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The Effects of Experience, Ownership, and Knowledge on IPO Survival: Empirical Evidence from Germany

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Abstract

We study the implications of ownership and its induced incentives on firm survival on the stock market for young and high-tech firms. Using a unique data set of all 341 firms listed on the *Neuer Markt*, the German counterpart of the NASDAQ, our results differ from studies on more traditional firms. Ownership by CEOs has no influence on firm survival when introducing measurements of human capital and intellectual property rights. This confirms assumptions that firms in the knowledge based industries differ also in their governance structure from traditional firms.

Key Words: Firm Survival, Corporate Governance, New Economy, Entrepreneurship

JEL Classification: G32, L11, M13, C14

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1. Introduction

A rich literature has been established identifying the determinants of stock market performance. These studies have relied upon unambiguous measures of performance, such as Tobin's Q, return-on-assets, book-to-market value (Fama and French, 1999). Such measures certainly seemed appropriate in gauging economic performance in well-defined markets consisting of tangible assets (Rajan and Zingales, 2000). In addition, theory has clearly identified factors determining stock market performance. The development of agency theory (Hart, 2001) made a clear link between corporate governance and incentives, on the one hand, and stock market performance, on the other.

Both measurement and theory were developed for markets based on tangible assets and for established firms. However, the emergence of the so-called New Economy stock markets, may cast doubts on both the measurement and determinants of stock market performance that have applied in traditional markets. In the absence of marketable assets, the evaluation of firms is quite difficult. Share prices, for instance, are heavily influenced by factors other than firm performance. This is well documented by the rise in share prices until mid 2000 – and followed by a rapid decline.[1] However, in the absence of positive earnings, revenues or positive cash-flows, it is hard to evaluate firms based on the traditional performance measures such as Tobin's q, earnings per share or returns on assets. Blair, Hoffmann and Tamburo

[1] Furthermore, for the equity market to work efficiently in that share prices sufficiently reveal the future value of a firm, investors should have information about the underlying assets. If the value of the firm is mostly based on intangible assets, like it is in the *New Economy*, it is difficult to evaluate them without information. But, without a valuation of these assets there is no information available (see Bond and Cummins, (2000) and Hall (2001) for a discussion about the use of stock market prices to evaluate high-tech firms).

(2001) conclude that finding new measures of performance will be the most important activity for evaluating economic activity based on knowledge or intangible assets.

Their plea for new ways to measure performance is particularly striking in view of the emergence of new stock markets consisting of high-technology and knowledge-based firms relying largely on intangible and non-marketable assets. As such markets and firms become more prevalent, the need for measures that adequately reflect stock market performance will become even more urgent.

One contribution of this paper is to suggest a measure reflecting performance in knowledge-based markets. This measure is adopted from the industrial organization literature, where there is a consensus on what constitutes appropriate performance measures for new firms – their ability to survive over time. In his *Journal of Economic Literature* survey on "Industrial Organization and the New findings on the Turnover and Mobility of Firms," Caves (1998) identifies firm survival as a consistent measure of firm performance in a wide range of studies. In particular, this literature considers firm survival to reflect a positive performance and exit a negative performance (Caves, 1998). A common methodology applied in analyzing firm survival as a performance measure is to estimate their hazard rate functions. In this industrial organization literature (Caves, 1998; Audretsch and Mahmood, 1996), identifying the determinants of firm failure offers insights into firm performance.

However, the performance measure of firm survival has not yet been applied to evaluating the stock market performance of firms.[2] Virtually every previous study analyzing stock market

[2] Fama and French (2001) and Baker and Kennedy (2002) analyze the survival of firms on the stock market *(NASDAQ*), but restrict their study to focusing only on firm age and size as major determinants of survival.

performance has relied on the traditional performance measures such as Blair, Hoffman, and Tamburo (2001) emphasize, these traditional measures may be limited in knowledge-based markets. Thus, in this paper, we rely on the measure of firm survival as an additional indicator of performance.[3]

A second contribution of this paper is to reconsider the determinants of stock market performance in knowledge-based markets consisting predominately of intangible and non-marketable assets. The economics of knowledge (Arrow, 1962) implies that human capital and intellectual property may contribute to stock market performance as well as the more traditional influences of incentives and ownership as suggested in the more traditional literature. In addition, the theory of learning and noisy selection introduced by Jovanovic (1982) and Hopenhayn (1992) implies that firm age and size should also be important determinants of stock market performance.

In the second section of this paper, hypotheses are developed linking this measure of stock market performance, survival, to characteristics specific to the firm, incentives, governance structure and the human capital and intellectual property of the firm. Measurement issues are discussed in the third section. The empirical results from estimating a hazard function model for firm survival on the German *Neuer Markt* are presented in the fourth section. Finally, in the last section, a summary and conclusion are provided. We find that, using this new

[3] However, we will not proclaim that the survival of firms is a substitute for market prices as an efficient performance measure. We totally agree that stock market prices are an efficient measure of firm quality. However, low liquidity reduces the information of share prices as a sufficient quality signal of a firm. All firms listed on the *Neuer Markt* in Germany need a designited sponsor which guarantees a "sufficient" liquidity of the shares. However, those prices may often reflect their economic interests (Puri, 1999). In the end, if the costs of

measure of stock market performance, firm survival, the traditional factors such as incentives, as expressed by ownership rights, is only a necessary but not a sufficient condition generating firm success. In particular, the empirical evidence suggests that human capital and intellectual property appear to be the most significant determinants of the performance of firms listed on the *Neuer Markt*. In addition, firm size is found to influence stock market performance. Thus, there is compelling evidence suggesting that the *New Economy* (markets) require not just new measures of performance, but also new and additional factors shaping that performance.

