth opportunities, leverage, firm size, firm size-squared, and the term structure of interest rates.[7] Myers (1977) claims that matching the maturities of assets and liabilities can help to reduce the underinvestment problem. Consistent with the results in Johnson (2003), a negative relationship is expected between asset maturity and the short-term debt ratio. Following Giannetti (2003), we proxy for asset maturity using the proportion of long-term assets in total assets.

[7] We are unable to include governance variables because they are unavailable pre-IPO. In a robustness check, we also include firm age as an additional control variable and obtain qualitatively similar results.

Kane et al. (1985) argue that firms with high earnings volatility prefer long-term debt so as to avoid the refinancing and liquidity risks that arise from the frequent renewal of short-term debt. We thus predict a negative relation between volatility and short-term debt. We follow Antoniou et al. (2006) and measure earnings volatility as the difference between the absolute value of the annual change in earnings (EBITD) and the average change.

High-growth firms should use more short-term debt to mitigate the underinvestment problem (Myers 1977). Thus, a positive relationship between short-term debt and growth opportunities is anticipated. Following previous studies of private firms (Scherr and Hulburt 2001; Giannetti 2003; Brav 2009), we measure growth opportunities as sales growth.[8]

Consistent with Scherr and Hulburt (2001) and Johnson (2003), we expect leverage to be negatively related to short-term debt as firms with high leverage tend to use more long-term debt to reduce the probability of bankruptcy (Morris 1992). We measure leverage as long-term debt plus short-term debt, divided by total assets.

Firm size is often used as a proxy for asymmetric information (Scherr and Hulburt 2001) as well as credit quality (Johnson 2003). Large firms have less asymmetric information and higher credit quality, suggesting a negative relationship between short-term debt and size. Following Scherr and Hulburt (2001), we measure size as the natural logarithm of total sales.

Diamond (1991) predicts a non-monotonic relationship between credit quality and debt maturity. Similar to previous research (Johnson 2003; Custódio et al. 2013), we use firm size to proxy for credit quality and use both size and size-squared to capture the potential non-monotonic relation between risk ratings and short-term debt. We expect short-term debt to be negatively related to firm size and positively related to size-squared.

Brick and Ravid (1985) argue that if the term structure of interest rates is upward sloping, firms should use long-term debt because the tax benefits are potentially greater. We

[8] We are unable to use the market-to-book ratio, a common measure of growth options for public firms, as market values are not available pre-IPO.

thus predict a negative relation between term structure and short-term debt. Consistent with Harford et al. (2013), we measure the term structure of interest rates as the difference between the month-end yields on ten-year government bonds and six-month treasury bills.

We winsorize the control variables at 1% and further require that the leverage and short-term debt ratios be in the unit interval. We provide variable definitions in the appendix.

5. Results

5.1. Summary Statistics

Table 1 presents summary statistics of the variables. We report the results for the full sample in Panel A and the results for two sub-periods pre- and post-IPO in Panel B. While the short-term debt ratio has a mean of 30.2% (median of 11.7%) for the full sample period, it has a higher mean of 36% (median of 22.8%) pre-IPO, which drops to 27.5% (median of 8%) post-IPO. This provides the first evidence of the decline in short-term debt (of 8.5% relative to the mean) after the IPO. After going public, firms change their leverage by a smaller magnitude compared to debt maturity: the mean leverage ratio is 45.7% (median of 40%) pre-IPO and increases to 48.1% (median of 44.5%) post-IPO. The t-tests in Panel B show that the differences in debt maturity and leverage pre- and post-IPO are statistically significant. Overall, firms have significantly longer debt maturity and higher leverage after the IPO.[9]

[INSERT TABLE 1 HERE]

5.2. IPOs and the Evolution of Financial Policies

In Figure 1, we further examine graphically the evolution of leverage and short-maturity debt from IPO–4 to IPO+5. Our window of analysis begins in the IPO–4 year, as

[9] In comparison to Scherr and Hulburts's (2001) sample of small (private) firms, the private firms in our sample are larger, have more growth opportunities, longer debt maturity, and lower leverage.

this is the starting point at which we have a reasonable number of observations prior to the IPO. The test window carries on up to IPO+5, as in Bouwan and Lowry (2012).

Debt maturity

Figure 1(a) illustrates the evolution of the debt maturity structures of IPO firms. The short-term debt ratio exhibits a moderate upward trend pre-IPO: it reaches a peak of 37.8% (median of 26.1%) in the IPO–2 year and remains at the same level in the IPO–1 year (median of 27.1%). The effect of the IPO on the short-term debt ratio becomes negative post-IPO. From IPO–1 to IPO there is a decline of 4.5% in the mean short-term debt ratio while there is an even higher drop of 7.2% in the median ratio. After the IPO year, there is a gradual downward trend in the mean and the median values of short-term debt up to IPO+5. Overall, our graphical evidence clearly shows a decrease in short-term debt usage post-IPO, which is consistent with our main hypothesis.

Leverage

Figure 1(b) shows the evolution of leverage in the periods pre- and post-IPO. Similar to short-term debt, there is a relative accumulation of leverage in the pre-IPO years, starting from IPO–4 and reaching its peak in the IPO–1 year (mean of 47.7% and median of 41.3%). A sharp drop in mean leverage of 10.5% (median of 14.8%) is observed from IPO–1 to IPO, which is consistent with the evidence in Pagano et al. (1998), Alti (2006), and Aslan and Kumar (2011). This decline is next followed by an upward trend in the mean and median of leverage up to IPO+5. Overall, we first observe a sharp decline in leverage between IPO–1 and IPO, as firms are likely to use their IPO proceeds to repay their debt. However, this impact appears to be temporary, as firms tend to lever up in the subsequent years (see also Alti 2006). This finding seems to be consistent with the argument based on asymmetric information, i.e., listed firms become less constrained and use more leverage due to lower asymmetric information, and liquidity and default risks. Our results are different from the

evidence of a decrease in leverage post-IPO for Italian and UK firms documented by Pagano et al. (1998) and Aslan and Kumar (2011).[10]

[INSERT FIGURE 1 HERE]

5.3. Univariate Analysis

In Panel A of Table 2, we compare pre and post-IPO short-term debt over different windows. First, we find a significant decline of 8.5% in the mean short-term debt post-IPO, compared to the pre-IPO level.[11] Both the mean and the median tests provide consistent and significant results. Next, we consider a narrower window in order to compare the use of short-term debt pre-IPO with that in first three years after the IPO; this test is in line with Model (1) in our multivariate analysis. The results show that the decline in short-term debt is significant for all windows, with the largest decline observed in the window between pre-IPO and IPO+2 (5.2%), followed by [pre-IPO, IPO+3] (4.4%), [pre-IPO, IPO+1] (3.9%), and [pre-IPO, IPO] (2.7%). Overall, consistent with the trend observed in Figure 1 (a), there is a significant increase in debt maturity post-IPO.

In Panel B, we test whether the lengthening of debt maturity post-IPO is driven by the decline in short-term debt (measured as short-term debt over total assets), the increase in long-term debt (measured as long-term over total assets), or a combination of both. The results indicate that the change in debt maturity post-IPO is due to firms simultaneously retiring short-term debt and issuing debt of long maturities. However, the decline in short-term debt usage appears to be the main driver of the increase in debt maturity post-IPO.

[10] Such a difference in our results and those reported by Pagano et al. (1998) and Aslan and Kumar (2011) may be caused by the varying bankruptcy codes. The bankruptcy law in the US is less creditor-friendly than those in the UK and Italy, suggesting that post-IPO US firms can rely more on debt finance than their UK and Italian counterparts. See Rajan and Zingales (1995) and Acharya et al. (2011) for detailed discussions.

[11] In unreported tests, we have considered various windows excluding the year of the IPO and found qualitatively similar results.

[INSERT TABLE 2 HERE]

5.4. Multivariate Analysis

Table 3 reports the regression results for our baseline models (1) and (2).[12] The results in Column (1) show that, controlling for changes in firm characteristics, there is a significant decline (3.7%) in short-term debt in the IPO year. Note that the financial statement in the year of the IPO is typically prepared after the IPO, meaning that any immediate effect of the IPO should be observed from the IPO year. Our results thus imply that firms reduce their reliance on short-term debt immediately after going public. The impact of the IPO on debt maturity is also significant in the IPO+1 year, although the magnitude of this impact is smaller (3%). This latter observation suggests that the IPO effect on debt maturity diminishes over time. In sum, the cumulative effect of the IPO decision on short-term debt in the first two years amounts to 6.7%. This represents an economically significant drop of nearly 20% relative to the mean short-term debt ratio pre-IPO (36%).

