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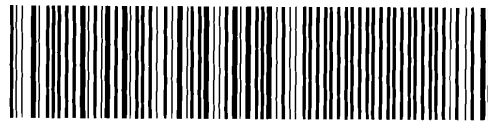

Growth and Exit of West German Firms - An Empirical Investigation on the Impact of Liability Statutes

by

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Abstract

In this paper we discuss determinants of firm survival and growth in Germany within its pre-1989 boundaries. We develop our central hypotheses on the basis of a simple theoretical model describing the self-selection of heterogeneous entrepreneurs into particular legal forms, and the implications for profitability and survival. We also describe institutional details of liability regulation and taxation rules which German entrepreneurs face when choosing a particular legal form for their firms. We then test the predictions of our model by considering the survival chances and employment growth rates of various types of enterprises in a sample of approximately 11000 West German firms in all major sectors of the German economy. In our analysis of firm survival we distinguish between voluntary liquidaton without losses to creditors, and bankruptcy as forced liquidation. Firms under limited liability are characterized by higher growth and higher insolvency rates than comparable firms under full liability. We also confirm the previously found negative relationship between employment growth and firm size which persists after controlling for selection biases. The likelihood of insolvencies is a nonmonotonic function of firm size.

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1 Introduction

The discussion on the determinants of survival and growth of firms, and with it on the determinants of labor demand has become popular among researchers and policy-makers alike. The reasons for a strong interest at the policy level are rather obvious. At the beginning of the 90s, many European economies have suffered the deepest recession since WW II. This has caused labour shedding of a magnitude unknown heretofore, and it has led to a sharp rise in the number of insolvencies. In Germany, the number of insolvencies continued to rise even at the apparent end of the recessionary phase, and the unemployment rate continues to remain at a high level. For 1994 we observe a postwar record in annual insolvencies, with about 19.000 firm failures and an estimated loss of 168,000 jobs. Similarly, the question of employment generation has become central to economic policy making especially in Germany whose economy is still plagued by high unemployment in the aftermath of unification with former East Germany.

The scientific investigation of industrial dynamics and the dynamics of employment demand has also become more popular recently. Starting with the early contributions by Gibrat (1931) and Simon and Bonini (1956), the relationship between firm size, firm growth, and industry structure has been under considerable scrutiny.[1] In part due to Birch's (1981, 1987) provocative statements about the dominating contribution of small and young firms to employment growth, the eighties have witnessed an upsurge of empirical studies on the evolution of firms, and especially on the supply of jobs so generated. Recent contributions to this literature include studies on the U.S. manufacturing sector by Brock and Evans (1986), Evans (1987a/b), Hall (1987), Dunne, Roberts and Samuelson (1988, 1989); on the British manufacturing sector by Dunne and Hughes (1994), and on new firms in the German manufacturing sector by Wagner (1994).

We add to this string of papers by presenting first estimates from a recently generated data set on the contribution of West German firms from all major sectors of the economy (rather than only the manufacturing sector) to the supply of jobs. While the general pattern derived here is not unlike that shown by the above authors, it also differs in major details. Our particular focus is on the implications of the firms' liability status. In a well-known paper, Stiglitz and Weiss (1981) predict that the selection of risky projects strongly depends on the adopted liability rule: under limited liability, projects with more growth potential but also higher risk of failure tend to be chosen. We develop a simple theoretical model in which the same risk-return tradeoff is at work, but where entrepreneurs with heterogeneous human capital can choose a particular liability regime and project.

In the empirical part of the paper, we analyze determinants of firm survival and growth. We relate survival and growth to the size of the firm, the firm's age, diversification, legal form, ownership status, and business sector. In our survival estimations, we differentiate between voluntary liquidation and bankruptcy. This distinction matters both conceptually and empirically: In our empirical analysis we show that limited liability firms are characterized by an above-average rate of insolvency, while they do not play a major role in voluntary business closings. To the best of our knowledge, this distinction is nowhere conceptualized in the

[1] See Scherer and Ross (1990) for a more detailed survey of this literature.

literature but in Schary (1991). The result that limited liability firms are more likely to exit via bankruptcy is surprising especially in view of the fact that German banks, not unlike those in other countries, aim towards full collateralization of risky credit by eventually resorting to the shareholder's private property, thus invalidating the liability limitation to shareholders.

Our survival estimates indicate that increasing firm size exerts a negative effect on the probability of voluntary liquidations. With respect to the probability of insolvencies, firm size exerts a positive marginal effect for firms with fewer than 18 employees and a negative effect for larger enterprises. By and large, firm age correlates negatively with the likelihood of both types of firm failure. Diversification tends to lower the likelihood of voluntary liquidation, but to our surprise does not affect the probability of compulsory liquidation.

In our analysis of firm growth we confirm previous research results that find a negative correlation between employment growth and firm size and age. More interestingly, limited liability firms tend to display considerably higher growth rates than single proprietorships which are the largest group of firms under unlimited liability. This, together with the significant increase in the probability of insolvency, confirms the hypothesis advanced by Stiglitz and Weiss (1981) and mimicked in our theoretical model, that limited liability leads entrepreneurs to invest in riskier projects with more growth potential.

We proceed as follows. In section 2, we describe a simple theoretical model relating the choice of liability rule to the entrepreneur's human capital, and demonstrate consequences on the firm's growth and survival potential. In Section 3 we describe the legal forms that can be adopted by a German firm and discuss their implications for liability and taxation. Section 4 contains a description of the data and the models used to analyze firm survival and growth. A presentation and discussion of the results from this analysis follows in section 5. We conclude in the final section and indicate avenues for further research.

2 Liability, Human Capital, and the Risk Structure of Projects - A Simple Model

Our central hypotheses can best be stated in the context of a simple model in which heterogeneous entrepreneurs endowed with given human capital can choose exactly one project from a continuum of project alternatives. This project may involve both the investment project of an existing firm; as well as the generation of the firm itself. We assume that the expected return of any project is known, and that the risk of project failure is positively correlated with that return. Unlike in the approach taken by Jovanovic (1982), we suppose that each entrepreneur knows with certainty his endowment of human capital, which positively affects the likelihood of project success.

The major complication in our model is the entrepreneur's choice of legal form. To keep matters simple, we will distinguish two types. The first - limited liability - will insure entrepreneurs against project failure, in which case the entrepreneur will have to pay some fixed amount not contingent on the expected return of the project. In the second case - unlimited liability - the entrepreneur´s losses incurred in case of project failure will depend on his financial engagement. We assume that upon failure, our investor will have to pay some amount proportional to the expected return of the project.

If the choice of a particular legal form would entail no costs, all entrepreneurs would opt for the limited liability status. Ceteris paribus, this choice would limit the losses in case of failure and therefore be strictly preferable. However, there are costs associated with choosing that legal form. For example, these costs may be due to tax rules or higher costs of capital. Note also that suppliers may treat firms with limited liability with greater caution than firms with full liability, e.g. by requesting advance payment for ordered materials and services. In all, adopting the status of limited liability is likely to involve higher costs. Due to these cost differences, the choices made by entrepreneurs endowed with different levels of human capital are less clear ex ante. However, we will show in the following model that some strong conclusions can be derived under fairly mild assumptions.

Formally, suppose that there is a continuum of projects from which the typical entrepreneur can choose that are indexed by their strictly positive and finite expected return δ. Under unlimited liability, the case indexed by U, project failure involves a loss of $\mu\delta$, $\mu > 0$. The payoff π involved in choosing a project type δ is summarized by

$$\pi^U = \begin{cases} \delta & \text{if success} \\ -\mu\delta & \text{if failure.} \end{cases} \tag{1}$$

Under limited liability, indexed by L, the corresponding payoff is given by

$$\pi^L = \begin{cases} \varphi\delta & \text{if success} \\ 0 & \text{if failure,} \end{cases} \tag{2}$$

where $\varphi < 1$ denotes the reduction in project yield due to the implicit cost of liability limitation. The loss in case of project failure is standardized to zero without loss of generality.

The probability of concluding a project successfully is a function of the entrepreneur's human capital and of project return in the case of success. In line with much of the financial markets literature, we assume on the latter a positive risk-return relationship: ceteris paribus, high-return projects are more likely to fail. As to the former, we suppose that human capital enhances the likelihood of successful project completion. Hence, the probability of successful completion of a project of type δ by an entrepreneur with endowment of human capital $H \in [\underline{H}, \overline{H}] \subset R_+$ is given by $p(H,\delta)$. Our assumptions are summarized in

$$\frac{\partial p}{\partial \delta} < 0, \quad \frac{\partial^2 p}{\partial \delta^2} > 0, \quad \frac{\partial p}{\partial H} > 0 \quad \text{and} \quad \frac{\partial^2 p}{\partial H \partial \delta} \geq 0. \tag{3}$$

Hence, the probability of success decreases at a decreasing rate in expected project return, and that probability increases in toto as well as at the margin in the entrepreneur's human capital.

Conditional upon the choice of liability rule, our entrepreneur is assumed to select a project of type δ by maximizing his expected profit. Under unlimited liability, this is

$$E(\pi^U) = p(H,\delta)\delta + \left[1 - p(H,\delta)\right](-\mu\delta) = \delta\left[(1+\mu)p(H,\delta) - \mu\right], \tag{4}$$

while under limited liability it is

$$E(\pi^L) = p(H,\delta)\varphi\,\delta\,. \tag{4'}$$

Assuming an interior solution which is obtained under very plausible assumptions, the first order condition under unlimited liability is given by

$$\frac{\partial p(H,\delta)}{\partial \delta}\delta + p(H,\delta) - \lambda = 0 \tag{5}$$

where $\lambda := \frac{\mu}{1+\mu} \in (0,1)$. Under limited liability, that first order condition reduces to the case where $\mu = 0$ and hence $\lambda = 0$. We henceforth assume that the second order condition holds throughout.

