Econometrics Working Paper EWP0905

ISSN 1485-6441

Department of Economics

Capital Structures in an Emerging Market: A Duration Analysis of the Time Interval Between IPO and SEO in China*

Yang Ni
Queen's School of Business, Queen's University

Shasha Guo
BP Canada
&
David E. Giles
Department of Economics, University of Victoria

June 2009

Abstract
We model the durations between firms' "Initial Public Offerings" (IPOs) and their subsequent "Seasoned Equity Offerings" (SEOs) in China during the period from 1 January 2001 to 1 July 2006. Duration analysis is applied by using the nonparametric Kaplan-Meier estimator of the hazard function, and parametric accelerated failure time models with time-varying covariates. The results of this analysis have important implications for the capital structure in emerging markets. Our evidence on financing decisions in China contradicts the predictions of both the trade-off theory and the pecking order theory. Firms do not issue equity after debt financing to offset the deviation from the target leverage ratio. Profitability is negatively related to debt ratios. Limited access to the corporate bond market and the privilege of the low effective tax rate that local governments give to firms have increased the cost of debt and decreased the benefit of debt, and make firms in China under-utilize the tax shield of debt. The most surprising finding is that profitability is positively related to the conditional probability of equity financing. Firms may intentionally manipulate the earnings to minimize the adverse section costs associated with equity financing and to meet the earnings requirement of China Securities Regulatory Commission set for SEO qualifications. Market timing is an important consideration when firms in China undertake equity financing.

Keywords	Duration analysis; conditional hazard probability; capital structure; initial public offering; seasoned equity offering; China
JEL Classifications	C16; C41; G32

Author Contact:

David E. Giles, Dept. of Economics, University of Victoria, P.O. Box 1700, STN CSC, Victoria, B.C., Canada V8W 2Y2; e-mail: dgiles@uvic.ca; Phone: (250) 721-8540; FAX: (250) 721-6214

1. Introduction

An "Initial Public Offering" (IPO) is the first sale of common shares from a newly listed firm on a public stock exchange. A "Seasoned Equity Offering" (SEO) is a follow-on stock offering subsequent to the firm's IPO. In this paper, we model time intervals (durations, or spells) between firms' IPOs and their subsequent SEOs in China during the period from 1 January 2001 to 1 July 2006.

An analysis of the durations between firms' IPOs and their subsequent SEOs in China is essential to investors and researchers for several reasons. First, the finance literature documents that firms issuing SEOs underperform the market both in the short run and the long run. Asquith and Mullins (1986), Masulis and Korwar (1986), and Mikkelson and Partch (1986) find that firms experience an average price drop of 2% to 3% when the news of SEO becomes public in the U.S. market. Jegadeesh *et al*. (1993), Loughran and Ritter (1995, 1997), Spiess and Affleck-Graves (1995), Lee (1997), Ahn and Shivdasani (1999), Eckbo *et al*. (2000), and Carlson *et al*. (2006) document the fact that firms making SEOs continuously suffer poor post-issue stock performance over the subsequent three to five years, with a decline of about 3% to 4% per year under various benchmarks. The same evidence is found by Cai (1998), and Kang *et al*. (1999) in the Japanese market; Jeanneret (2000) in the French market; Stenle *et al*. (2000) in the German market; and Pastor and Martin (2004) in the Spanish market. Announcement effects and negative long-term abnormal returns also exist in the Chinese stock market. Tan and Wu (2003) find that the stock prices of firms announcing SEOs slip rapidly and generate a negative abnormal return of 3.54% on or around the announcement dates in China, and that returns remain negative for a considerable period.

Although the phenomenon of negative returns following SEOs is not new to the finance literature, there has been very little empirical work on the time intervals between firm's IPOs and their first SEOs. If the durations are defined as these time intervals, the hazards of these durations have the obvious implications of loss for investors because of underperformance of SEO firms both in the short run and the long run. An analysis of the Chinese stock market is of particular interest because of the high frequency of SEOs in the Chinese stock market. In China, many firms make SEOs to reach a higher level of capitalization soon after their IPOs. Thus, using duration models to identify factors that are significant determinants of the durations between firms' IPOs and their first SEOs is of great importance to investors.

Duration analysis also offers an ideal tool for testing the capital structure theory in finance. In a similar paper, Alti (2006) studies the debt financing of firms following IPOs. We focus on the next equity financing of firms following IPOs. SEOs are important equity financing events for firms, and in our duration analysis, the hazard probabilities of the durations from IPOs to SEOs are effectively the probabilities of equity financing. The finance literature offers two competing hypotheses to explain firms' capital structure. The first one is the trade-off model. According to the trade-off model, firms identify their optimal leverage ratios by weighing the costs and benefits of debt. The benefits of debt include the tax deductibility of interest and the reduction of agency conflicts between managers and stockholders, and the costs of debt include direct costs of financial distress and agency conflicts between stockholders and bondholders (Modigliani and Miller, 1963; Jensen and Meckling, 1976; Myers, 1977; Ross, 1977；Stulz, 1990; Hart and Moore, 1995). At the optimal point, the marginal benefits of debt just offset the marginal costs. Therefore, the trade-off theory predicts that there exists an optimal leverage ratio for each firm and the leverage ratio of each firm will be mean-reverting to its optimal debt ratio. In duration analysis, this implies a higher leverage ratio predicts a higher hazard probability of the duration from IPO to SEO (the probability of equity financing) in the next period to keep the leverage ratio mean-reverting to its optimal leverage ratio.

Myers and Majluf (1984) and Myers (1984) develop an alternative capital structure theory of the pecking order model. They suggest that managers' information about the value of a firm's securities and prospects are always superior to that of investors. Therefore, firms issue equities only when the managers believe their stocks are overvalued. The market interprets managers' actions rationally and corrects the equity price to its intrinsic value, on or around the announcement day. Because of these adverse selection costs, firms finance new investments first with retained earnings, then with debt, and equity is the last resort. Therefore, variation in a firm's leverage is driven by the firm's earning rather than the costs and benefits of debt in the trade-off model. In the duration analysis, this implies a higher earnings ratio or growth opportunity predicts a lower probability of equity financing to avoid the adverse selection costs. Thus, duration modeling offer us a good tool to test the trade-off and pecking order hypotheses by checking how financing decisions respond to variation in long term leverage, earning, and growth opportunities.

One unique feature of the Chinese capital market makes the duration model the ideal tool to test two competing capital structure hypothesis in that country. Hovakimian *et al*. (2004) suggest that studying only the probability of equity issues could be misleading, and they suggest analyzing the probability of debt *vs*. equity financing rather than the probability of equity financing only. We don't face this problem in this study, as the corporate bond market in China is very small and undeveloped.

Chinese firms find it almost impossible to make public debt financing in the local bond market, and they have to rely on banks for loans.

Duration models also have several advantages over the econometrics methods used in the previous capital structure literature. Some previous papers have used Ordinary Least Square (OLS) estimation. OLS is obviously inappropriate as the dependent variables, which are usually binary outcomes of issuing equity or not, are bounded within [0, 1]. Accordingly, other studies have used the logit or probit models, which focus on the unconditional probability of the event occurring. Duration models are superior to the unconditional models because they are concerned not only with the unconditional probability of a certain event will end in the next interval, but also with its conditional probability (that a certain event will end in the next interval given that it has already lasted to this point in time). Using unconditional probability model to predict whether firms will issue equity in the next period (usually the next year in the finance literature) neglects information about whether the firms have issued equity recently. It is possible that firms choose not to issue equity in the next period simply because they just undertook substantial equity financing very recently. Duration analysis can easily take this into consideration.