The results in Column (2) show that the dummy variable D_{Post_IPO} is significantly negative, suggesting that the IPO effect on debt maturity is not a temporary but a permanent one. Specifically, we find that after going public firms reduce their short-term debt ratio by 2.5%, which represents 7% of the pre-IPO level. This evidence of a statistically and economically significant, lasting impact of the IPO event on debt maturity provides strong support for our main hypothesis. Taken together with the results in Column (1), this finding suggests that a firm's IPO decision has both temporary and permanent effects on its choice of debt maturity.

In Columns (3)–(6), we consider alternative model specifications. First, in Columns (3) and (4), we do not control for industry and year effects. We obtain results that are similar

[12] Due to data availability and different model specifications, the number of observations varies across models.

to those reported in Columns (1) and (2), although the IPO effects appear to be more significant, both statistically and economically. In Column (3), the IPO effect on short-term debt is statistically significant from IPO to IPO+2. The magnitude of the decline in the short-term debt ratio in the first three years after the IPO is 10.9%, representing nearly a third (30.5%) of the pre-IPO level. The results in Column (4) also show that the short-term debt ratio post-IPO declines by 3.7%, which represents more than 10% of the pre-IPO level. Second, in Columns (5) and (6), we include individual firm fixed effects to control for unobserved firm factors affecting debt maturity. We document qualitatively similar results, although the IPO effect appears to be less significant than in the baseline results in Columns (1) and (2).

Regarding the control variables, we obtain results generally consistent with our prior expectations and previous empirical findings. First, asset maturity is significantly negative, except in Columns (5) and (6), suggesting that firms do attempt to match the maturities of their assets and liabilities. This finding is consistent with our prediction and is in line with Johnson (2003) and Custódio et al. (2013). However, firm-level earnings volatility and growth opportunities are both insignificant, although the former variable is marginally significant with an unexpected (positive) sign in Column (2), while the latter variable is significant with an unexpected (negative) sign in Column (6). The insignificance of growth opportunities is not uncommon in previous studies of private firms (e.g., Scherr and Hulburt 2001). As expected, leverage is negatively related to short-term debt, similar to the findings of Johnson (2003) and Custódio et al. (2013). Highly levered firms use less short-term debt to mitigate the liquidity and refinancing risks associated with short-term debt. Size and size-squared are both negative and significant (except in Column (6) for size and (4) for size-squared). The former finding supports the argument that large firms should use less short-term debt for signaling purposes, consistent with asymmetric information models (Flannery

1986). The latter finding regarding size-squared is, however, not in line with Diamond's (1991) model implication that this variable should be positively related to short-term debt due to a non-monotonic relationship between credit quality and debt maturity. Next, we observe a positive relationship between short-term debt and the term structure of interest rates (except in Column (2)), which is consistent with Johnson (2003) but does not support the taxation hypothesis. Note that the prediction of a negative relationship between short-term debt and term structure is based on the assumption that the term structure is upward sloping, which is not always met in our sample period. In short, we find that the short-term debt ratio is negatively related to asset maturity, leverage, size, and size-squared, but is positively associated with the term structure of interest rates.

In summary, our results show that going public allows firms to reduce their reliance on short-term debt. The IPO effect on debt maturity is most pronounced in the IPO and IPO+1 years and then weakens over time. Although firms adjust their debt maturity structures most significantly in the first few years after the IPO, the switch to more long-term debt appears to be a permanent one. We note that our results are not in conflict with the recent evidence of a secular decrease in debt maturity (Custódio et al. 2013). Specifically, Custódio et al.'s (2013) conclusions that the composition and nature of publicly listed firms are responsible for the decline in debt maturity over time do not contradict our results because while these firms may use relatively more short-term debt than those that went public and entered the Compustat database earlier, our results show that they rely relatively less on short-term debt compared to the pre-IPO period.[13]

[INSERT TABLE 3 HERE]

[13] In (unreported) analysis, we examine the relation between IPOs and debt maturity over time. Although we have already controlled for the evolution of debt maturity by including year effects, we further investigate whether the IPO effects on short-term debt change over two (pre-crisis) periods 1998–2002 and 2003–2006. The results show that there is no significant difference in the strength of the IPO – debt maturity relation over time.

5.5. Additional Robustness Checks

In this section, we perform two additional robustness tests using the incremental financing approach and the difference-in-differences estimator.[14] First, we investigate the effect of the listing status on debt maturity using a sample of newly issued debt. The advantage of this approach is that we can test whether firms prefer long-term or short-term debt in incremental financing activities (Elyasiani et al. 2002; Brockman et al. 2010; Custódio et al. 2013). Using this incremental approach allows us to take the perspective of a prospective creditor who determines his/her preferred maturity structures of new debt issues upon evaluating the borrowing firm's characteristics (Brockman et al. 2010), including its listing status. Data on new debt issues also comes from S&P Capital IQ. In Table 4, we re-estimate our model of debt maturity for the newly constructed sample of debt issues. The results in Column (1) of Table 4 confirm our earlier results that firms prefer to issue less (more) short-term (long-term) debt post-IPO. Specifically, after going public, firms reduce the proportion of short-term debt in new debt issues by 3.5%.

Second, to address the concern that our results are driven by omitted time trends or unobserved differences between IPO and non-IPO (private) firms that may affect the debt maturity choice, we conduct a difference-in-differences regression analysis. Unlike Column (1), we now adopt the balance sheet approach and use our original sample and a new sample of non-IPO firms, also collected from the same database S&P Capital IQ. We perform one-to-*n* matching with replacement to identify matching firm-year observations because this approach has lower data requirements, as well as provides better matches and less bias (Roberts and Whited 2012). For a firm-year observation in the treatment group (IPO firms), we find matching firm-year observations in the control group (non-IPO firms) that are in the same industry and the IPO–1 year, and are similar in size and growth opportunities (allowing

[14] We are grateful to the reviewer for encouraging us to pursue these additional robustness checks.

for a deviation of 30%). Our sample includes 3,248 firm-year observations in total, with 2,767 observations in the treatment group and 481 observations in the control group.[15]

We next estimate the following model:

$$ST_{it} = \beta_0 + \beta_1 D_{Post\_IPO*} + \beta_2 IPO_{firms} + \beta_3 D_{Post\_IPO*} \times IPO_{firms} + \boldsymbol{\theta}' \boldsymbol{X}_{it} + \varepsilon_{it}. \quad (3)$$

For the treatment group (IPO firms), D_{Post_IPO*} is defined the same way as D_{Post_IPO} used in Model (2), that is, D_{Post_IPO*} is a dummy variable that takes the value of 1 from the IPO year onward, and 0 pre-IPO. However, for the control group (non-IPO firms), D_{Post_IPO*} takes the value of 1 from the (counterfactual) *hypothetical* IPO year onward, and 0 in the years before the *hypothetical* IPO event. Essentially, this dummy variable controls for omitted time trends common to both IPO and non-IPO firms. Next, IPO_{firms} is a dummy that takes the value of 1 for the (treatment) IPO firms, and 0 for the (control) non-IPO firms. Our main variable of interest is the interaction term between D_{Post_IPO*} and IPO_{firms}. According to our prediction, we expect $D_{Post\_IPO*} \times IPO_{firms}$ to be significantly negative.

In Column (2), the coefficient on D_{Post_IPO*} is significantly positive, suggesting that a common, secular increase in short-term debt for both IPO and non-IPO firms exists. This finding is consistent with Custódio et al.'s (2013) evidence of the evolution of debt maturity. Next, the coefficient on IPO_{firms} is significantly positive, indicating that the treatment IPO firms overall use more short-term debt than the control non-IPO firms. Most importantly, our variable of interest, $D_{Post\_IPO*} \times IPO_{firms}$ is significantly negative (-9.1%), revealing that IPO firms reduce their short-term debt ratio by more than 9% after becoming public, consistent with our baseline results.

Overall, we show that our main findings are robust to tests using the incremental approach and the difference-in-differences estimator. The latter analysis, in particular,

[15] We have fewer matched firm-year observations because there are quite a few missing values of total debt in non-IPO (private) firms.

controls for omitted time trends and unobserved differences in IPO and non-IPO firms, thus alleviating the concern that our findings are driven by confounding effects.

[INSERT TABLE 4 HERE]

6. What Drives the Increase in Debt Maturity Post-IPO?

In this section, we investigate which types of firms reduce their short-term debt ratio post-IPO. In particular, we examine the IPO effects on debt maturity conditional on firm factors and IPO-related characteristics that proxy for the degrees of asymmetric information and the agency costs of debt and equity.