We can show in the context of this simple model that projects selected under limited liability carry a higher return if successful, and are more risky than projects selected under unlimited liability. This effect is even more pointed if entrepreneurs endowed with high human capital tend to prefer limited liability. Without imposing much stronger assumptions it was not possible to demonstrate within our model that they indeed do. There is a systematic reason for this, however. Any increase in human capital results in two effects: a direct increase in the probability of success; and, via the choice of a higher return project, a decrease in that very probability. While we can give plausible conditions under which one dominates the other, we are unable to evaluate the different strength of the two forces under limited versus unlimited liability.

We now state the formal results in two propositions, and formally specify conditions under which limited liability is chosen by entrepreneurs endowed with higher human capital. The proofs can be found in Appendix A.

PROPOSITION 1: $\delta^L(\overline{H}) > \delta^U(\underline{H})$

We show in the proof that for any level of human capital, projects chosen under limited liability will have higher expected return than projects chosen under full liability, i.e. $\delta^L(H) > \delta^U(H)$. From this result the proposition follows immediately because $\delta^L(H)$ can be shown to be strictly increasing in human capital H. Thus, the difference in expected returns will increase if the propensity to adopt liability limitations increases with the entrepreneur's human capital.

PROPOSITION 2: $p(\overline{H}, \delta^L(\overline{H})) < p(\underline{H}, \delta^U(\underline{H}))$ if $\frac{1}{\delta^L}\frac{\partial p}{\partial H} \leq \frac{\partial}{\partial \delta}\frac{\partial p}{\partial H}$.

Thus, the failure rate of high human capital types adopting limited liability will be higher than the failure rate of individuals with low human capital levels under full liability if the average marginal increase in success probability due to higher human capital is smaller or equal to the respective marginal increase.

Let $\delta(\mu, H)$ be the solution to (5), and

$$E(\pi^U(\mu,H)) := \delta(\mu,H)\left[(1+\mu)p(H,\delta(\mu,H)) - \mu\right] \text{ as well as}$$
$$E(\pi^L(H)) := p(H,\delta(0,H))\varphi\delta(0,H).$$

Lemma: For all H, there exists a unique $\tilde{\mu}(H)$ such that $E(\pi^U(\tilde{\mu}(H),H)) = E(\pi^L(H))$.

Furthermore, $\mu \lesseqgtr \tilde{\mu}(H) \Rightarrow E(\pi^U(\tilde{\mu}(H),H)) \lesseqgtr E(\pi^L(H))$.

As we show in Appendix A, the choice of limited liability is more likely with increased human capital, if either the optimal project choice involves a much higher return project under limited than under unlimited liability; or if the increase in the probability of project success with an increase in human capital is much stronger if the higher return limited liability project is chosen.

Thus our simple model predicts the following two regularities. First, firms operating under limited liability should perform at relatively high rates of return when compared to firms under unlimited liability. And second, these firms should be characterized by above-average mortality. These are our two central hypotheses. We have added conditions under which entrepreneurs endowed with higher human capital indeed choose limited liability. However, the latter are difficult to verify. This especially calls for an empirical clarification.

A number of qualifications apply when we try to test these predictions empirically. First, since we cannot observe profitability in our data, we will interpret employment growth as an indicator of profitability. Second, insolvencies are not the only type of exit from a given market. Over time, entrepreneurs may adjust their expectations to changes in business conditions and simply choose to liquidate voluntarily. Our simple one-shot model cannot help us to develop insights with respect to this decision. While we do not explore theoretically the underlying mechanisms that bring about voluntary liquidations, we will have to differentiate them from insolvencies in our empirical analysis. Finally, there may be other reasons why German entrepreneurs (or managers) choose a particular legal form. Clearly, the simple model captures only some institutional aspects of legal forms and liability statutes in the Federal Republic of Germany. In the following section we discuss this institutional framework in more detail.

3 Institutional Aspects of Liability Limitations

In this section, we discuss the legal forms that can be adopted by a German firm operating for profit[2], together with the liabilities taken by its owners under each legal form. Not unlike international practice, German business law distinguishes between legal forms in which firms have no legal capacity separate from its owners, and those in which firms do have this capacity. Characteristic examples of the former are the individual proprietorship *(Einzelunternehmung)*[3] and the civil law association *(BGB-Gesellschaft)*[4]. Limited and general commercial partnerships *(Kommanditgesellschaft (KG)* and *Offene Handelsgesellschaft (OHG))* also share that legal status. However, these two types of partnerships can be parties in real estate transactions and in litigation. Legal forms in which firms have full legal capacity are the commercial partnership limited by shares *(Kommanditgesellschaft auf Aktien - KGaA)*, the limited liability company *(Gesellschaft mit beschränkter Haftung - GmbH)* and the joint stock corporation *(Aktiengesellschaft - AG)*.

A second standard distinction is between the non-corporate firm *(Personengesellschaft)* and the corporate firm *(Kapitalgesellschaft - KG)*. For the legal forms explicitly considered in this paper, the drawing line between those is exactly analogous to that between legal capacities.

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[2] In our present analysis, we have removed the nonprofit organizations from our data base.

[3] Individual proprietorships are run by the owner, with at most one dormant partner.

[4] The civil law association is used as a convenient legal form for temporary projects. One therefore should expect a livelihood substantially shorter than that of firms under other legal forms.

For the purpose of our analysis, two major differences stand out between these two legal forms, namely the tax treatment of profits and equity, and the liability of their owners. As to the tax treatment, the major difference is that in the first group of non-corporate firms without legal capacity, only the owners are tax liable. Both, the firm's current profits and its stock of equity are taxed in proportion to the owner's share. The profit and wealth components are added to, and treated identically to the partner's other income and wealth. By contrast, corporate firms are separate legal identities also for tax purposes. Corporate retained earnings are taxed at a (constant) marginal rate of currently 50 percent while earnings distributed are taxed at a rate of 36 percent. Corporate wealth is also taxed at the level of the corporation. In contrast to U.S. shareholders, the typical German shareholder is not double-taxed on his share of corporate earnings distributed. Indeed, he receives a full rebate on the corporate income taxes withheld. However, he is fully tax liable for his share of corporate wealth. It follows first that in contrast to non-corporate income, corporate income, if retained, is always taxed at a relatively high percentage rate, and corporate wealth is double taxed.

As to the liability of the owners of non-corporate and corporate firms: As customary, the owners of the former type of firm are fully liable with their entire personal assets[5], and not only with the equity deposited with the firm, while the owners of the latter type are only liable up to the amount of their individual share. Speaking in broad terms, limited liability must be "bought" at the cost of increased tax liability, although the differential cost is not nearly as large as in the U.S.[6]

As we will show below, the limited liability company as a non-public corporate legal form is much more important in Germany than in the Anglo-Saxon countries. Several reasons could account for this. First, the limited liability status used to be advantageous relative to that of the public corporation because, up to a change in legislation effective 1987, disclosure requirements were substantially weaker. For all practical purposes they still are to date, since German courts do not as yet enforce the disclosure rule with great vigour. Second, the limited liability status has become increasingly important relative to the non-corporate legal forms, all involving full liability, because the 1977 corporate income tax reform has led to a reduction in the corporate income tax burden on distributed earnings, and the 1980 change in legislation on *GmbHs* has incorporated the possibility of a limited liability company involving just one partner, a status not available before.[7]

The comparative advantages and disadvantages of the different legal forms with respect to tax treatment and liability have also led to a legal form combining the advantages of both, namely the limited commercial partnership formed with a limited liability company (*GmbH & Co. KG*). Under this legal form, both, liability is limited, and profits are subject to the partners' income tax. In particular, retained earnings can be made subject to the lower tax rate often applying to income, as long as the partners agree to distribute all earnings, and to deposit (part

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[5] By exception, the *Kommanditgesellschaft* considers two types of shareholders, one of which is fully liable, and the other liable only up to the share value.

[6] Even that smaller increase in tax burden can be substantially reduced by skillful financing arrangements (Raab 1993).

[7] Rather than depositing his assets in his company, a wealthy owner of a one person *GmbH* can substantially save taxes on both corporate wealth and on retained earnings by holding minimal equity; distributing all earnings to himself; and using his assets as a personal collateral for debt financing.

of) them after taxation. In addition, equity is only subject to double taxation in as much it is associated with the *GmbH & Co. KG*.

As mentioned above, the overall distribution of legal forms has been subject to rather dramatic changes over the last two decades. We used establishment census data from 1970 and 1987 to compare the absolute number and share of firms in various legal forms. The absolute number of firms with limited liability grew by a factor of more than 6 in this period. In 1970, only 1.8 per cent of all firms were incorporated in this form, accounting for about fifteen per cent of all employees. However, by 1987, about 10.5 per cent of all firms were *GmbHs* and the employment share accounted for by this legal form had risen to almost 26 percent.[8] In terms of total employment share, all other legal forms lost in comparison to the *GmbH*. Especially non-corporate legal forms like the individual proprietorship and the civil law association (*BGB-Gesellschaft*), the *OHG*, and stock-based legal forms like the *AG* and *KGaA* lost in importance.

