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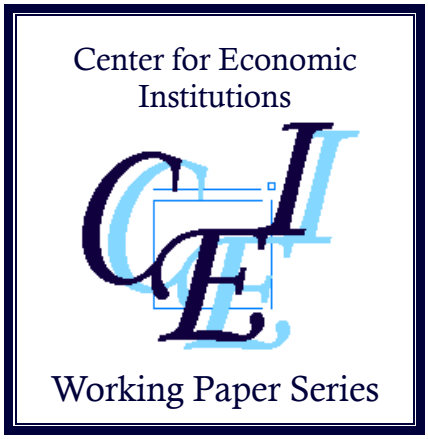

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Firm Survival in New EU Member States*

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Abstract: We analyze firm survival determinants in four new European Union member states (Czech Republic, Hungary, Poland, and Slovakia). We employ the Cox proportional hazards model on firm-level data over the period of 2006–2015. We show that less concentrated control of large shareholders, higher solvency, and more board directors are linked with increased probability of firm survival in all four countries. However, an excessive number of board directors shows a detrimental effect. Firms with foreign owners and higher returns on their assets exhibit better survival chances. On the other hand, larger firms and those hiring international auditors show lower probabilities of survival. A number of determinants specifically influence firm survival in different ways across countries. This fact emphasizes that differences in business conditions are important when studying firm survival.

Keywords: firm survival; new EU member states; survival and exit determinants; hazards model; panel data

JEL Classification: D22, G01, G33, G34, P34

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1. Introduction

The economic reforms of the 1990s in Central and Eastern Europe (CEE) were aimed at creating competitive market economies and more efficient enterprises by firm restructuring, privatization, and supporting institutional reforms (Aussenegg and Jelic, 2007). Large numbers of new firms were entering the market at that time, and while firms' entry might be quite easy, their survival on the market was often difficult (Geroski, 1995). This fact is particularly important for firms from the new member states of the European Union (EU) that first had to go through an uneasy transformation process before their EU accession (Estrin et al., 2009) and almost immediately had to cope with the global financial crisis (GFC) that, in general, negatively affected their performance (Hanousek et al., 2015). Hence, the existence of healthy companies and knowledge of the determinants of firms' failures are particularly vital in new EU countries, especially from the long-term perspective of European integration, employment, and economic growth. However, firms from the new EU states, and emerging markets in general, are under-represented in empirical survival analyses. Therefore, in this paper, we aim to contribute to the literature and analyze firm survival in four new EU members: the Czech Republic, Hungary, Poland, and Slovakia.

We chose the four countries based on several criteria. The first institutional criterion is related to foreign trade. As early as December 1991, the former Czechoslovakia, Poland, and Hungary signed the so-called "Europe Agreements" with the European Union. These countries have striven to establish a workable framework for international trade and cooperation. Such an arrangement was institutionalized in March 1993 in the form of the Central European Free Trade Agreement (CEFTA), consisting of founding countries the Czech Republic, Slovakia, Hungary, and Poland (and Slovenia). Second, the formation of the CEFTA reflected the importance of international trade as a means of economic coordination, mirrored in the high degree of economic convergence achieved among the four countries already in the late 1990's (Kočenda, 2001; Kočenda et al., 2006). Third, already in the early 1990s, the four countries formed a cultural and political alliance, called the Visegrád Group, for the purposes of furthering their European integration, along with economic and energy cooperation. Fourth, all four countries adopted relatively expedient privatization programs and transformed into market economies more effectively, as compared to other transition countries (Estrin et al., 2009). Fifth, as an attestation of similarity in their economic developments, and after complying with the *acquis communautaire*, all four members of the Visegrád Group joined the European

Union on May 1, 2004. Sixth, the four countries are key participants in the international East-West production networks in Europe (Frensch et al., 2016). Hence, the four countries form a relatively homogenous group of economies that share common features in terms of their economic advancement that is also mirrored in their production structures.