6.1. Firm Characteristics

We first examine whether the increase in debt maturity post-IPO is consistent with the arguments based on asymmetric information and/or agency costs of debt. Firms with private information tend to hold higher levels of short-term debt for signaling purposes or simply because they are refused the option of long-term debt as lenders prefer frequent monitoring via short-term debt. Once private firms go public, their levels of asymmetric information decrease, thus reducing the need for using short-term debt and improving access to long-term debt. We expect the impact of IPOs on debt maturity to be more pronounced for firms with higher levels of asymmetric information. To test this prediction, we follow prior research (Bharath et al. 2009; Leary and Michaely 2011; Custódio et al. 2013) and employ two commonly-used measures of asymmetric information, namely size and growth opportunities; small and high-growth firms are expected to have more asymmetric information.[16]

[16] In unreported results, we use age as alternative measure of asymmetric information and find qualitatively similar results. Although asymmetric information can be proxied by other variables such as analysts forecast coverage and dispersion, stock return volatility, R&D etc., we are unable to use these proxies due to the unavailability of data for the pre-IPO period.

In Columns (1)–(4) of Table 5, we split our sample into two sub-samples of small and large firms. The results in Column (1) show that small firms reduce the short-term debt ratio significantly, by 6%, 4.2%, and 4%, respectively from IPO to IPO+2. In Column (2), however, there is no evidence of a statistically significant change in short-term debt post-IPO for large firms. The results in Columns (3) and (4) show that, post-IPO, small firms significantly reduce their short-term debt ratio by 3.6%, while large firms see no significant change in their debt maturity structures. Combining the results in Columns (1)–(4) suggests that the decline in short-term debt post-IPO is only evident in small firms and that the IPO effect on debt maturity is driven by the results for this subsample of firms.

In Columns (5)–(8), we examine whether the IPO effect on debt maturity varies with growth opportunities. The results in Column (5) show that all IPO dummies are insignificant, suggesting that low-growth firms do not reduce their short-term ratio after the IPO. However, in Column (6), there is strong evidence of a negative effect of the IPO on debt maturity: high-growth firms significantly reduce their short-term debt by 4.9% and 5.2% in the IPO and IPO+1 years, respectively. The results in Columns (7)–(8) show that while low-growth firms experience no permanent change in the short-term debt ratio post-IPO, high-growth firms see a 3.8% increase in their debt maturity post-IPO. Overall, the effect of the IPO on debt maturity is only seen in high-growth firms. Considering that high-growth firms tend to have more asymmetric information (see Bharath et al. 2009; Leary and Michaely 2011, among others), this finding is consistent with our prediction based on asymmetric information.

As reviewed in the previous section, agency theory suggests that high-growth firms have higher agency costs of debt and should maintain a substantial amount of short-term debt in order to mitigate the underinvestment problem. This implies that firms facing higher agency costs of debt should experience a less pronounced decline in short-term debt post-IPO (Myers 1977). To the extent that growth opportunities can also be used as a proxy for the

agency costs of debt (i.e., firms with more growth face higher agency costs of debt), our results in Columns (5)–(8), which show that only high-growth firms reduce short-term debt ratio, are inconsistent with the agency theory's prediction. In Columns (9)–(12), we re-examine this prediction through another measure of the agency costs of debt. Following Custódio et al. (2013), we consider leverage as a proxy for the agency costs of debt, i.e., firms with high (low) leverage have higher (low) agency costs of debt. The results in Columns (9) and (10) show that the IPO effect is only relevant for highly levered firms, which reduce the short-term debt ratio by 6.3%, 5%, and 4.4% between IPO and IPO+2; these magnitudes are stronger than in the baseline results in Table 3. The results in Columns (11) and (12) are qualitatively similar. While there is a significantly negative effect of the IPO event on short-term debt for firms with high leverage, there is little evidence of this effect for firms with low leverage (i.e., the IPO dummy is only marginally significant in Column (11)). Taken together, the results in Columns (9)–(12) do not support the argument based on the agency costs of debt. Although highly levered firms have higher agency costs of debt, they use significantly less short-term debt post-IPO.

In sum, the IPO effect on debt maturity is only significant in small, high-growth, and highly-levered firms, which is consistent with the arguments based on asymmetric information and is inconsistent with theories based on the agency cost of debt.[17]

[INSERT TABLE 5 HERE]

6.2. Dilution Ratio and the Use of the IPO Proceeds

We now study the impact of managerial ownership and the intended use of IPO

[17] In unreported results, we also examine the results conditional on other firm characteristics. For example, using the modified Altman z-score as a proxy for financial distress, we also rule out the possibility that the decrease in short-term debt post-IPO is due to bankruptcy reasons.

proceeds on a firm's decision on its debt maturity post-IPO. In Columns (1)–(4) of Table 6, we sub-divide our sample according to the median of the dilution ratio, which is defined as the proportion of primary shares offered to the total number outstanding pre-IPO (Habib and Ljungqvist 2001). We use the dilution ratio as a proxy for the agency costs of equity because the higher the proportion of the primary shares issued during the IPO, the higher the dilution ratio, and the more severe the agency conflict between managers and shareholders post-IPO. The results in Columns (1) and (2) show that only firms with a high dilution ratio reduce their short-term debt in the IPO and IPO+1 years. Columns (3) and (4) also reveal that the IPO effect on debt maturity is only evident for firms with a high dilution ratio. Taken together, these results are consistent with our prediction that firms with weak interest alignment between managers and shareholders and high agency costs of equity should experience the most pronounced decline in short-term debt usage post-IPO.

We further examine the IPO effect on debt maturity conditional on the intended use of the IPO proceeds. A large proportion of firms (54%) in our sample (926 firms) declared in their IPO prospectuses that they would use the proceeds from new equity capital to repay their outstanding debt. To the extent that these newly listed firms use the IPO proceeds to retire their existing short-term debts, we are likely to observe a more pronounced negative relation between IPOs and short-maturity debt. To examine this conjecture, we examine two sub-samples of IPO firms according to their intended use of the IPO proceeds.

Columns (5)–(8) report the regression results for two groups: (1) firms that use the IPO proceeds to repay their debts, and (2) those that do not use the IPO proceeds to repay their debts. The results in Column (5) show that firms in the first group reduce their short-term debt by 4.3% and 2.8% between the IPO and IPO+1 years, which is comparable to the baseline results in Table 3. In Column (6), we find that firms in the second group only reduce their short-term debt in the IPO+1 year, though by a larger magnitude (4.1%). Next, in

Columns (3) and (4), we find evidence of a permanent change in debt maturity post-IPO for both groups of firms.[18] Overall, we find that regardless of the use of the IPO proceeds, both groups of firms use less short-term debt post-IPO. Simply put, the effect of IPOs on debt maturity is significant, irrespective of the intended use of the IPO proceeds. This finding rules out a possibility that the main findings of our paper are restricted to the group of firms that retire debt using the proceeds from equity capital. Consistent with the results for a sample of newly debt issues reported earlier, we argue that there is another channel through which IPOs affect debt maturity. After going public, firms making new debt issues prefer debt of longer maturities, thus ending up with a smaller proportion of short-term debt over time.

[INSERT TABLE 6 HERE]

7. Sample Selection, Endogeneity, and Simultaneity

7.1. Sample Selection and the Endogeneity of the IPO decision

Our use of a transition sample consisting of IPO firms largely mitigates the concern of sample selection. Gao et al. (2013) argue that using a transition sample controls for the time-invariant unobservable firm characteristics pre- and post-IPO, thus helping to reduce the selection bias. However, we further address the sample selection concern by running a treatment regression. This approach can deal with sample selection and, more importantly, the endogeneity of the IPO decision. Going public is not an exogenous event as it can be influenced by (unobserved) firm characteristics that may also affect the choice of debt maturity. In the treatment regression, the D_{Post_IPO} dummy variable is treated as endogenous. Formally, the approach involves estimating the following equations:

[18] The Chow test (unreported) indicates no significant difference in the magnitudes of the D_{Post_IPO} coefficient for the two groups of firms.

$$D^*_{Post\_IPO} = \boldsymbol{\gamma}'\boldsymbol{Z}_{it} + \omega_{it} \qquad \textit{First-stage regression} \qquad (4)$$

$$D_{Post\_IPO} = 1 \; if \; D^*_{Post\_IPO} > 0; = 0 \; otherwise$$

$$ST_{it} = \beta_1 D_{Post\_IPO} + \boldsymbol{\theta}'\boldsymbol{X}_{it} + \varepsilon_{it} \qquad \textit{Second-stage regression} \qquad (5)$$

In the first stage, we estimate a probit model with D_{Post_IPO} being the binary dependent variable. We use profitability as an instrument for D_{Post_IPO}. Note that profitability satisfies all the conditions about the instrument for debt maturity as it affects the IPO decision but does not influence the choice of debt maturity (Johnson 2003; Brockman et al. 2010).[19] However, there is no consensus in the prior literature on the direction of the effect of profitability on the propensity of firms going public. Pagano et al. (1998) argue that this effect can be positive, as high profits are needed for the listing requirements. On the other hand, Aslan and Kumar (2011) contend that highly profitable firms will not need external equity, thus implying a negative relationship. To perform the treatment regression, we consider a larger sample consisting of both IPO firms and non-IPO firms that never became public. This sample has 10,731 firm-year observations, out of which 9,562 belong to 1,712 IPO firms with the remaining 1,169 observations belonging to 761 private firms. As in the difference-in-differences analysis, data on private firms are from S&P Capital IQ.