4 Data and Variables

4.1 Data Source and Sample Construction

We only provide a brief description of data source and sample construction here. A more detailed account is given in Appendix B of this paper. The data originate with Germany's largest credit rating agency and were obtained in six-month intervals starting in July 1989. For the purpose of this analysis, eight linked cross-sections were available. The unit of observation is the legally independent enterprise. The initial sample consisted of 13346 firms. Due to a number of exclusions (e.g. of agricultural and public sector firms) and data constraints described in some detail in Appendix B, we use information on the survival status of 10961 firms. Firm relocations, mergers, and changes in ownership are not counted as exits (i.e. failures) in our analysis, since they do lead to a reorganization, but not necessarily to the termination of economic activities pursued in the enterprise. Among the 10961 relevant observations, we observe employment growth rates for only 8068 enterprises. The difference between the number of firms with growth rate observations and the number of firms with information on their survival status is due to two sources. First, for non-survivors our data do not allow us to compute employment growth rates. Second, there are a number of cases in which the credit-rating agency did not update the employment information in our sample. Since both of these effects may cause selection biases, we account for them in our analysis of employment growth rates.

4.2 Specification and Variable Definitions

The first dependent variable analyzed here is the firm's survival status. Note that the survival status data obtained from the credit rating data has been complemented by a large

[8] To this figure we should add the employment in *GmbH*'s run by *Kommanditgesellschaften*. Unfortunately, the data do not allow for the separation of this component from the share of employment provided by the *KG*'s.

number of telephone interviews (see Appendix B for details). We consider the survival information combined from these two sources as highly reliable. Firms were classified as *insolvencies* if they had been in business prior to July 1, 1989 and had declared an insolvency until March 1, 1994. If a voluntary business liquidation (without losses to creditors) had occurred during the same period, the firms were classified as *voluntary liquidations*. In the empirical analysis, we estimate logit specifications for the combined group of closed enterprises. Since liability limitations will not work to the entrepreneur's advantage in the case of voluntary liquidations, it is unlikely that combining both exit types is an innocuous estimation strategy. Therefore, we test for systematic differences between exit types in a multinomial logit specification with no exit as the base category and insolvency and voluntary liquidation as the two choices. All of the independent variables used in the survival analysis are taken to represent predetermined values and are obtained from the time period prior to July 1, 1989.

In our specification of growth equations we differ from previous studies that have used credit rating data. Instead of attributing employment data to a particular year, we make use of the precise "date of interview" information in our data and compute the corresponding annual growth rate. For each firm, the longest possible time that elapsed between interviews is taken in order to obtain more robust growth estimates. Unfortunately, the data are not updated often enough by the credit rating agency to compute successive growth rates for a large number of firms. The age and size variables in the growth equations refer to the size and age of the firm at the beginning of the respective growth period. Following Evans (1987a/b) we specify regressions with the firm's employment growth rate as the dependent variable, and a second-order polynomial in logarithms of age and size as the main independent variables. To test our hypotheses regarding the correlation between legal forms and growth, we employ a set of dummy variables characterizing the legal form of the firm at the beginning of the observation period.

In the following section we briefly discuss measurement issues and the definitions of the dependent and independent variables.

Survival Status. Measuring the firm's survival span is less trivial than it seems at first sight, since it involves the difficult task of determining exactly when a firm ceases and when it starts to exist. For example, some researchers have argued that a change in ownership, location or even legal form may induce changes substantial enough to change the firm's identity. In our data set, we are confronted with similar questions, since roughly one third of all firms are characterized by a date of foundation coinciding with their last change of legal form. Fortunately, we have information on the date(s) of foundation of the legal predecessor(s) of this "new" entity. Firm mortality is not easily pinned to a particular date, either. In particular, a firm may declare bankruptcy, but continue production for years to come. However, we have information on the date when a firm had to register its financial misfortune, as well as a date when the firm actually went out of production.

We use an "economic" measure of total survival span which represents the longest possible combination of birth and mortality dates (i.e. the time elapsed between the earliest registered date of foundation and the latest recorded entry regarding the firm's liquidation). To give a stylized example, a firm founded in 1950 as a non-corporate firm (this date being recorded as the start of the earliest legal predecessor) may have changed its legal form, and

thus appears as newly founded and incorporated in 1960. The firm may have declared bankruptcy in 1987 and finally ceased production in 1989. By our definition, survival spans 39 years in this stylized example.

When comparing our mortality data to those of other studies, it should be kept in mind that take-overs and mergers are occasionally taken to represent firm deaths (e.g. in Dunne and Hughes 1994) while we only interpret them as firm failures if the firm ceases to exist as an economically active unit, irrespective of ownership.

Employment Growth Rate. The central variable in the analysis of firm growth is the firm's employment growth rate. As indicated in the above, the computation of growth rates for our data is somewhat more difficult than in standard panel data. However, since the date of the interviews is recorded in the dataset, the growth rate can be computed from the employment data and the time difference between interviews. Our definition of the growth rate g is

$$g = \frac{\log E(t_2) - \log E(t_1)}{t_2 - t_1} \quad ,$$

where E(t) is the firm's number of employees at time t, and t_2 and t_1 are interview dates. Since this computation introduces an additional source of heteroskedasticity in our regressions, we use White's (1984) method of computing a robust variance-covariance matrix for the growth equations. In addition to heteroskedasticity, this method of computing an employment growth rate requires us to use vintage (or time) dummies in our regressions. We do so by introducing dummy variables for all combinations of interview years that delimit the growth observation periods.

Firm Size. The firm's initial size is computed as the natural logarithm of the firm's number of employees (full-time equivalents). For the survival analysis, we use information from the latest interview prior to July 1, 1989 to compute the measure LSIZE. In the growth equations, LSIZE is computed from the interview data at the beginning of the period for which we compute a growth rate. As it turns out, the implications from using the same measure in survival and growth equations are only minor.

Firm Age. It is clear that considerations similar to those regarding the survival time of an enterprise have to be taken into account in the case of the firm's age. Again, we assume that the firm began to exist at the earliest registered day of foundation. The logarithm of the firm's age will be denoted LAGE.

Legal Form. As discussed in section 3, German law allows for a number of ways in which entrepreneurs can enter the economic arena. These forms of incorporation may bring along different ways of taxation, liability statutes and mandatory ownership structures. For the purpose of the empirical analysis, we will use the dummy variables

BGB - civil law association (*BGB-Gesellschaft*),

GMBH - limited liability firm (*Gesellschaft mit beschränkter Haftung*),

GMBHCO - limited commercial partnership formed with a limited liability company (*GmbH & Co. KG*),

KG - limited commerical partnership (*Kommanditgesellschaft*),

OHG - general commerical partnership (*Offene Handelsgesellschaft*),

AG - stock-based corporate firm (*Aktiengesellschaft* and *Kommanditgesellschaft auf Aktien*).

The reference group are enterprises in the form of the individual proprietorship (*Einzelunternehmen* and *Gewerbebetrieb*). To avoid simultaneity problems, all of these variables again refer to the earliest listed information in our data, i.e. the legal form status prior to the beginning of the period of observation. For example, firms may have changed their legal form after this information was recorded, in order to reduce liability in the face of increasing debt. This transition process itself may be of considerable interest (e.g. for the prediction of insolvencies), but we presently do not make use of this information, since our data do not allow us to treat the simultaneity problem in a convincing manner.

Diversification. This is a simple dummy variable (*DIVERS*) assuming the value 1 if the firm has a secondary industry classification in a one-digit sector different from the primary one, and 0 otherwise.

Subsidiary Firms. Our data allow us to identify enterprises which are direct subsidiaries of other firms. This variable (*SUBSIDIARY*) is based on the ownership structure of the firm and is coded as 1 if the enterprise is under complete control of other firms.

Industry Classification. We use a set of 28 dummy variables at the two digit level to control for industry-specific effects.[9]

5 Descriptive Statistics and Estimation Results

5.1 Descriptive Statistics

We first describe several features of the firms contained in our data set before proceeding to a discussion of the estimation results. Table 1 presents descriptive statistics for the full sample with 10961 observations and for the sample of firms for which we were able to compute employment growth rates (8098 observations).

TABLE 1 ABOUT HERE

A number of points are noteworthy. First, the average employment of firms in the growth sample is considerably higher than in the overall sample. Second, firms in the growth sample are about 2.5 years older than in the complete sample. And finally, the share of single proprietorships among the firms in the full sample is larger, i.e. firms with limited liability occur somewhat more frequently in the growth sample than in the total sample. We conjecture that this form of selectivity is simply a reflection of the business orientation of credit rating firms. Firms with limited liability are more likely to encounter supplier firms which are willing to invest in information about this particular customer. Larger firms are likely to do more business transactions which may again involve a larger number of suppliers who would want to obtain information about their customer's willingness to pay. At this point, it is not clear what the effect of this sampling distortion is. If limited liability firms have a greater ex ante probability of being observed and if they display above-average growth as our model would suggest, then a positive correlation between sampling and growth might emerge. On the other hand, if small

[9] Interestingly, the use of legal form dummies in the regressions described below renders *one*-digit industry controls virtually insignificant.

firms tend to be screened out and the size-growth correlation is negative, then a negative correlation between sampling and growth is possible. Since other studies using credit-rating data have not investigated the effect of sampling bias other than the standard survivor bias, we cannot make use of previous experience to answer this question. We will come back to this point in our conclusions. Note that the median size of firms in our sample is relatively small. 50 per cent of all firms have fewer than 8 employees at the beginning of the sampling period.