2. Determinants of Firm Performance

One of the main goals of this paper is to suggest that performance for high-tech firms may be shaped by additional factors than have been identified in the traditional economy. Thus, in this section, we identify those factors shaping firm performance. Three disparate literatures have identified different types of factors influencing performance, as measured by survival on the stock market. One perspective is from the industrial organization literature, which focuses on characteristics of firm size and growth as reflecting the process of firm learning about its market viability. The second perspective is provided by agency theory, which emphasizes the role that incentives and ownership rights play in shaping firm performance. The third perspective is based on the economics of knowledge and identifies human capital and intellectual property as significant assets determining performance.

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providing market liquidity exceed the benefit of future transactions, the designated sponsors abandon their relationship to those firms. As a consequence, sooner or later they are delisted from the stock market.

2.1 Age, Size and Growth: The IO Perspective

We start by analyzing the determinants of what affects firm survival, as analyzed through the lens of the Industrial Organization (IO) literature.[4] According to this branch of literature, a firm can only survive – not only in the very long run - when the revenues are large enough to cover the costs. With imperfect competition, a positive price-cost margin can only be sustained by a natural monopoly, lower average cost functions compared to the competitors, collusion, and any kind of market power and strategic competition which prevents entry or pushes exits. Most of these advantages are strongly correlated to firm size. Since entry is associated with sunk costs, young and small firms lose a huge amount of their rare financial resources before they enter the product market. The only way to survive is to grow and attain a minimum size that allows them to compete or collude with the incumbent firms.

Since entry and exit rarely occurs in one time period, the age of the firm also influences the survival rate of firms, expressed by the *struggle of survival* or the *Darwinian* survival of the fittest. Thus, the age of a firm can easily be interpreted as their ability to have survived until the current period. The duration of survival depends on its ability to learn about its own production and cost functions and to react on changes on the supply or demand site (Audretsch, 1995). The age of a firm is also a measure of information which is not easily accessible for outsiders and captures learning-by-doing and changes in average stock of endowments of successive age cohorts (Agarwal and Gort, 2002). The stock of such learning accumulates with increases in a firm's age but also the information that a firm accumulates

[4] There is only a small numbers of theoretical papers analyzing the effects of age, size, and growth on firm survival. Jovanovic (1982) developed a learning model where "age" captures the experience of a firm and thus is the major determinant of firm survival. In contrast, Hopenhayn (1992) showed that size is the main dimension of heterogeneity of firms and thus determines firm survival positively. Recently, Cooley and Quadrini (2001) showed that, age, and growth are no independent factors of firms. They parameterize their model and show that

about itself (see Audretsch, 1995). Firms enter the market with incomplete knowledge of the quality of their endowments, managerial quality and the quality of their products and services and they learn progressively as they produce (Jovanovic, 1982 and Hopenhayn, 1992). Younger firms will therefore be associated with a higher risk than older ones. Thus, firm size and age seem to be the key factors that influence the likelihood of survival for new firms positively (Caves, 1998; Sutton, 1997).

2.2 Ownership as an Incentive Mechanism: The Agency Perspective

Ownership as an Incentive for Managers

Although it is recognized that firms may grow purely by chance following proportional growth rates (Sutton, 1997), performance also depends on managerial and executive competence. Thus, the outcome of a firm can be easily described as a function of the decision-making managers and a statistical "influence" or "disturbance" term. This, however, is the basic assumption of agency theory. Ever since Berle and Means (1932) stressed the consequences of the separation of ownership and control, most of the work on executive behavior and firm performance is based on agency theory, surveyed by Shleifer and Vishney (1997) and Bebchuk, Fried and Walker (2002). The pivotal point in this part of the literature is that the performance of a firm depends also on factors which are not under control of the executives and also not contractual. This gives managers the opportunity to act in their own economic self-interests. The more the shares are dispersed, the higher are the costs of monitoring and controlling the managers compared with the benefits for an individual

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size affects firm survival positively, while the influence of age is ambivalent. Younger firms may have less

shareholder. Furthermore, since such investments are associated with a moral hazard problem – the controlling shareholder has to bear the whole costs while the outcome of the effort is a public good – the incentive to control the CEO's decreases with the dispersion of shares. This increases the opportunity of managers to act in their own interests and thus they will seek higher-than-market salaries, job securities, perquisites, or direct capture of assets or cash flow (Jensen and Meckling, 1976). That self-interest can be reduced by providing incentives to the executives to act in the shareholders interest, either by compensation schemes or by share ownership.

Since the allocation of ownership directly influences the incentives, ownership would provide a strong incentive for executives to behave in the interest of other shareholders and thus increase the value of the firm (Jensen and Meckling, 1976).

Following the theoretical arguments and the empirical findings, ownership could provide an incentive for executives to run a firm and thus decrease the failure of a firm. If the firm is bankrupt, manager owners loose their private benefits of control and their source of future income. Thus, ownership serves as an incentive mechanism for managers to take actions that prevent firm failure, although it may reduce the return of the invested capital.