Table 7 reports the results from the treatment regression estimated using the maximum likelihood estimator. The first-stage regression results show a significantly negative relation between the D_{Post_IPO} dummy variable and profitability. This suggests that profitable firms are less likely go public, which is consistent with Aslan and Kumar (2011). More importantly, in the second-stage regression, we find the coefficient on the D_{Post_IPO} dummy variable to be significantly negative with an even larger magnitude (7.6%) than in our baseline regressions. Our main qualitative conclusions thus remain unchanged after controlling for sample selection and endogeneity. Note that the endogeneity test is

[19] In unreported results, we use lagged profitability and find qualitatively similar results.

significant, thus rejecting the hypothesis that the D_{Post_IPO} dummy variable is exogenous and confirming the validity and relevance of our treatment regression. However, a potential limitation of our approach here is that the instrument, profitability, can affect leverage (Johnson 2003; Brockman et al. 2010).[20] We address this issue in the next subsection.

[INSERT TABLE 7 HERE]

7.2. Joint Determination of Leverage and Debt Maturity

It is well-established in the literature that debt maturity and leverage are simultaneously determined (Elyasiani et al. 2002; Barclay et al. 2003; Johnson 2003; Datta et al. 2005; Brockman et al. 2010). To deal with the simultaneity bias, previous research typically runs a two-stage least squares (2SLS) regression using an instrument for leverage that does not affect debt maturity. We adopt this approach and use either tangibility or the effective tax rate as an instrument for leverage. Tangibility is the most commonly used instrument in literature (Johnson 2003; Datta et al. 2005; Brockman et al. 2010) because it is one of the most important determinants of leverage (Frank and Goyal 2009) and is not considered to be related to debt maturity in prior debt maturity studies. Recent research by Hall (2012), however, argues that tangibility may also affect debt maturity. To address this concern, we consider an alternative instrument, namely the effective tax rate. Prior research has used the effective tax rate as an instrument for leverage in the debt maturity equation because it positively affects leverage but does not affect debt maturity (Barclay et al. 2003).

Table 8 presents the results for the 2SLS regression using either tangibility or the effective tax rate as an instrument for leverage. In the first-stage regression reported in Columns (1) and (3), tangibility is, as expected, significantly and positively related to

[20] Following Gao et al. (2013), we have also considered the industry-level underwriter concentration as an alternative instrument, and obtained qualitatively similar results. Our model is, however, over-identified if we include both profitability and the industry-level underwriter concentration as instruments.

leverage. Firms with more tangible assets tend to use more leverage, which is in line with the argument that tangible assets can be used as collateral, thus facilitating borrowing. In Column (2), we find that the IPO effect on short-term debt persists up to the IPO+3 year. Firms reduce the short-term debt ratio by 12.1%, 9.6%, 7.7%, and 6.5% between IPO and IPO+3. In Column (4), the second-stage results confirm the permanent decline of short-term debt post-IPO: firms reduce their short-term debt by 7.2%. Further, the IPO effect seems stronger than what is reported earlier for the full- and sub-sample results. In Columns (5)–(8), using the effective tax rate an alternative instrument for leverage, we find it to be positively related to leverage, as expected. More importantly, our main conclusions still hold with the coefficients on the variables of interest having even greater magnitudes. We thus conclude that our results are robust, and if anything, become economically stronger after accounting for the joint determination of debt maturity and leverage.[21]

[INSERT TABLE 8 HERE]

8. Credit Conditions and the Effect of IPOs on Debt Maturity

In this section, we examine whether the effect of IPOs on debt maturity is dependent on macroeconomic and credit conditions. The financial crisis of 2007–2008 serves as a useful event for this test as it was a "credit crunch" that significantly contracted the supply of bank loans (Ivashina and Scharfstein 2010; Santos 2011). The association between the crisis and debt maturity structure has been shown in Almeida et al. (2011), who find that firms with debt maturing right after the third quarter of 2007 cut their quarterly investment rates by 2.5%. It can be argued that the refinancing and liquidity risks associated with short-term debt

[21] This finding also helps address the concern that, due to the negative relation between leverage and short-maturity debt and a negative association between leverage and IPOs, our results regarding the impact of IPOs on debt maturity simply reflect a leverage effect. Our analysis rules out this interpretation because we find evidence of a robust positive impact of the listing status on debt maturity after controlling for leverage in both our baseline and 2SLS regressions.

were most severe during the crisis period, having drastic effects on real corporate behavior. Accordingly, we hypothesize that IPO firms had greater incentives to reduce their short-term debt and exposure to those risks during the crisis. To test this hypothesis, we examine two subsamples of firms that went public over two different periods, namely the crisis period of 2007–2008 and the non-crisis period.[22]

Table 9 summarizes the regression results. In Column (1), the effect of IPOs on debt maturity during the crisis was significant until IPO+3 as firms reduced the short-term debt ratio by 20.2%–32% each year between the IPO and IPO+3 years.[23] However, the results for the non-crisis period in Column (2) show that the IPO effect is only significant up to IPO+2, with significantly smaller magnitudes, as confirmed by the Chow test. In Columns (3) and (4), we find that after going public, firms reduced their short-term debt ratio drastically by 20.6% over the crisis period, but only by 2.9% in the non-crisis period. The difference of 17.7% in the D_{Post_IPO} dummy variable between the two periods is also statistically significant according to the Chow test. In sum, our results provide evidence of a more pronounced IPO effect on debt maturity during the crisis. This is consistent with the prediction that IPO firms sought to lengthen their debt maturity more significantly as they were more concerned about the severe refinancing and liquidity risks during the crisis.

[INSERT TABLE 9 HERE]

9. Conclusion

We investigate the effect of IPOs on debt maturity structures for a sample of US firms that went public between 1998 and 2011. Based on agency theories and asymmetric

[22] The results remain qualitatively the same if we define the crisis period as 2007–2009.
[23] In (unreported) results, we find that the short-term debt to total assets ratio decreased by 1.7%, while the long-term debt to total assets ratio increased by 2.4% during the crisis period.

information models, we hypothesize that after going public, firms have longer debt maturity structures as they have less incentive to use short-term debt and greater access to long-term borrowings. Our results provide strong support for this hypothesis as we document a permanent drop of 2.5% (or 7% relative to the pre-IPO level) in the short-term debt ratio post-IPO. The IPO effect on debt maturity seems to be most pronounced in the first few years after the IPO. In the IPO and IPO+1 years, firms reduce their short-term debt ratio by about 7%, which represents nearly a fifth of the short-term debt ratio pre-IPO. These results are robust to using the incremental financing approach, and the difference-in-differences estimator controlling for omitted time trends and unobserved differences between IPO and non-IPO firms.

We also find that the IPO effect on debt maturity is only evident in small and high-growth firms, which is consistent with the argument based on asymmetric information. Further, the negative relation between IPOs and short-term debt is only seen in firms with high leverage and those with a high dilution ratio (i.e., a measure of agency costs of equity). The former finding is inconsistent with the argument based on the agency costs of debt, while the latter is in line with the argument based on the agency costs of equity.

Our empirical findings continue to hold in additional tests in which we control for the endogeneity associated with the listing decision and the simultaneity bias due to the joint determination of leverage and debt maturity. Finally, we show that the negative IPO effect on debt maturity varies with macroeconomic conditions: it was magnified by credit shocks during the financial crisis of 2007–2008.

Overall, our study provides new evidence on the evolution of debt maturity over the life cycle of a company. It highlights a significant impact, both in the short and long run, of the decision to go public on the choice of debt maturity structure post-IPO. Hence, our paper also contributes to a broader discussion following Jensen's (1989) critique of public

corporations.[24] Our results compliment recent studies in documenting the benefits of going public, including the greater ability to take advantage of growth opportunities (Mortal and Reisel 2013), especially conventional investment projects (Ferreira et al. 2014), and the ability to innovate in industries with greater need for external finance (Acharya and Xu 2015). Our evidence of the positive IPO effect on debt maturity suggests that another benefit of listing is to gain access to long-term borrowings, which is useful for firms wishing to pursue long-term investment projects but having limited access and exposure to financial markets. To the extent that long-term investment projects are important to high-growth firms operating in R&D intensive industries such as computers, electronics, biotechnology, and pharmaceuticals (Jensen 1989), our study thus shows that listing can be particularly beneficial for such firms.

[24] See the Economist "The endangered public company" and "The big engine that couldn't". 19 May 2012. Available at: http://www.economist.com/node/21555552 and http://www.economist.com/node/21555552 (Access: 27 March 2015).