TABLE 2 ABOUT HERE

With the theoretical model presented in section 2 of the paper we were not able to resolve the question whether entrepreneurs with high human capital would choose legal forms with liability limitation as a response to the enhanced risk of project failure. Recall that this ambiguity arises naturally in our model, since we assume that increased human capital has two effects. On the one hand, it reduces the risk of project failure, all else being equal. On the other hand higher human capital makes it worthwhile for the entrepreneur to choose projects with higher returns and thus with higher *ex ante* risk. Since we cannot derive simple theoretical predictions, we turn to a subsample of our data to shed some light on this question. To arrive at this particular subsample, we selected 3440 firms which were owned and managed by one person and for which we had information to infer the terminal educational degree of the entrepreneur from our data. As a side-effect of this selection process, some types of legal forms are dropped, but the most interesting groups - single proprietorships, *GmbH*s, and *GmbH&Co.KG*s are well-represented.

The degree information obtained from the data allows us to classify the entrepreneurs into those with little human capital (i.e. not even apprenticeship training), those with apprenticeship training, master-craftsmen, individuals with university training, and finally individuals who held a doctoral degree or a professorship at the beginning of our sampling period. The distribution of legal form choices is quite revealing. Table 2 displays the percentage of legal forms within each human capital group. Legal forms with limited liability (*GmbH* and *GmbH&Co.KG*) account for only 10 percent of all firms if the entrepreneur does not have apprenticeship training. For those with apprenticeship the percentage is 27 per cent, for master craftsmen it is 14.6 per cent. Conversely, entrepreneurs with a university degree choose limited liability in 57.9 per cent of all cases, and individuals with a doctorate or a professorship relie in 77.1 per cent of all cases on liability limitations for their own enterprise.

Clearly, the subsample used here is selective and the human capital indicators are rather crude. The topic needs further substantiation, but we are nonetheless surprised how clearly the data point to a nexus between human capital and the choice of legal form. By implication, Table 2 also provides evidence that the second proposition derived from our model will be of some relevance.

TABLE 3 ABOUT HERE

Table 3 presents sample frequencies of insolvencies and voluntary liquidations by firm age and firm size. Broadly speaking, this table confirms previous findings that point to a negative relationship between firm age and mortality, as well as between firm size and

mortality. This pattern is consistent with the view that "better" firms survive longer and grow while weaker competitors drop out (Jovanovic 1982). It is difficult, however, to explain the ratio between insolvencies and voluntary liquidations. For small firms, age and insolvencies appear to be correlated negatively while there is no easily discernable pattern for larger firms.

For young firms, we can compare our mortality estimates to those of Wagner (1994, Table I) who presents survival rates for new manufacturing firms in Lower Saxony. For firms that are initially two years old the average mortality rate in Wagner's data is about 28 per cent for cohorts of firms founded in 1979, 1980, 1981 and 1982. In our data, we compute a mortality rate of about 24 per cent in manufacturing for the given age group. The difference is small enough to be accounted for by differences in industry composition, but it may also be due to the fact that single proprietorships are underrepresented in our sample.

TABLES 4 AND 5 ABOUT HERE

Table 4 contains mortality rates (again decomposed into insolvencies and voluntary liquidations) by legal form and industry. Clearly, limited liability companies (*GmbH*) and limited commercial partnerships formed with a limited liability company (*GmbH&CoKG*) display the highest insolvency rates. More than 55 per cent of all exits of firms with these legal forms in our sample are insolvencies. By contrast, for single proprietorships, only about one tenth of all exits are accounted for by insolvencies. While Table 4 cannot reveal whether some of these differences are driven by age and size effects, the basic patterns are consistent with the predictions from the model described in section 2. A look at industry differences is instructive, too. Irrespective of the legal form adopted by the firm, mortality rates are particularly high in trade and services, with insolvencies accounting for about one quarter of all exits. The latter statement needs to be qualified somewhat, however, since the current tabulations have not been weighted yet to reflect the sampling probabilities.

In Table 5 we present average employment growth rates by firm age and size. Note that these rates are potentially distorted by the fact that the respective observation periods differ. The standard deviations are subject to the same qualification. Nonetheless, generally the growth rates tend to decrease with age and size of the firm. Of course, this result may be entirely due to selection effects. We will address the selection issue below where we also test for growth differentials between firms incorporated in different legal forms.

5.2 Failure Estimates

Since our observations originate from a cross-sectional stock sample, applying hazard rate analysis directly would lead to biased results.[10] Instead, we follow Evans (1987a/b) and analyze the probability of failure in the time period from July 1, 1989 to December 31st, 1994 as a function of firm size, firm age and legal form variables as measured prior to the beginning

[10] See Cox and Oates (1984, p. 178) for a discussion of left-truncated samples and the appropriate estimation techniques.

of this period.[11] The failure estimates are presented in Table 6. The probability of exit is modelled as a function of firm size, age and legal form on July 1, 1989 (or prior to this date). We also control for diversification and ownership status. The inclusion of the latter variable reflects our concern that subsidiaries may be subject to decision-making processes external to the subsidiary firm.

TABLE 6 ABOUT HERE

In the simple logit estimates with pooled exit types, both firm size and firm age display a significant and strong negative effect on the firm's likelihood of failure. The marginal effects of size and age are negative for all firms in the sample. Diversified firms are characterized by a relatively low liquidation risk while our dummy variable for subsidiary status is not significantly different from zero in this specification. Firms in the legal forms of a *GmbH&CoKG* or *OHG* have significantly higher failure rates than single proprietorships, but the *GmbH* dummy is not significantly different from zero. Finally, stock-based companies (*AGs*) display below-average failure risks even when firm size and age are included in the regressions. The latter result is likely to reflect the harsh screening that firms are subjected to in German financial markets before their shares are traded publicly.

However, distinguishing between insolvency and voluntary liquidation as the two exit types clearly improves our understanding of exit dynamics. It turns out that the distinction does not only matter conceptually, but that it is of empirical importance as well. The hypothesis of identical coefficients for both choices (i.e. correctness of the simple logit specification) can be rejected quite easily. The respective chi-square test statistic is 279.6 with 40 degrees of freedom ($p<0.001$). Testing separately for the identity of the legal form dummies or the age and size variables also yields highly significant test statistics ($p<0.001$). This is not surprising: the result simply suggests that insolvency and voluntary liquidation are very different exit mechanisms.[12]

The patterns revealed by the coefficients are broadly consistent with our hypotheses. We first consider the effect of the legal form and ownership dummy variables before analyzing the marginal effects of firm age and firm size.[13] Firms in the legal form of *GmbH* or *GmbH&CoKG* are much more likely to exit via insolvencies than via voluntary liquidation. Compared to the reference group of individual proprietorships and holding all other variables

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[11] We also estimated ordered logit specifications in which the dependent variable was defined in terms of survival span after July 1, 1989. The results did not differ much from the simple logit estimates.

[12] In terms of the determinants of exit, our estimates are complementary to those derived by Schary (1991). She considers retained earnings, dividends, and technological indices as determinants of exit in the New England cotton textile industry, but without apparent success.

[13] Note that usually the sign and extent of the marginal effects cannot be assessed directly from the coefficients. The marginal effect of a single independent variable x_i on the probability P_j of outcome j is given by $\partial P_j / \partial x_i = P_j\left[\beta_{ij} - \sum_k \beta_{ik} P_k\right]$ the sign of which need not be identical with the sign of the choice-specific coefficient β_{ij}. For $k=2$ (as in the case described here), the marginal effect of x_i on, say, P_1 takes the form $\partial P_1 / \partial x_i = P_1(1-P_1)\beta_{i1} - P_1 P_2 \beta_{i2}$ and its sign definitely coincides with the sign of β_{i1} if β_{i1} and β_{i2} have opposite signs. Note that this is the case for the coefficients of the dummy variables *GMBH*, *AG*, *KG*, and *SUBSIDIARY* in Table 6.

constant, the insolvency rate of GmbH firms is 3.11 per cent higher than the insolvency rate of sole proprietorships (computations of marginal effects at the sample mean), while their propensity to choose exit via voluntary liquidation is actually somewhat lower than in the case of fully liable owners. Liability limitations seem to induce a shift towards greater usage of insolvencies as an exit mechanism. If we consider GmbH&CoKG-type firms, the respective increase in the probability of insolvency is 2.04 percentage points ($p<.01$), while there is no significant difference in the likelihood of voluntary liquidation between these firms and fully liable single proprietorships. These estimates do therefore confirm the expectations derived from our simple model. Note that this result is inconsistent with Storey's (1994) suggestion that the bank's quest for full collateralization of risky credit may undermine liability limitations. Quite to the contrary, limited liability represents an option that tends to be used extensively as Table 2 suggested already. The multinomial logit results confirm that the results from the earlier tabulation are not just artefacts of industry composition or of other observable variables like firm size and age.

