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Firm Mortality and Natal Financial Care

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Abstract

We construct a mortality table for U.S. public companies during 1985–2006. We find that the age-specific mortality rates of firms initially increase, peaking at age three, and then decrease with age, implying that the first 3 years of public life are critical. Financial intermediaries involved around the "public birth" of a firm (e.g., venture capitalists (VCs) and high-quality underwriters) are associated with lower firm mortality rates, sometimes for up to 7 years after the initial public offering (IPO). VCs reduce mortality rates more through natal financial care than through selection, whereas high-quality underwriters affect firm mortality more through selection.

I. Introduction

One of the distinct advantages of corporations over other business forms is their potential for unlimited life (Ross, Westerfield, and Jordan (2009), p. 6). Nevertheless, a great majority of publicly traded firms live even less than 20 years (e.g., Myers (1999), Morris (2009)). A natural question then arises: Why do some firms "die" sooner than others? While the mortality of a public firm can be due to various economic reasons, some of which are inherent to the firm and its management, in this paper we focus on a specific external dimension: the role of

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financial intermediaries. In particular, we explore to what extent certain financial intermediaries present at the early stage of a firm's public life affect its mortality.

We begin by computing age-specific mortality rates (the incidences of involuntary death of public firms such as liquidation, delisting, and permanent trading halts, conditional on firms having survived thus far) for U.S. public firms during 1985–2006. We find that mortality rates initially increase, peaking at 3 years after a firm goes public, and then decrease with age. In contrast to the stylized fact noted in the industrial organization literature that survival risk decreases as a firm ages, our results indicate that U.S. public firms need to survive up to the critical age of 3 years after the initial public offering (IPO) before their survival risk starts diminishing.[1]

Since the early years of a firm's public life turn out to be critical to its long-term survival, we next investigate whether financial intermediaries involved around the public birth of a firm affect its subsequent mortality. When a firm is publicly listed for the first time, two important financial intermediaries may be present: venture capitalists (VCs), who provide financing to many firms before their IPOs, and underwriters, who serve as the gatekeepers during the IPO process and provide investment banking services and support for firms after their IPO.

After controlling for the usual determinants of survival (e.g., leverage, size, age, and growth opportunities), we find that VCs and reputable underwriters are associated with a significantly lower probability of involuntary death. This finding is robust to various sample restrictions and econometric specifications, alternative definitions of involuntary death, and alternative measures capturing the quality of financial intermediaries. In addition, while the effect of financial intermediaries on firm mortality is most pronounced during the early critical years of a firm's public life, this effect can last sometimes up to 7 years after the IPO.

The observed reduction in mortality rates by financial intermediaries can arise from their ability to simply pick the "right" firms to take public (selection), or from their ability to add value through involvement and interaction with the firm (treatment or "natal financial care"). We then explore, for each financial intermediary, the relative importance of its selection to treatment effort in improving a firm's post-IPO survival chances.

We measure treatment by a financial intermediary through the extent of its involvement with the firm. For VCs, our proxies are the number of rounds of VC financing and the stage of the firm when it receives its first VC investment. For underwriters, we compute the likelihood of an ongoing relationship between an IPO firm and its underwriter, using subsequent securities issuances led by the same underwriter. We measure selection by a financial intermediary based on the rationale that the presence of a high-quality intermediary reflects the combined effect of both its selection and treatment. By orthogonalizing each indicator for the presence of such an intermediary with our proxy for its treatment, the residual component captures its selection effect.

[1] An early piece in this literature is Audretsch (1991). Agarwal and Gort (2002) show that both industry factors (exogenous shocks) and firm characteristics (endogenous response) affect firm survival. Loderer, Neusser, and Waelchli (2009) find that firm age impairs institutional memory and affects its survival.

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To quantify which effect by a financial intermediary (selection or treatment) is stronger in reducing mortality rates, we apply the methodology for comparison of prognostic factors by Heinze and Schemper (2003). We find that while both selection and treatment by each financial intermediary affect mortality, VCs improve a firm's survival chances more through treatment than through selection. By contrast, the observed lower mortality rates of firms associated with high-quality underwriters arise mainly from underwriters' selection efforts.

We recognize that our treatment proxies can potentially overestimate the magnitude of the true treatment effort. This is because both treatment and firm quality can be positively associated with the extent of involvement (e.g., financial intermediaries are likely to be involved more with good firms than with bad firms). By construction, our selection proxies can thus potentially underestimate the magnitude of selection. To address this possible bias, we employ a modified version of our approach, allowing financial intermediaries to select firms not only based on pre-IPO factors but also on post-IPO realization of certain firm characteristics. The inclusion of post-IPO firm characteristics expands the information set of the intermediaries beyond what is known to them before or during the IPO, when selection takes place. As a result, the estimated selection proxy intends to overestimate the magnitude of selection, and the residual component thus underestimates treatment.

Under this alternative approach, we verify that VCs' treatment remains relatively more important in reducing firm mortality, even when their selection is possibly overestimated. Consistently, underwriters' selection remains more important than treatment. Taken together, our results imply that treatment is more (less) important than selection in reducing firm mortality for VCs (high-quality underwriters).

Our paper complements findings in the existing literature that VCs are associated with higher firm survival (e.g., Jain and Kini (2000), Krishnan, Ivanov, Masulis, and Singh (2011), and Puri and Zarutskie (2012)). Krishnan et al. (2011) show that VC reputation is positively associated with four performance metrics measured over 3 years after the IPO. Despite the evidence of selection, reputable VCs have more pronounced involvement with their portfolio firms through board seats or share holdings, and they improve the corporate governance of these firms. Puri and Zarutskie use the U.S. Census data to study the life cycle of VC- and non-VC-backed public and private firms. Among many stylized facts, the authors find that VC-backed firms tend to have lower failure rates, especially in the first 4 years after VC investment. This pattern is later seen to reverse.

Our paper differs from the above studies by focusing on the influence of both VCs and underwriters on reducing mortality of public firms. Specifically, our approach allows us to explore the difference in the importance of the main reasons (selection and treatment by financial intermediaries) that can affect mortality rates. To the best of our knowledge, this is the first paper to show that the relative importance of these reasons depends on the type of intermediary. We are also among the first to document the decaying effect of high-reputation underwriters on reducing a public firm's mortality.

Previous literature has explored individual channels through which financial intermediaries add value during the going-public process. VCs provide funding

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for some firms at their startup stage. They are also actively involved in a firm's operations before it files for an IPO. To obtain repeated rounds of financing, the firm is subject to VCs' extensive screening, advising, and monitoring. In addition, VCs add value through professionalization of managers (Hellmann and Puri (2002)), improving efficiency (Chemmanur, Krishnan, and Nandy (2011)), providing industry expertise (Gompers, Kovner, and Lerner (2009)), monitoring (Lerner (1995)), catalyzing an innovation-friendly corporate culture (Tian and Wang (2014)), and enhancing corporate governance (Krishnan et al. (2011)). Though underwriters are not involved with an IPO firm at its startup stage as much, and their interactions with firms are often concentrated on underwriting and advising on corporate events such as securities issuance or mergers and acquisitions, their advice during these events can have a lasting effect on top management's views on financial strategy (e.g., whether to use debt aggressively, or to diversify early in related business lines through acquisitions, etc.). Existing literature has documented that reputable underwriters might affect firm value beyond simply selecting which firms to take public. For instance, this can take place through improving corporate governance (Lee and Masulis (2011), Wang, Winton, and Yu (2010)), stabilizing share prices of IPO firms (Hanley, Kumar, and Seguin (1993), Aggarwal (2000)), and providing industry expertise and analyst research (Cliff and Denis (2004), Degeorge, Derrien, and Womack (2007), and Liu and Ritter (2011)). This strand of literature focuses on the various means to an end. Instead, our paper focuses on the end itself: firm survival.

The remainder of the paper is organized as follows: Section II describes the construction of the mortality table of public firms and shows firm mortality as a function of age. Sections III and IV analyze whether and how, respectively, a firm's mortality can be affected by the financial intermediaries present at the IPO stage. Section V briefly summarizes various robustness tests and extensions. Section VI presents our conclusions. Variable definitions are given in the Appendix. Details on all robustness tests and extensions are in the Internet Appendices (available at www.jfqa.org).

II. Mortality Tables for U.S. Public Firms

A. Defining Birth and Death of U.S. Public Firms

To identify the birth of a public firm, we follow Queen and Roll (1987) and Fama and French (2004) and use the year of the firm's first appearance on the Center for Research in Security Prices (CRSP) tape during the period of 1926–2006. Similarly to Fama and French, we focus only on common shares and exclude closed-end funds, etc. Death of a public firm is more difficult to define. A firm may have a voluntary death (going private or being acquired or merged), or it may experience an involuntary death (being liquidated or forced to delist from the exchange). Our study on mortality focuses on involuntary deaths.

Similarly to Queen and Roll (1987), we distinguish between a voluntary and an involuntary death of a public firm based on its 3-digit CRSP delisting code. There are six types of codes: active (100–171), mergers (200–290), exchanges

(300–390), liquidations (400–490), dropped (500–591), and expirations (600–610). For all publicly traded companies that have appeared on the CRSP tape at any time in the period 1926–2006, we assign each firm during each year of its public life to one of the following three mutually exclusive categories based on its delisting code: i) active (codes 100–171), ii) voluntary death (codes 200–290 or 300–390), and iii) involuntary death (codes 400–490 or 500–591).[2]

As we focus on involuntary deaths, we consider liquidations (codes 400–490) or delistings from the exchange (codes 500–591).[3] Liquidation involves a termination of a firm's operation and forced sales of its remaining assets; therefore, it can be unambiguously viewed as involuntary. Unlike liquidation, however, a firm can be dropped for reasons other than being involuntary or terminal. In the robustness analyses, we further examine individual delisting codes for the causes of a firm being dropped, and we narrow the definition of involuntary death regarding dropped firms to codes where the reasons seem more likely to be involuntary. In the first alternative specification, we restrict the analysis of dropped firms to delisting codes falling into 535–591 (e.g., delisted due to unlisted trading privileges, insufficient number of market makers, insufficient number of shareholders, price fell below acceptable level, insufficient capital, surplus, and/or equity, insufficient (or noncompliance with rules of) float or assets, and company's request for liquidation and deregistration). In the second, even narrower definition, we restrict the causes of being dropped to the following: 551 (delisted due to insufficient number of shareholders), 552 (price fell below acceptable level), 560 (insufficient capital, surplus, and/or equity), 561 (insufficient (or noncompliance with rules of) float or assets), 574 (bankruptcy, declared insolvent), 581 (failure to register under Section 12(g) of the Securities Exchange Act), 582 (failure to meet exception or equity requirements), 583 (denied temporary exception requirement), 584 (failure to meet exchange's financial guidelines for continued listing), 585 (protection of investors and the public interest), 587 (corporate governance violation), and 591 (delist required by the Securities and Exchange Commission). Section I of Internet Appendix A describes in detail the delisting codes used to define involuntary deaths and the results estimated under these two narrower definitions. Our main findings are robust.