Board of Directors and Ownership

Boards are an economic institution that may help to solve the agency problems between managers and the shareholders. They provide managers with incentives contractually and ensure that the contracts are fulfilled by the management. Based on the contractual

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experience, according to the Jovanovic (1982) model, but otherwise are associated with higher growth rates.

arrangements, the board decides whether to keep the CEO or to replace her (see Hermalin and Weisbach, 1998).

Citing Adam Smith, Hermalin and Weisbach (2001, p. 4) conclude that directors of joint stock companies are more likely to be the managers rather of other people's money than their own, it cannot well be expected that they should watch over it with the same anxious vigilance as owners. Thus, ownership shares of the directors may reduce agency problems. First, ownership may increase the independence of the board members from the managers and thus fosters the possibility and incentive to control them independently. Tightly held firms, in which founders are still active and the CEO has a large ownership position, tend to have insider-dominated boards. Thus, low ownership by the directors will result in a less bargaining power with the CEO. Also the free-rider problem may be overcome if the directors have ties to the firm and thus a strong intent in the company's well being (Shivdasani, 1993). The longer the firm survives on the stock market, the longer directors generally have their seats on the boards and the associated directorship income without the financial loss of all their equity. Thus, ownership by the governing board members should increase their power and interest in firm survival and thus decrease the hazard rate of firms.

Investors and Ownership

In providing equity, venture capitalists play a major role in the governance structure of young and high-tech firms (Audretsch/Lehmann, 2002; Kaplan and Stroemberg, 2002). Ownership by venture capitalists may increase their incentive to invest in information collecting and monitoring activities (Lehmann, 2003). They may also be more likely to strengthen the

management teams as their control rights via ownership increases. The effect of ownership by venture capitalists is somewhat ambigous. One the one side, the longer a firm survives, the longer is the period to disinvest for venture capitalists without giving a signal which might induce adverse effects for other shareholders. Thus, the presence of venture capitalists as owners should increase the survival rate of the firms. Otherwise, it is well known that venture capitalists in contrast to banks invest in firms with a higher idiosyncratic and industry risk (Audretsch/Lehmann, 2003). This selection effect toward higher risk firms may lead to a negative effect of venture capital ownership on firm survival in the sample.

2.3 Human Capital and Intellectual Properties

The survival of a firm will be not only influenced by the incentives of the executives and their controlling boards, but also by their capabilities and *visions* (Rotemberg and Saloner, 2000). Even when managers have the correct incentives and the power to implement their decisions (see Rajan and Zingales, 1998), they make good or bad decisions because they differ in their capabilities. In high-tech markets, competitive advantage largely comes from non-physical assets including human capital, ideas and intellectual property rights (see Audretsch and Stephan 1996, or Rajan and Zingales, 2000, Fabel, 2003).

Since human capital is assumed to play a dominant role in founding new firms in the high technology sector (Audretsch and Stephan, 1996; Bates, 1990; Zucker et al., 1998) one could also assume that it also plays a critical factor in explaining firm failures. As an example, Bates (1990) shows that owner educational background is a major determinant of failure of small business firms. He reports that highly educated entrepreneurs are less likely to fail.

The same should hold for board members which have the right to hire and fire managers, to evaluate and change the policy of the firm and the rights to acquire information about the firm's financial situation. However, as Jensen (1986) assumes, board directors may be an ineffective governance mechanism if they are not able to evaluate the information given to them, to recognize the problems of a firm or to punish the management. This problem is exacerbated in young and high-tech firms, where information about the kind of competition or the production process is seldom available and the performance of managers difficult to measure. Thus, not only the incentive to control the managers will be insufficient, but also the ability to evaluate their actions.

Additionally, the role of directors may play an important role by providing information and advice to managers. So the managers may have an incentive to choose board members with high specialized human capital. The associated utility reduction by reducing the manager's leeway may thus be lower than the benefit of control and monitoring, even if the CEO's are also the main owners of the firms. This may be the also case, if the CEO does not know his ability for sure (see Holmstrom, 1999; Hermalin and Weisbach, 1998).

Summing up, we would expect the survival rate of firms is positively influenced by the human capital of board members.

Patents are one exceptional example of intangible assets for which property rights are to some extend defined and protected by existing legal systems. An advantage over other kinds of intangible assets, is that patents can be owned and sold if a firm has effective ownership over the patents. A firm's patents may also be the output of a kind of "knowledge production function," with human capital and corporate culture as non-tangible and spending in R&D as

monetary inputs (Griliches, 1989). Finally, patents may give a kind of monopoly to small firms which allows for extraordinary future cash flows. The capital market will thus reward innovative firms with a premium of prices on their shares. Thus, patents should increase the likelihood of surviving for a small firm.

Since the number of patents may be a measure of the "intellectual firm assets", patents owned by an executive manager or the CEO still may express her specialized human capital. As Rajan and Zingales (1998, 2000) point out, ownership is not necessary to protect the rents, since the individual patent is a critical resource of the firm and the patent owner has – legally – the power to withdraw this resource. Thus, the ownership of the patent offers the threat of exclusion (Grossman and Hart, 1986). Since a patent owner has both, the power to withdraw the asset and the power to distribute the rents, no rational economic agent will spend a huge amount of money in fear of a hold up situation. The patent owner cannot be excluded from the firm, even if his human capital is no more valuable to the firm, which means the low share of ownership may be a self commitment of the CEO as the patent owner not to behave in such a way in order to attract equity from outside investors.[5] Based on the arguments of Grossman and Hart (1986), asset ownership of the firm may help to protect the rents of the patent owner which are not fully protected by law.