More importantly, unconditional probability models can use only the one period of accounting ratios to predict the financing decision of the firms in the next period. They fail to incorporate more accounting ratios from different periods to perform dynamic testing. Duration models can incorporate the accounting ratios in all of the time intervals to test for a changing of conditional hazard probability, which will reveal any dynamic relationship. Finally, as Fama and French (2002) point out, the most serious but unsolved problem in the empirical capital structure literature is understated standard errors that can arise in either cross-section regressions or panel regressions. They propose using the Fama and MacBeth (1973) method to address this problem. However, the Fama-MacBeth procedure is inefficient when the dependent variable suffers from an errors-in-variables problem. Duration models can include time-varying covariates as well as ones whose values are constant for the duration of the spells that are being analyzed. So, in addition to modeling the amount of time that elapses between IPOs and SEOs (rather than just modeling the probability that an SEO occurs), duration analysis facilitates the use of a very rich range of information. In addition to modeling the time intervals between IPOs and SEOs and testing the trade-off theory and pecking order theory in China, one of the contributions of this paper is that it is the first to adopt this superior type of statistical modeling to this particular area of the finance literature.

In our application, we first use the nonparametric Kaplan-Meier estimator to study the duration dependence without assuming a specific specification for the underlying distribution of the data. Then we set up a parametric model to identify the variables that affect the probability of an exit from the duration. The nonparametric Kaplan-Meier estimator helps us to understand the relationship between the probability of an exit and the time spent within the duration, and the parametric models which factors are significant in affecting the conditional probability of an exit from the duration. The results of both the nonparametric and parametric estimations can be used to predict the potential date of a firm's first SEO.

The finance literature has focused on extensive empirical testing in the context of developed countries, particularly the U.S.. Rajan and Zingales (1995) analyze the determinants of capital structures across the G-7 countries[1] and find that the insights from modern finance theory are portable across developed countries. Research into the determinants of capital structure in emerging markets has generally been neglected. A few studies that report international comparisons of capital structure determinants find the evidence supporting either the trade-off or pecking order theory. For example, Eldomiaty (2007) finds firms are adjusting long-term and short-term debts to their target level in Egypt, which lends support to the trade-off theory. On the other hand, Booth *et al*. (2001) provide evidence supporting the pecking order theory in ten developing countries. However, our results for China contradict the predictions of both the trade-off theory and pecking order theory. Firms do not issue equity after debt financing to offset the deviation from the target leverage ratio. Profitability is negatively related to debt ratios. Limited access to the corporate bond market and the privilege of effective low tax rate the local governments give to firms have increased the cost of debt and decreased the benefit of debt, and make firms in China under-utilize the tax shield of debt. The most surprising finding is that profitability is positively related to the conditional probability of equity financing. Firms may manipulate the earnings to minimize the adverse section costs associated with equity financing and meet the earnings requirement of China Securities Regulatory Commission (CSRC) set for SEO qualification. Market timing is an important consideration when firms in China make equity financing. As modern financing theory has been tested mainly with data from developed economies that have many similarities, our findings suggest that country-specific features could be important for capital structure choices in emerging markets.

The rest of this paper is ordered as follows. Section 2 summarizes the trade-off and pecking order models and their predications. Section 3 briefly introduces the history and development of the Chinese capital market. Section 4 introduces the econometric methods that we use. Section 5 deals with the sample selection, data sources and control variables that are included in the estimation. Section 6 provides our empirical results, and section 7 concludes.

2. Theoretical Background and Prediction

2.1. The trade-off theory

According to the trade-off theory, firms identify their optimal leverage ratios by weighing the benefits and costs of debt. The benefits of debt include the tax deductibility of interest and the reduction of agency conflicts between managers and stockholders. The costs of debt include direct costs of financial distress and agency conflicts between stockholders and bondholders. The interest on debt is deducted from pre-tax income. The benefit of deduction of interest from pre-tax income increases as the firm borrows more. At a moderate debt level, the tax advantages dominate and the probability of financial distress is trivial. But as the leverage ratio increases, the probability of financial distress grows and the bankruptcy cost will play a substantial role. At the optimal point, the marginal benefit of debt just offsets the marginal cost of debt. Thus, the trade-off theory predicts that there exists an optimal debt ratio for each firm and the leverage ratio of each firm will be mean-reverting to its optimal debt ratio. In duration analysis, this implies that a higher leverage ratio will result in a higher hazard probability for the duration from IPO to SEO in the next period, in order to keep the leverage ratio mean-reverting to its optimal debt ratio.

Here, we use the book leverage ratio to test the trade-off hypothesis. Book debt, D, is defined as the sum of the book value of total liabilities and preferred stock minus deferred taxes and convertible debt, and book leverage ratio, D/A, is defined as book debt divided by the book value of total assets. Alti (2006) finds that immediately after going public, hot-market firms increase their leverage ratios by issuing more debt and less equity relative to cold-market firms, and at the end of the second year following an IPO, the impact of market timing on leverage vanishes completely. This evidence gives strong support to the trade-off hypothesis. In our case, if a higher D/A predicts a higher hazard probability in the next period, which suggests that the firms tend to make equity financing immediately after debt financing, the result will be consistent with the finding of Alti (2006) and will provide further evidence favoring the trade-off hypothesis. However, if the duration between the IPO and SEO is unaffected by D/A, this would imply that the optimal leverage ratio doesn’t exist, suggesting in turn a minor role for the trade-off theory in the financing decision of the firms in China.

In addition to undertaking duration analysis, we also follow the tradition of debt ratio studies and estimate a model in which leverage is regressed on profitability and a set of control variables. The dependent variable in this regression is the leverage. The explanatory variable of interest is lagged profitability. The trade-off theory suggests that high profitability is associated with high leverage ratio. All other things equal, higher profitability implies potentially higher tax savings from debt, and lower probability of bankruptcy. However, the dynamic version of the trade-off theory (Fischer *et al*., 1989) implies that firms passively accumulate earnings and losses, letting their debt ratios deviate from the target as long as the costs of adjusting the debt ratio exceed the costs of having a sub-optimal capital structure. If so, firms that were highly profitable in the past are likely to be under-levered, while firms that experienced losses are likely to be over-levered. Under the dynamic trade-off hypothesis, the negative relation between profitability and observed leverage arises not because profitability affects target leverage, but because it affects the deviation from the target. In our analysis, we use the earnings variables of return on assets (ROA) and return on equity (ROE) to measure firms' profitability. Here, ROA, is defined as the net income divided by the book value of assets, and ROE is defined as the net income divided by the book value of equity.

2.2. The pecking order hypothesis

According to the pecking order hypothesis, the costs and benefits of debt are minor concerns when compared with the costs of issuing new securities. The latter include both transaction costs and adverse selection costs. Adverse selection arises as a result of information asymmetry between managers and investors. As discussed in section 1, Myers and Majluf (1984) suggest that managers always have better information than investors about the value of a firm's securities and its prospects. Thus, firms issue equity only when the managers believe that their stocks are overvalued. The market interprets managers' actions rationally and corrects the equity price to its intrinsic value on or around the announcement day. This also explains the negative return of SEO stocks at that time. Adverse selection costs are incurred only when firms issue securities, and they are lower for debt than for equity. As a result, firms finance new investments first with retained earnings, then with debt, and use equity as a last resort. The implication of the pecking order hypothesis is that firms with high profitability generate high retained earnings and use them to finance projects internally. Firms with lower profitability need external funds to finance their investments as they don't have sufficient internal funds.

In our duration analysis, this implies that a higher earnings ratio predicts a lower hazard probability of the duration from IPO to SEO in the next period, to avoid the adverse selection costs. The ideal earnings variable to test the pecking order hypothesis is the ratio of cash to short-term investments to the book value of assets (CASH/A), this being a measure of the firm's financing deficit. However, measures of this ratio are not available for many firms in China. Again,. we use ROA and ROE to measure firms' profitability. If the pecking order hypothesis holds in China, we should find that ROA and ROE are negatively related to the hazard probability of the duration in the next period and positively related to the time spell of the duration, as high profitability firms rely more on internal financing and less on outside equity financing.

The pecking order hypothesis also has implications for the leverage regression. The profitable firms will retain earnings and become less levered, while unprofitable firms will borrow and become more levered, thus creating a negative relation between profitability and observed leverage ratio in the next period. The original pecking order model of Myers and Majluf (1984) suggests that firms never issue equity. The dynamic version of the pecking order hypothesis (Lucas and McDonald, 1990) suggests that equity issues occur when adverse selection costs are low. Plausible proxies for the time-varying adverse selection costs are market performance, and market-to-book ratio (M/B) – the latter being defined as market value of equity divided by book value of equity.