Other unexpected results with respect to the legal form dummy variables, for example the high mortality rate of *OHG* firms, cannot be explained easily on the basis of this model and require further analysis. One can conjecture that *OHG*s tend to represent family enterprises in which ownership succession problems may lead to a relatively high rate of voluntary liquidations. [14]

The results also suggest that the preferred exit mode of subsidiaries is a regular voluntary liquidation. This result can be explained with two particular regulations in German bankruptcy and commercial law. First, banks tend to insist on a declaration of patronage (*Patronatserklärung*) when they issue loans to subsidiaries of large conglomerates. In such a declaration, the parent firm commits to securitization of the loan or credit. Second, German corporate law contains provisions according to which a subsidiary firm cannot file for bankruptcy unless its corporate owners declare bankruptcy at the same time (*Durchgriffshaftung*). The latter regulation is supposed to prevent the abuse of subsidiaries for the purpose of intentful loan and credit defaults.

Since firm age and firm size enter the model as a quadratic approximation, we compute the marginal effects of these two variables for each of the exit alternatives. In the case of voluntary exit, both variables have a negative marginal effect on failure chances for virtually all firms in the sample. However, in the case of insolvencies we find that only the age effect is consistently negative and monotically increasing towards zero with increasing age. The marginal effect of firm size on the probability of exit via insolvency is initially positive for firms with up to 18 employees at the beginning of the observation period and negative for larger firms. To the best of our knowledge, this result of a non-monotonic relationship between the risk of insolvency and firm size has not been reported in the literature. It may indicate that the exit mechanism of insolvency is not „profitable" for firms below some minimum size, but the result warrants further examination.

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[14] We thank Rupert Windisch for this suggestion.

5.3 Growth Estimates

In Table 7 we present OLS and two-stage Heckman estimates of our employment growth equation. Although selection effects matter statistically (the correlation coefficient between the errors in the selection and the growth equations is significant), the actual effect of the selection correction on the coefficients of the growth equation are quite weak. We find strong evidence against Gibrat's "law" of proportionate effect. Small firms are characterized by higher employment growth than larger firms. The marginal effect of firm size is negative for 93.8 per cent of all observations in the sample. The effect of firm age is less pronounced: it is negative for 86.4 per cent of the observations in the sample and only weakly significant for the majority of cases.

TABLE 7 ABOUT HERE

Since the probit selection equation pools both selection processes (see Appendix C), the coefficient estimates are somewhat difficult to interpret. In the selection equation we use detailed information (obtained at the beginning the observation period) on the speed with which firms pay their bills. This is obviously a central variable in credit rating data. In Table C.1, long delays prior to payment have a negative effect on sample inclusion. This effect is caused by the non-survivor group of firms which appear to be in financial problems a long time before the actual liquidation is invoked. Creditreform also issues a recommendation with respect to granting trade credit. The dummy variable "no credit experience" is apparently a good predictor for the likelihood that employment information will not be updated. Again, this may reflect the demand-driven information collection process within the credit rating firm.

Finding a negative correlation between the selection and growth equations is surprising at first sight, although Dunne and Hughes (1994) report similar results in about half of their industry-specific regressions. In order to cast some light on this result, we also estimated the two-stage model excluding the non-survivors. This regression yielded an even larger negative correlation of about -0.570. Conversely, only including non-survivors but excluding observations for which no information updating by the credit rating firm had occurred yielded a slightly positive, but insignificant correlation coefficient. The latter result reflects the typical non-survivor bias as reported by Evans (1987a/b).

From these results it appears that firms with strong employment growth are not as well represented in the database as are weaker enterprises. Considering the business rationale of the credit rating firm, a "preferred treatment" of weaker firms may make sense if information about such firms is requested with greater frequency. We reserve a more detailed treatment for future work, but we conjecture that some firms may be able to signal a financially stable condition to their suppliers so that information on this group of firms is demanded less frequently than information on financially weak enterprises.

Consistent with the hypotheses developed in section 2, the legal form dummy variables are strongly correlated with employment growth rates. Firms in the legal forms of *GmbH*, *GmbH&Co.KG*, *KG* and *OHG* display growth rates that are approximately 4 per cent higher than those of single proprietorships. Considering the employment growth rates of *KG* and *OHG* firms, we do not have a simple explanation of the respective level differences in growth rates. However, these legal forms may be preferred by entrepreneurs with strong financial

positions. Since we cannot measure such differences, they may be picked up via the legal form dummy variables. Time and industry dummies prove to be highly significant in both specifications although the same qualitative results can be obtained without including them. Nonetheless, employment growth is a noisy process with most of the variance remaining unexplained.

While these results confirm our hypotheses with regard to the effect of liability limitations, they may be subject to distortions if the estimated slope parameters differ across various legal forms. However, using a simple distinction between limited liability firms (*GmbH* and *GmbH&CoKG*) and all other enterprises, we cannot detect major differences in the growth-size relationship . In the third column in Table 7, we present growth estimates for firms in the legal form of *GmbHs* or *GmbH&CoKG* with the first legal form as the reference group. The slope coeffients are remarkably close to those in the first and second column. This is good news for researchers who cannot distinguish in their data between different legal forms, but this result may be specific to our data and needs further corroboration. It is also remarkable that the estimated correlation coefficient virtually drops to zero for firms with limited liability. It seems natural that a credit rating agency should treat firms with liability limitations differently from firms in which owners carry the full burden of liability in the case of failure. These differences in treatment may be reflected in the substantially lower correlation coefficient.

It is well known that a number of econometric problems may occur in the type of growth equations used here. In particular, the negative correlation between firm size and growth rates may be a statistical artefact of measurement error as Hall (1987) points out. One way to circumvent the appearance of the same measurement error on the left-hand and right-hand side of our growth equation is to rewrite the growth equation and to use $log(E(t_2))/(t_2-t_1)$ as the dependent variable and $log(E(t_1))/(t_2-t_1)$ as an additional independent variable together with log $log(E(t_1))$. Note that these two variables are not perfectly collinear due to the differences in observation intervals. Measurement problems with respect to $log(E(t_1))$ will now introduce deviations of the coefficient of $log(E(t_1))/(t_2-t_1)$ from unity but towards zero. Both in OLS and two-stage stage Heckman estimates, the respective coefficient is smaller than one, but on the order of 0.99 or higher, and the other coefficients remain virtually unchanged. Simple measurement errors are therefore unlikely to cause the notable deviation from Gibrat's Law.

6 Conclusions and Future Research

Firm survival and employment growth are important measures of firm performance. In the present paper, we have provided first empirical results for West Germany on the determinants of these performance measures from a newly developed data base. While our results on the effects of firm size and age on firm survival and growth confirm at the qualitative level those derived for the corresponding firm populations in other countries, they differ quantitatively in major ways yet to be explored in more detail. Our estimates suggest in particular that a separate consideration of the modes of exit is highly desirable.

The data also have allowed us to investigate the effect of liability limitations in the form of particular legal forms. The economic importance of limited liability enterprises in the West

German economy is documented by their growing number and share of employment. Most of our ex ante expectations regarding the survival chances and growth rates of these firms were confirmed by the regression results. In particular, we found that liability limitations are correlated with above-average employment growth and higher risk of insolvency. Thus, the basic hypotheses developed in our simple model were confirmed.

Our empirical work also has emphasized the need to control for a number of potential biases in the data base we are using. Credit rating data have some appeal, because panel information can be obtained at rather low costs. However, using them in empirical work of this type can be extremely costly in terms of "data cleaning" and risk of misleading results if sample selectivity is not controlled for appropriately. These considerations should be taken into account by the numerous research groups in Europe and beyond which are currently trying the use these data to their full potential.

In spite of these reservations, this data base offers some unique opportunities for analysis not exploited so far. Its strength is in the detailed documentation of ownership and management structures. Any changes in these, as well as in the legal form with its implications on liability and the tax treatment of profits, could be developed as predictors of firm growth as well as failure.These issues will be the object of future work.

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Appendix A - Proofs

PROPOSITION 1: $\delta^L(\overline{H}) > \delta^U(\underline{H})$

PROOF: The proof is in two steps. We first show that $\delta^L(H) > \delta^U(H)$. This implies in particular that $\delta^L(\overline{H}) > \delta^U(\underline{H})$ Second, we show that $\partial \delta^L(H) / \partial H > 0$.

The first statement is shown by implicitely differentiating (5):

$$\frac{\partial \delta}{\partial \lambda}\Big|_{\lambda=0} = - \frac{-1}{\frac{\partial^2 p}{\partial \delta^2}\delta + 2\frac{\partial p}{\partial \delta}}.$$

Since the denominator is negative due to the second order condition, this derivative is negative. Hence an increase of λ from zero to a positive level, i.e. a move from limited to unlimited liability, decreases the chosen project's expected return.

The second statement is obtained by again implicitly differentiating (5):

$$\text{(P1)} \qquad \frac{\partial \delta}{\partial H}\Big|_{\lambda=0} = - \frac{\frac{\partial^2 p}{\partial H \partial \delta}\delta + \frac{\partial p}{\partial H}}{\frac{\partial^2 p}{\partial \delta^2}\delta + 2\frac{\partial p}{\partial \delta}} .$$

By the assumptions on $p(H,\delta)$ collected under (3), the numerator is positive while the denominator is again negative by virtue of the second order necessary condition. Hence the derivation is positive, yielding a monotonic increase of $\delta^L(H)$ in H. •

PROPOSITION 2: $p(\overline{H}, \delta^L(\overline{H})) < p(\underline{H}, \delta^U(\underline{H}))$ if $\frac{1}{\delta^L}\frac{\partial p}{\partial H} \le \frac{\partial}{\partial \delta}\frac{\partial p}{\partial H}$.

PROOF: By Proposition 1 and (3), $p(H, \delta^L(H)) < p(H, \delta^U(H))$ In particular $p(\underline{H}, \delta^L(\underline{H})) < p(\underline{H}, \delta^U(\underline{H}))$.