[5] One possible way is to shift the shares towards close family members like the wife or siblings. Since ownership is restricted to 100%, an increase in the shares of one share-holder is associated with a decrease of another shareholder. We experimented and could find a significant positive correlation between the ownership of the patent holder and non institutional shareholders and a negative correlation with firms and venture capitalists, even the value of the coefficients are rather small.

3. Data set and descriptive statistics

To test the hypotheses that firm survival on the stock market is determined by factors reflecting incentives and ownership, human capital and intellectual property and the firm-specific characteristics of age and size, we use a unique dataset of 341 firms listed on the *Neuer Markt* in Germany from 1997 until 2002. This dataset is collected combining individual balance sheet data from IPO prospectuses, publicly available information from on-line datasources including the *German Patent office*, the *Deutsche Boerse*, and information from newspapers to get further information for the kind of delistings. Since the start of the *Neuer Markt*, 74 firms have been delisted. Although the *Deutsche Boerse* considers delisting "penny stocks" like they at the NASDAQ before June 2002, the firms in this database are not affected by the penny-stock rules. [6] These 74 firms are banned from the *Neuer Markt* because they broke the rules and also listed voluntarily[7] (20), declaration of insolvency (32), takeovers (22) or voluntarily delisting (20),[8] if the costs of being listed at the "Neuer Markt" exceed the expected future benefits. A delisting from the *Neuer Markt* leads automatically to a listing in the *Regulated Market*, which is a market segment with low stringent requirements and which is also perceived as less attractive to the companies as fewer analysts look at this segment. Small firms with a high probability of generating future cash flows are willing to pay a significant fee (about 250,000 Euro per year), to be listed on the *Neuer Markt*, since it increases the probability of raising new capital in the future.

[6] The new "penny stock" rule will delist firms if the average price for the admitted shares on exchange days is less then €1 per share for a period of 30 consecutive exchange days and the relevant company's market capitalization is less then 20m Euro (see www.deutsche-boerse.com).

[7] For example they could not present annual balance sheet data although they are admonished several times and has to pay a penalty, criminal misbehavior like insider trading or frauds.

[8] This occurs in cases when the designated sponsors close his relationship stop to secure a certain amount of volatility of the shares. The abundance of the sponsorship serves as a signal of the low quality and the expected

The number and kind of *delisting* as well as all the IPO-Data are provided by the *Deutsche Boerse* (www.deutsche-boerse.com). We take the months a company succeeded on the *Neuer Markt* since the first listing (IPO-Date) as the endogenous variable. Since the market – and the number of listings and delistings – was highly dynamic over this period, we take the number of months instead of years. The *number of employees* is used as a measure for the firm size prior to IPO. The difference in size before and after the IPO of the firm constitutes the *growth rates* of the employees (as measured by the difference of the natural logarithm). Further information from IPO data are the *age* of a firm (as measured in years before being listed on the stock market) and the *names* and *titles* of the executives and the board members. The variable *Board Human Capital* measures the number of directors with an academic degree (either doctor or professor). Data on the ownership structure are also taken from the IPO prospectus information. We include the ownership concentration of the CEO, the board of directors, friends and families, and venture capitalists, by including the variables *Executive Ownership, Director Ownership, Venture Capital Ownership* and *Friends & Family Ownership*. Ownership concentration is measured by the Herfindahl Index. Since patents are not included in the annual reports, we use the database from the *Deutsche Patentamt* (www.dpma.de) to identify patent activity. Thus, we are able to control whether the patent is owned by the CEO or the firm by including the variables *Firm Patents* and *Executive Patents.*

Table 1 provides the descriptive statistics of the exogenous variables included in the regression model, each calculated for the surviving firms ("stay") and the delisted firms ("exit"). Since the estimations of different means across the two groups depend on the

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low performance in the future. Also some firms quit the market voluntarily because they are no longer able to pay the costs for staying at the *Neuer Markt*.

assumption of an equal variance, Levine's test for equal variances is also provided. The results show that firms which were delisted are on average four years younger before they entered the stock market compared to the surviving group. This is in line with the findings of Fama and French (2001) for US Stock Markets that the age of firms listed on the stock market decreased in the last 20 years. The data provide no significant difference between the means of either firm size or growth rates. The firms also do not differ in the type of insider shareholding by executives, boards and family members (including other persons). On average, CEO's are tightly linked to their firms and most shares of the firms are held by family members. The two groups differ in the shares held by institutional shareholders. Venture capitalists and other firms have significantly lower shares on firms in the group which would be delisted in the future.

Surviving firms show more patents per firm and a higher number of executives and controlling board with academic titles. Interestingly, the number of shares of the CEO as a patent owner is rather small. The data show that, on average, a patent owner only holds about 2.6% of the shares in the surviving firm (compared to 0.41% in the group of the delisted firms). This rather small amount of shares is far away from any powerful position to protect his rents. Thus, there is preliminary evidence that the measures reflecting incentives and ownership, human capital and intellectual property, and firm age and size, differ between firms that exited and those that survived.