Baker and Wurgler (2002) argue that neither the trade-off nor the pecking order theories are consistent with the negative effect of long-past market-to-book ratios on firm leverage, and the intention of the firms to exploit temporary fluctuations in the cost of equity is very strong. Thus, a firm is more likely to issue equity when its relative market values are high, and to repurchase equity when its relative market value is low. Therefore, a firm's capital structure is the cumulative outcome of past attempts to time the equity market. The predictions of the market timing hypothesis of Baker and Wurgler (2002) share the same predictions as the pecking order hypothesis.

3. Background of the Chinese Capital Market

The Chinese capital market is relatively young. China began to reform its economy structure in the early 1980s. The government's intention in developing the capital market was to improve the efficiency of its State-owned Enterprises (SOEs), which were part of the government bureaucracy and enjoyed annual funding from the government. The two stock exchanges in mainland China, the Shanghai Stock Exchange and Shenzhen Stock Exchange, were established in 1990 and 1991 respectively. Since then, the Chinese stock market has experienced a remarkable growth. By January 2007, for example, the Chinese stock market had a market capitalization of over US$ 1.4 trillion, representing 116.13% of that country's GDP in 2006[2].

As the objective of establishing and developing stock markets in China was to raise capital to finance SOEs' investments, the greatest difficulty that the Chinese government faces is the trade-off between the issue volume and issue price. On one hand, the government desires to sell more shares in order to finance the investment in SOEs. On the other hand, the government is reluctant to sell more shares because of the concern that too large offering could cause stock prices to fall, which in turn could decrease the interest of the investors and attract political opposition to selling state-owned shares at a discount. Thus, the CSRC sets very stringent quotas on equity issues and regulates the equity issuing process.

As most listed Chinese firms were under-capitalized at their IPO, they prepared an SEO to reach a higher level of capitalization soon after the IPO issuance. Some managers in China view equity financing as essentially trouble free as equity financing doesn't require the coupon payments and principal repayments associated with debt financing. So they want an SEO regardless of their financial needs. Therefore, to protect the shareholders' interests, the CSRC issued a series of regulations on the qualification for an SEO. The most rigid regulation is the minimum ROE requirement, which developed as follows: in September 1994, a firm's three-year average ROE had to be no less than 10%; in January 1996, it had to be no less than 10% for each of previous three years; and in March 1999, a firm's three-year average ROE had to be no less than 10%, and no less than 6% for any of the three years. Another unique feature of the Chinese capital market is that the corporate bond market is very small and undeveloped. For example, while China's bond market was only 27% of GDP in 2006, only 6% of bonds, including commercial paper, were issued by non-financial firms. The corporate bond market provides only 1.4% of the total financial needs of firms in China[3]. Therefore, firms in China have to rely on banks for borrowing instead of the corporate bond market for public debt financing.

4. Econometric Methodology

Duration modeling has been widely used in many areas, including in economics and finance. For example, Lane *et al*. (1986), Cole and Gunther (1995), and Weelock and Wilson (1995) study the duration dependence of bank failures; Li (1999) examines the determinants of the length of time high yield debt issuing companies spend in Chapter 11 bankruptcy; Klein and Marion (1997) and Walti (2005) investigate the duration of exchange rate regimes in foreign exchange markets; Cumming and MacIntosh (2001), and Giot and Schwienbacher (2003) use survival analysis to model the venture capital duration; Leung *et al*. (2003) apply survival analysis to examine the entry of foreign banks in China; and Shih and Giles (2009) analyze of the duration of the spells associated with interest rate values in Canada under inflation targeting.

We now present some essential definitions for our duration analysis. We define T as the duration variable of interest, and t as the value of this random variable. Thus, the unconditional probability that duration T will be less than the value t is given by the cumulative distribution function, written as $F(t) = Pr(T < t)$. The corresponding density function is $f(t) = dF(t)/dt$. When analyzing duration data it is useful to specify the survival function, $S(t) = [1 - F(t)] = Pr(T \geq t)$, and another useful way of characterizing the distribution of T is *via* the hazard function:

$$\lambda(t) = \lim_{dt \to 0} \frac{\Pr(t < T < t + dt \mid T \geq t)}{dt} = \frac{f(t)}{S(t)}.$$

The hazard gives the probability that the duration T will terminate at time $T = t$, given that it has survived until time t. Roughly speaking, $\lambda(t)$ is the instantaneous rate at which durations will complete at t, given that they have lasted that long.

It is easy to show that $\lambda(t) = -dlnS(t)/dt$, and the hazard function provides a convenient way of identifying so-called "duration dependence". If $d\lambda(t)/d(t) > (<) 0$ at $t = t^*$, then a positive (negative) duration dependence exists at time t^*, implying that the probability that the duration will terminate increases (decreases) as the spell length increases. The condition $d\lambda(t)/dt = 0$ for all t defines the memory-less case, as exhibited by the exponential distribution. Hazard functions can be monotonic or non-monotonic in t, depending on the choice of distribution for the durations.

In this study we first use the well-known nonparametric method, the Kaplan and Meier (1958) product-limit estimator, which is useful for estimating the survival and hazard functions. This can be seen as a preliminary analysis in suggesting functional forms and specifying models as no assumptions have been made about the underlying distribution of T. A significant advantage of Kaplan-Meier estimation is that it doesn't have any assumption of distribution, thus avoiding any potential misspecification. However, a disadvantage is that it does not allow us to incorporate covariates (explanatory variables) into the model for the durations, and this limits the conclusions that be drawn from the analysis.

Suppose there are k completed spells in the sample of size n, and they are ordered as $t_1 < t_2 < \ldots\ldots <$ t_k. Due to censoring issues and possible "ties" in the data, k is generally less than n. Let h_j denote the number of completed spells of duration t_j (j = 1, 2… k). Let m_j represent the number of observations censored between t_j and t_{j+1} and m_k be the number of observations whose durations are greater than t_k, the longest complete duration. Let n_j be the number of spells that are neither completed nor censored before duration t_j. Therefore,

$$n_j = \sum_{i \geq j}^{k} (m_i + h_i) .$$

Recall that the hazard function $\lambda(t_j)$ is the rate at which spells are completed at duration t_j, given that the spells have reached duration t_j. A natural estimator of $\lambda(t_j)$ is $\hat{\lambda}(t_j) = (h_j/n_j)$, the ratio of the number of "failures" in duration t_j to the number of spells "at risk" at duration t_j. The Kaplan-Meier product limit estimator for the survival function is

$$\hat{s}(t_j) = \prod_{i=1}^{j} [(n_i - h_i)/n_i] = \prod_{i=1}^{j} (1 - \hat{\lambda}_i) ; \qquad j = 1, 2\ldots k.$$

An alternative way to proceed in duration analysis is to adopt parametric methods. This requires the underlying distribution of the data-generating process to be specified. We begin with some common hazard functions since the exact functional form of the hazard function is unknown, and we choose the most appropriate specification for describing the distribution data using formal model-selection criteria. A potential weakness of the parametric approach is that ultimately the underlying distribution may be mis-specified. However, it has a major advantage over the Kaplan-Meier method because covariates can be introduced into the model in a simple way. These explanatory variables can be of two types – "time-invariant" ones, whose values remain constant during a measured spell; and time-varying" covariates whose values change during the life of a spell. In the current context, an example of the former type of covariate would be the industrial sector for the company. Quarterly profits would be an example of the latter type of covariate.