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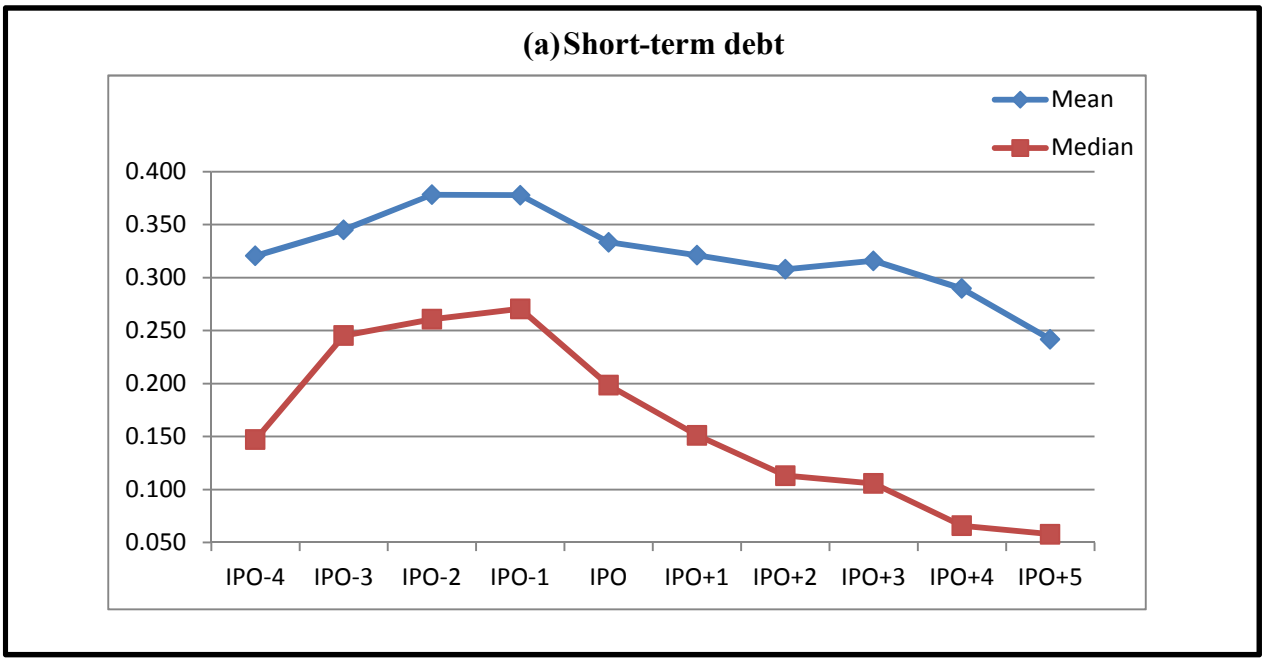
Figure 1: Evolution of short-term debt and leverage

This figure illustrates the evolution of the short-term debt and leverage ratios of our sample of US firms that did an IPO during the period 1998–2011.



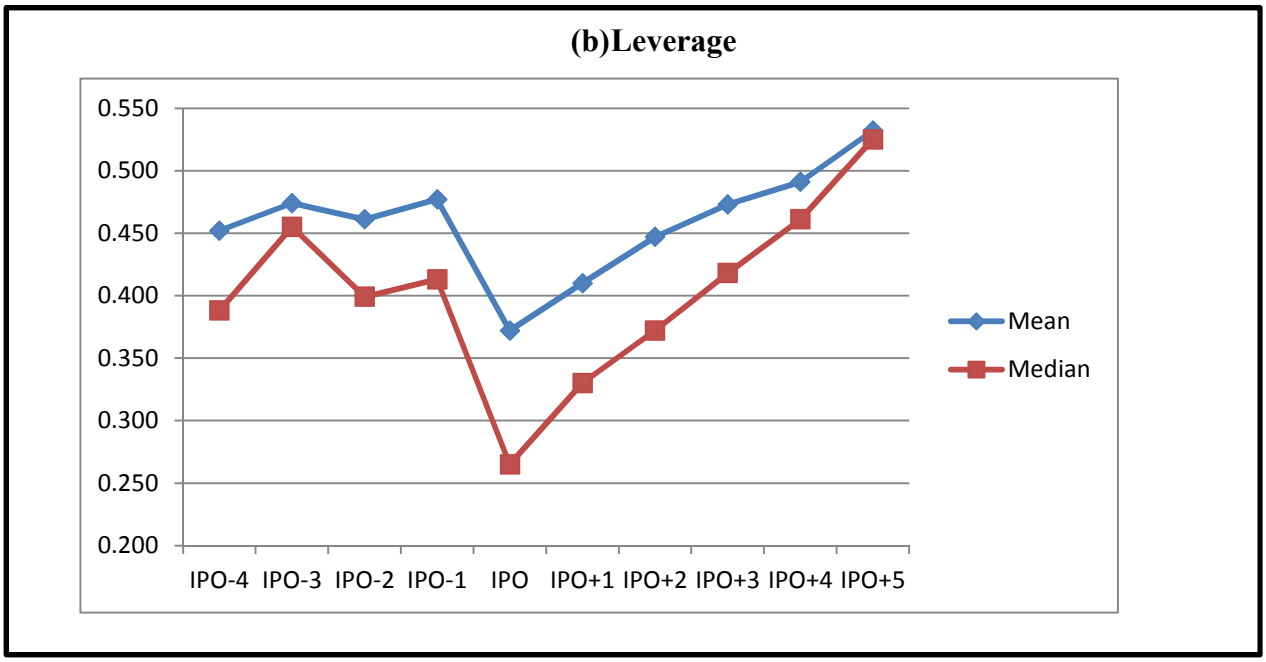


Table 1: Summary statistics

The table reports the summary statistics, including the mean, median, standard deviation (std dev.), minimum (min), and maximum (max) of the variables. Our sample consists of 9,562 firm-year observations covering the period 1994–2012. Short-term debt is measured by short-term borrowings plus the current portion of long-term debt divided by total debt. Asset maturity is long term assets divided by total assets. Firm-level volatility is the difference between the absolute value of the annual change in earnings (EBITD) and the average earnings change. Growth opportunities is measured by sales growth. Leverage is short-term debt plus long term debt divided by total assets. Size is the natural logarithm of total sales. Term structure is the difference between the (month-end) yields on ten-year government bonds and six-month treasury bills. Panel A presents the summary statistics for the full sample. Panel B reports the summary statistics for the periods pre- and post-IPO. Here we also report the p-values of the t-test for differences in means.

Panel A: Full sample

Variable	Mean	Median	Std dev.	Min	Max
Short-term debt (%)	0.302	0.117	0.358	0.000	1.000
Asset maturity	0.340	0.201	0.328	0.000	1.000
Firm-level volatility	21.685	5.761	58.301	-68.612	325.046
Growth opportunities (%)	0.795	0.185	2.516	-0.900	19.486
Leverage (%)	0.473	0.433	0.354	0.000	1.000
Size	4.995	5.158	2.156	-4.106	9.251
Size squared	29.603	26.601	20.570	0.020	85.701
Term structure	1.465	1.650	1.364	-0.580	3.650

Panel B: Sub-sample periods

	Pre-IPO					Post-IPO					
Variable	Mean	Median	Std dev.	Min	Max	Mean	Median	Std dev.	Min	Max	Mean test (p-value)
Short-term debt (%)	0.360	0.228	0.364	0.000	1.000	0.275	0.080	0.352	0.000	1.000	0.000
Leverage (%)	0.457	0.400	0.347	0.000	1.000	0.481	0.445	0.358	0.000	1.000	0.000

Table 2: Univariate analysis

This table reports the results for our univariate tests. Panel A examines the evolution of the short-term debt ratio reporting the p-values of the t-test for differences in means and those of the Wilcoxon-Mann-Whitney test for differences in medians. Panel B reports the summary statistics of short-term and long-term debt, scaled by total assets and the p-values of the tests for differences in means.