To address the question of whether young and high-tech firms have additional determinants influencing firm survival, we apply a proportional hazard duration model (see Kiefer, 1988) to estimate the likelihood of being delisted. The model is defined in terms of $h(t,x)$ and λ is

the hazard at time t for an individual with covariates *x*, reflecting the influences described in chapter 2. Let *T* be a non-negative random variable. It describes the duration of life on the stock market until the firm is delisted from the market segment. The probability for being delisted within an interval *(0,t)* is given by the distribution function *F(t).* The derivation is called density of *T* and named by *f(t).* The complement of the distribution function is called survivor function S*(t)=1-F(t)* and indicates the probability for staying on the stock market at *t.* A central element in the analysis of duration data is the concept of the hazard function. It is defined as the conditional probability for being delisted from the market within the interval $t+\Delta t$ given the firm has been on the market at *t*

$$\begin{aligned}\lambda(t) &= \lim_{\Delta t \to 0} \frac{\Pr(t \le T < t+\Delta t \mid t \le T)}{\Delta t} \\ &= \lim_{\Delta t \to 0} \frac{\Pr(t \le T < t+\Delta t)}{\Delta t \Pr(t \le T)} \\ &= \frac{f(t)}{1-F(t)} = \frac{f(t)}{S(t)}\end{aligned} \qquad (1)$$

Using this the survivor function *S(t)* as probability for being not dropped out of the market can be written as follows:

$$S(t) = \exp\left(-\int_0^t \lambda(u)\,du\right) \qquad (2)$$

To obtain a regression model we allow the failure rate to be a function of covariates *x*

(3) $$\lambda(t,x) = \lambda_0(t)\exp(x\beta)$$

where β is the vector of unknown parameters and $\lambda_0(t)$ is an arbitrary unspecified baseline hazard function for continuous *T*.

However, hazard rates may not be constant over time.Thus we prefer a Weibull[9] model in order to estimate the hazard rates[10] and assume that the baseline hazard rate $\lambda_0(t)$ takes the form $\lambda_0(t) = \lambda\alpha(\lambda t)^{a-1}$.

Consequently, the regression equation has the following form

(4) $$\lambda(t,x) = \lambda\alpha(\lambda t)^{a-1}\exp(x\beta)$$

where x is a vector of characteristics, and β is a vector regression coefficients. The hazard function is increasing (decreasing) in time *t* if $\alpha > 1$ ($\alpha < 1$), and constant if $\alpha = 1$.

In order to analyze the effects of incentives and human capital on firm survival separately, we proceed to test the following nested specifications of the hazard rate:

(5) *Hazard rate =*

(5a) *f(Age, Size, Growth, Ownership)*

(5b) *f(Age, Size, Growth, Ownership, Academic Titles Executives)*

[9] A plot of the hazard rates confirms the assumption that the Weibull model will be the most appropriate.

[10] Also the Weibull estimations allows for a better control of unobserved heterogeneity. Since the selection of an appropriate distribution may also be a subjective matter, we present alternatives estimations as further kind of "robustness" of the results.

(5c) *f(Age, Size, Growth, Ownership, Academic Titles Executives and Board), Firm Patents)*

(5d) *f(Age, Size, Growth, Ownership, Academic Title Executives and Board, Firm Patents,*

(5e) *f(Age, Size, Growth, Ownership, Academic Title Executives and Board, Firm Patents, Patents and Ownership).*

The sign of the coefficient indicates the direction of the effect of the explanatory variable on the conditional probability of being delisted. A positive coefficient increases the value of the hazard function and therefore indicates a "negative" impact on the likelihood of a firm being delisted. Otherwise a negative coefficient indicates that the particular covariate reduces the likelihood of the firm being delisted and thus has a "positive" impact for the firm's probability staying on the stock market.

Table 2 shows the estimates of the proportional hazard model under the assumption that the baseline hazard rate follows a Weibull distribution. Since the choice of the underlying model is not free from arbitrariness, we provide alternative estimations in the following sections.

4. Empirical results

4.1 Results from the Weibull hazard rates

The results from a Weibull estimation of equation (5a-e) are presented in Table 2. The exogenous variables are divided into three groups. The first group, consisting of *Executive Ownership, Board Ownership, Venture Capita*l and *Family Ownership,* reflects the factors

from the traditional agency theory, including incentives and ownership. The second group reflects knowledge assets, and consists of *Executive Human Capital, Owner Human Capital, Board Human Capital, Firm Patents,* and *Executive Patents*. The third group reflects the firm-specific characteristics which are the focus of the industrial organization literature, and consist of *Age, Size* and *Growth*.

First, the value of the shape parameter (*shape*) is much larger than one, indicating an increasing hazard rate for all specifications. Therefore, given the fact that a firm was on the stock market in t the probability increases with the time on the market that the firm will be delisted in the next short interval $t+\Delta t$.

In the first column the traditional agency theory variables are included along with the standard firm-specific variables that frame the firm-performance relationship in industrial organization. The negative and statistically significant coefficient of Executive Ownership is consistent with the much confirmed findings in the Agency Theory literature that a higher share of managerial ownership leads to a higher performance.[11] The statistically insignificant coefficients of Board Ownership, Venture Capital and Family Ownership reflect the ambivalent findings in the agency theory literature about the relationship between these ownership shares and firm performance.