Thus, it suffices to show that under the condition of Prop. 2,

$$\frac{dp}{dH}\Big|_{\lambda=0} = \frac{\partial p}{\partial H}\Big|_{\lambda=0} + \frac{\partial p}{\partial \delta}\frac{\partial \delta}{\partial H}\Big|_{\lambda=0} \le 0.$$

Rewriting and using (P1), our condition changes to

$$\frac{\left\{\frac{\partial p}{\partial H}\frac{\partial^2 p}{\partial \delta^2}\delta - \frac{\partial^2 p}{\partial H \partial \delta}\frac{\partial p}{\partial \delta}\delta + \frac{\partial p}{\partial H}\frac{\partial p}{\partial \delta}\right\}}{\frac{\partial^2 p}{\partial \delta^2}\delta + 2\frac{\partial p}{\partial \delta}} \le 0 .$$

The denominator is negative. Conversely, the first expression of the numerator is positive due to (3). A sufficient condition for the numerator to be nonnegative is thus $\frac{\partial p}{\partial H} - \frac{\partial^2 p}{\partial H \partial \delta}\delta^L \le 0$ or $\frac{1}{\delta^L}\frac{\partial p}{\partial H} \le \frac{\partial}{\partial \delta}\frac{\partial p}{\partial H}$. •

Let $\delta(\mu, H)$ be the solution to (5), and

$E(\pi^U(\mu,H)) := \delta(\mu,H)\left[(1+\mu)p(H,\delta(\mu,H)) - \mu\right]$ as well as

$E(\pi^L(H)) := p(H,\delta(0,H))\varphi\delta(0,H)$.

Lemma: For all H, there exists a unique $\tilde{\mu}(H)$ such that $E(\pi^U(\tilde{\mu}(H),H)) = E(\pi^L(H))$.

Furthermore, $\mu \lesseqgtr \tilde{\mu}(H) \Rightarrow E(\pi^U(\tilde{\mu}(H),H)) \lesseqgtr E(\pi^L(H))$.

Proof: (i) $\mu = 0$ implies $E(\pi^U(0,H)) > E(\pi^L(H))$. Conversely, $\mu \to \infty$ implies $E(\pi^U(\mu,H)) < E(\pi^L(H))$ as maximal returns are finite if the project is successful, but losses under unlimited liability increase without bounds if the project fails.

(ii) Reformulating and differentiating the necessary condition (5) w.r.t. μ, we obtain

$$(1+\mu)\left[\frac{\partial^2 p}{\partial\delta^2}\delta + 2\frac{\partial p}{\partial\delta}\right]\frac{\partial\delta}{\partial\mu} + \left(p - 1 + \frac{\partial p}{\partial\delta}\delta\right) = 0.$$

Since $p \leq 1$ and $\frac{\partial p}{\partial\delta} < 0$ by assumption (3), the term in the curved bracket is negative. Furthermore, the term in angular brackets is negative by the second-order condition. Hence $\frac{\partial\delta}{\partial\mu}$ must be negative to satisfy the equality.

The choice of limited liability is more (less) likely with increased human capital endowment, if $\frac{\partial\tilde{\mu}}{\partial H} \lesseqgtr 0$. In particular, with $\frac{\partial\tilde{\mu}}{\partial H} < 0$ the range of μ under which unlimited liability is chosen decreases with increasing H.

Differentiating $E(\pi^U(\tilde{\mu}(H),H)) \equiv E(\pi^L(H))$ and reformulating slightly, we obtain

$$\frac{\partial}{\partial\mu}E(\pi^U(\tilde{\mu}(H),H))\frac{\partial\tilde{\mu}}{\partial H} \equiv \frac{\partial}{\partial H}\left[E(\pi^L(H)) - E(\pi^U(\tilde{\mu}(H),H))\right].$$

Since $\frac{\partial}{\partial\mu}E(\pi^U(\tilde{\mu}(H),H)) = \delta(\mu,H)\left[p(H,\delta(\mu,H)) - 1\right] < 0$, $\frac{\partial\tilde{\mu}}{\partial H} \lesseqgtr 0$ if the difference in expected profits between limited and unlimited liability increases (decreases) given δ is optimally adjusted. More specifically

$$\frac{\partial\tilde{\mu}}{\partial H} \lesseqgtr 0 \Leftrightarrow \frac{1+\mu}{\varphi} \lesseqgtr \frac{\delta(0,H)}{\delta(\mu,H)}\frac{\frac{\partial p}{\partial H}(H,\delta(0,H))}{\frac{\partial p}{\partial H}(H,\delta(\mu,H))}.$$

The left hand term in this inequality exceeds unity by the assumptions that $\mu > 1, \varphi < 1$. Both right hand terms also exceed unity; the first by Lemma, and the second again by the Lemma together with the assumption specified under (3) that $\frac{\partial}{\partial\delta}\left(\frac{\partial p}{\partial H}\right) \geq 0$. Thus, the choice of limited liability is more likely with increased human capital, if either the optimal project choice involves a much higher return project under limited than under unlimited liability; or the increase in probability of project success with an increase in human capital is much stronger if the higher return limited liability project is chosen. •

Appendix B - Data Source and Sample Construction

The data used in this study originate with Verband der Vereine Creditreform (VVC), the largest German credit rating agency. Typically, firms enter the Creditrefom data base for two possible reasons. First, a customer or supplier firm may want to inquire about the financial situation of the respective enterprise.[15] Second, credit rating agencies also exploit economies of scope and scale and gather information proactively, in particular by systematically recording publicly available information on new firms.[16] Thus, the initial entry into the database is not necessarily driven by contemporaneous demand for information regarding a specific company.

In the initial interview, VVC records information, specifically on the ownership structure of the firm, primary and (if appropriate) secondary 5-digit industry classifications, legal status, management, current employment, current and past annual sales, the date of incorporation, and dates of incorporation of legal predecessors of the firm. The time of data entry is recorded together with these variables. If the information is updated at a later point, the respective interview date is again recorded with the data. Hence a change in the respective variables can be observed by comparing entries made after the first interview.

Contrary to most panel data explicitly gathered for scientific purposes, the intervals between interviews are not fixed and can indeed vary substantially. Since the credit rating firm's decision to update information on a particular firm is endogenous, we are confronted with a potentially important source of selection bias. However, Creditreform does not delete entries from the database even when an enterprise is liquidated at some point or if - for reasons to be discussed below - a new identification number is assigned to the firm and the original entry is no longer updated.

Since 1989, Creditreform has been supplying data on West German enterprises to a research group located at the University of Mannheim and the ZEW towards studies on the dynamics of private sector employment and enterprise failure. These data were drawn from the Creditreform data base in intervals of approximately six months.[17] Currently, eight linked cross-sections are available.

Information updating by credit rating agencies tends to be demand-driven. Thus, even if company data is entered into the database initially, no updating of the initial information will occur in a large number of cases. In previous studies (e.g. Evans 1987a/b), such cases have usually been discarded under the assumption that no biases were present. In order to avoid making use of such a strong assumption, the credit rating data were supplemented with information obtained from telephone interviews. Between October 1993 and March 1994, about 2900 telephone interviews were conducted to collect information on companies for which little or no updating had occurred. Companies were interviewed if (1) the general company information had not been updated by Creditreform within three years prior to October 1, 1993, (2) data on the number of employees was missing or (3) sales figures were missing or referring to years prior to 1991. The total number of selected companies was 2835. If the company appeared to have been liquidated, competitors, suppliers or chambers of commerce were contacted in order to verify the liquidation and its date.

In the telephone surveys, we tried to collect detailed information on the survival status of the company, in particular whether the company was still operating or not, as well as data

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[15] Business transactions usually involve trade credit, i.e. credit extending after delivery between billing and payment. Credit may extend over even longer periods if orders are firm-specific in Williamson's (1975) sense. In such cases, firms have an interest to assure that their business partners are both willing and able to redeem the credit; and in particular that they are not in immediate danger of foreclosing. The role of trade credit for U.S. firms is investigated empirically in Rajan and Petersen (1994).

[16] Creditreform uses several information sources in this context. The most important one is a data entry in the "*Handelsregister*" which is compulsory for all incorporated firms and for the larger sole proprietorships.

[17] This panel database is described in more detail in Stahl (1991).

on the date at which a change in the survival status of the company had taken place. We differentiated between the following states. (1) company operating, (2) company liquidated, (3) relocation, (4) change of legal form with subsequent new entry in the database, (5) merger, (6) ownership succession by a family member, (7) company sold to a non-family member, (8) company not found. In Table B.1 the frequencies of these events are summarized.

Some results are of particular interest. First, about 12% out of the interviewed companies had gone out of business between 1987 and 1990 without Creditreform indicating the liquidation in the records. This compares to a total liquidation rate of about 10.3 per cent for the sample used in the survival/failure analysis. Second, about 3% of the companies exited during the observation period by selling or transfering the company to a new owner. Third, we were not able to track 268 (about 9%) of the companies. Therefore we cannot be sure about their survival status but we have reasons to assume that most of them ceased to exist prior to the beginning of our sampling period.