B. Age-Specific Mortality Rates

Age-specific mortality rate (ASMR) is the conditional probability that a cohort of a certain age will die in the next year, computed by scaling the number of deaths during a period by the number of members of the cohort existing at the beginning of the period. In our setting, $\text{ASMR}(x,t)$ is defined as the number of

[2] If a firm emerges from bankruptcy and becomes publicly traded again or goes public after being acquired, we treat it as the public birth of a new company. This is because firms usually go through substantial restructuring under Chapter 11 or leveraged buyout. It is hard to argue that they are the same firms as those prior to the bankruptcy filing or buyout. In Section VII of Internet Appendix A, as a robustness check, we exclude IPO firms that were previously a leveraged buyout. We find similar results.

[3] Our sample has no expirations whose delisting codes are 600–610.

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involuntary deaths of firms between age x and age $x + 1$ during year t divided by the number of existing firms of age x at the beginning of year t. We then generate, for each age $x = 0, 1, 2, \ldots, 80$, an $\text{ASMR}(x)$, by averaging $\text{ASMR}(x, t)$ across t.

To illustrate, consider $\text{ASMR}(5, 2000)$, the ASMR for firms of age 5 in calendar year 2000. Table A3 of Internet Appendix A reports that 766 firms went public in 1995, among which 451 firms survived until the beginning of year 2000. In year 2000, 16 involuntary deaths of firms between ages 5 and 6 occurred. Therefore, $\text{ASMR}(5, 2000) = 16/451 = 3.55\%$. Next, we repeat this process to obtain $\text{ASMR}(5, t)$ for each t over a chosen sample period and average $\text{ASMR}(5, t)$s across t. For example, $\text{ASMR}(5) = \sum_{1985}^{2006} \text{ASMR}(5, t)/22$ for the 1985–2006 period.

A mortality table, first developed by Graunt (1662), is a collection of $\text{ASMR}(x)$s. To focus on the first few years, we slightly vary the above methodology by computing ASMRs for 0-, 1-, 2-, 3-, 4-, and 5-year age bins thereafter (i.e., 5–9, 10–14, 15–19, . . . , 70–74, and 75–79). To estimate the ASMRs for the 5-year age bins after the initial 4 years, we count the number of involuntary deaths during a given 5-year age interval and divide this number by the number of firms existing at the beginning of that interval. To annualize the ratio, we multiply by one-fifth.

By construction, ASMRs are backward looking. To build a meaningful mortality table without substantial gaps, we need a sufficient number of deaths of firms of various ages. Therefore, we calculate ASMRs during the period 1985–2006, using all firms entering the CRSP tape between 1926 and 2006.

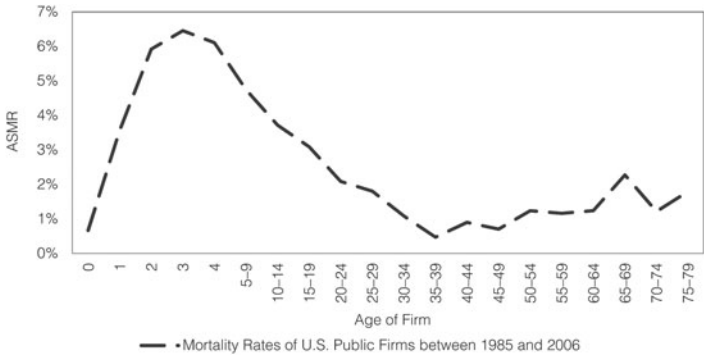
In Figure 1 we plot $\text{ASMR}(x)$ against age x. The horizontal axis shows the different age groups. Single years are used for ages 0–4. Five-year age bins are used beyond the fifth year of age. The vertical axis shows the ASMRs.

Figure 1 reveals that the mortality rates of U.S. public firms increase for the first 3 years after the IPO, attain a peak of approximately 6% at age 3, and

FIGURE 1

Mortality Rates of U.S. Public Firms

Figure 1 shows the ASMRs of U.S. public firms calculated during the period 1985–2006.



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then decrease monotonically over the next 40 years to about 2%.[4] Figure 1 thus suggests that the early years of public life of an average U.S. firm have a profound impact on its long-term survival: Firms that survive until 3 years after their IPO tend to stay in business for a long time.

III. Do Financial Intermediaries Affect Mortality Rates?

The finding that the early years of a firm's public life are critical for its existence raises the question about what factors at this early stage are associated with a firm's subsequent survival chances. We focus on two financial intermediaries involved around the public birth of a firm: venture capitalists and lead underwriters.

We extract information on VC backing and underwriters from Thomson Reuters' Securities Data Company (SDC) Platinum and VentureXpert databases and merge these data with the universe of CRSP firms from 1926 to 2006. Due to limitations in data coverage by Thomson Reuters (a more complete coverage of VCs and underwriters does not begin until 1975), we replicate our mortality table during the period 1985–2006 for firms that went public between 1975 and 2006.

For each sample firm, we determine whether it is VC backed and whether it is taken public by a high-quality underwriter. We identify the quality of an underwriter by its reputation rank, developed by Carter and Manaster (1990) and Carter, Dark, and Singh (1998), and updated by Loughran and Ritter (2004). For IPOs with multiple lead underwriters, we average the ranks of all involved lead underwriters. We classify an underwriter as a high-reputation underwriter if its reputation ranks above the sample median of 8.

Figure 2 graphs ASMRs for the period 1985–2006 for firms that are VC backed and firms that are not (Graph A), and for firms that are taken public by high-reputation and low-reputation underwriters (Graph B), respectively. The methodology used to construct Figure 2 follows that used to construct Figure 1.

Graph A of Figure 2 reveals that for each age, VC-backed firms (dotted line) have lower mortality rates than those not backed by VCs (dashed line). The effect is stronger for the critical early years, since the gap between the dotted and dashed lines widens between ages 0 and 3 and then slowly disappears as firms become older. In contrast to Figure 1, which indicates a peak in ASMRs around the age of 3 for an average U.S. public firm, we note from Graph A of Figure 2 that such a peak in ASMRs exists mainly for firms without VC support; the peak is far less pronounced for VC-backed IPOs.

Graph B of Figure 2 reveals that ASMRs for firms taken public by underwriters of high reputation (dotted line) are lower than those for firms taken public by less reputable underwriters (dashed line) for almost all age groups. The gap in mortality rates between these two subsamples during the early years appears to be more pronounced than that for VCs in Graph A. More importantly, we do not observe an obvious peak in the ASMRs around the age of 3 or any other early ages for firms taken public by high-reputation underwriters.

[4] Section III of Internet Appendix A shows that this inverted U-shape pattern exists for various subperiods during 1926–2006.

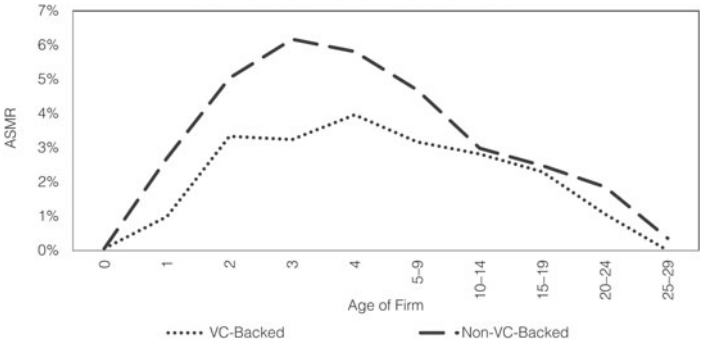
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FIGURE 2

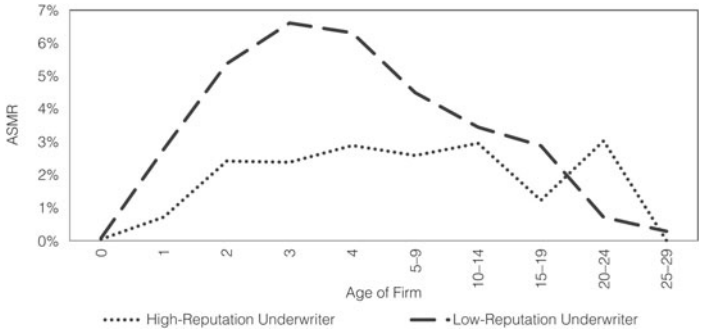
Venture Capital, Underwriter Reputation, and the Difference in Mortality Rates for U.S. Public Firms (1985–2006)

Graph A of Figure 2 compares the ASMRs of U.S. public firms calculated during the period 1985–2006 between firms that are backed by VCs at the time of IPO (dotted line) and those that are not (dashed line). Graph B compares the ASMRs between firms taken public by high-reputation (dotted line) and low-reputation (dashed line) underwriters.

Graph A. ASMRs of VC-Backed and Non-VC-Backed IPOs



Graph B. ASMRs of IPOs with High- and Low-Reputation Underwriters



A. Pooled Logit Regressions

Graphs A and B of Figure 2 reveal a link between the mortality rates of U.S. public firms and the financial intermediaries involved with these firms around their IPO stage. We now analyze this relation in a formal multivariate framework, controlling for important factors that have been documented to affect firm mortality. To ensure the data quality for the regression analyses, we further restrict our sample period to 1985–2006. We extract a sample of IPO firms from Thomson Reuters' SDC Platinum database. Following the common filtering criteria in the IPO literature, we exclude unit offers, rights offers, closed-end funds, foreign issues, real estate investment trusts, American depositary receipts, and partnerships. Our search of the SDC database yields 7,638 firms that went public between Jan. 1985 and Dec. 2006.[5] We then merge the IPO sample with CRSP. The final sample

[5]In Section VII of Internet Appendix A, we impose additional sample restriction criteria such as removing firms with offer price below \$5 and removing reverse leveraged buyouts (LBOs). Our findings do not change.