Panel A: Evolution of short-term debt

	Time period		Mean/Median test (p-value)
[Pre, Post]	Pre -IPO	Post-IPO	
Mean	0.360	0.275	0.000
Median	0.228	0.080	0.000
[Pre, IPO]	Pre-IPO	IPO	
Mean	0.360	0.333	0.016
Median	0.228	0.199	0.001
[Pre, IPO+1]	Pre-IPO	IPO+1	
Mean	0.360	0.321	0.001
Median	0.228	0.151	0.000
[Pre, IPO+2]	Pre-IPO	IPO+2	
Mean	0.360	0.308	0.000
Median	0.228	0.113	0.000
[Pre, IPO+3]	Pre-IPO	IPO+3	
Mean	0.360	0.316	0.001
Median	0.228	0.106	0.000

Panel B: Short-term debt and long-term debt pre- and post-IPO

	Pre-IPO	Post-IPO	Mean test (p-value)
Short-term debt/total assets	0.063	0.037	0.000
Long-term debt/total assets	0.204	0.216	0.009

Table 3: Baseline regression results

The table reports the baseline regression results regarding the effect of IPOs on debt maturity structures. The dependent variable is the short-term debt ratio, measured by short-term borrowings plus the current portion of long-term debt divided by total debt. D_{IPO} is a dummy variable that takes the value of 1 in the IPO year, and 0 otherwise. D_{IPO+i} with i=1..3 is a dummy variable that takes the value of 1 in the IPO+i year, and 0 otherwise. D_{Post_IPO} is a dummy variable that takes the value of 1 from the IPO year onward, and 0 in the years pre-IPO. The control variables are defined as follows. Asset maturity is long term assets divided by total assets. Firm-level volatility is the difference between the absolute value of the annual change in earnings (EBITD) and the average earnings change. Growth opportunities is measured by sales growth. Leverage is short-term debt plus long term debt divided by total assets. Size is the natural logarithm of total sales. Term structure is the difference between the (month-end) yields on ten-year government bonds and six-month treasury bills. Industry effects are proxied by 48 Fama-French industry dummy variables. T-statistics are reported in parentheses. Standard errors are heteroskedasticity-consistent. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
D_{IPO}	-0.0371***		-0.0459***		-0.0227**	
	(-3.02)		(-3.86)		(-1.97)	
D_{IPO+1}	-0.0300**		-0.0379***		-0.0198*	
	(-2.36)		(-3.22)		(-1.65)	
D_{IPO+2}	-0.0194		-0.0261**		-0.0044	
	(-1.41)		(-2.06)		(-0.32)	
D_{IPO+3}	-0.0022		-0.0136		0.0018	
	(-0.15)		(-0.98)		(0.11)	
$D_{Post\ IPO}$		-0.0247***		-0.0368***		-0.0157*
		(-2.95)		(-5.14)		(-1.77)
Asset maturity	-0.1020***	-0.0813***	-0.1030***	-0.0850***	-0.0044	0.0102
	(-12.14)	(-13.64)	(-13.03)	(-14.86)	(-0.15)	(0.52)
Firm-level volatility	9.30×10^{-5}	$8.90\times10^{-5*}$	6.10×10^{-5}	6.30×10^{-5}	7.83×10^{-6}	3.50×10^{-5}
	(1.26)	(1.86)	(0.84)	(1.35)	(0.08)	(0.64)
Growth opportunities	-0.0018	-0.0013	-0.0014	-0.0009	-0.0017	-0.0035**
	(-1.17)	(-0.88)	(-0.89)	(-0.63)	(-1.18)	(-2.43)
Leverage	-0.3550***	-0.3430***	-0.3630***	-0.3510***	-0.2510***	-0.2830***
	(-27.33)	(-33.96)	(-29.44)	(-36.44)	(-12.40)	(-18.62)
Size	-0.0221***	-0.0320***	-0.0225***	-0.0312***	0.0187**	0.0072
	(-3.67)	(-6.07)	(-3.80)	(-6.02)	(2.13)	(0.94)
Size-squared	-0.0019***	-0.0009*	-0.0018***	-0.0008	-0.0049***	-0.0039***
	(-3.15)	(-1.82)	(-2.95)	(-1.64)	(-4.21)	(-4.54)
Term structure	0.0099*	0.0005	0.0079***	0.0080***	0.0124***	0.0091***
	(1.65)	(0.11)	(2.67)	(3.40)	(4.63)	(4.31)
Intercept	0.6740***	0.6940***	0.7020***	0.7030***	0.4820***	0.5110***
	(18.96)	(24.17)	(45.86)	(50.65)	(15.91)	(21.00)
Industry effects	Yes	Yes	No	No	No	No
Year effects	Yes	Yes	No	No	No	No
Firm effects	No	No	No	No	Yes	Yes
N	6,092	9,562	6,092	9,562	6,092	9,562
Adj. R-squared	0.301	0.298	0.281	0.282	0.251	0.256

Table 4: Robustness checks using the incremental approach and difference-in-differences estimator

This table reports two main robustness checks. In Column (1), we examine the effect of IPOs on the maturity structures of new debt issued by the IPO firms. In Columns (2), we use the balance sheet approach as in Table 3 but now perform a difference-in-differences analysis for a sample of treatment (IPO) and matched control (non-IPO) firms. We use one-to-*n* matching with replacement to identify matching firm-year observations. For a firm-year observation in the treatment group, we find matching firm-year observations that are in the same industry and year (i.e., the IPO−1 year), and are similar in size and growth opportunities (allowing for a deviation of 30%). For the treatment IPO firms, D_{Post_IPO*} is a dummy variable that takes the value of 1 from the IPO year onward, and 0 pre-IPO. For the control non-IPO firms, D_{Post_IPO*} is a dummy variable that takes the value of 1 from the (counterfactual) *hypothetical* IPO year onward, and 0 in the years before the *hypothetical* IPO event. The IPO_{firms} is a dummy takes the value of 1 for IPO firms (treatment group), and 0 for non-IPO firms (control group). Other variable definitions are provided in the appendix and the notes to Table 3. Standard errors are heteroskedasticity-consistent. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	(1)	(2)
$D_{Post\ IPO}$	-0.0352***	
	(-2.92)	
$D_{Post\ IPO*}$		0.0700**
		(2.25)
IPO_{firms}		0.1284***
		(5.92)
$D_{Post\ IPO*} \times IPO_{firms}$		-0.0914***
		(-2.76)
Asset maturity	-0.0584***	-0.0848***
	(-7.23)	(-7.36)
Firm-level volatility	-0.0002***	0.0001
	(-2.84)	(1.18)
Growth opportunities	-0.0029*	-0.0040
	(-1.75)	(-0.69)
Leverage	-0.2058***	-0.3607***
	(-14.45)	(-20.24)
Size	0.0058	-0.0412***
	(0.85)	(-2.66)
Size-squared	5.04×10^{-5}	4.50×10^{-5}
	(0.07)	(0.03)
Term structure	0.0057	0.0184***
	(0.97)	(2.65)
Intercept	0.3780***	0.5515***
	(6.44)	(9.76)
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	7,302	3,248
Adj. R-squared	0.089	0.283