The lack of empirical survival analyses in emerging markets might be caused by data limitations. To overcome this defect, we build an extensive data set of 41,496 firms paired with a set of potential determinants of firms' exits and deliver a corporate survival analysis in the four new EU members. In this way, we fill an existing gap in the literature that studies and identifies factors that potentially impact firms' ability to survive.

Most of the survival studies focus on financial variables in order to predict corporate distress (Kumar and Ravi, 2007). However, especially in small and medium companies, financial statements might be quite misleading. This is not meant solely in the sense of fraudulent accounting practices (Koskivaara, 2004), but also in terms of "creative accounting" or "cooking the books" within the legal limits. According to Kirkos et al. (2007), financial statement fraud costs US businesses around $400 billion annually. As noted by Hajek and Henriques (2017), financial fraud may be an effective indicator of substantial financial problems that cause bankruptcy. Hence, there exist many reasons why it might be difficult to predict companies' distress using their own financial statements.

Perhaps that is why there is still no broadly accepted single method of evaluating a company's financial health. Apart from a wide set of utilized variables, research methods also vary greatly and range from statistical methods, through neural networks, decision trees, and fuzzy logic to many other artificial intelligence and soft computing techniques; Kumar and Ravi (2007) provide an excellent survey of the methods, data sources, and financial ratios frequently employed when evaluating corporate financial health.

In this paper, we proceed in line with a resource-based theory of the firm (Wernerfelt, 1984; Barney, 1991) and intentionally do not (primarily) focus on financial variables. Hence, we deviate form a mainstream use of financial variables to assess firm survival, and we contribute to the existing literature by focusing on a wide set of firm survival determinants that characterize a firm from various angles. We employ some indicators that are quite widely used in other empirical studies (firm performance, linkage with capital market, firm size and age). However, our contributive focus rests on our additional employment of variables that are much less frequently used and downright sparsely employed in analyses targeting emerging markets. These are indicators that

capture firm characteristics related to their legal form, ownership structure, corporate governance, and business organization. To make our analysis easy to compare with other studies, we apply the Cox proportional hazards model (Cox, 1972), which is by far the most commonly used model in empirical firm survival literature (Manjón-Antolín and Arauzo-Carod, 2008).

Our contribution to the literature is threefold. First, we analyze a fairly homogenous group of countries that experienced transition from planned to market economies and managed to join the EU rapidly after their transformations. Second, our analysis is based on a representative set of firms from various industries, and industry-specific effects are accounted for. Further, our time span covers both the GFC and post-crisis periods. Third, we analyze firm survival with a rich set of determinants that characterize firms from various angles. Specifically, in terms of the empirical evidence, we detect several factors that increase the probability of firm survival in all new EU states under research: namely the *Number of large shareholders*, the *Number of board directors*, and the *Solvency ratio*. Both *Foreign ownership* and Returns on assets (*ROA*) are determinants with a positive effect on firm survival in all countries except Slovakia. As for risk factors that lower the probability of firm survival in all countries, we have identified two determinants—the *Number of board directors* and, surprisingly, *Firm size*—for all countries except Hungary. Several other determinants have a specific influence in each of the countries of this study. The most surprising result is that employing an *International audit firm* lowers the probability of firm survival (with the exception of Hungarian firms). Several other determinants exhibit a specific influence in each of the countries in the study. This fact emphasizes that differences in business conditions are important when studying firm survival. Further, some of our results are in contrast to those reported in studies from developed markets and show the necessity of studying firm survival in emerging markets in detail.

In the rest of the paper, we review related literature in Section 2 that is followed by a description of the data and the employed methodology (Section 3). We present our detailed results along with empirically supported inferences in Section 4. The last section is a brief conclusion.