Three parametric distributions are considered in this paper: Weibull, Log-Normal and Log-Logistic. Table 1 summarizes the probability density, survival and hazard functions for these three parametric distributions. Two unknown parameters θ (location) and p (shape) are involved in these distributions, and they can be estimated by the approach of the maximum likelihood. We usually set $\theta = \exp(-\beta' X_i)$, where X_i is a vector with values of the covariates at observation i, and β is the corresponding vector of coefficients. The Weibull distribution has a strictly monotonic hazard, while the Log-Normal and Log-Logistic distributions can have non-monotonic hazard functions. Regarding model specification, a general-to-specific modeling approach is followed. Akaike's information criterion (AIC) and the Bayesian information criterion (BIC) are used to select the preferred specification.

5. Sample Selection and Data

5.1. Identification of durations

In this study the spells are defined as the times between firms' IPOs and their first SEOs. As firms issue quarterly financial statements, we use quarters as the unit of time for the durations. For example, if a firm's IPO date is 10 January, 2001 and its first SEO date is 29 May, 2002, there are five complete quarters during this period (the March 2001, June 2001, September 2001, December 2001 and March 2002 quarters), and so the duration of this spell is identified as five periods.

5.2. Sample selection criteria

For inclusion in our sample, a spell has to satisfy the following criteria. First, the IPO should be completed between 1 January 2001 and 1 October 2004. The sample starts in 2001 because stocks in China were not required to issue quarterly financial statement before 2001. Thus, quarterly accounting data are not available before 2001. Our sample ends in October 2004 because after that date the Chinese government suspended IPO issuances to reform relevant policy. The first SEO in the sample occurred on 19 April, 2001, and the last SEO occurred on 22 May, 2006.

Second, only A shares are considered. There are two types of shares in the Chinese stock market: A shares and B shares. Most firms issue only A shares. The main difference between A shares and B shares is that the former are denominated in local currency (RMB) and were initially restricted to domestic investors, while B shares are denominated in a foreign currency (US$ or HK$) and were initially reserved for foreign investors. Compared with A shares, the B share market is small, illiquid, and full of poor-quality firms. For these reasons, we analyze only A shares.

Finally, firms that have been delisted, "special treated" (ST), or "particular treated" (PT) are excluded from the sample. In China, firms may be delisted, special treated and particular treated for either poor performance or financial statement fraud. These firms are either outliers or their financial statements are not reliable.[4] Accordingly, our sample consists of 159 firms and 969 quarterly observations.

5.3. Control variables

In addition to the variables that we use to test the capital structure theory, we also control for some firm and IPO characteristics. Controlling for these variables not only gives a precise estimate of the effects of the variables of interest in financing decision, but the signs of the control variables' coefficients themselves can also shed light on the two competing capital structure models.

First, we control for firm size, measured as the logarithm of the value of total assets. Large firms are more likely to obtain loans from banks because they are usually less risky. Second, we control for the IPO offering size, which is defined as the numbers of shares offered in the IPO, divided by all shares outstanding. When the IPO size is smaller, capital raised from the equity market may not be enough for the firm's growth or new investment projects. In this case, it may be urgent for the firm to make an SEO to reach a higher level of capitalization, which will lead to a spell of shorter duration. Third, we control for the proportion of state-owned shares - the number of shares owned by the state divided by all shares outstanding. As the primary objective of developing equity markets in China is to raise capital to finance SOEs, SOEs might make equity financing more frequent. But it is also possible that as firms with higher ratios of state-owned shares are usually very big, even a small *percentage* will result in a large *number* of shares being offered, which could cause a plunge in the whole stock market. Also, many firms with high ratios of state-owned shares are usually from regulated industries (such as the Communication, and Petroleum sectors) in China. With these concerns, the government may be reluctant to sell more shares to avoid a crash of the whole stock market and loss of control over firms. Thus, prior to our analysis, we don't have a prediction of the effect of the ratio of state-owned shares.

We also control for tangible assets. Rajan and Zingales (1995) suggest that firms with more tangible assets are more likely to use debt instead of equity because more tangible assets suggest less growth opportunity. Asset tangibility is defined as net fixed assets divided by the book value of total assets. In addition to representing growth opportunities, tangible assets are also a proxy for the difficulty of debt financing. In China, firms have to rely on banks instead of the corporate bond market for debt financing. Firms with more tangible assets are more likely to get loans from banks as they have more mortgageable property. Finally, we control for growth opportunities. Myers (1984) argues that as the agency costs of debt are higher than equity for firms with higher growth opportunities, those firms are more likely to use equity. As more than half of Chinese firms' R&D data are unavailable, we use the actual sales growths of the next period to proxy for the growth opportunities. Finally, to control for industry characteristics, as some accounting ratios are not comparable across industries, we include industry dummies which are created according to the industrial classification of the CSRC.

6. Empirical Evidence

6.1. Nonparametric estimation results

Figure 1 shows the distribution of the spells from firms' IPOs to their first SEOs. It is clear that a duration of three quarters has the highest frequency. This graph also reveals, for example, that 40% of firms issue their first SEOs within one year after their IPOs in the Chinese stock market. The mean and median such durations are 8.8 and 8 quarters respectively.

The estimated Kaplan-Meier survival function appears in Figure 2. The survival function is downward sloping and declines at a decreasing rate, and this pattern suggests that the hazard varies with time. The associated estimated hazard function is shown in Figure 3. The estimated hazard function displays a non-monotonic pattern of duration dependence. For example, there is 15% chance that the duration will end after five quarters, and there is 20% chance that the duration will end after seven quarters. Combined with Figure 1, the sudden increase and decrease in the Kaplan-Meier hazard for lives in excess of around fifteen quarters may be an artifact of the small number of observations in this range. The implication of these results is that when we turn to parametric survival models, we need only to consider the distributions such as the Log-Logistic and Log-Normal, which allow for time-varying non-monotonic hazard functions.

6.2. Parametric estimation results

Table 2 displays the summary statistics for the variables used in our analysis. Panel A of Table 3 gives the joint distributions of IPO years and SEO years, while Panel B gives the industry distribution of the firms in our sample. This sample covers 20 industries out of the 23 industries classified by the CSRC.

Because the nonparametric estimation results suggest that the hazard probability is time-varying and non-monotonic, we only provide the results estimated using the time-varying Log-Logistic and Log-Normal distributions[5]. The sign of the coefficient in the duration model gives the relationship of the variable with the length of the duration. For example, a significantly positive (negative) sign suggests that the variable is positively (negatively) related to the duration, but negatively (positively) related to the hazard probability and the probability of equity financing. In all of the duration model results in this paper, the Log-Logistic distribution is preferred to the Log-Normal distribution according to the AIC and the BIC. Although the results associated with the control variates differ somewhat across the Log-Logistic and Log-Normal models, the results associated with the primary explanatory variables are consistent in all of the specifications that we have considered.

Figures 4 to 7 provide plots of the survival and hazard functions for the preferred estimated Log-Logistic and Log-Normal models. These functions depend on the values of the explanatory variables in the models, so they are fitted here using the sample mean values of the covariates. For both distributions, the survival functions are downward sloping and decline at a decreasing rate. The estimated hazard functions are non-monotonic - there is positive duration dependence and then negative duration dependence. This finding supports our use of underlying distributions that are not constrained by their very nature to imply duration dependence of just one sign. The duration dependencies implied by Figures 5 and 7 are very similar. For the Log-Logistic model there is a maximum hazard of 0.34, occurring after seven quarters, while for the Log-Normal model the maximum hazard of 0.3 arises at eight quarters. From Table 2, the sample median duration is also eight quarters. It will be recalled that the hazard at each period, here, is the conditional probability that a firm will undertake an SEO in this period, given that it has "survived" thus far since its IPO. So, the estimated parametric hazard functions imply maximized conditional probabilities of exit to SEO consistent with the observed behavior of a "typical" firm in the sample. The hazard function for the Log-Logistic model declines from its maximum somewhat more rapidly than does that for the Log-Normal model. However, "It should be kept in mind that values for long durations are less precisely estimated than values for short durations are" (Kiefer, 1988, p. 660). Overall, our results are quite robust to the choice between the Log-Logistic and Log-Normal models.