Table 5: Firm characteristics and the effect of IPOs on debt maturity

The table presents the effect of IPOs on debt maturity conditional on firm size, growth opportunities, and leverage. Columns (1)–(4) present the models for the two sub-samples of firms with above and below the median of size. Columns (5)–(8) present the models for the two sub-samples of firms with above and below the median of growth opportunities. Columns (9)–(12) present the models for the two sub-samples of firms with above and below the median of leverage. Variable definitions are provided in the appendix and the notes to Table 3. T-statistics are reported in parentheses. Standard errors are heteroskedasticity-consistent. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	Firm size				Growth opportunities				Leverage			
	Small (1)	Large (2)	Small (3)	Large (4)	Low (5)	High (6)	Low (7)	High (8)	Low (9)	High (10)	Low (11)	High (12)
D_{IPO}	-0.0600***	-0.0095			-0.0239	-0.0492***			-0.0243	-0.0626***		
	(-3.31)	(-0.58)			(-1.29)	(-2.96)			(-1.33)	(-4.22)		
D_{IPO+1}	-0.0422**	-0.0183			-0.0085	-0.0516***			-0.0186	-0.0503***		
	(-2.03)	(-1.19)			(-0.46)	(-2.89)			(-0.94)	(-3.30)		
D_{IPO+2}	-0.0398*	0.0008			-0.0034	-0.0369			-0.0031	-0.0439***		
	(-1.67)	(0.05)			(-0.19)	(-1.58)			(-0.13)	(-2.89)		
D_{IPO+3}	0.0132	-0.0090			0.0123	-0.0128			0.0216	-0.0248		
	(0.49)	(-0.54)			(0.67)	(-0.51)			(0.86)	(-1.50)		
D_{Post_IPO}			-0.0362***	-0.0072			-0.0052	-0.0376***			-0.0228*	-0.0367***
			(-2.91)	(-0.67)			(-0.41)	(-3.31)			(-1.78)	(-3.56)
Asset maturity	-0.1493***	-0.0733***	-0.1365***	-0.0429***	-0.0819***	-0.1293***	-0.0549***	-0.1094***	-0.1642***	-0.0645***	-0.1500***	-0.0496***
	(-9.16)	(-7.72)	(-10.56)	(-5.54)	(-7.09)	(-9.98)	(-5.65)	(-10.30)	(-8.51)	(-7.37)	(-10.38)	(-8.64)
Firm-level volatility	-4.58×10^{-5}	-4.35×10^{-5}	-0.0004*	-1.11×10^{-5}	0.0001	3.19×10^{-5}	6.07×10^{-5}	8.67×10^{-5}	0.0002	6.01×10^{-5}	0.0003**	8.76×10^{-6}
	(-0.15)	(-0.58)	(-1.78)	(-0.20)	(1.08)	(0.27)	(0.76)	(0.92)	(1.34)	(0.91)	(2.36)	(0.22)
Growth opportunities	-0.0024	0.0009	-0.0021	0.0028	-0.0059	-0.0019	-0.0392	-0.0016	-0.0025	-0.0014	-0.0021	-0.0024
	(-1.40)	(0.27)	(-1.34)	(0.82)	(-0.18)	(-1.13)	(-1.48)	(-1.13)	(-1.30)	(-0.59)	(-1.14)	(-1.09)
Leverage	-0.3228***	-0.3532***	-0.3665***	-0.2926***	-0.3555***	-0.3473***	-0.3305***	-0.3488***	-0.6357***	-0.2126***	-0.5815***	-0.1802***
	(-14.25)	(-21.43)	(-22.49)	(-24.95)	(-19.83)	(-17.76)	(-24.57)	(-23.52)	(-10.33)	(-8.45)	(-14.12)	(-8.84)
Size	-0.0069	-0.1633***	-0.0012	-0.1140***	-0.0247***	-0.0189*	-0.0296***	-0.0323***	-0.0021	-0.0591***	-0.0049	-0.0731***
	(-0.81)	(-3.46)	(-0.18)	(-2.68)	(-2.94)	(-1.89)	(-4.74)	(-4.47)	(-0.26)	(-5.71)	(-0.74)	(-6.94)
Size-squared	-0.0029	0.0099***	-0.0058***	0.0069**	-0.0018**	-0.0017	-0.0014**	-0.0002	-0.0042***	0.0019**	-0.0043***	0.0034***
	(-1.49)	(2.92)	(-4.18)	(2.32)	(-2.28)	(-1.60)	(-2.35)	(-0.28)	(-4.33)	(1.99)	(-5.53)	(3.72)
Term structure	0.0439**	-0.0222	0.0394*	-0.0369**	-0.0081	0.0224	0.0408**	0.0013	0.0257**	-0.0020	0.0137*	0.0011
	(2.08)	(-1.40)	(1.93)	(-2.53)	(-0.48)	(1.09)	(2.02)	(0.07)	(2.33)	(-0.33)	(1.91)	(0.23)
Intercept	0.6079***	1.1230***	0.6121***	0.9070***	0.7160***	0.6611***	0.6246***	0.7209***	0.8155***	0.6100***	0.8320***	0.6059***
	(3.19)	(6.80)	(3.81)	(5.70)	(11.24)	(5.78)	(7.74)	(6.79)	(3.52)	(13.89)	(3.65)	(15.31)
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,046	3,046	4,781	4,781	3,046	3,046	4,781	4,781	3,046	3,046	4,781	4,781
Adj. R-squared	0.178	0.261	0.217	0.195	0.315	0.287	0.298	0.297	0.157	0.238	0.178	0.195

Table 6: IPO characteristics and the effect of IPOs on debt maturity

The table reports the effect of IPOs on debt maturity conditional on two IPO-related characteristics, namely the dilution ratio and the intended use of the IPO proceeds. In Columns (1)–(4), we sub-divide the sample into two sub-samples of firms with above and below the median of the dilution ratio, which is defined as proportion of primary shares to the total outstanding shares pre-IPO. In Columns (5)–(8), we sub-divide the sample according to the use of the IPO proceeds. 926 out of 1,712 firms declared that they would use the IPO proceeds to repay their debt. Variable definitions are provided in the appendix and the notes to Table 3. T-statistics are reported in parentheses. Standard errors are heteroskedasticity-consistent. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	Dilution ratio				Use of IPO proceeds			
	Low dilution (1)	High dilution (2)	Low dilution (3)	High dilution (4)	Repay debts (5)	Do not repay debts (6)	Repay debts (7)	Do not repay debts (8)
D_{IPO}	-0.0071	-0.0527**			-0.0429***	-0.0328		
	(-0.32)	(-2.37)			(-2.89)	(-1.55)		
D_{IPO+1}	-0.0219	-0.0475**			-0.0283*	-0.0411*		
	(-0.93)	(-2.17)			(-1.90)	(-1.76)		
D_{IPO+2}	0.0011	-0.0287			-0.0141	-0.0359		
	(0.05)	(-1.21)			(-0.89)	(-1.35)		
D_{IPO+3}	0.0163	-0.0088			-0.0097	-0.0058		
	(0.62)	(-0.34)			(-0.57)	(-0.21)		
D_{Post_IPO}			-0.0075	-0.0378**			-0.0241**	-0.0335**
			(-0.51)	(-2.53)			(-2.45)	(-2.13)
Asset maturity	-0.0875***	-0.1164***	-0.0629***	-0.0909***	-0.1050***	-0.0839***	-0.0815***	-0.0524***
	(-5.31)	(-8.07)	(-5.47)	(-8.89)	(-11.70)	(-3.69)	(-13.09)	(-2.94)
Firm-level volatility	-0.0002*	0.0004**	-9.20×10^{-5}	0.0002**	0.0001*	-0.0004***	$9.20\times10^{-5*}$	-0.0003**
	(-1.83)	(2.44)	(-1.06)	(2.57)	(1.82)	(-2.79)	(1.83)	(-2.04)
Growth opportunities	0.0049*	-0.0047*	0.0044*	-0.0035	-0.0035	-0.0004	-0.0024	-0.0004
	(1.88)	(-1.66)	(1.73)	(-1.41)	(-1.49)	(-0.21)	(-1.15)	(-0.18)
Leverage	-0.3819***	-0.3553***	-0.3442***	-0.3530***	-0.3660***	-0.3110***	-0.3370***	-0.3330***
	(-16.53)	(-15.13)	(-19.59)	(-19.35)	(-23.70)	(-11.88)	(-28.49)	(-15.95)
Size	-0.0236**	-0.0028	-0.0305***	-0.0179**	-0.0489***	-0.0019	-0.0497***	-0.0061
	(-2.08)	(-0.32)	(-3.02)	(-2.39)	(-4.58)	(-0.23)	(-5.67)	(-0.79)
Size-squared	-0.0013	-0.0045***	-0.0009	-0.0027***	0.0008	-0.0036***	0.0012	-0.0042***
	(-1.13)	(-4.75)	(-0.92)	(-3.52)	(0.78)	(-3.42)	(1.50)	(-4.60)
Term structure	0.0129	-0.0017	0.0035	-0.0014	0.0031	0.0299**	5.02×10^{-5}	0.0116
	(1.40)	(-0.15)	(0.47)	(-0.18)	(0.47)	(2.24)	(0.01)	(1.27)
Intercept	0.7060***	0.6775***	0.7293***	0.6881***	0.7110***	0.6470***	0.6760***	0.7080***
	(3.95)	(14.28)	(4.08)	(19.52)	(17.97)	(8.02)	(21.39)	(9.15)
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,923	1,935	3,023	3,036	3,745	2,347	6,235	3,327
Adj. R-squared	0.303	0.345	0.293	0.334	0.320	0.203	0.297	0.216

Table 7: Dealing with sample selection and endogeneity

The table reports the results from the treatment regression in which D_{Post_IPO} is considered to be endogenous; D_{Post_IPO} is a dummy variable that takes value of 1 from the IPO year onward, and 0 otherwise. The sample includes both IPO firms and private firms that never went public. It consists of 9,562 IPO firm-year observations (1,712 firms) and 1,169 non-IPO (private) firm-year observations (761 firms). Column (1) presents the first-stage (probit) regression results in which probability, measured as return on assets, is used as an instrument for D_{Post_IPO}. Column (2) presents the second-stage regression results obtained using the maximum likelihood estimator. Here the dependent variable is short-term debt, measured by short-term borrowings plus the current portion of long-term debt divided by total debt. All other variables are defined in the appendix and the notes to Table 3. T-statistics are reported in parentheses. Standard errors are heteroskedasticity-consistent. χ-test is the statistics from the Rho (Chi-squared) test of endogeneity under the null of exogeneity. P-values are reported in the square brackets. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	(1)	(2)
D_{Post_IPO}		-0.0764^{***}
		(-3.64)
Asset maturity	0.0585^{**}	-0.0881^{***}
	(2.02)	(-14.47)
Firm-level volatility	-0.0002^{***}	$5.42\times10^{-5***}$
	(-3.09)	(3.44)
Growth opportunities	-0.0034	-0.0034^{**}
	(-0.60)	(-2.33)
Leverage	0.1095^{***}	-0.3958^{***}
	(2.63)	(-40.54)
Size	0.1977^{***}	-0.0384^{***}
	(7.75)	(-7.20)
Size-squared	0.0019	-0.0019^{***}
	(0.75)	(-3.69)
Term structure	0.1212^{***}	0.0206^{***}
	(12.51)	(5.21)
Profitability	-0.2258^{***}	
	(-8.10)	
Intercept	-0.9690^{***}	0.8452^{***}
	(-15.12)	(29.35)
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	10,731	10,731
Rho (χ-test)		-0.1292^{***}
		[0.000]