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contains 7,174 firms and 54,814 firm-year observations. Of these 7,174 firms, 2,445 are still active by the end of 2006, whereas 2,058 have experienced an involuntary death.

1. Estimation Strategies

To predict the occurrence of involuntary deaths of U.S. public firms, we follow the discrete time hazard model outlined in Shumway (2001). Specifically, we estimate a pooled logit model in which the dependent variable takes the value of 1 if a firm experiences involuntary death in a given year, and 0 otherwise:

$$\Pr(\text{involuntary death}) = f\left(\begin{array}{c}\text{financial intermediary proxy, control variables,}\\ \text{industry-FE, exchange-FE, year-FE}\end{array}\right),$$

where FE is fixed effects. The unit of analysis is firm-year pair.[6] To take into account the fact that observations from the same firm are likely to be correlated over time, standard errors are clustered at the firm level.[7]

Our independent variable of interest is the proxy for the presence of high-quality financial intermediaries involved in a firm's IPO. To capture the presence of VCs, we use "VC-Backed," a dummy variable equal to 1 if the IPO is backed by a VC, and 0 otherwise. Alternatively, we follow Nahata (2008) and compute "VC Reputation" as a proxy for the quality of a VC. Each VC's reputation score for a given year is the fraction of total proceeds of IPOs the VC has invested in since 1980.[8] If more than one VC participates in funding an IPO firm, we take the average of each VC's reputation score. This variable is set to 0 for IPOs without VCs.

To capture the quality of an underwriter, we use its reputation rank ("UW Reputation"). For IPOs with multiple lead underwriters, "UW Reputation" is the average rank of these underwriters. To ensure the comparability of proxies between VCs and underwriters, we also use "High-Reputation UW," a dummy variable equal to 1 if an underwriter ranks above the sample median of 8, and 0 otherwise.

We control for factors identified by previous studies to affect a firm's mortality: business cycle, industry characteristics, age, growth opportunities, and size. We include year-fixed effects and industry-fixed effects, where industry classification is based on the Fama–French 12 industries (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_12_ind_port.html). Since our definition of involuntary death is based on exchange delisting and delisting requirements can vary across exchanges, we also include exchange-fixed effects.

[6]We use the pooled logit model because it is computationally more efficient than the Cox proportional hazard model (Glennon and Nigro (2005)). As a robustness check, we reestimate our tests using the Cox proportional hazard model. Our findings remain unchanged (see Section VIII of Internet Appendix A).

[7]In a robustness check, we control for autocorrelation and cross-correlation of the residuals by reestimating our models using two-dimension clustering (e.g., Thompson (2011)). We also reestimate our model without clustering but instead divide the test statistics by the average number of firm-years per firm as suggested by Shumway (2001). We find similar results regardless of the estimation approach (see Section IX of Internet Appendix A).

[8]Using 1980 instead of the beginning year of our sample alleviates the potential forward-looking bias. Alternatively, we follow Krishnan et al. (2011) and compute "VC Reputation" for a given year as the fraction of total proceeds of IPOs that the VC has invested in the 3-year rolling window. The correlation between the two VC reputation measures is 0.904. Our results (not tabulated) are similar.

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We control for both a firm's age since its public birth and the length of its existence prior to IPO. The (public) age of a firm is the number of years between the current calendar year and the year in which the firm first appeared on the CRSP tape. "Incubation Time," the length of a firm's existence as a private firm before its IPO, is defined as the natural logarithm of 1 plus the difference between a firm's founding year and IPO year (Loughran and Ritter (2004)). Note that while Figures 1 and 2 suggest a nonlinear effect of age, our model adopts a linear specification for age because the nature of this nonlinearity is firm specific and could be difficult to specify. In the robustness section (Section IV of Internet Appendix A), we reestimate our models using various nonlinear specifications with respect to age and find similar results.

We measure a firm's growth opportunities by its "Market-to-Book" ratio, calculated as the book value of the firm's total assets plus the market value of its equity minus the book value of equity, scaled by the book value of total assets. Our proxy for size is the natural logarithm of firm sales (Francis, Schipper, and Vincent (2005)).[9]

Lastly, financial distress is a key determinant of survival. The traditional measure for the possibility of bankruptcy or distress is Altman's (1968) Z-score. Since our study utilizes firms in the CRSP universe, and a substantial number of firms have zero or quasi-zero debt (Strebulaev and Yang (2013)), there is great variation in the original Z-score. To ensure the conservativeness of our analysis, we adopt Sufi's (2009) modified Z-score, calculated as the sum of 3.3 $\times$ earnings before interest and taxes, sales, 1.4 $\times$ retained earnings, and 1.2 $\times$ working capital, all scaled by the book value of the firm's total assets. The modified Z-score also allows us to study the role of leverage as a separate factor. We control for "Leverage," calculated as the long-term debt of the firm divided by total assets. To account for the possible inability of some firms to borrow long-term debt, we also use total debt over assets as an alternative proxy. Our findings do not change.

2. The Pooled Logit Regression Results

Table 1 reports the coefficient estimates of the pooled logit regressions. Standard errors clustered at the firm level are in parentheses. The marginal effects for the key variables are in square brackets underneath the standard errors. All variables constructed with accounting data are lagged by a period. For this reason, we effectively estimate our models starting from the first year of a firm's public life. This should not affect our inferences, as Figure 2 shows that any association between financial intermediaries and ASMRs for age 0 is negligible.

Column 1 of Table 1 reveals that the dummy variable for VC backing is negatively and significantly related to the incidence of involuntary death. This suggests that, controlling for industry-, year-, and exchange-fixed effects, as well as other factors that can affect firm mortality, VC-backed firms are associated with a lower probability of involuntary death. We observe similar findings in column 2: The coefficient of "VC Reputation" is negative and significant, suggesting that issuing

[9]Using sales instead of market capitalization mitigates the correlation between our size proxy and the market-to-book ratio. Our findings are similar when using the firm's total assets as an alternative proxy for size.

TABLE 1

Determinants of the Mortality Rates of U.S. Public Firms (1985–2006)

Table 1 reports the parameter estimates for the pooled logit models predicting firms' involuntary death (CRSP delisting codes 400–591). The unit of analysis is firm-year pair. The estimation uses all firm-year observations in the period 1985–2006 for firms that went public between 1985 and 2006. The dependent variable is a dummy variable equal to 1 if a firm experiences involuntary death in a given year, and 0 otherwise. "VC-Backed" is a dummy variable equal to 1 if a firm is backed by a venture capitalist, and 0 otherwise; "VC Reputation" is the fraction of total proceeds of IPOs that a VC firm has invested in since 1980; "VC Reputation" equals 0 if an IPO firm is not backed by VC, and the average value of the reputations of all involved VCs otherwise; "UW Reputation" is the rank of the lead underwriter of the IPO or, for IPOs with multiple lead underwriters, the average value of the ranks of all lead underwriters; "High-Reputation UW" is an indicator variable that takes the value of 1 if the IPO is conducted by an underwriter with a reputation above the sample median; "Incubation Time" is defined as the natural logarithm of 1 plus the number of years between the founding year of the firm and the IPO year; "Size" is the natural logarithm of the firm's sales; "Market-to-Book" is the market value of the firm's assets divided by their book value; "Z-score" is Sufi's (2009) modified version of Altman's (1968) Z-score; "Leverage" is the ratio of the firm's long-term debt divided by the book value of the firm's total assets; and "Age" is the number of years between the current calendar year and the year of the firm's IPO. All variables constructed from accounting data are lagged by 1 year in the estimation. A detailed description of variable construction is provided in the Appendix. All regression models include year-, exchange-, and industry-fixed effects (FE), where industry classification is based on the Fama–French 12 industries. Marginal effects for the variables of interest are in square brackets. Standard errors, clustered at the firm level, are in parentheses. $^{+}$, *, and ** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Variables	1	2	3	4	5	6	7	8
VC-Backed	−0.315**				−0.266**		−0.148*	−0.139^{+}
	(0.065)				(0.067)		(0.070)	(0.078)
	[−0.007]				[−0.006]		[−0.003]	[−0.003]
VC Reputation		−0.102**				−0.032		−0.007
		(0.028)				(0.026)		(0.028)
		[−0.002]				[−0.001]		[−0.000]
High-Reputation UW			−0.378**		−0.321**			−0.035
			(0.076)		(0.078)			(0.090)
			[−0.008]		[−0.007]			[−0.001]
UW Reputation				−0.112**		−0.107**	−0.103**	−0.099**
				(0.013)		(0.013)	(0.013)	(0.015)
				[−0.002]		[−0.002]	[−0.002]	[−0.002]
Incubation Time	−0.153**	−0.159**	−0.156**	−0.126**	−0.153**	−0.128**	−0.126**	−0.127**
	(0.030)	(0.030)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Size	−0.310**	−0.313**	−0.306**	−0.265**	−0.299**	−0.265**	−0.264**	−0.264**
	(0.020)	(0.020)	(0.020)	(0.022)	(0.021)	(0.022)	(0.022)	(0.022)
Age	0.021**	0.027**	0.023**	0.017*	0.019*	0.018*	0.015^{+}	0.016^{+}
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Market-to-Book	−0.277**	−0.277**	−0.318**	−0.321**	−0.316**	−0.320**	−0.320**	−0.319**
	(0.045)	(0.045)	(0.038)	(0.038)	(0.038)	(0.038)	(0.039)	(0.039)
Leverage	1.048**	1.047**	1.116**	1.091**	1.097**	1.086**	1.083**	1.083**
	(0.133)	(0.132)	(0.136)	(0.139)	(0.138)	(0.139)	(0.140)	(0.140)
Z-score	−0.072**	−0.071**	−0.075**	−0.077**	−0.077**	−0.077**	−0.078**	−0.078**
	(0.012)	(0.012)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)
Intercept	−2.458**	−2.460**	−2.254**	−1.899**	−2.251**	−1.913**	−1.925**	−1.935**
	(0.677)	(0.678)	(0.680)	(0.691)	(0.680)	(0.691)	(0.690)	(0.690)
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exchange-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	37,863	37,863	36,473	36,473	36,473	36,473	36,473	36,473
Pseudo-R^2	0.156	0.155	0.162	0.167	0.163	0.167	0.168	0.168

firms associated with more reputable VCs face a smaller chance of involuntary death during their public life.