Columns (1) and (2) in Table 4 provide estimates of the effect of leverage in the duration models. The insignificance of leverage that is displayed there suggests that the current leverage ratio has no relation with the probability of equity financing in the next period. A firm will not make equity financing after debt financing to keep the leverage ratio mean-reverting to its optimal leverage ratio. This result suggests a minor role for the trade-off hypothesis in China.

Columns (3) and (4) in Table 4 give the results of regressing leverage on lagged profitability and a group of control variables, using ordinary least squares. The leverage ratio is significantly and negatively related to previous profitability. Profitable firms in China will retain earnings and become less leveraged, while unprofitable firms will borrow and become more leveraged, thus creating a negative relation between profitability and the observed leverage ratio in the next period. This finding again contradicts the trade-off hypothesis and favors the pecking order hypothesis. Firm size is found to be significantly positive at the 1% level, suggesting that large firms are more likely to use debt financing instead of equity financing. Although this is consistent with the prediction of the trade-off model that well-established firms prefer debt financing to make use the tax deduction shield of debt, it does not necessarily support the trade-off hypothesis in China. Large firms in China could have higher leverage ratios simply because they are more likely to get loans from banks, as they are usually less risky. Sales growth is also significantly positive at the 1% level. This result contradicts the prediction of Myers (1984) that firms with higher growth opportunities are more likely to use equity. In China, firms with higher growth opportunities are more likely to use debt financing to expand their business.

The results in Table 5 are quite striking. The two profitability proxies, ROA and ROE, are both significantly negative in all specifications, suggesting that more profitable firms are more likely to use equity financing. This result contradicts the prediction of both the trade-off hypothesis and pecking order hypothesis. The trade-off theory suggests that more profitable firms should rely more on debt financing to make use of tax shield of debt. The pecking order theory suggests that more profitable firms are less likely to make equity financing because of enough internal funds. However, in China, more profitable firms are more likely to make equity financing. We provide more analysis of this in Table 8.

Table 6 relates the proxy of adverse selection costs to the firms' equity financing decisions. Two proxies of adverse selection costs, market-to-book ratio and stock return are both significantly negative in all specifications. This suggests the market timing has a first order effect on the equity financing decision of the firm. The intention of firms to exploit temporary fluctuations in the cost of equity is very strong. Thus firms are more likely to issue equity when their relative market values are high to minimize the adverse selection costs.

Table 7 summarizes the predictions of different capital structure theories and our evidence in China. The evidences in China contradict all predictions of the trade-off hypothesis. Firms in China don't have a target leverage ratio. The profitable firms in China will retain earnings and become less levered, while unprofitable firms will borrow and become more levered. The negative correlation between profitability and leverage also suggests firms in China have under-utilized the tax shield of debt. As the corporate bond market in China is very small, firms in China have to rely on banks for debt financing. Limited resources from corporate bond market and strict covenants imposed by banks have increased the cost of debt financing. And in order to support local economy, some local governments in China may give a lower tax rate, tax rebate, and even exemption on tax to the listed firms to support their growth and investment. For example, Ninxia Province gives a tax rebate of 15% to all local listed firms, and the city of Yinchuan in that province gives another 15% rebate to all local listed firms. Thus, listed firms in the city of Yinchuan get a total tax rebate of 30%.[6] These privileges of lower effective tax rate of listed firms have decreased the relative benefit of debt, making firms underutilize the tax shield of debt in China.

The evidence from China supports one prediction of the pecking order hypothesis: market timing has a first-order effect on firms' equity financing decisions. However, it contradicts another prediction of this hypothesis: more profitable firms are less likely to use equity financing because of adequate internal funds. Given the results in Table 5, we consider the profitability variables in time periods - immediately before the equity financing; and at all other times. We test the equality of the means (t-test) and medians (Wilcoxon-Mann-Whitney test) between the two time periods. The results appear in Panel A of Table 8, where we see that these differences are significant at the 1% level. The differences are also numerically striking. The mean of ROA during "other times" is only 4%, while the mean of ROA immediately before equity financing is 5.3%. The corresponding median values are 3% and 4.5%. The differences associated with ROE are comparable to those for ROA. All of this reinforces the findings of Table 5: firms' profitability increases significantly immediately before equity financing. However, the trade-off hypothesis suggests that more profitable firms should rely more on debt, and the pecking order hypothesis suggests that more profitable firms should rely more on internal funds, all of which implies a negative relationship between profitability and the probability of equity financing.

There are several possible reasons for this surprising finding. First, in the hot market when the stock returns are high, firms' profits are usually also higher than other periods. Thus higher profitability could be just another proxy of "market timing" of the firms to minimize the adverse selection costs. To separate the effects of profitability and market timing, we estimate the duration models for profitability by controlling for market-to-book ratio and stock return. The results are presented in Panel B of Table 8. We find that ROA and ROE are still significantly negative after controlling for market-to-book ratio and stock returns. More importantly, market-to-book ratios are no longer significant after including ROA and ROE. This evidence negates the possibility that a firm's profitability is just a proxy for market timing. Second, firms may intentionally manipulate their earning data before equity financing to minimize the adverse selection costs. By presenting an impressing balance statement, the managers want to convince the investors that their firms have good prospects and can better utilize the capital raised by SEOs. Finally, as the CSRC has put a minimum requirement of ROE for SEO qualifications, firms may manipulate their earnings data to meet the requirement of CSRC to get the approval of SEOs.

7. Conclusions

In this paper we model the durations between firms' "Initial Public Offerings" (IPOs) and their subsequent "Seasoned Equity Offerings" (SEOs) in China during the period from January 2001 to July 2006. Both nonparametric and parametric duration models are estimated.

Our results have important implications for the capital structure in emerging market. Evidences of financing decision in China contradict the predictions of both the trade-off theory and pecking order theory. Firms in China will not make equity financing after debt financing to keep the leverage ratio mean-reverting to its optimal leverage ratio. This suggests that firms in China don't have a target leverage ratio, suggesting a minor role for the trade-off theory. The negative correlation between profitability and leverage contradicts the trade-off theory, and gives some support to the pecking order theory. Profitable firms in China retain earnings and become less levered, while unprofitable firms borrow and become more levered. It also suggests firms in China have under-utilized the tax shield of debt. As the corporate bond market in China is very small, firms in China have to rely on banks for debt financing. Limited resources from the corporate bond market and strict covenants imposed by banks have increased the cost of debt financing. Moreover, the privilege of effective low tax rates that local governments give to firms decreases the benefit of debt. All of these factors make firms in China under-utilize the tax shield of debt.

The most surprising finding in our paper is that profitability is positively related to the conditional probability of equity financing. The trade-off hypothesis suggests that more profitable firms should rely more on debt, while the pecking order hypothesis suggests that more profitable firms should rely more on internal funds. Both imply a negative relationship between profitability and the probability of equity financing. Chinese firms may intentionally manipulate earnings to minimize the adverse section costs associated with the equity financing and meet the return on equity requirement set by the CSRC for SEO qualifications. Market timing is an important consideration when Chinese firms issue equity. As modern financing theory has been tested mainly with data from developed economies that have many similarities, our findings suggest that country-specific features could be important for capital structure choices in emerging markets.

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Footnotes

* The views expressed in this paper are those of the authors, and should not be attributed to their employers.

1. The countries are the U.S., Germany, Canada, Italy, France, Japan, and the U.K..

2. Source: "*Market Capitalization of China Stock Market",* Xinhua News Agency, available at http://news.xinhuanet.com/fortune/2007-03/10/content_5826536.htm .

3. Source: *China Bond*, October 2006.

4. Our data source is *Hong Kong and Macau Finance Database,* available at http://www.gazxfe.com.

5. In addition, on the basis of Akaike's information criterion and the Bayesian information criterion, we found that the Log-Logistic and Log-Normal distributions are preferred to the Weibull distributions, for example. The first two distributions have non-monotonic hazards, while the Weibull has a constant (time-invariant) hazard.

6. Source: *Official website of Yinchuan Government*, available at http://www.nxycds.gov.cn/SiteAcl.srv?id=65&aid=944&type=td_info .