Of the industrial organization variables, only size has a statistically significant impact on firm performance. As the so-called stylized fact has established (Caves, 1998), the likelihood of firm survival is positively related to firm size.

When the measures of executive and owner human capital are included, the results remain virtually unchanged. However, when a measure of human capital of the board members is included in the third column the results change dramatically. Most strikingly, the coefficient of Executive Ownership loses its statistical significance, but the coefficient for venture capital becomes positive and statistically significant. This suggests that after controlling for the impact of the human capital of the board, the share of ownership accounted for by venture capital becomes more important in determining firm performance than does the ownership share of executives. In particular, the positive coefficient on venture capital means the likelihood of firm survival decreases as the ownership share of the venture capitalist increases. This supports the theory of Aghion and Bolton (1992) and suggestions by Hart (2001) that venture capital firms actually have larger shares in higher risk firms.

However, when measures of intellectual property are included in the last two columns, the coefficient of the board human capital measure becomes statistically significant. In Column 4 the number of patents held by the firm is included, and in Column 5 also the number of patents held by the chief executive. Both the measure of board human capital as well as the two different measures of firm and executive intellectual property is positively related to the likelihood of firm survival.

Taken together, the results from estimating the Weibull Hazard Function for these firms in Table 1 provide some striking contrasts to the conventional findings in traditional markets.

[11] We found no significant effect using a square term testing for a non-linear relationship as proposed by Morck et al. (1988).

Consistent empirical evidence based on firms in traditional markets had supported the agency theories that the incentives for a strong performance favored ownership by executives. However, we find for young and high-tech firms, which consist mainly of start-ups in high technology and knowledge-intensive markets, that incentives no longer favor executive ownership, but rather the degree of human capital embodied in the board directors.

Assuming that strong managers select their controlling board directors, and the power of a CEO is positively correlated with his equity held on the firm, our results are plausible in the context of knowledge based markets. Furthermore, the delisting of an entrepreneurial firm is almost associated with a break down for his and his family's future income.[12] Thus, their incentive to choose directors may differ from managers of firms in the "old economy". In contrast, they have a strong incentive to select directors with high levels of knowledge and human capital to receive advice. The rather low equity shares of the directors in many firms (see table 1) are more likely to be a "gift" from the managers to select the directors.

4.2 Robustness tests: Misspecification and Unobserved heterogeneity

One problem associated with hazard models is the specification of the underlying baseline hazard rate. To examine whether the results vary significantly according to the assumptions of the underlying baseline hazard rate, the regressions are run for different types of distributions (see table 3). Since the log-normal, the log-logistic and the Gamma models cannot be

[12] Remember that the German insolvency law does not protect the entrepreneur as it is the case in the US (chapter 11). In the best case, the entrepreneur has to wait up to 7 years before starting a new company. Also, after a brake down of his firm, his monthly earnings are restricted to a minimum amount

expressed in the proportional hazard metric, the estimations are expressed in the accelerated failure time metric. In accelerated failure time models, the effect of the explanatory variables is to rescale time directly (see Kiefer, 1988) and the metric is of the form:

(6) $$\ln(t_i) = X_i\beta^* = \varepsilon_i \text{, or } t_i = \gamma_i \exp(z_i)$$

where $\gamma_i \equiv \exp(-X\beta^*)$ and $\varepsilon_i = \sigma\mu_i$ is a generalized error term with μ_i as the error term and σ as a scale factor. Values of the survival time scaling factor $\gamma_i > 1$ indicate accelerated failure or a reduction in the survival rate, whereas values of $\gamma_i < 1$ decelerate failure or increase survival rate. Only the Weibull models can be expressed by the accelerated failure time metric and the proportional hazard metric. The relationship between the proportional hazard and the accelerated failure time representation in this case is given by $\beta^* = -\sigma\beta$ where $\sigma = 1/p$ and p is the Weibull parameter. To facilitate a comparison with the other estimations, the first column in table 3 also contains the results from the previous Weibull estimations expressed by the accelerated failure time model.

The major results of the previous estimations (table 2) do not differ significantly according the specification of the underlying baseline hazard. However, the impact of size and the venture capitalists diminishes, when the baseline hazard is specified by a log-logistic and log-normal distribution. Thus, we also included the partial-likelihood approach introduced by Cox (see Kiefer, 1988) to estimate the coefficients in the proportional hazard model without specifying the form of the baseline hazard function. In the absence of all information about

the baseline hazard, only the order of the durations provides information about the unknown coefficient. Also in this specification the results do not change form the previous estimations, with the exception of firm size.

Besides the problem of misspecification of the baseline hazard rates, any continuous distribution like a hazard function may be affected by unobserved differences between the observations introduced in the estimations. This may lead to a misspecification but is especially problematic in duration models. Implications of unobserved heterogeneity are that the model will over-estimate the degree of negative duration dependence in the true baseline hazard, and underestimate the degree of the positive duration dependence, because "flat" hazards will be more negative and "rising" hazards will be flat or even non-monotonic. Also the proportionate response of the hazard to variation in each regressor at any survival time may be attenuated.