Columns 3 and 4 of Table 1 show the effect of underwriters. The coefficients of the dummy for high-reputation underwriters (column 3) and underwriter reputation (column 4) are statistically significant at the 1% level. After controlling for industry-, year-, and exchange-fixed effects, as well as other determinants of mortality, firms taken public by more reputable underwriters are less likely to experience involuntary deaths post IPO.

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Next, we estimate specifications that take into account the joint effect by the two types of financial intermediaries at the IPO stage. The model in column 5 of Table 1 includes the dummies for VC backing and for a high-reputation underwriter leading the offering. In column 6, we replace these two dummy variables with their corresponding reputation equivalents, "VC Reputation" and "UW Reputation." Column 7 combines our variable capturing the presence of venture capital ("VC-Backed") with the reputation of the underwriter involved with the IPO firm. Column 8 includes all metrics for VCs and underwriters.

Columns 5–8 of Table 1 reveal that both types of financial intermediaries are associated with lower mortality rates, as the coefficients of the various proxies for VC and underwriters remain negative for all specifications. These coefficients are also significant except for column 6, where "VC Reputation" is no longer significant.

To illustrate the economic significance of the effect, we run a test using the specification of model 7 of Table 1. The probability of an involuntary death in a year for a firm whose other variables are set to their median levels decreases from 1.60% to 1.38% if the firm is backed by VCs. This amounts to an almost 13% decrease in the death rate. Similarly, the probability of an involuntary death in a year for a firm whose other variables are set to their median levels decreases from 2.03% to 1.46% if the quality of the firm's underwriter increases from the 25th to the 75th percentile of its empirical distribution. This amounts to a 28% decrease in the death rate.

All control variables have intuitive signs. Larger firms and firms with greater growth opportunities and higher Z-scores are less likely to face involuntary deaths. In contrast, firms with more debt in their capital structures have lower survival chances. The incubation time of a firm also reduces the probability of involuntary deaths, suggesting that a firm suffers more from "liability of newness" if it rushes to the public market shortly after it has been founded.

B. How Long Does the Effect Last?

Figure 2 reveals that financial intermediaries interacting with firms around their IPO stage are positively related to the firms' post-IPO survival chances. We verify this formally in Table 1. Figure 2 also shows that the differences in ASMRs between VC-backed and non-VC-backed IPOs and between IPOs employing high- and low-reputation underwriters are more pronounced during the early years after the IPO. We substantiate this finding by examining how long the association between financial intermediaries and the incidence of involuntary death can be detected in the data.

We use a rolling-window framework to identify when the effect of financial intermediaries on mortality rates starts to diminish. We begin by estimating model 5 of Table 1 but restricting the observations of each firm to years 0–4 after it goes public. That is, we examine the effect of financial intermediaries on the probability of involuntary death in years 0–4 after an IPO. We repeat the analysis for years 1–5, 2–6, 3–7, . . . , 8–12 after a firm goes public.[10]

[10]Due to the short window period in this type of analysis and the rare occurrence of involuntary death, especially for older firms, some of the estimations in the later windows (7–11 and 8–12) do not

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Columns 1–9 of Panel A of Table 2 present the results for various windows. We observe that the presence of a VC no longer affects the probability of involuntary death after 5 years after the IPO (column 7), whereas the presence of a high-reputation underwriter no longer affects mortality after 7 years after the IPO (column 9). In addition, the marginal effects for the dummy for VC backing and high-reputation underwriters are much larger during the early years, indicating that the economic impact of these intermediaries is more pronounced

TABLE 2

Persistence of the Effect of Financial Intermediaries on the Mortality Rates of U.S. Public Firms

Table 2 gives parameter estimates for the pooled logit models predicting firms' involuntary death (CRSP delisting codes 400–591) for different rolling windows: years 0–4, 1–5, 2–6, . . . , 8–12 after the IPO. The unit of analysis is firm-year pair. The dependent variable is a dummy variable equal to 1 if a firm experiences involuntary death in a given year within a specific window after its IPO. "VC-Backed" is a dummy variable equal to 1 if a firm is backed by a VC; "VC Reputation" equals 0 if an IPO firm is not backed by VC, and is the average value of the reputations of all involved VCs otherwise; "UW Reputation" is the rank of the lead underwriter of the IPO or, for IPOs with multiple lead underwriters, the average value of the ranks of all lead underwriters; "High-Reputation UW" is an indicator variable that takes the value of 1 if the IPO is conducted by an underwriter with a reputation above the sample median, and 0 otherwise; "Incubation Time" is defined as the natural logarithm of 1 plus the number of years between the founding year of the firm and the IPO year; "Size" is the natural logarithm of the firm's sales; "Market-to-Book" is the market value of the firm's assets divided by their book value; "Z-score" is Sufi's (2009) modified version of Altman's (1968) Z-score; "Leverage" is the ratio of the firm's long-term debt divided by the book value of the firm's total assets; and "Age" is the number of years between the current calendar year and the year of the firm's IPO. All variables constructed from accounting data are lagged by 1 year in the estimation. A detailed description of variable construction is provided in the Appendix. All regression models include exchange- and industry-fixed effects (FE), where industry classification is based on the Fama–French 12 industries. Marginal effects for the variables of interest are in square brackets. Standard errors, clustered at the firm level, are in parentheses. $^{+}$, *, and ** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Years								
	0–4	1–5	2–6	3–7	4–8	5–9	6–10	7–11	8–12
Variables	1	2	3	4	5	6	7	8	9
Panel A. Effect of VC-Backed and High-Reputation UW from Model 5 of Table 1									
VC-Backed	−0.487**	−0.435**	−0.384**	−0.314**	−0.229*	−0.235*	−0.124	−0.091	0.087
	(0.102)	(0.097)	(0.087)	(0.092)	(0.100)	(0.107)	(0.114)	(0.129)	(0.138)
	[−0.010]	[−0.010]	[−0.010]	[−0.009]	[−0.006]	[−0.006]	[−0.003]	[−0.002]	[0.001]
High-Reputation UW	−0.454**	−0.408**	−0.417**	−0.456**	−0.392**	−0.317**	−0.342**	−0.262^{+}	−0.277
	(0.124)	(0.109)	(0.102)	(0.106)	(0.113)	(0.120)	(0.132)	(0.150)	(0.172)
	[−0.010]	[−0.010]	[−0.013]	[−0.014]	[−0.011]	[−0.009]	[−0.008]	[−0.005]	[−0.005]
Incubation Time	−0.291**	−0.261**	−0.249**	−0.201**	−0.151**	−0.040	−0.046	0.044	0.009
	(0.046)	(0.041)	(0.039)	(0.040)	(0.044)	(0.047)	(0.052)	(0.059)	(0.067)
Size	−0.186**	−0.226**	−0.247**	−0.257**	−0.288**	−0.313**	−0.315**	−0.325**	−0.320**
	(0.032)	(0.031)	(0.027)	(0.027)	(0.030)	(0.032)	(0.036)	(0.040)	(0.045)
Age	0.208**	0.151**	0.048^{+}	0.030	−0.024	−0.003	−0.032	0.009	0.073
	(0.040)	(0.030)	(0.026)	(0.028)	(0.030)	(0.032)	(0.038)	(0.043)	(0.047)
Market-to-Book	−0.245**	−0.250**	−0.264**	−0.268**	−0.287**	−0.356**	−0.474**	−0.464**	−0.621**
	(0.050)	(0.050)	(0.049)	(0.053)	(0.047)	(0.059)	(0.073)	(0.082)	(0.112)
Z-score	−0.133**	−0.092**	−0.076**	−0.064**	−0.059**	−0.062**	−0.083**	−0.090**	−0.103**
	(0.022)	(0.024)	(0.017)	(0.015)	(0.015)	(0.015)	(0.011)	(0.017)	(0.019)
Leverage	1.092**	1.111**	1.069**	1.147**	0.997**	0.965**	0.920**	1.008**	1.001**
	(0.234)	(0.195)	(0.181)	(0.173)	(0.186)	(0.220)	(0.282)	(0.277)	(0.317)
Intercept	−4.144*	−2.913**	−2.400**	−2.296**	−1.599**	−0.992*	−0.529	−0.729	−0.830
	(1.699)	(0.800)	(0.693)	(0.603)	(0.546)	(0.436)	(0.495)	(0.576)	(0.648)
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exchange-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	17,602	20,929	19,477	16,819	14,491	12,471	10,601	8,887	7,430
Pseudo-R^2	0.186	0.162	0.151	0.135	0.133	0.125	0.144	0.137	0.149

(continued on next page)

converge in the presence of year-fixed effects. For the estimations that do converge, we find similar results. Therefore, we do not include year-fixed effects in the regressions.

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TABLE 2 (continued)

Persistence of the Effect of Financial Intermediaries on the Mortality Rates of U.S. Public Firms