Table 1: Parametric Density, Survival and Hazard Functions

	Weibull	Log-Normal	Log-Logistic
***f*(*t*)**	$\theta p(\theta t)^{p-1}\exp[-(\theta t)^{p}]$	$[p/(\theta t)]/\phi(-p\log(\theta t))$	$\theta p(\theta t)^{p-1}/[1+(\theta t)^{p}]^{2}$
***S*(*t*)**	$\exp[-(\theta t)^{p}]$	$\Phi(-p\log(\theta t))$	$1/[1+(\theta t)^{p}]$
***λ*(*t*)**	$\theta p(\theta t)^{p-1}$	$\phi(-p\log(\theta t))/\Phi(-p\log(\theta t))$	$\theta p(\theta t)^{p-1}/[1+(\theta t)^{p}]$

Note: p and θ are (positive) shape and scale parameters.

Table 2: Summary Statistics

	Mean	Std. Dev.	Min.	Q1	Median	Q3	Max
Duration (Quarters)	8.781	4.774	1.000	5.000	8.000	12.000	22.000
Survival Time (Quarters)	4.891	3.734	1.000	2.000	4.000	7.000	22.000
Leverage Ratio	0.362	0.167	0.000	0.237	0.359	0.476	0.965
Return on Asset	0.043	0.039	-0.056	0.018	0.034	0.058	0.353
Return on Equity	0.059	0.053	-0.131	0.027	0.050	0.078	0.457
Stock Return	-0.033	0.152	-0.492	-0.126	-0.010	0.035	0.717
Market-to-Book Ratio	6.931	6.295	0.668	3.120	5.133	8.894	69.723
Total Assets (in Billions)	3.438	21.225	0.289	0.660	1.068	1.942	362.609
Firm Size (Log. of Assets)	20.884	0.904	19.483	20.276	20.735	21.341	26.617
State-Owned Shares Ratio	0.373	0.270	0.000	0.007	0.458	0.620	0.796
IPO Size (Ratio)	0.324	0.078	0.032	0.279	0.321	0.370	0.603
Tangible Assets (Ratio)	0.306	0.204	0.000	0.146	0.269	0.433	0.886
Sales Growth (%)	0.215	0.383	-0.541	0.000	0.035	0.328	3.822

Note: Q1 and Q3 denote the first and third sample quartiles, respectively.

Table 3: Sample Breakdown by Year and Industry

Panel A. Distributions of IPO Year and SEO Year

Year of SEO\ Year of IPO	2001	2002	2003	2004	Total
2001	6				6
2002	14	2			16
2003	8	20	0		28
2004	14	17	18	4	53
2005	3	5	10	32	50
2006	2	1	3	0	6
Total	47	45	31	36	159

Panel B. Distributions of Industry

Industry	N	%	Industry	N	%
Electricity Generation	5	3.14	Retail	4	2.52
Electronic Equipment	11	6.92	Coal	1	0.63
Real Estate Services	5	3.14	Timber and Furniture	1	0.63
Real Estate	1	0.63	Agriculture	3	1.89
Textiles	8	5.03	Business Services and Agencies	1	0.63
Utilities	1	0.63	Chemicals	22	13.84
Highway Transportation	1	0.63	Petroleum and Natural Gas	1	0.63
Radio, Television, and Publishers	1	0.63	Food Products	4	2.52
Transportation by Air	1	0.63	Water Transportation	2	1.26
Manufacturing Equipment	21	13.21	Communication Service	1	0.63
Computers	1	0.63	Communication	2	1.26
Computers Service	9	5.66	Construction	7	4.40
Transportation Services	3	1.89	Farming	1	0.63
Metal and Nonmetal	17	10.69	Pharmaceutical Products	17	10.69
Paper and Printing	5	3.14	Banking	2	1.26
Total				159	100

Table 4: Financing Decision and Leverage Ratio

	Duration Analysis: Leverage		Leverage Regression	
	Log-Logistic	Log-Normal	ROA	ROE
VARIABLES	(1)	(2)	(3)	(4)
Leverage	-0.443	-0.240		
	(-0.726)	(-0.531)		
Return on Asset			-0.450***	
			(-3.078)	
Return on Equity				-0.200**
				(-2.245)
Firm Size	0.249**	0.153	0.079***	0.082***
	(2.192)	(1.565)	(4.070)	(4.186)
State-Owned Shares Ratio	0.388**	0.281	0.027	0.029
	(2.159)	(1.579)	(0.595)	(0.642)
IPO Size	1.956*	2.091**	-0.002	0.013
	(1.883)	(2.327)	(-0.011)	(0.067)
Tangible Assets	0.643**	0.516	0.113	0.118
	(1.964)	(1.511)	(1.399)	(1.458)
Sales Growth	0.216	0.183	0.084***	0.086***
	(1.380)	(1.341)	(4.319)	(4.315)
Constant	-4.759**	-2.928	-1.521***	-1.595***
	(-2.117)	(-1.491)	(-3.315)	(-3.455)
LogL	-133.436	-138.011		
AIC	316.872	326.022		
BIC	438.779	447.928		
Observations	969	969	969	969
R^2			0.518	0.513

Note: t-statistics based on robust standard errors appear in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 5: Financing Decision and Profitability

	Duration Analysis: Profitability			
	Log-Logistic	Log-Normal	Log-Logistic	Log-Normal
VARIABLES	(1)	(2)	(3)	(4)
Return on Asset	-4.933***	-5.166***		
	(-6.496)	(-5.970)		
Return on Equity			-2.314***	-2.495***
			(-2.907)	(-3.149)
Firm Size	0.160*	0.117*	0.207**	0.143*
	(1.823)	(1.654)	(2.298)	(1.884)
State-Owned Shares Ratio	0.322**	0.233	0.350**	0.259
	(1.964)	(1.420)	(1.966)	(1.489)
IPO Size	1.280	1.434*	1.567	1.733**
	(1.251)	(1.793)	(1.455)	(1.963)
Tangible Assets	0.473*	0.433	0.500*	0.430
	(1.650)	(1.332)	(1.662)	(1.235)
Sales Growth	0.145	0.117	0.177	0.149
	(1.197)	(0.931)	(1.330)	(1.128)
Constant	-2.547	-1.714	-3.711*	-2.496
	(-1.341)	(-1.103)	(-1.922)	(-1.528)
LogL	-119.709	-124.960	-129.512	-133.899
AIC	289.419	299.920	309.024	317.799
BIC	411.325	421.826	430.930	439.706
Observations	969	969	969	969

Note: Asymptotic "t-statistics" based on robust standard errors appear in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 6: Financing Decision and Market Timing

	Duration Analysis: Market Timing			
	Log-Logistic	Log-Normal	Log-Logistic	Log-Normal
VARIABLES	(1)	(2)	(3)	(4)
Market-to-Book Ratio	-0.017**	-0.018**		
	(-2.145)	(-1.991)		
Stock Returns			-1.515***	-1.787***
			(-4.239)	(-5.448)
Firm Size	0.184**	0.119	0.220**	0.175**
	(2.087)	(1.535)	(2.480)	(2.313)
State Owned Shares Ratio	0.370**	0.271	0.290	0.206
	(2.061)	(1.576)	(1.551)	(1.181)
IPO Size	1.559	1.857**	2.399**	2.556***
	(1.431)	(2.060)	(2.145)	(2.962)
Tangible Assets	0.520*	0.383	0.588*	0.501
	(1.891)	(1.202)	(1.659)	(1.364)
Sales Growth	0.175	0.142	0.230**	0.186
	(1.391)	(1.113)	(1.998)	(1.399)
Constant	-3.242*	-2.053	-4.357**	-3.626**
	(-1.718)	(-1.240)	(-2.486)	(-2.310)
LogL	-131.301	-135.715	-115.882	-117.406
AIC	312.602	321.430	281.764	284.813
BIC	434.509	443.337	403.671	406.720
Observations	969	969	969	969

Note: Asymptotic “t-statistics” based on robust standard errors appear in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 7: Predictions of Corporate Financing Hypotheses and Evidence in China