Thus, the hazard rate for each observation $\lambda_\nu(t) \equiv \lambda(t, X|\nu) = \lambda(t, X)\nu$ where $\lambda(t, X)$ is the hazard function considered in the estimations. Unobserved differences between observations are thus introduced via a multiplicative scaling factor, (ν). It summarizes the impact of the omitted variables on the hazard rate. This random variable takes positive values, with the mean normalized to one and finite variance. Furthermore it is assumed that ν is distributed independently of X and t. The relationship of this frailty survivor function to the non-frailty can be expressed by $S_\nu(t) \equiv S(t, X|\nu) = [S(t, X)]^\nu$.

For continuous time models the Gamma and Inverse Gaussian distributions have been mostly used. The results are printed in table 2, compared with the non-frailty estimation. The 'theta'

value reported in the table is the estimate of the frailty distribution variance. In both regressions, the parameter 'theta' is insignificant, indicating a negligible unobserved heterogeneity. The coefficients on the covariates are almost the same as those in the non-frailty model (table 2, first column). However, the Weibull distribution shape parameter is larger in both frailty models, indicating that the baseline hazard slopes upwards to a greater extend.

5. Conclusion

A voluminous literature has established empirical support for the main premises of agency theory that the incentive structure dictates that a predominant ownership share by executives will result in a superior firm performance. These theories and the subsequent supporting empirical evidence were based on firms in traditional markets. This paper has challenged any assumption that such theories and relationships will hold for high technology and knowledge-based startup firms.

We turned to newly listed firms on Germany's *Neuer Markt*. Those firms differ from traditional firms in Germany in that they are not only generally new, but more importantly are formed around new technologies and ideas. Many of these firms have no product, sales or positive cash flow. The findings from this paper suggest that the determinants of firm performance are strikingly different in New Economy markets, because the importance of the traditional factors shaping firm performance in traditional markets, such as executive ownership, disappears when measures of knowledge included. In particular, the degree of human capital of the controlling board as well as the intellectual property of the firm clearly

dwarfs the role of executive ownership in influencing firm performance. As the Old Economy gives way to the New Economy the main function of the board may be shifting from control to adding value. This reflects the new role for incentives to appoint CEOs with technological competence, leading us to conclude that young and high-tech firms may, in fact, need new governance.

Appendix

Table 1: Descriptive statistics of the exogenous variables

	Mean		Min/Max	
Variable	Delisting	Surviving	Delisting	Surviving
Age (***)	7.656 (8.255)	11.06 (11.738)	1 (52)	1 (107)
Employees before IPO (Size)	198.29 (293.323)	217.71 (397.567)	2 (1700)	3 (3030)
Employees after the IPO	289.89 (364.27)	326.38 (465.308)	3 (3683)	12 (1873)
Growth rate	0.58 (1.76)	0.47 (1.57)	-3.0 (5.0)	-4.0 (8.0)
Ownership				
Executive Ownership	37.07 (33.06)	35.2 (31.708)	0 (100)	0 (100)
Board Ownership	7.11 (15.08)	7.87 (17.26)	0 (63)	0 (100)
Friends, Family Ownership	59.66 (34.12)	54.81 (35.14)	0 (100)	0 (100)
Venture Capitalists Ownership (**)	10.94 (17.82)	14.32 (22,33)	0 (90)	0 (100)
Firm Patents (**)	2.15 (8.15)	4.73 (15.36)	0 (50)	0 (142)
CEO Patents (***)	0.41 (2.438)	2.59 (9.408)	0 (20)	0 (50)
Human Capital Executives (***)	0.36 (0.677)	0.61 (0.857)	0 (3)	0 (5)
Executive Ownership Human Capital with title (***)	0.12 (.241)	0.41 (0.241)	0 (5)	0 (5)
Human Capital Board	1.38 (1.210)	1.49 (0.270)	0 (100)	0 (100)

Note: (*,**,***) means significant test of equality of means (variance). T-test for Equality of means under equal variances if p(levine's test for equal variances) <= 0.10

Table 2: Hazard Estimations (Weibull, log relative-hazard from).

Dependent variable: Months at the stock-market before delisting (N=74)

Variables	(5a)	(5b)	(5c)	(5d)	(5e)
Executives Ownership	-1.0454	-1.0912	-.84189	-.67761	-.14016
	(.50108)**	(.51119)**	(.537749)	(.52964)	(.58330)
Board Ownership	-.07047	-.06319	.23497	.49674	.33632
	(2.1346)	(2.1592)	(2.1678)	(2.1365)	(2.20537)
VC Ownership	2.3978	2.5119	2.9603	3.8258	4.18030
	(.43327)	(.45872)	(1.7074)*	(1.6528)**	(1.6765)**
F&F Ownership	.67638	.66011	.46345	.41814	.34001
	(.43327)	(.45872)	(.48012)	(.45984)	(.45714)
Executives Human Capital	-	-.32726	-.16597	.78606	.95215
		(.62494)	(.63332)	(.75860)	(.74570)
Human Capital Ownership	-	1.0250	.85546	-1.17065	-1.64563
		(1.6939)	(1.6832)	(2.0544)	(1.9967)
Board Human Capital	-	-	-.163348	-1.7998	-.25406
			(.11222)	(.10602)*	(.11185)**
Firm Patents	-	-	-	-.043438	-.04147
				(.01621)***	(.015518)***
CEO Patents Ownership	-	-	-	-	-10.19205
					(5.9028)*
Age	.03959	.04647	.04892	.05067	.04871
	(.08121)	(.08288)	(.08721)	(.08834)	(.08962)
Size	-.28172	-.29143	-.28957	-.28389	-.28741
	(.14272)**	(.14600)**	(.15073)*	(.15408)*	(.15116)**
Growth	.00667	.00175	.03494	-.042507	-.04247
	(.10151)	(.10349)	(.11039)	(.11228)	(.11065)
Constant	-10.2280	-10.2552	-10.2395	-10.9926	-11.3064
	(1.1678)***	(1.1983)***	(1.2157)***	(1.2723)***	(1.2943)***
Shape	3.2276	3.2480	3.2885	3.5076	3.6107
	(.2853)	(.28939)	(.29151)	(.31112)	(.31959)
LL	-30.7406	-30.5540	-29.4353	-24.8602	-22.6279

Note: *; **; *** indicates significance on the.1; .05; .001 level.