	Years								
	0–4	1–5	2–6	3–7	4–8	5–9	6–10	7–11	8–12
Variables	1	2	3	4	5	6	7	8	9
Panel B. Effect of VC Reputation and UW Reputation from Model 6 of Table 1									
VC Reputation	−0.104*	−0.085*	−0.082*	−0.077+	−0.047	−0.048	−0.017	0.003	0.034
	(0.051)	(0.042)	(0.038)	(0.041)	(0.041)	(0.040)	(0.042)	(0.045)	(0.045)
	[−0.002]	[−0.002]	[−0.002]	[−0.002]	[−0.001]	[−0.001]	[−0.000]	[0.000]	[0.000]
UW Reputation	−0.158**	−0.141**	−0.132**	−0.121**	−0.102**	−0.075**	−0.080**	−0.066*	−0.034
	(0.020)	(0.018)	(0.017)	(0.018)	(0.020)	(0.022)	(0.023)	(0.027)	(0.029)
	[−0.003]	[−0.003]	[−0.004]	[−0.004]	[−0.003]	[−0.002]	[−0.002]	[−0.001]	[−0.001]
Incubation Time	−0.269**	−0.239**	−0.222**	−0.174**	−0.126**	−0.023	−0.025	0.063	0.018
	(0.047)	(0.042)	(0.040)	(0.041)	(0.045)	(0.048)	(0.053)	(0.061)	(0.069)
Size	−0.120**	−0.171**	−0.200**	−0.219**	−0.259**	−0.297**	−0.298**	−0.310**	−0.319**
	(0.036)	(0.033)	(0.029)	(0.029)	(0.031)	(0.034)	(0.037)	(0.042)	(0.046)
Age	0.198**	0.146**	0.047+	0.030	−0.023	−0.004	−0.034	0.007	0.071
	(0.041)	(0.030)	(0.027)	(0.028)	(0.030)	(0.032)	(0.038)	(0.043)	(0.047)
Market-to-Book	−0.243**	−0.252**	−0.269**	−0.274**	−0.293**	−0.362**	−0.482**	−0.471**	−0.622**
	(0.051)	(0.051)	(0.050)	(0.054)	(0.048)	(0.060)	(0.073)	(0.083)	(0.112)
Z-score	−0.132**	−0.091**	−0.076**	−0.064**	−0.060**	−0.062**	−0.084**	−0.091**	−0.103**
	(0.022)	(0.024)	(0.018)	(0.016)	(0.015)	(0.015)	(0.012)	(0.017)	(0.020)
Leverage	1.074**	1.088**	1.049**	1.118**	0.972**	0.943**	0.902**	1.001**	1.011**
	(0.232)	(0.195)	(0.181)	(0.175)	(0.188)	(0.222)	(0.285)	(0.280)	(0.317)
Intercept	−3.749*	−2.590**	−2.122**	−2.024**	−1.343*	−0.758+	−0.236	−0.464	−0.649
	(1.560)	(0.814)	(0.709)	(0.615)	(0.563)	(0.451)	(0.504)	(0.590)	(0.656)
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exchange-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	17,602	20,929	19,477	16,819	14,491	12,471	10,601	8,887	7,430
Pseudo-R^2	0.194	0.169	0.157	0.140	0.136	0.126	0.145	0.138	0.148

at the very early stage of a firm's public life cycle, when the mortality rate tends to be higher.

Graph A of Figure 3 plots the coefficients of the dummy for VC backing and the dummy for high-reputation underwriters from Panel A of Table 2 over various windows: years 0–4, 1–5, 2–6, 3–7, 4–8, 5–9, 6–10, 7–11, and 8–12 (solid lines), as well as the corresponding 95% confidence intervals (dotted lines). We observe from the top figure in Graph A that the solid line for coefficient estimates for the VC-backing dummy and the dotted lines for the 95% confidence interval remain below 0 prior to the years 5–9 window. After year 5, the confidence interval includes 0, indicating that the coefficient associated with the VC-backing dummy becomes statistically indistinguishable from 0. The bottom figure in Graph A indicates that both the coefficient estimate for the dummy of high-quality underwriters and the 95% confidence interval remain beneath the line of 0 until a firm reaches year 7 after its IPO.

Next, we repeat our rolling-window analysis using model 6 of Table 1, where the quality of financial intermediaries is measured by VC reputation and underwriter reputation. We find similar results, which we present in Panel B of Table 2: The effect of underwriters lasts up to 7 years after the IPO, longer than the effect of VCs, which is limited to the very early life of the firm, up to 3 years after

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the IPO. The marginal effect of both types of financial intermediaries tends to be larger during the early years after the IPO.

Graph B of Figure 3 plots the coefficients for "VC Reputation" and "UW Reputation" (solid lines), as well as the corresponding 95% confidence intervals (dotted lines). Consistent with the findings in Panel B of Table 2, the lines for the coefficient for "VC Reputation" ("UW Reputation") as well as the 95% confidence intervals remain below the line of 0 until 3 (7) years after the IPO.

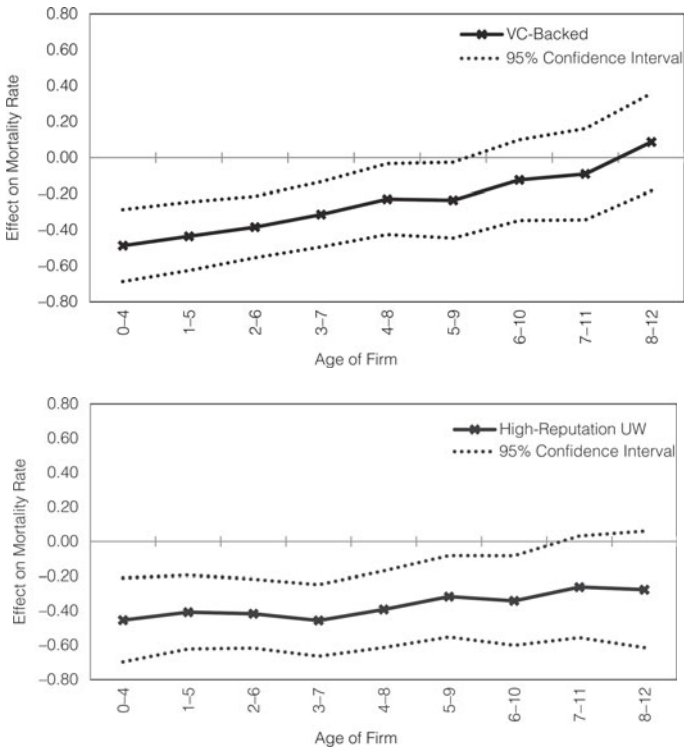
To summarize, Table 2 and Figure 3 reveal that the effect of financial intermediaries on reducing mortality rate can be detected for up to 5 years for VCs and up to 7 years for underwriters. An analysis of the marginal effects suggests that the economic impact of VCs and underwriters is larger during the early years of a firm's public life than during later years.

FIGURE 3

Effect of Venture Capital and Underwriters on Mortality Rates for U.S. Public Firms (1985–2006)

Graph A of Figure 3 shows 9 age-specific parameter estimates for "VC-Backed" and "High-Reputation UW" from the pooled logit models estimated in Panel A of Table 2. Graph B shows parameter estimates for "VC Reputation" and "UW Reputation" from the pooled logit models estimated in Panel B of Table 2. The dotted lines represent a 95% confidence interval constructed as ±1.96 standard deviations around each point estimate.

Graph A. Parameter Estimates from Panel A of Table 2



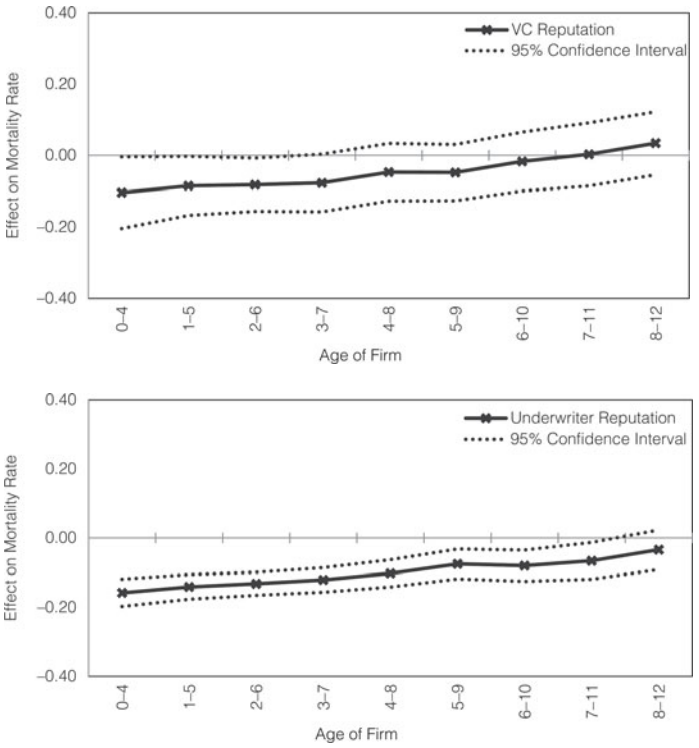
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FIGURE 3 (continued)

Effect of Venture Capital and Underwriters on Mortality Rates for U.S. Public Firms (1985–2006)

Graph B. Parameter Estimates from Panel B of Table 2



C. Potential Impact on Mortality from Interactions between Financial Intermediaries

It is plausible that the effect of one financial intermediary depends on the magnitude of the effect of the other. In this section, we explore this potential interaction between the two by reestimating Table 1 with an additional interaction term between the VC variable and the underwriter variable. The results are reported in columns 1–3 of Table 3. We note that the coefficient for the interaction term "VC Reputation" × "UW Reputation" is insignificant. It is marginally significant at the 10% level for "VC-Backed" × "High-Reputation UW" and "VC-Backed" × "UW Reputation," respectively, albeit with a counterintuitive sign.

However, as Norton, Wang, and Ai (2004) point out, for nonlinear models such as logit, neither the direction nor the statistical significance of the coefficient estimate of the interaction term can be informative about, and consistent with, the economic interpretation captured by marginal effect. By definition, the marginal effect for the interaction term in our logit model is the magnitude of change in the probability of involuntary death given a change in both VC and underwriter variables. In contrast to linear models, this effect is determined by

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TABLE 3

The Effect of Interactions between Financial Intermediaries

Table 3 reports the parameter estimates for the pooled logit models predicting firms' involuntary death (CRSP delisting codes 400–591). The dependent variable is a dummy variable equal to 1 if a firm experiences involuntary death in a given year, and 0 otherwise. The unit of analysis is firm-year pair. In columns 1–3, the estimation uses all firm-year observations in the period 1985–2006 for firms that went public between 1985 and 2006. In columns 4 and 5, the estimations are based on firms that are not backed by VCs. The variable "VC-Backed" is a dummy variable equal to 1 if a firm is backed by a venture capitalist, and 0 otherwise; "VC Reputation" is the fraction of total proceeds of IPOs that a VC firm has invested in since 1980; "VC Reputation" equals 0 if an IPO firm is not backed by VC, and the average value of the reputations of all involved VCs otherwise; "UW Reputation" is the rank of the lead underwriter of the IPO or, for IPOs with multiple lead underwriters, the average value of the ranks of all lead underwriters; "High-Reputation UW" is an indicator variable that takes the value of 1 if the IPO is conducted by an underwriter with a reputation above the sample median. The same set of control variables used for Table 1 ("Incubation Time," "Size," "Market-to-Book," "Z-score," "Leverage," and "Age") are included in the estimations but not tabulated. All variables constructed from accounting data are lagged by 1 year in the estimation. A detailed description of variable construction is provided in the Appendix. All regression models include year-, exchange-, and industry-fixed effects (FE), where industry classification is based on the Fama–French 12 industries. Standard errors, clustered at the firm level, are in parentheses. $^{+}$, *, and ** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Variables	1	2	3	4	5
VC-Backed	−0.323**		−0.443*		
	(0.076)		(0.193)		
VC Reputation		−0.157			
		(0.119)			
High-Reputation UW	−0.462**			−0.394**	
	(0.115)			(0.120)	
UW Reputation		−0.111**	−0.117**		−0.108**
		(0.014)	(0.016)		(0.017)
VC-Backed × High-Reputation UW	0.255^{+}				
	(0.151)				
VC Reputation × UW Reputation		0.016			
		(0.015)			
VC-Backed × UW Reputation			0.047^{+}		
			(0.027)		
Control variables	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Exchange-FE	Yes	Yes	Yes	Yes	Yes
No. of obs.	36,473	36,473	36,473	19,202	19,202
Pseudo-R^2	0.164	0.167	0.168	0.163	0.168

the value of all covariates. Consequently, both the sign and the magnitude of this marginal effect can vary with the predicted probability of involuntary death.