Model	Variable	Hypothesis Prediction			Our Finding
		Trade-off (static)	Trade-off (dynamic)	Pecking order	
Duration Model	Leverage	Negative	Negative		Not Significant
	Profitability	Positive	Positive	Positive	Negative
	M/B			Negative	Negative
	Stock Return			Negative	Negative
Leverage Model	Profitability	Positive	Negative	Negative	Negative

Table 8: Financing Decision and Profitability after Controlling for Market Timing

Panel A. Profitability before Equity Financing and Other Time

Profitability	Time before SEO (n = 159)		Other Time (n = 810)		Test of Difference (p-value)	
	Mean	Median	Mean	Median	Mean	Median
Return on Asset	0.053	0.045	0.040	0.030	0.000	0.001
Return on Equity	0.070	0.070	0.057	0.047	0.002	0.000

Panel B. Financing Decision and Profitability after Controlling for Market Timing

	Duration Analysis: (Log-Logistic)			
	ROA		ROE	
VARIABLES	(1)	(2)	(3)	(4)
Return on Asset	-4.477***	-4.193***		
	(-4.939)	(-5.764)		
Return on Equity			-1.805**	-1.291**
			(-2.019)	(-2.122)
Market-to-Book Ratio	-0.009		-0.011	
	(-1.135)		(-1.040)	
Stock Returns		-1.200***		-1.390***
		(-3.706)		(-3.973)
Firm Size	0.154*	0.187**	0.194**	0.225**
	(1.786)	(2.166)	(2.146)	(2.573)
State-Owned Shares Ratio	0.312*	0.233	0.344*	0.267
	(1.914)	(1.407)	(1.953)	(1.486)
IPO Size	1.165	1.796*	1.431	2.119*
	(1.122)	(1.776)	(1.325)	(1.944)
Tangible Assets	0.460*	0.497	0.484*	0.536
	(1.658)	(1.550)	(1.682)	(1.522)
Sales Growth	0.139	0.178	0.168	0.220*
	(1.195)	(1.564)	(1.307)	(1.952)
Constant	-2.331	-3.238*	-3.327*	-4.257**
	(-1.244)	(-1.831)	(-1.701)	(-2.437)
LogL	-119.007	-107.678	-128.731	-114.517
AIC	290.014	267.357	309.462	281.034
BIC	416.797	394.139	436.245	407.817
Observations	969	969	969	969

Note: In Panel A, a t-test is used for the difference in means, and a Wilcoxon-Mann-Whitney test is used for the difference in medians.

In Panel B, asymptotic "t-statistics" based on robust standard errors appear in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Figure 1: Distribution of Spells from Firms' IPOs to Their First SEOs