Table B.1
Survival Status of Companies
(Telephone Survey Results)

Survival Status of the Company	Count
Company Operating	2058
Company Closed	321
Relocation	18
Change of Legal Form and New Entry	74
Merger	5
Ownership Succession by a Family Member	27
Company Sold to a Non-Family Member	64
Company not Found	268
Σ	2835

We also tried to assess the validity of Creditreform information for those firms that had been interviewed recently. We called all 94 companies in our overall sample located in the area observed by the Saarbrücken Creditreform office. We were able to track and verify the company information on all 94 firms and did not find any major discrepancies between Creditreform information and the actual situation of the company. We conclude that company information that has been updated by the credit rating firm is very reliable. In particular, we feel reassured that it correctly represents the survival status of the company.

Based on the original data and the complementary information from the telephone survey, we were able to construct a comprehensive sample of West German firms. Our original VVC sample included observations on 13346 West German firms, i.e. legally independent enterprises. From this sample we excluded professionals (*Freie Berufe*) and non-profit organizations (246 observations), and all firms in the agricultural, energy or public service sectors (312 observations). Moreover, a number of firms (290 observations) had ceased to exist prior to July 1, 1989 and were discarded from the sample. These exclusions are based on

exogeneous criteria and should therefore not bias our results in any way. We consider the remaining 12498 cases as our relevant sample.

Since firms are tracked via a unique identifier, we are bound to lose observations whenever the credit rating agency changes the identification number of a particular enterprise. For example, we lose 226 observations for enterprises that relocated and moved to a region observed by a regional credit rating office different from the one that had originally administered the data. Furthermore, there are 564 cases of ownership succession (without merger) which were accompanied by the release of a new identification number. We are fairly certain that none of these cases involved (at least initially) a closing of the respective business. We do not consider these cases as exits or firm failures, since the respective firms may continue to exist and pursue their previous economic activities. In 158 other cases we were able to conclude that the firm had been subject to a merger. These cases are excluded here, but will be subject to future investigations together with the ownership succession cases. Taken together, relocations, ownership successions and mergers account for 948 cases.

Due to missing values regarding the date of firm formation we lose 317 cases, and 114 observations have to be dropped because other independent variables are suspect or missing. These cases did not display any particular pattern, and we do not expect any sampling distortions to emerge in this context. Finally, for 268 firms the credit rating information was completely outdated and we were unable to track these firms in our telephone survey. It is likely that the majority of these firms had ceased to exist prior to the beginning of our sampling period. Thus our final sample for this study consists of 10961 observations. We do not expect that our selection procedures will result in a major distortion of the results reported in this paper. However, we plan to investigate some cases in future work, in particular mergers and ownership successions.

A serious source of selection bias arises for our growth estimates, since we are not able to calculate employment growth rates for 2863 out of the remaining 10961 enterprises. First, 1130 firms have ceased to exist during the period under consideration. Neglecting these firms in the growth estimation is likely to introduce the classical survivor bias. Second, in the case of 1733 firms we were not able to obtain updated employment information *either* from the original credit rating database *or* from the telephone interviews described above. For the purposes of our survival estimates, the situation is somewhat different. For all 10961 firms we were able to obtain information on the survival status.

Appendix C - Coefficient Estimates for Heckman Selection

Table C.1

Selection Equation (Probit)

Independent Variables	*Coefficient Estimate (t-statistic)*	*Independent Variables*	*Coefficient Estimate (t-statistic)*
LSIZE	.1958 (2.990)	No Experience With Respect to Payment Behavior	-.1484 (0.810)
LSIZESQ	-.0334 (9.184)	Pays Bills Without Delay	Reference Group
LAGE	.1686 (1.579)	Payment within 30 days	-.2482 (4.891)
LAGESQ	-.0112 (3.319)	Payment takes longer	-.2055 (2.355)
LSIZE*LAGE	.02552 (3.319)	Pays slowly	-.5124 (3.466)
SUBSIDIARY	-.1543 (2.502)	Payment after reminder	-.6483 (2.720)
DIVERSIFICATION	.0694 (1.810)	Payments Overdue	-1.742 (3.601)
GMBH	.2359 (6.168)	No Credit Experience	-1.057 (5.587)
GMBHCO	.07351 (1.215)	Crediting Advised	Reference Group
OHG	-.0264 (0.241)	Crediting Possible	.01491 (0.169)
KG	-.0036 (0.046)	Crediting Within Limits	.0272 (0.258)
BGB	-.0471 (0.521)	Crediting With Securities	-.2091 (1.173)
AG	.3805 (2.826)	No Credits Recommended	-.2345 (0.937)
CONSTANT	-.4722 (1.038)		
Test Statistics	χ^2 *(df)*		
Size and Age	478.57 (5)	Payment Dummies	37.80 (6)
Legal Form Dummies	47.22 (6)	Crediting Dummies	42.97 (6)
Industry Dummies	128.57 (27)		
Number of oberservations	10961	log Likelihood	-3034.29

Note: Single proprietorships are the reference group for legal form dummies.

Table 1
Descriptive Statistics

	All Firms (10961 Observations)		Firms with Employment Growth Observations (8098 Observations)	
Variable	Mean	Standard Dev.	Mean	Standard Dev.
Employment Growth	-	-	0.039	0.195
SIZE	275.58	2252.21	342.16	2347.31
AGE	29.15	35.26	31.57	35.90
LSIZE	2.51	2.07	2.86	2.12
LSIZESQ	10.62	15.93	12.71	17.05
LAGE	2.79	1.14	8.79	1.12
LAGESQ	9.12	6.28	78.66	19.44
LSIZE*LAGE	7.94	8.47	26.16	20.91
DIVERS	0.181		0.189	
SUBSIDIARY	0.130		0.153	
Legal Form Dummy Variables				
Single Proprietorship	41.7%		35.8%	
GMBH	36.3%		39.7%	
GMBHCO	10.0%		11.4%	
BGB	2.1%		1.8%	
OHG	1.7%		1.7%	
KG	3.9%		4.2%	
AG	4.3%		5.4%	
Industry Dummy Variables				
MANUFACTURING	28.8%		29.7%	
CONSTRUCTION	17.7%		18.3%	
TRADE	23.0%		21.4%	
TRANSPORTATION	6.5%		6.7%	
FINANCE	3.5%		3.9%	
SERVICE	20.5%		19.0%	

Table 2
Choice of Legal Form by Entrepreneur's Terminal Degree
in Single-Owner Enterprises
Column Percentage (Number of Observations)

	Entrepreneur's Terminal Degree					
Legal Form	No Apprentice-ship Training	Apprenticeship Training	Master Craftsman	University Training	Doctorate or Professorship	Total
Single Proprietorship	82.98% (117)	69.12% (620)	82.75% (1406)	38.23% (237)	16.86% (14)	69.60% (2394)
BGB	3.55% (5)	3.90% (35)	2.65% (45)	3.87% (24)	6.02% (5)	3.31% (114)
GmbH&Co.KG	8.51% (12)	9.59% (86)	4.41% (75)	28.71% (178)	44.58% (37)	11.28% (388)
GmbH	4.96% (7)	17.39% (156)	10.18% (173)	29.19% (181)	32.53% (27)	15.81% (544)
Total	100% (141)	100% (897)	100% (1699)	100% (620)	100% (83)	100% (3440)

Note: Unweighted Sample Estimates $\chi^2 = 626.06$ $(df = 12)$

Table 3
Total Mortality, Insolvency and Voluntary Liquidation Rates
by Firm Age and Firm Size
(July 1, 1989 - March 1, 1994)

% Total Mortality
(% Insolvencies, % Voluntary Liquidations)
Number of Observations

Firm Size on July 1, 1989 (Employees)	Firm Age on July 1, 1989 (Years)						
	<2	2-5	5-10	10-25	25-50	>50	Total
1-19	23.7 (7.3, 16.4) 274	19.0 (5.0, 14.0) 1119	14.9 (4.1, 10.8) 1557	9.9 (2.4, 7.5) 2458	10.5 (0.9, 9.6) 1269	9.6 (0.7, 8.9) 868	12.9 (2.9, 10.0) 7545
20-49	6.3 (6.3, 0.0) 16	19.4 (16.1, 3.3) 62	11.3 (6.5, 4.8) 168	6.6 (3.8, 2.8) 318	5.6 (2.3, 3.3) 213	4.7 (2.2, 2.5) 236	7.5 (4.3, 3.2) 1013
50-99	0.0 (0.0, 0.0) 12	8.3 (5.6, 2.7) 36	4.0 (1.3, 2.7) 75	4.2 (3.0, 1.2) 168	8.8 (4.8, 4.0) 125	6.1 (2.0, 4.1) 148	5.9 (3.0, 2.8) 564
100-500	5.0 (5.0, 0.0) 20	4.5 (0.0, 4.5) 44	7.2 (2.4, 4.8) 83	3.0 (1.7, 1.3) 235	3.8 (1.7, 2.1) 234	1.6 (1.0, 0.6) 308	3.2 (1.5, 1.7) 924
> 500	0.0 (0.0, 0.0) 15	3.1 (0.0, 3.1) 32	9.3 (2.3, 7.0) 43	3.0 (0.6, 2.4) 169	1.7 (0.0, 1.7) 178	1.5 (0.4, 1.0) 478	2.2 (0.4, 1.8) 915
Total	19.9 (6.5, 13.4) 337	17.9 (5.3, 12.6) 1293	13.7 (4.1, 9.6) 1926	8.5 (2.4, 6.1) 3348	8.3 (1.3, 7.0) 2019	5.6 (0.9, 4.7) 2038	10.3 (2.7, 7.6) 10961