Table 8: Joint determination of debt maturity and leverage

This table reports the results from the two-stage least square regression that deals with the joint determination of debt maturity and leverage. Columns (1), (3), (5), and (7) report the first-stage regression results, in which we use either tangibility, measured as property, plant and equipment, divided by total assets (Columns (1) and (3)), or the effective tax rate, measured as income tax expense over earning before tax (EBT) (Columns (5) and (7)) as an instrument for leverage. Columns (2), (4), (6), and (8) report the results from the second-stage regression, in which the dependent variable is short-term debt, measured by short-term borrowings plus the current portion of long-term debt divided by total debt. In the second stage, the fitted values of leverage estimated from the first stage are used. All other variables are defined in the appendix and the notes to Table 3. T-statistics are reported in parentheses. Standard errors are heteroskedasticity-consistent. χ-test statistics is the statistics from the Chi-squared test of endogeneity under the null of exogeneity. *F*-test is the statistics from the *F*-test of instrument validity under the null that the instruments are insignificant in the first-stage regression. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	Model 1		Model 2		Model 1		Model 2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage		-1.1490***		-0.8610***		-1.3248***		-1.2213***
		(-8.03)		(-11.61)		(-3.27)		(-2.66)
D_{IPO}	-0.1002***	-0.1210***			-0.0843***	-0.1214***		
	(-4.62)	(-4.12)			(-5.82)	(-3.09)		
D_{IPO+1}	-0.0728***	-0.0964***			-0.0698***	-0.1035***		
	(-3.35)	(-3.55)			(-4.67)	(-2.92)		
D_{IPO+2}	-0.0537**	-0.0765***			-0.0551***	-0.0774**		
	(-2.36)	(-2.94)			(-3.38)	(-2.40)		
D_{IPO+3}	-0.0650**	-0.0650**			-0.0369**	-0.0625**		
	(-2.30)	(-2.34)			(-2.11)	(-2.16)		
D_{Post_IPO}			-0.0715***	-0.0715***			-0.0624***	-0.0889***
			(-5.05)	(-4.66)			(-6.22)	(-2.80)
Asset maturity	0.0004***	-2.00×10^{-5}	0.0005***	-0.0001	0.1649***	0.0585	0.1692***	0.0724
	(2.98)	(-0.17)	(3.80)	(-1.35)	(15.52)	(0.86)	(20.79)	(0.93)
Firm-level volatility	-0.0005***	-0.0005***	-0.0004***	-0.0002**	-0.0005***	-0.0003	-0.0004***	-0.0003
	(-3.94)	(-3.37)	(-4.40)	(-2.44)	(-4.69)	(-1.41)	(-5.69)	(-1.32)
Growth opportunities	-0.0013	-0.0067*	-0.0016	-0.0051*	-0.0008	-0.0013	-0.0018	-0.0019
	(-0.47)	(-1.85)	(-0.65)	(-1.82)	(-0.49)	(-0.52)	(-1.18)	(-0.78)
Size	0.0651***	-0.0174	0.0678***	-0.0499***	0.0167***	-0.0087	0.0209***	-0.0176
	(5.66)	(-0.91)	(7.12)	(-3.42)	(2.90)	(-0.80)	(4.11)	(-1.45)
Size-squared	-0.0016	0.0021	-0.0019**	0.0038***	0.0020***	0.0004	0.0015***	0.0012
	(-1.34)	(1.36)	(-2.13)	(3.20)	(3.09)	(0.36)	(2.74)	(1.17)
Term structure	0.0062	0.0142	0.0210***	0.0152**	0.0084	0.0153	0.0345***	0.0284
	(0.60)	(1.20)	(3.04)	(2.10)	(1.08)	(1.29)	(6.58)	(1.63)
Tangibility	0.1069***		0.1216***					
	(8.10)		(12.74)					
Effective tax					8.00×10^{-5***}		3.00 ×10^{-5**}	
					(2.73)		(2.23)	
Intercept	0.4482***	1.0210***	0.4395***	0.9410***	0.5593***	1.2257***	0.4791***	1.0977***
	(3.43)	(9.01)	(3.55)	(13.57)	(8.95)	(5.21)	(8.83)	(4.87)
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,320	2,320	3,827	3,827	4,460	4,460	6,881	6,881
χ-test	55.58***		60.16***		6.30***		12.31***	
F-test	61.82***		158.29***		7.47***		4.99***	

Table 9: Credit conditions and the effect of IPOs on debt maturity

This table reports the regression results of the effect of IPOs on debt maturity conditional on whether the IPO took place during the recent financial crisis of 2007–2008. All other variables are defined in the appendix and the notes to Table 3. T-statistics are reported in parentheses. Standard errors are heteroskedasticity-consistent. P-values of the F-statistics obtained using the Chow test for differences in the coefficient estimates are reported in square brackets. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	Crisis period	Non-crisis period	Crisis period	Non-crisis period	F-stat of Chow test	F-stat of Chow test
	(1)	(2)	(3)	(4)	(1-2)	(3-4)
D_{IPO}	-0.2024**	-0.0352**			3.44*	
	(-2.49)	(-2.57)			[0.064]	
D_{IPO+1}	-0.3017**	-0.0322**			4.47**	
	(-2.49)	(-2.28)			[0.035]	
D_{IPO+2}	-0.3068**	-0.0268*			3.41*	
	(-2.08)	(-1.77)			[0.065]	
D_{IPO+3}	-0.3195*	-0.0078			3.12*	
	(-1.85)	(-0.49)			[0.078]	
$D_{Post\ IPO}$			-0.2059**	-0.0285***		3.88**
			(-2.55)	(-3.12)		[0.049]
Asset maturity	-0.1317***	-0.0998***	-0.1161***	-0.0799***		
	(-6.09)	(-9.18)	(-6.03)	(-10.35)		
Firm-level volatility	3.34×10^{-5}	8.74×10^{-5}	3.72×10^{-5}	8.47×10^{-5}		
	(0.16)	(0.94)	(0.22)	(1.34)		
Growth opportunities	-0.0021	-0.0016	-0.0006	-0.0012		
	(-0.44)	(-1.05)	(-0.14)	(-0.87)		
Leverage	-0.3031***	-0.3552***	-0.2970***	-0.3436***		
	(-8.73)	(-25.62)	(-9.45)	(-32.85)		
Size	-0.0395***	-0.0186***	-0.0440***	-0.0291***		
	(-3.10)	(-3.19)	(-3.66)	(-6.06)		
Size-squared	-0.0012	-0.0021***	-0.0009	-0.0010**		
	(-0.85)	(-3.21)	(-0.65)	(-2.05)		
Term structure	0.0068	0.0070	0.0636***	0.0051		
	(0.35)	(0.87)	(2.68)	(1.11)		
Intercept	0.8427***	0.6322***	0.8779***	0.6370***		
	(7.06)	(10.36)	(7.39)	(12.27)		
Industry effects	Yes	Yes	Yes	Yes		
Year effects	Yes	Yes	Yes	Yes		
N	726	5,366	851	8,711		
Adj. R-squared	0.419	0.293	0.407	0.296		

Appendix

Variable Definitions

This table provides a description of our variables. Data on all variables are from the S&P Capital IQ database, with the exception of term structure, which is retrieved from the Federal Reserve Bank of St. Louis website.

Variable	Definition
Short-term debt	Short-term borrowings plus the current portion of long-term debt divided by total debt
D_{IPO}	Dummy variable that takes the value of 1 in the IPO year, and 0 otherwise
D_{IPO+1}	Dummy variable that takes the value of 1 in the IPO+1 year, and 0 otherwise
D_{IPO+2}	Dummy variable that takes the value of 1 in the IPO+2 year, and 0 otherwise
D_{IPO+3}	Dummy variable that takes the value of 1 in the IPO+3 year, and 0 otherwise
D_{Post_IPO}	Dummy variable that takes the value of 1 from the IPO year, onward, and 0 otherwise
Asset maturity	Long term assets divided by total assets
Firm level volatility	The difference between the absolute value of the annual change in earnings (EBITD) and the average change
Growth opportunities	Change in total sales divided by lagged sales
Leverage	Short-term debt plus long term debt divided by total assets
Size	Log of total sales
Term structure	The difference between the month-ends yields on ten-year government bonds and six-month treasury bills
Dilution ratio	Proportion of primary shares to the total outstanding shares pre-IPO
Profitability	Net income divided by total assets
Tangibility	Property, plant, and equipment divided by total assets
Effective tax rate	Income tax expense over earning before tax (EBT)