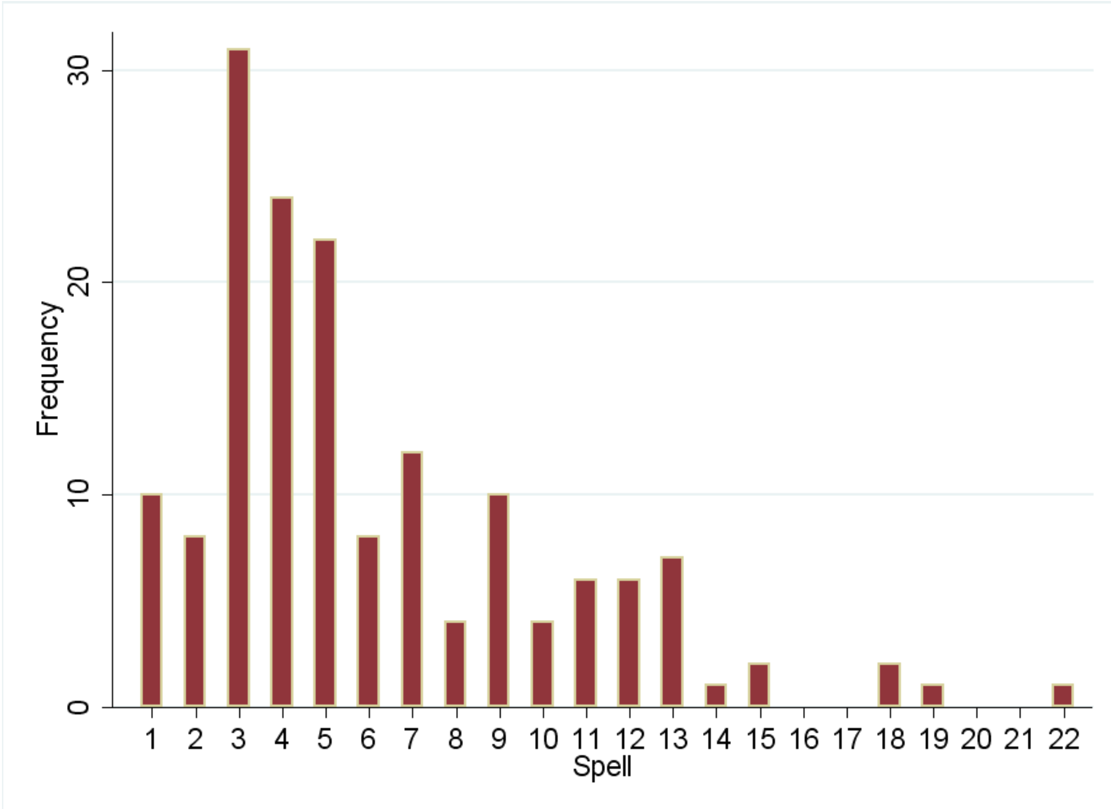

Figure 2: Kaplan-Meier Survival Function

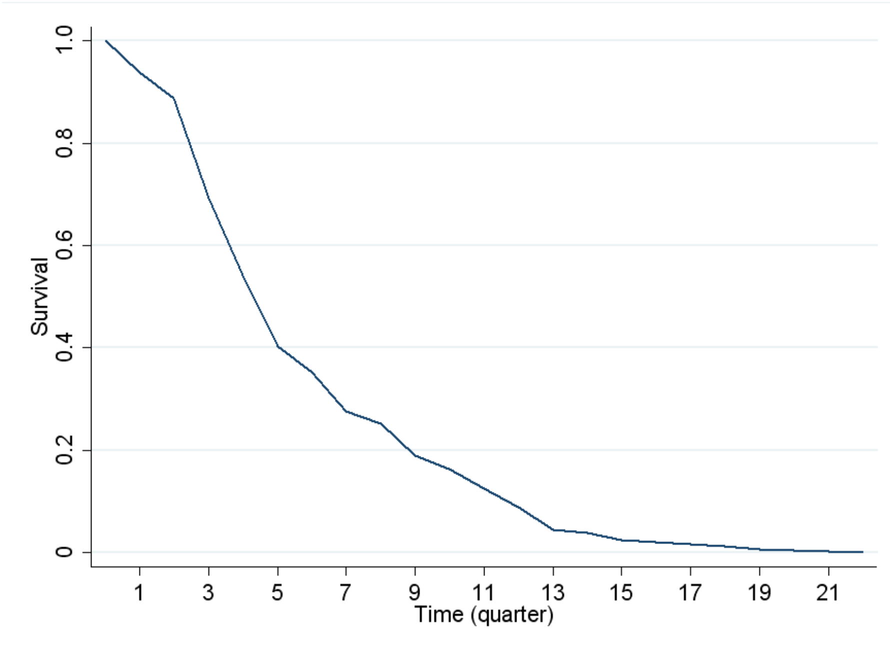

Figure 3: Kaplan-Meier Hazard Function

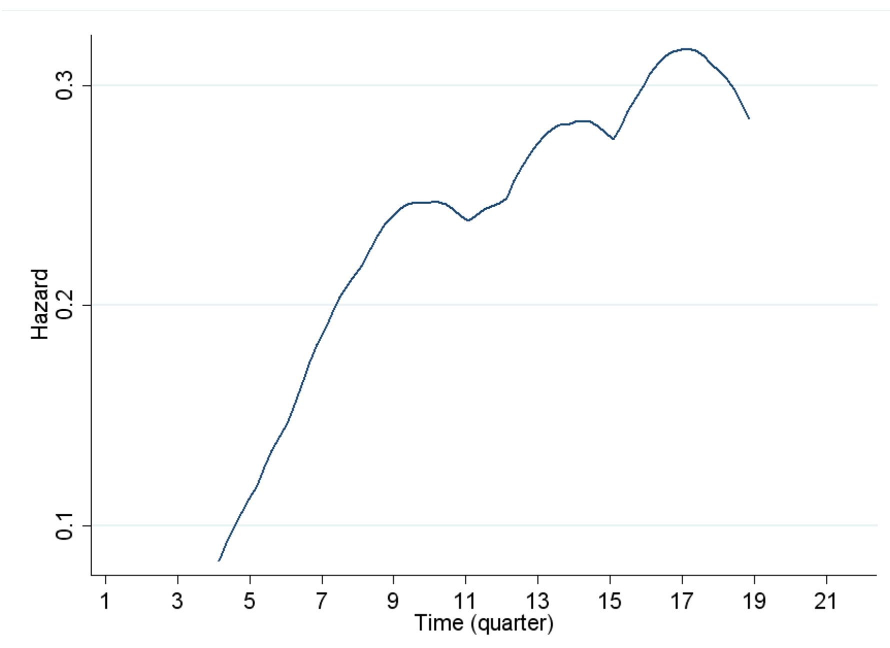

Figure 4: Log-Logistic Survival Function

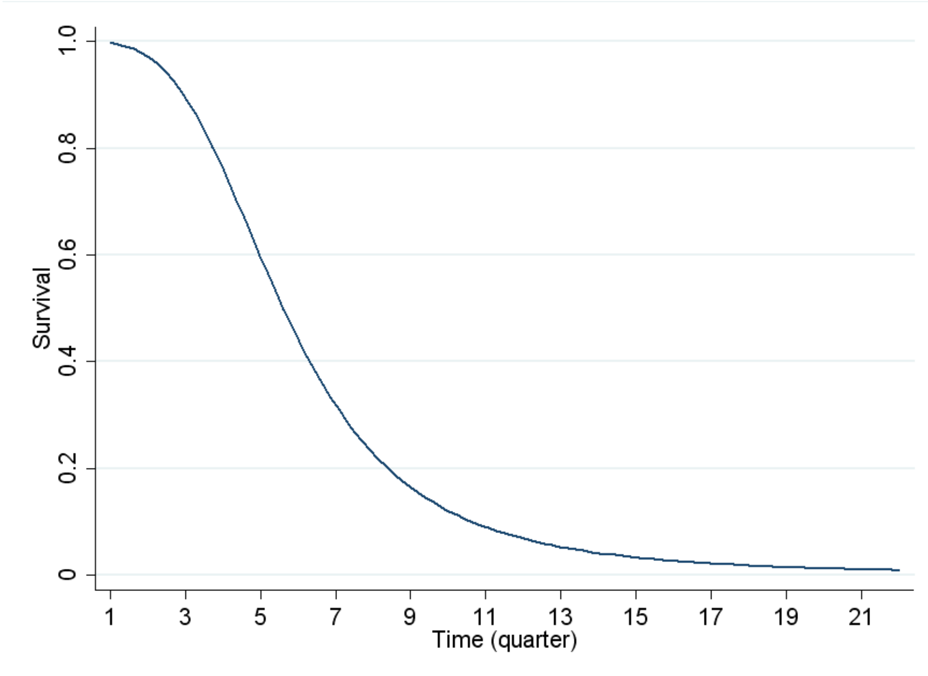

Figure 5: Log-Logistic Hazard Function

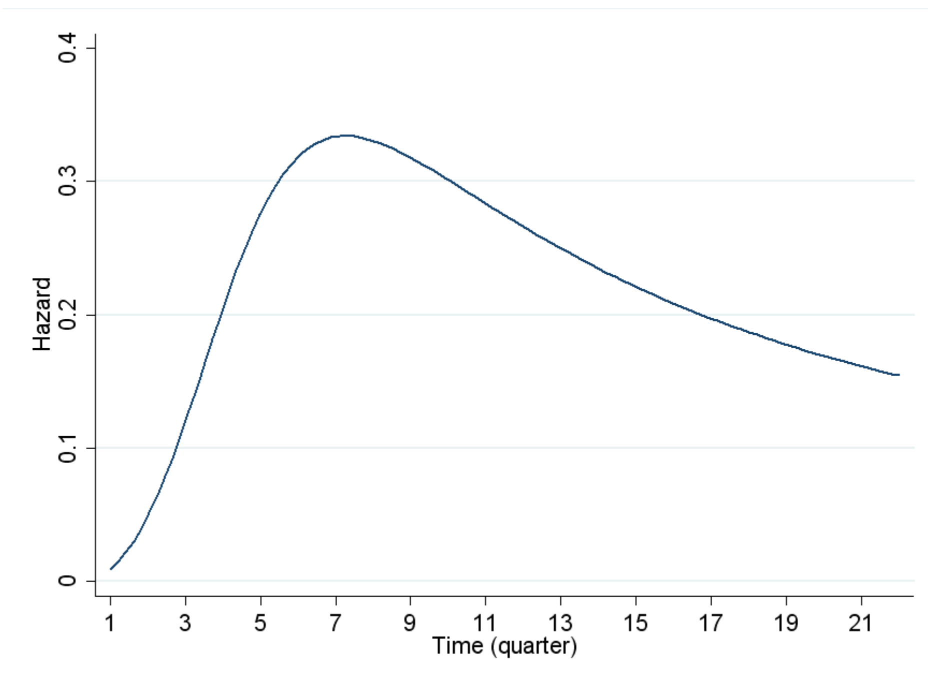

Figure 6: Log-Normal Survival Function

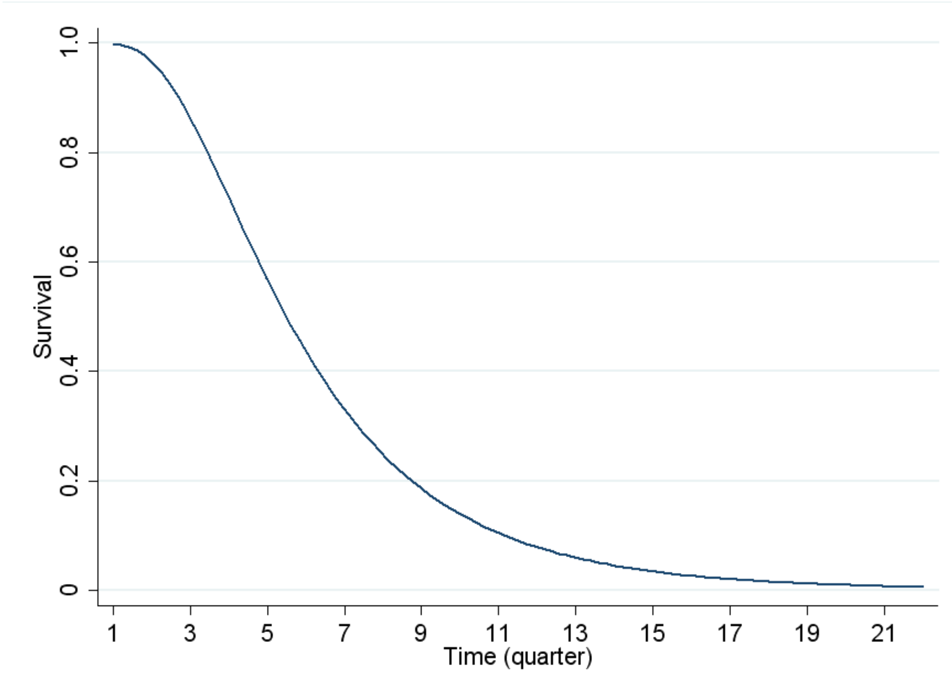

Figure 7: Log-Normal Hazard Function