To facilitate the interpretation of the interaction terms "VC-Backed" × "High-Reputation UW" and "VC-Backed" × "UW Reputation," for each level of predicted probability of involuntary death, we compute Norton et al.'s (2004) z-statistics to examine the statistical significance associated with the corresponding marginal effect of each interaction term.

Graph A of Figure 4 plots the z-statistics for the interaction term "VC-Backed" × "High-Reputation UW" over different expected values of involuntary death. The horizontal axis is the predicted probability of involuntary death estimated using the pooled logit specification in column 1 of Table 3. The solid lines lying above and below the line of 0 represent the 95% confidence interval. We note that the values of z-statistics lie above the line of 0, indicating that the marginal effect for the interaction term is positive. However, most of them are within the 95% confidence interval, except for some that fall outside the interval when the predicted probability of involuntary death is low. This indicates that the marginal effect for the interaction term is statistically insignificant except when the predicted probability of involuntary death from the above logit model is relatively low.

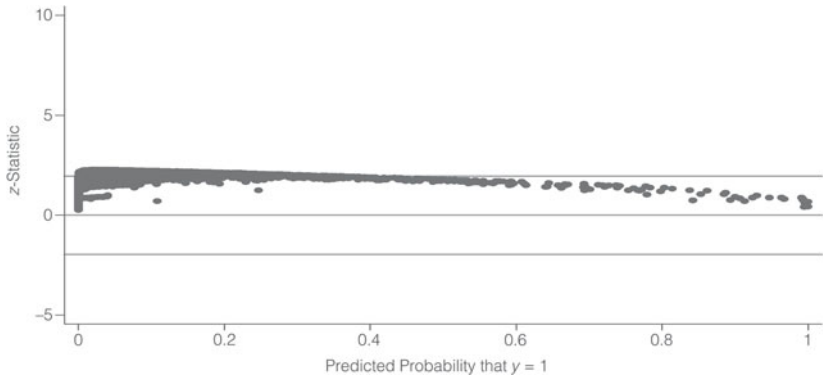
https://doi.org/10.1017/S0022109014000581 Published online by Cambridge University Press

FIGURE 4

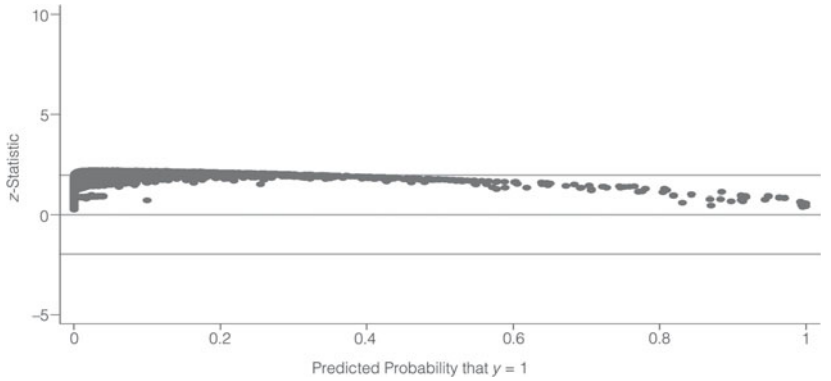
Interaction Effects as a Function of Predicted Probability of Involuntary Death

Figure 4 shows the *z*-statistics of the marginal effect of the interaction term between the two financial intermediaries as a function of the predicted probability of involuntary death. In Graph A, the vertical axis shows the *z*-statistics of the marginal effect of "VC-Backed" × "High-Reputation UW" based on the specification in column 1 of Table 3. The horizontal axis shows the values of the predicted probability of involuntary death ranging from 0 to 1. In Graph B, the vertical axis shows the *z*-statistics of "VC-Backed" × "UW Reputation" estimated using the specification in column 3 of Table 3. The horizontal lines lying above and below the line of 0 represent a 95% confidence interval.

Graph A. z-Statistics of the Marginal Effect of "VC-Backed × High-Reputation UW" from Column 1 of Table 3



Graph B. z-Statistics of the Marginal Effect of "VC-Backed × UW Reputation" from Column 3 of Table 3



In Graph B of Figure 4 we plot the *z*-statistics using the specification in column 3 of Table 3. Similarly, the marginal effect for the interaction term "VC-Backed" × "UW Reputation" is statistically significant only for values of expected involuntary death that are relatively low. Thus, Figure 4 reveals that the marginal significance of each interaction term exists only when the probability of involuntary death is low. To put it differently, only when death is unlikely, the effect of one financial intermediary depends on the magnitude of the effect of the other. We conclude that in the context of firm survival, the interaction is less important from an economic point of view.

Alternatively, we explore to what extent the interaction between the two intermediaries affects our findings by examining the role of underwriters on the mortality of firms not backed by VCs, a situation free from this potential

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compounding effect. This test also helps us address whether the high-reputation underwriter effect is really a VC effect.[11] By construction, we are able to estimate only models 3 and 4 in Table 1 for this test. The results are reported in columns 4 and 5 of Table 3. We find that high-reputation underwriters reduce firm mortality even in the absence of VC financing. These findings suggest that the interactions between the two financial intermediaries at the IPO stage are not affecting our main insights.

IV. Which Effect, Selection or Treatment, Is More Important?

Our results so far establish a significant relationship between a public firm's mortality and the presence and quality of financial intermediaries around its IPO. This association may be the outcome of selection (financial intermediaries identify firms with ex ante higher survival chances), treatment or natal financial care (financial intermediaries perform functions that improve firms' ex post survival chances), or both. In Internet Appendix B, we establish that both selection and treatment contribute to the reduction in mortality rate by financial intermediaries.[12] In this section, we use the method for comparison of the relative importance of prognostic factors developed by Heinze and Schemper (2003) to estimate which effect (selection or treatment) is more important for each financial intermediary. In what follows, we describe our proxies for treatment and selection, then the methodology and results.

A. Proxies for Treatment

Our first proxy for treatment is "VC Number of Rounds," which is the number of investment rounds received by the firm.[13] A larger number of rounds indicates more extensive VC involvement with the firm. For non-VC-backed firms,

[11] Li and Masulis (2007) document a substantial increase in investment banks' venture equity holdings in IPOs since the early 1990s, implying that underwriters' incentives should have become more aligned with those of VCs. Since VCs may be involved with startup firms long before their IPOs and often participate in selecting underwriters, it can be argued that the underwriter effect we document mirrors the VC effect.

[12] The separation of selection and treatment is a classic problem in corporate finance (see Li and Prabhala (2007) for a survey of existing econometric approaches to address selection). In Internet Appendix B, we show that a treatment effect by financial intermediaries on reducing a firm's mortality exists even after we control for selection. This insight is obtained using the two most common econometric approaches: a 2-stage model with Heckman (1979) correction for self-selection and instrumental variables analysis. Sorensen (2007) uses a structural matching model to separate selection from treatment by VCs. We are unable to adopt his method in our context because the outcome in his model is the act of going public, which is cleanly observed, whereas the outcome in our model is the probability of post-IPO survival until time t, which itself has to be estimated from another model. Our tests also reveal that VCs and high-reputation underwriters both influence firm mortality. Existing models do not handle this extra dimension.

[13] The VentureXpert database is well known for its "round-splitting" problem (Gompers and Lerner (1999)), in which the same financing round is counted more than once. When constructing "VC Number of Rounds," we adopt the approach by Du (2013) to identify split rounds and eliminate the later round if two financing rounds occur within 3 months. Using the number of rounds without this splitting correction does not change our findings.

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this variable is set to 0. Following Gompers (1995), our second proxy captures the intensity of the relationship between VCs and their portfolio companies using the stage of the company when VCs make their first investments. Specifically, "VC Stage" equals 0 for non-VC-backed firms, 1 for stages other than the early and seed stages, and 2 for the early and seed stages.[14] Higher values of this step variable indicate more treatment from VCs.

Unlike VCs, whose interaction with a firm mainly occurs during its pre-IPO period, underwriters are involved with firms during and after their IPOs. To avoid forward-looking bias when analyzing how the interaction between a firm and its underwriter affects the firm's mortality, we follow Bhattacharya and Daouk (2009) and construct "Likelihood of Relationship" that estimates the probability of a firm and its underwriter having an ongoing relationship. Specifically, this variable is defined as $\exp(-1 \times$ "Time Since Last Offering"), where "Time Since Last Offering" is the number of years since the latest securities offering a firm has completed with its IPO underwriter. To illustrate, consider a firm that went public in 1995 and completed a seasoned offering with the same underwriter in 1998. "Time Since Last Offering" equals 0 in 1995, 1 in 1996, and 2 in 1997. It restarts as 0 in 1998 and equals 1 in 1999, 2 in 2000, and so on. If a firm does not have a post-IPO securities offering, or has switched to a different underwriter for subsequent offerings, "Time Since Last Offering" keeps on growing by one with each passing year since the firm's IPO. By construction, "Time Since Last Offering" is negatively related to the presence of a continuing relationship. With a negative exponential transformation, "Likelihood of Relationship" decreases from 1 to 0 as "Time Since Last Offering" goes from 0 to infinity. This implies that "Likelihood of Relationship" is positively related to the ongoing relationship between a firm and its IPO underwriter.[15] It is important to point out that although "Likelihood of Relationship" can also measure successful securities issuances, there would be no successful issuance unless there was a relationship that issuer and underwriter considered to be value-adding.