Table 3: Alternative Hazard Ratio Estimations for equation (5e)

Depending variable: duration on the stock market before the delisting (in month, N=74)

Variables	I (Weibull)	II (log-logistic)	III (log-normal)	IV (Gamma)	V (Cox)
Executives Ownership	.038818	.02165	.04384	.03880	.94390
	(.16151)	(.19551)	(.18849)	(.16211)	(.56076)
Board Ownership	-.09314	.23364	.45405	-.07541	.99289
	(.61019)	(.58214)	(.65031)	(.62865)	(2.2055)
VC Ownership	-1.1577	-.78015	-.62019	-1.1417	37.9455
	(.44570)***	(.56606)	(.16290)	(.47006)**	(65.091)**
F&F Ownership	-.094166	-.06023	-.08681	-.09232	1.3218
	(.12609)	(.16463)	(.16290)	(.12815)	(.63442)
Human Capital Executives	-.26369	-.17328	-.140442	-.258532	2.12270
	(.20402)	(.19419)	(.22533)	(.20884)	(1.5601)
Human Capital Ownership	.455759	.41264	.38397	.45084	.272339
	(.55081)	(.51416)	(.61215)	(.55343)	(.53160)
Human capital Board	.07036	.05895	.060128	.070186	.80134
	(.03027)**	(.03500)*	(.03685)*	(.03042)**	(.09044)**
Firm Patents	.01148	.01305	.01162	.01151	.96459
	(.00419)***	(.00431)***	(.00529)**	(.00422)***	(.01509)**
Patents Ownership	2.82269	3.7069	4.0734	2.8572	.000122
	(1.62629)*	(1.5932)**	(2.02115)**	(1.6637)*	(.00072)*
Age	-.013492	-.019284	-.23387	-.01356	1.0378
	(.02479)	(.026229)	(.02865)	(.02489)	(.09336)
Size	.079600	.07607	.08842	.07980	.78430
	(.04134)**	(.05067)	(.05169)*	(.04165)**	(.12034)
Growth	.011762	.01311	.02214	.011833	.97690
	(.03063)	(.035567)	(.03838)	(.03073)	(.10750)
Constant	3.13133	2.9765	2.8792	3.12249	-
	(.20436)***	(.24740)***	(.25927)***	(.21835)***	
Parameter:	3.61075	.18749	.3487	.27911	-
	(.31959)	(.01799)	(.02803)	(.030554)	
LL	-22.6279	-26.060	-28.284	-22.6208	-253.811
LR chi-square	28.95***	20.46**	18.17	25.74**	20.4*

Note: *; **; *** indicates significance on the.1; .05; .001 level.

Note: Model I-V are in accelerated failure time, model VI is semi-parametric proportional hazards (hazard ratio coefficient <1 equivalent to a negative sign).

Table 4: Test of unobserved heterogeneity

Variables	(5e) (Weibull)	(5e) Gamma	(5e) Inverse Gauss
Executive Ownership	-.14016	-.11383	-.12909
	(.58330)	(.64113)	(.62690)
Board Ownership	.33632	.01618	.11461
	(2.20537)	(2.41101)	(2.3608)
VC Ownership	4.18030	4.1208	4.1704
	(1.6765)**	(1.89273)**	(1.8380)**
F&F Ownership	.34001	.24754	.29100
	(.45714)	(.534429)	(.50800)
Human Capital Executives	.95215	.88966	.91754
	(.74570)	(.795808)	(.78430)
Human Capital Ownership	-1.64563	-1.606006	-1.6363
	(1.9967)	(2.11995)	(2.0978)
Human Capital Board	-.25406	-.28531	-.27503
	(.11185)**	(.12730)**	(.12312)**
Firm Patents	-.04147	-.046122	-.04486
	(.015518)***	(.017858)***	(.017537)***
Patents Ownership	-10.19205	-.046122	-11.3852
	(5.9028)*	(6.70897)*	(6.5942)*
Age	.04871	.052707	.051787
	(.08962)	(.09674)	(.095399)
Size	-.28741	-.33135	-.31667
	(.15116)**	(.17548)**	(.16871)*
Growth	-.04247	-.055437	-.05013
	(.11065)	(.12011)	(.117736)
Constant	-11.3064	-12.0490	-11.865
	(1.2943)***	(1.7391)***	(1.7146)***
Shape	3.6107	3.94208	3.8521
	(.31959)	(.56170)	(.5381)
LL	-22.6279	-22.341	-22.431
Theta		.13819	.11872
		(1.95902)	(.24945)

Note: *; **; *** indicates significance on the.1; .05; .001 level.

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