Note: Unweighted Sample Estimates

Table 4
Total Mortality, Insolvency and Voluntary Liquidation Rates
by Legal Form and Industry
(July 1, 1989 - March 1, 1994)

% Total Mortality
(% Insolvencies, % Voluntary Liquidations)
Number of Observations

	Industry						
Legal Form	Manu-facturing	Construction	Trade	Trans-portation	Finance	Services	Total
Single Proprietorship	10.8 (1.4, 9.4) 1082	7.6 (1.4, 6.2) 1053	14.7 (1.0, 13.7) 1348	15.6 (2.6, 13.0) 275	19.6 (0.0,19.6) 56	12.3 (0.9, 11.4) 757	11.8 (1.3, 10.5) 4571
BGB	7.0 (0.0, 7.0) 43	5.9 (2.0, 3.9) 51	23.4 (2.1, 21.3) 47	0.0 (0.0, 0.0) 7	40.0 (0.0, 40.0) 5	10.3 (0.0, 10.3) 48	11.7 (0.9, 10.7) 231
OHG	3.8 (0.0, 3.8) 52	11.1 (5.6, 5.5) 18	24.5 (0.0, 24.5) 49	20.0 (6.7, 13.3) 15	0.0 (0.0, 0.0) 11	14.6 (0.0, 14.6) 41	13.4 (1.1, 12.3) 186
KG	6.8 (1.2, 5.6) 162	4.0 (4.0, 0.0) 25	10.5 (0.9, 9.6) 114	2.9 (2.9, 0.0) 35	0.0 (0.0, 0.0) 19	6.8 (2.7, 4.1) 73	7.0 (1.6, 5.4) 428
GMBHCO	7.3 (3.6, 3.7) 422	7.8 (3.6, 4.2) 166	11.3 (3.1, 8.2) 159	8.3 (1.9, 6.5) 108	0.0 (0.0, 0.0) 13	8.8 (2.6, 6.2) 228	8.3 (3.1, 5.2) 1096
GMBH	9.1 (4.9, 4.2) 1213	10.1 (5.9, 4.2) 622	13.4 (5.2, 8.2) 783	7.4 (2.9, 4.5) 242	6.9 (2.9, 4.0) 102	10.5 (4.3, 6.2) 1020	10.3 (4.8, 5.5) 3982
AG	0.6 (0.0, 0.6) 176	0.0 (0.0, 0.0) 9	0.0 (0.0, 0.0) 26	0.0 (0.0, 0.0) 29	1.1 (0.6, 0.5) 178	2.0 (2.0, 0.0) 49	0.9 (0.4, 0.5) 467
Total	8.7 (2.9, 5.8) 3150	8.3 (3.1, 5.2) 1944	14.1 (2.4, 11.7) 2526	10.4 (2.5, 7.9) 711	5.7 (1.0, 4.7) 384	10.7 (2.7, 8.0) 2246	10.3 (2.7, 7.6) 10961

Note: Unweighted Sample Estimates

Table 5
Logarithmic Employment Growth Rates
by Firm Age and Firm Size

Mean Logarithmic Growth Rate (Standard Deviation)
Number of Observations

	Firm Age on July 1, 1989 (Years)						
Firm Size on July 1, 1989 (Employees)	<2	2-5	5-10	10-25	25-50	>50	Total
1-19	13.9 (25.6) 167	9.5 (23.1) 699	7.95 (21.0) 1002	5.9 (19.1) 1664	3.7 (20.7) 867	1.1 (16.5) 626	6.1 (20.5) 5025
20-49	6.2 (24.9) 15	1.9 (26.9) 46	5.3 (20.5) 139	2.5 (17.8) 271	-1.7 (19.3) 183	-0.5 (14.6) 214	1.3 (18.7) 868
50-99	8.3 (10.4) 11	-0.6 (25.9) 30	-0.2 (22.2) 70	4.7 (18.7) 152	-1.1 (19.2) 110	1.2 (18.9) 127	1.6 (19.8) 500
100-500	3.9 (20.9) 17	0.9 (11.5) 41	-2.3 (22.7) 73	-0.5 (20.8) 207	0.9 (17.7) 215	0.4 (15.8) 298	0.2 (18.2) 851
> 500	-12.5 (25.7) 13	-2.1 (15.5) 30	-2.2 (10.8) 37	0.5 (10.1) 151	-0.8 (12.8) 169	-0.6 (11.8) 454	-0.8 (12.2) 854
Total	10.8 (25.4) 223	7.9 (23.0) 846	6.4 (21.1) 1321	4.6 (18.8) 2445	1.8 (19.4) 1544	0.3 (15.3) 1719	3.9 (19.5) 8098

Note: Unweighted Sample Estimates

Table 6
Failure Estimates
(t-Statistics in Parentheses)

	Logit		*Multinomial Logit*			
	Point Estimates	*Marginal Effects on Probability of Failure*	*Point Estimates*		*Marg. Effects on Probability of*	
Independent Variables			*Insolvency*	*Voluntary Liquidation*	*Insolvency*	*Voluntary Liquidation*
LSIZE	-.296 (4.114)	SIZE	.371 (2.653)	-.494 (6.084)	SIZE	
LSIZESQ	.005 (0.409)	neg. for all firms	-.126 (4.745)	.022 (1.898)	pos. for firms <18 employees, neg. else	neg. for all firms
LAGE	-.247 (4.030)		-.688 (5.562)	-.130 (1.946)		
LAGESQ	.004 (0.335)	AGE	-.065 (2.285)	.006 (0.409)	AGE	
LSIZE*LAGE	-.002 (0.128)	neg. for all firms	.161 (3.293)	-.004 (0.171)	negative for all firms	neg. for 92% of firms
SUBSIDIARY	.119 (0.806)	+0.56%	-.555 (2.001)	.578 (3.516)	-0.91%	+1.80%
DIVERSIFICATION	-.212 (2.381)	-1.81%	-.084 (0.523)	-.303 (2.946)	-0.16%	-1.73%
GMBH	.040 (0.475)	+0.36%	1.079 (6.147)	-.296 (2.878)	+3.11%	-2.00%
GMBHCO	.287 (2.127)	+1.96%	1.117 (4.449)	111 (0.668)	+2.04%	+0.38%
OHG	.488 (2.167)	+2.02%	160 (0.218)	.692 (2.896)	+0.08%	+5.61%
KG	-.172 (0.840)	-1.16%	.534 (1.273)	-.184 (0.795)	+0.67%	-1.02%
BGB	-.083 (0.401)	-0.93%	-.812 (1.115)	.089 (0.397)	-1.07%	+0.90%
AG	-1.434 (2.451)	-2.58%	.596 (0.727)	-2.029 (2.651)	+0.20%	-2.70%
CONSTANT	-.900 (2.829)	-	-3.606 (4.740)	-.945 (2.737)	-	-
Test Statistics						
Size and Age χ^2 (df)	222.46 (5)		289.61 (10)			
Legal Form Dummies χ^2 (df)	18.35 (6)		77.62 (12)			
Industry Dummies χ^2 (df)	75.55 (27)		120.69 (54)			
log Likelihood	-3576.79		-3873.44			
Number of oberservations	10961		10961			

Note: 27 industry dummy variables were included in all regressions. Single proprietorships are the reference group for legal form dummies. Marginal effects for the dummy variables were computed at sample means within the respective group of firms.

Table 7
Employment Growth Estimates

Independent Variables	*OLS (All Firms)*	*Heckman (All Firms)*	*Heckman (Limited Liability Firms)*
LSIZE	-.0971	-.1053	-.0989
	(11.137)	(11.791)	(7.092)
LSIZESQ	.0047	.0055	.0052
	(9.066)	(11.241)	(6.335)
LAGE	.0205	.0072	-.0049
	(.916)	(.384)	(0.156)
LAGESQ	-.0021	-.0013	-.0009
	(1.567)	(1.184)	(0019)
LSIZE*LAGE	.0037	.0034	.0036
	(3.554)	(3.213)	(2.044)
SUBSIDIARY	.0160	.0191	.0111
	(2.077)	(2.528)	(1.296)
DIVERSIFICATION	-.0015	-.0032	-.0027
	(.266)	(.597)	(.0076)
GMBH	.0507	.0447	
	(7.645)	(7.571)	
GMBHCO	.0558	.0534	.0070
	(7.010)	(6.521)	(.512)
OHG	.0486	.0473	
	(3.496)	(2.905)	
KG	.0413	.0400	
	(4.042)	(3.565)	
BGB	-.0125	-.0115	
	(.702)	(.725)	
AG	.0212	.0132	
	(1.722)	(.943)	
CONSTANT	.0620	.1638	.1638
	(.647)	(.815)	(.815)
Correlation between Selection and Growth Equation		-.304	-.087
		(3.566)	(1.201)
S.E.E.	.1866	.1865	.1876
Test Statistics	*F (df)*	*χ^2 (df)*	*χ^2 (df)*
Size and Age	82.87 (5, 8039)	601.57 (5)	231.05 (5)
Legal Form Dummies	13.50 (6, 8039)	80.69 (6)	-
Industry Dummies	3.26 (27, 8039)	104.00 (27)	60.09 (27)
Time Dummies	9.58 (18, 8039)	140.17 (18)	83.68 (18)
Adjusted R-squared	0.0849	0.0861	0.0832
Number of oberservations	8098	10961	5078

Note: 27 industry dummy variables were included in all regressions. Single proprietorships are the reference group for legal form dummies. For the coefficients of the selection equation for the full sample see Appendix B.