By focusing on the relationship with financial intermediaries, we attempt to capture the potential effect of treatment. The underlying rationale is that treatment can occur only if there is an ongoing relationship between the firm and its intermediary. In the absence of a link between the relationship and firm mortality, it is selection (the financial intermediary just picks good firms to take public) rather than treatment (the financial intermediary reduces the mortality rate of firms through its interactions with them) that is likely to account for our results.

[14] VentureXpert has three variables that capture the stage when the firm is first financed by VCs. We use the level 2 variable, which identifies the stage of the firm as early stage, seed, expansion, later stage, acquisition, public market, other, or VC partnership.

[15] Multiple mergers between investment banks or between investment and commercial banks took place during our sample period. To construct "Likelihood of Relationship," we assume that the interaction between the firm and its underwriter(s) is ongoing if the seasoned securities issuances are underwritten by the lead underwriter who has taken the firm public or by a bank that has acquired the lead underwriter of the firm's IPO. For example, Cowen merged with Société Générale in 1998 to form SG Cowen Securities Corp. An ongoing relationship is assumed if a firm has its IPO underwritten by Cowen and subsequently uses SG Cowen Securities Corp as an underwriter for a seasoned issue. We first obtain information on mergers between underwriters from Ljungqvist, Marston, and Wilhelm (2006). We then manually match and verify the histories of the underwriters in our sample through extensive Web searches.

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B. Proxies for Selection

A comparison of the relative importance between selection and treatment effects also requires a proxy for selection by each financial intermediary. To arrive at this proxy for VCs, we rely on the rationale that the presence of VCs captures the combined effect of both their selection and treatment. To extract the selection component, we first regress the dummy for VC backing on our treatment proxy, "VC Stage." "Selection (VC Stage)," defined as the residuals from such a regression of the combined effect on our treatment proxy, serves as a proxy for VC selection.

Alternatively, we extract a proxy for the selection component by regressing the dummy for VC backing on our treatment proxy "VC Number of Rounds." "Selection (VC Number of Rounds)," defined as the residuals from this regression, serves as an alternative measure for VC selection.

We arrive at proxies for the underwriter's selection effect in a similar manner. To extract the selection component from the dummy for high-reputation underwriter ("High-Reputation UW"), we construct "Selection (High-Reputation UW)" as the residuals from regressing the "High-Reputation UW" dummy on "Likelihood of Relationship." The same rationale applies: "High-Reputation UW" captures the combined effect of both selection and treatment by underwriters, and the residuals from a regression of this combined effect on our treatment proxy "Likelihood of Relationship" thus provide an estimate for selection. Alternatively, we construct "Selection (UW Reputation)" by regressing "UW Reputation" on "Likelihood of Relationship."

C. Comparing Relative Importance of Selection and Treatment

1. The Partial PEV Approach

Schemper (1993) and Heinze and Schemper (2003) argue that the relative importance of a prognostic factor for an outcome variable can be quantified by the proportion of total variation in the outcome variable that can be attributed to the factor under consideration. In linear models, R^2 is a natural candidate measure of explained (attributed) variation. Unfortunately, there is a lack of consensus regarding the "right" equivalent measure in the context of logistic regressions. Mittlboeck and Schemper (1996) review measures intended to capture explained variation in logistic regression models, and they conclude that the R^2 based on squared raw residuals is a "good" measure.[16]

Heinze and Schemper (2003) advance the partial proportion of explained variation (PEV) measure based on the above definition of R^2 and propose an approach for comparison of this measure across variables. The partial PEV captures the decline in explained variation that arises when a candidate variable is removed from a model containing a set of prespecified variables. In other words, the partial PEV is calculated as the difference of the measures of explained

[16]Mittlboeck and Schemper (1996) point out that a "good" measure should i) have intuitive interpretation; ii) be consistent with the basic character of the logistic regression; iii) have the range of its potential values between 0 and 1; and iv) be numerically consistent with the classical multiple R^2.

variation for the full model and for a model without the factor of interest (Schemper (1993)). Conceptually, the partial PEV adjusts the importance of the factor of interest by artificially keeping the effect of other factors (controls) constant.

2. Relative Importance of Selection and Treatment Effect on Firm Mortality

To compare the relative importance of selection versus treatment by each financial intermediary on affecting firm mortality, we estimate a modified version of our pooled logit model from Table 1, replacing our financial intermediary proxy with the corresponding selection and treatment proxies described in Sections IV.A and IV.B as follows:

$$\Pr(\text{involuntary death}) = f\left(\begin{array}{c}\text{selection proxy, treatment proxy, control variables,}\\ \text{industry-FE, exchange-FE, year-FE}\end{array}\right).$$

We compare the magnitude of the partial PEV between our selection and treatment proxies. Statistical significance is determined by means of 500 bootstrap replications.

Table 4 reports the partial PEVs for selection and treatment by VCs (Panels A and B) and underwriters (Panels C and D). In column 1, we calculate the partial PEVs by including the baseline set of controls as in Table 1, "Incubation Time," "Size," "Age," "Market-to-Book," "Z-score," "Leverage," as well as industry-, exchange-, and year-fixed effects. In column 2, our set of control variables includes, additionally, a measure for the presence of the other financial intermediary.

Column 1 of Panel A in Table 4 reveals that when "VC Stage" is used as a proxy for treatment, the partial PEV for the VC treatment factor is 0.113%, significantly higher than the partial PEV of 0.033% for the VC selection factor ($p = 0.001$). When "VC Number of Rounds" is used as a proxy for treatment (column 1 of Panel B), the partial PEV for VC selection is 0.070%, while the partial PEV for VC treatment is 0.110%, and the difference is statistically significant ($p = 0.001$).

Column 2 in Panels A and B of Table 4 reports the partial PEVs with the dummy for high-reputation underwriter included as an additional control. This allows us to take into account the possibility that the VC's effect on firm mortality might depend on underwriter quality. We obtain similar results. Thus, our analysis suggests that treatment by VCs seems to be relatively more important than selection in contributing to the reduction of firm mortality.

Next, we compare the relative importance of selection and treatment by reputable underwriters in Panels C and D of Table 4. In column 2 of both panels, the set of control variables also includes the dummy for VC backing, to take into account the possibility that the effect of underwriter quality on firm mortality may depend on the existence of a VC.

We observe that the partial PEVs for our selection metrics, "Selection (High-Reputation UW)" and "Selection (UW Reputation)," are higher than those for our treatment metrics. The difference is statistically significant in three of the four cases. Different from VCs, underwriters' selection, rather than treatment, seems to be the more important determinant of firm survival.

To summarize, while both treatment and selection by each financial intermediary can lead to lower firm mortality rates, VCs affect mortality more through

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TABLE 4

Relative Importance of Selection versus Treatment for Financial Intermediaries

Table 4 compares the relative importance of selection versus treatment in predicting involuntary death. Relative importance is quantified by the method for comparison of prognostic factors in logistic models developed by Heinze and Schemper (2003). Partial PEV is the proportion of explained variation (PEV) that can be attributed to a candidate factor in addition to the PEV that can be attributed to a set of control factors. In Panel A, the selection proxy, "Selection (VC Stage)" is the residuals from regressing "VC-Backed" on "VC Stage." In Panel B, the selection proxy, "Selection (VC Number of Rounds)," is the residuals from regressing "VC-Backed" on "VC Number of Rounds." In Panel C, the selection proxy, "Selection (High-Reputation UW)," is the residuals from regressing "High-Reputation UW" on "Likelihood of Relationship." In Panel D, the selection proxy, "Selection (UW Reputation)," is the residuals from regressing "UW Reputation" on "Likelihood of Relationship." The control variables in column 1 include "Incubation Time," "Size," "Age," "Market-to-Book," "Z-score," "Leverage," industry-fixed effects, exchange-fixed effects, and year-fixed effects. The control variables in column 2 include the set in column 1 plus a variable that captures the quality and presence of the other intermediary. For the analysis of VC selection versus treatment (Panels A and B), this variable is "High-Reputation UW." For the analysis of underwriter selection versus treatment (Panels C and D), this variable is "VC-Backed." A detailed description of variable construction is provided in the Appendix. In each panel, the first row shows the partial PEV for the selection factor. The second row shows the partial PEV for the treatment factor. The last row shows *p*-values testing the difference in partial PEVs between candidate factors. Empirical confidence intervals and *p*-values are obtained from 500 bootstrap replications.

		Partial PEV	
	Proxy	1	2
Panel A. Selection versus Treatment (VC Stage) for VCs			
(1) Selection Proxy	Selection (VC Stage)	0.033%	0.019%
(2) Treatment Proxy	VC Stage	0.113%	0.045%
	p-value	0.001	0.001
Panel B. Selection versus Treatment (VC Number of Rounds) for VCs			
(1) Selection Proxy	Selection (VC Number of Rounds)	0.070%	0.046%
(2) Treatment Proxy	VC Rounds	0.110%	0.055%
	p-value	0.001	0.097
Panel C. Selection (High-Reputation UW) versus Treatment (Likelihood of Relationship) for Underwriters			
(1) Selection Proxy	Selection (High-Reputation UW)	0.215%	0.159%
(2) Treatment Proxy	Likelihood of Relationship	0.181%	0.154%
	p-value	0.058	0.673
Panel D. Selection (UW Reputation) versus Treatment (Likelihood of Relationship) for Underwriters			
(1) Selection Proxy	Selection (UW Reputation)	0.506%	0.394%
(2) Treatment Proxy	Likelihood of Relationship	0.181%	0.154%
	p-value	0.001	0.001

treatment relative to selection. By contrast, the lower mortality for firms associated with a high-quality underwriter arises mainly from its selection.

D. Measurement Noise in the Proxies for Treatment and Selection

The partial PEV analyses in the previous section rely on our proxies for treatment (the extent of involvement by financial intermediaries with an IPO firm) capturing well the treatment effort. It is plausible, however, that financial intermediaries are likely to spend more time and get more involved with good firms than with bad firms. Consequently, our treatment proxies can potentially overestimate each financial intermediary's treatment effort, and by construction, our selection proxies would underestimate its selection. To address this possible bias, we employ a modified version of an economic model that is intended to overestimate the magnitude of selection.

In the case of VCs, we estimate the magnitude of VC's selection by regressing the dummy for VC backing on both pre-IPO and post-IPO firm characteristics. The pre-IPO firm characteristics include factors identified by the literature to affect VC's selection (e.g., Lee and Wahal (2004)): "Size before Offering" (natural logarithm of the total assets of the firm before the offering date), "Book Value

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per Share" before the offering date, and year- and industry-fixed effects.[17] The post-IPO firm characteristics are "Size," "Leverage," "Market-to-Book," and "Z-score," measured 1 year after the IPO. The economic rationale behind this approach is as follows: By including post-IPO firm characteristics in addition to those before the IPO, we expand substantially the information set of the VCs beyond what is known before or around the IPO stage, where their selection takes place. Essentially, we allow VCs to select firms based on not only what is known before or around the IPO stage, captured by the pre-IPO variables, but also based on information about the firm after the IPO. Consequently, the predicted value for "VC-Backed" overestimates VC selection, and by construction, the residual should underestimate treatment.

Similarly, in the case of underwriters, we regress the dummy variable for high-reputation underwriter on both pre-IPO and post-IPO firm characteristics. The firm characteristics prior to IPO include "Proceeds" (natural logarithm of the IPO proceeds), "Book-Building Period" (natural logarithm of 1 plus the number of days in registration), "Filing Price Range" (the difference between the high and low prices in the prospectus), and "VC-Backed." The post-IPO firm characteristics are the same as the post-IPO variables used for VCs. As before, the predicted value for "High-Reputation UW" overestimates underwriter's selection, and by construction, the residual should underestimate treatment.

Table 5 presents the PEV analysis using these biased proxies for treatment and selection. Panel A shows that treatment is more important than selection for VCs, even if treatment is underestimated and selection is overestimated. By contrast, Panel B reveals that selection remains more important than treatment for underwriters, consistent with our findings in Table 4. Thus, our results that VCs' treatment is more important relative to their selection, and underwriters'

TABLE 5

Measuring Selection and Treatment: Alternative Approach

Table 5 compares the relative importance of selection versus treatment in predicting involuntary death. Relative importance is quantified by the method for comparison of prognostic factors in logistic models developed by Heinze and Schemper (2003). Partial PEV is the proportion of explained variation (PEV) that can be attributed to a candidate factor in addition to the PEV that can be attributed to a set of control factors. In Panel A, we regress the dummy for VC backing on firm-specific variables measured both before IPO and at 1 year after IPO, and extract the forecasted value and residuals. The characteristics prior to IPO include "Size before Offering" (natural logarithm of the total assets of the firm before the offering date), "Book Value per Share" before the offering date and year- and industry-fixed effects. The post-IPO characteristics include "Size," "Leverage," "Market-to-Book," and "Z-score." In Panel B, we similarly regress the dummy variable "High-Reputation UW" on firm-specific variables measured both before IPO and at 1 year after IPO, and extract the forecasted value and residuals. The characteristics prior to IPO include "Proceeds" (natural logarithm of the IPO proceeds), "Book-Building Period" (natural logarithm of 1 plus the number of days in registration), "Filing Price Range" (the difference between the high and low prices in the prospectus), and "VC-Backed." The post-IPO characteristics are the same as the post-IPO characteristics used in Panel A. In each panel, the first row shows the partial PEV for the forecasted value, the second row shows the partial PEV for the residual term, and the third row shows *p*-values testing the difference in partial PEVs between the first two rows. Empirical confidence intervals and *p*-values are obtained from 500 bootstrap replications.

Panel A. Selection versus Treatment for VCs

Variables	VC
Forecasted (overestimation of selection)	0.001%
Residual (underestimation of treatment)	0.155%
p-value	0.001

Panel B. Selection versus Treatment for Underwriters

Variables	UW
Forecasted (overestimation of selection)	0.824%
Residual (underestimation of treatment)	0.017%
p-value	0.001

[17] A more detailed discussion of firm-specific factors that affect VCs' selection is provided in Internet Appendix B.

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selection is more important relative to their treatment, are robust to the presence of a potential upward bias in our proxies for treatment.

V. Robustness and Extensions

Internet Appendix A describes in detail various robustness tests we performed. It also contains the raw mortality table used to construct the age-specific mortality rates of U.S. public firms. As Internet Appendix A indicates, our results are robust to alternative definitions of involuntary deaths, sample restrictions, estimation techniques, and clustering of standard errors. In particular, when examining whether the importance of financial intermediaries for firm survival varies systematically with aggregate economic conditions, we find that financial intermediaries are linked to lower mortality rates regardless of whether firms go public during periods of economic booms or busts. Our results also remain unchanged if we divide the sample into a "normal period" (1985–1995) and a "bubble and crash period" (1996–2006), suggesting that the reversal in the relationship between underwriter reputation and IPO underpricing in the 1990s (e.g., Beatty and Welch (1996)) does not drive our findings.

In Internet Appendix B, we describe both a Heckman (1979) two-stage and an instrumental variable (IV) approach that extant literature has used to address the issue of selection. We show that the treatment effect by financial intermediaries on reducing a firm's mortality exists even after we control for selection. While these two approaches are traditional ways to take into account the effect of selection, they offer little insight regarding the question as to which effect (selection or treatment) is relatively more important.

VI. Conclusion

In this paper, we ask three related questions about the mortality of U.S. public firms. First, what is their age-specific mortality rate after IPO? Second, do financial intermediaries involved in the IPO process affect firm mortality? Third, if they do, how?

To address the first question, we construct a mortality table for U.S. public companies during 1985–2006. We find that the first 3 years after a firm goes public are critical to its long-term survival: The mortality rates of public firms increase with age, peak at 3 years, and then decrease with age.

Second, we explore the role of two financial intermediaries during the IPO stage on a firm's post-IPO mortality. We find that after controlling for the usual determinants of survival, the presence of VCs and high-quality underwriters is associated with lower death rates for sometimes up to 7 years after the IPO. The economic impact of these intermediaries is more pronounced during the early stage of a firm's public life.

Lastly, we explore to what extent "natal financial care," defined as financial intermediaries' involvement and interaction with a firm around its public birth, affects post-IPO mortality. Using an approach for comparison of the relative importance of prognostic factors, we show that VCs reduce the incidence of involuntary death more through treatment than selection, whereas underwriters affect firm mortality more through selection than treatment.

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Appendix. Variable Definition and Construction

Age. A discrete variable that measures the firm's public age. Constructed as the number of years between the current year and the year in which the firm first appeared on the CRSP tape. Source: CRSP.

Book-Building Period. Natural logarithm of 1 plus the length of the book-building period (days in registration). Source: Thomson Reuters' SDC Platinum.

Book Value per Share. Book value per share before the offering date. Source: Thomson Reuters' SDC Platinum.

Filing Price Range. Difference between the high and low prices in the prospectus. Source: Thomson Reuters' SDC Platinum.

High-Reputation UW. A dichotomous variable that takes the value of 1 if the firm has an underwriter with a reputation above the sample median (8.0), and 0 otherwise. Source: Jay Ritter's Web site (http://bear.warrington.ufl.edu/ritter/ipodata.htm).

Incubation Time. A continuous variable that measures a firm's incubation time. Constructed as the natural logarithm of 1 plus the number of years between the founding year of the firm and the year in which the firm appeared for the first time on the CRSP tape. Source: Jay Ritter's Web site (http://bear.warrington.ufl.edu/ritter/ipodata.htm) and our own Internet searches.

Leverage. A continuous variable that measures the long-term debt of a firm divided by the firm's total assets. Constructed as DLTT/AT. Source: Compustat.

Likelihood of Relationship. A continuous variable, between 0 and 1, which measures the likelihood of an ongoing relationship between a firm and its IPO underwriter. Constructed as $\exp(-1 \times \textit{Time Since Last Offering})$, where *Time Since Last Offering* is the number of years since the last securities offering completed by the firm through its IPO underwriter. Source: Thomson Reuters' SDC Platinum.

Market-to-Book. A continuous variable that measures the market value of a firm's assets divided by their book value. Constructed as (AT + CSHO $\times$ PRCC_F $-$ CEQ)/AT. Source: Compustat.

Proceeds. Natural logarithm of the IPO proceeds (in millions of dollars). Source: Thomson Reuters' SDC Platinum.

Size. A continuous variable that measures the size of a firm. Constructed as the natural logarithm of firm sales (SALE). Source: Compustat.

Size Before Offering. Natural logarithm of the total assets of a firm before the offering date. Source: Thomson Reuters' SDC Platinum.

UW Reputation. A continuous variable that measures the reputation of a firm's underwriter. A lead underwriter's reputation is the rank measure as developed by Carter and Manaster (1990) and Carter et al. (1998), and updated by Loughran and Ritter (2004). For IPOs with multiple lead underwriters, it is the average of their reputation ranks. Source: Jay Ritter's Web site (http://bear.warrington.ufl.edu/ritter/ipodata.htm).

VC-Backed. A dichotomous variable that takes the value of 1 if the firm is backed by a VC, and 0 otherwise. Source: Thomson Reuters' VentureXpert.

VC Number of Rounds. A discrete variable that measures the number of investment rounds received by the firm. Defined only for VC-backed firms; set to 0 for non-VC-backed firms. Constructed as the number of investment rounds received by the firm by all VCs involved. Corrected for round splitting following Du (2013). Source: Thomson Reuters' VentureXpert.

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VC Reputation. A continuous variable that measures the reputation of a firm's VC. Defined only for IPOs backed by a VC; set to 0 for IPOs not backed by a VC. The reputation measure for each VC is constructed, following Nahata (2008) and Wang et al. (2010), as the fraction of total proceeds of IPOs that the VC has invested in since 1980. For IPOs with multiple VCs, it is the average of their reputations. Source: Thomson Reuters' VentureXpert.

VC Stage. A step variable equal to 0 for firms not backed by VCs. For firms backed by a VC, it takes the value of 2 if the first investment round received by the firm is at an early or seed stage, and 1 if the first investment round received is not at an early or seed stage. Stage definitions follow the level 2 classification of VentureXpert: early stage, seed, expansion, later stage, acquisition, public market, VC partnership, and other. Source: Thomson Reuters' VentureXpert.

Z-score. A continuous variable that measures the probability of bankruptcy (Altman's Z-score). Constructed, following Sufi (2009), as $3.3 \times$ (EBIT/AT) + (SALE/AT) + $1.4 \times$ (RE/AT) + $1.2 \times$ (WCAP/AT). Source: Compustat.

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