2. Related studies

Since the seminal work of Beaver (1966) and Altman (1968), there has been a considerable amount of research examining firm failure and survival (for relevant reviews,

see Santarelli and Vivarelli, 2007; Manjón-Antolín and Arauzo-Carod, 2008). Hence, we present an overview of studies that are directly related to our analysis and deliberately do not cover less relevant parts of the firm survival literature. To our knowledge, Harhoff et al. (1998) conducted the first study to consider a company's legal form as an indicator of riskiness and to establish its empirical impact on growth and firm exit. They used the Cox proportional hazards model based on a sample of approximately 11,000 West German companies operating in all major economic sectors. They showed that limited liability companies have higher insolvency rates than those with full liability.

Some determinants of firm survival might already be considered as stylized facts, such as firm age and size (Geroski, 1995, 2010). Buehler et al. (2006) confirmed that larger firms have lower hazard rates of exiting than smaller firms, and the same applies to size, i.e., bankruptcy rates decrease with age. Esteve-Pérez and Mañez-Castillejo (2008) found that the probability of exit for larger firms is about 32–39% lower than that of small firms. They also confirmed that firm age is important for explaining firm survival; however, the effect is not straightforward. They observed a relatively unusual relationship between the hazard rate and age, i.e., the risk of exit is high in the early days of a firm, then decreases before increasing later.

Another stylized fact inferred from the abundant empirical evidence is that firm survival depends on the industry in which the firm operates (Dunne et al., 1989); naturally, expanding industries have better survival rates (Agarwal and Audretsch, 2001). Financial health and firm performance are obviously important determinants of firm survival (Görg and Spaliara, 2014). Also, access to external financial resources positively impacts firm growth and survival (Musso and Schiavo, 2008). Recently, Guariglia et al. (2016) used in their models the ratio of shareholders' funds to total assets (i.e., solvency) as a control variable, and it proved to be positively associated with firm survival in all cases.

Ownership structure appears to be a significant factor for firm survival, as suggested by Bridges and Guariglia (2008)—based on a sample of UK firms, they confirmed that global engagement (i.e., foreign owned or exporting company) enhances survival probabilities. Many European countries, especially these new ones, have active policies for attracting foreign direct investment; however, as stated by Mata and Portugal (2002), benefits from foreign direct investment are more relevant with higher rates of survival of foreign-owned firms and the greater ability of foreign firms to overcome obstacles to survival.

Firm survival literature focusing on firms' governance is rather sparse. Among the first, Gilson (1990) focused on the ownership and board composition of firms in default

or bankruptcy. Daily and Dalton (1994) found the relationships among governance structures and corporate bankruptcy quite significant and concluded that corporate governance structure is a good predictor of a company's financial distress. Later on, Dalton et al. (1998) conducted a meta-analysis of 54 empirical studies addressing board composition and 31 studies of board leadership structure and their relationship to firms' financial performance. Only slight evidence of a systemic relationship between governance structure and financial performance was provided.

The effect of ownership concentration is "theoretically complex and empirically ambiguous" (Earle et al., 2005, p. 254). In fact, Shleifer and Vishny (1986) argued that the presence of large shareholders who have a strong incentive to monitor and discipline top management can help avoid the traditional "free-rider" problem associated with ownership dispersion, thus mitigating firm failure (i.e., the alignment hypothesis). This argument, however, is intensely refuted by Claessens et al. (2000), who pointed out that because large shareholders exercise control rights to maximize their profits, they can put the firm at risk of management failure (i.e., the expropriation hypothesis). Due partly to the ambiguity of the above-mentioned theoretical debates, empirical results regarding the effect of ownership concentration on firm performance presented by previous studies are diverse in their content and views (Wang and Shailer, 2015). Accordingly, the impact of ownership concentration on firm survival is also theoretically unpredictable.

Using the Cox proportional hazards model and a sample of 125 Australian firms, Chancharat et al. (2012) showed that the survival time of the initial private offerings (IPO) of the "new economy" firms is positively related to board independence. Moreover, company size and leverage are found to be negatively correlated with firm survival. Iwasaki (2014) analyzed the survival status of approximately 750 Russian firms after the financial crisis using unique survey data from 2005 and 2009. The significance of this study is that it paid attention to the role of governance bodies as influencing firm survival. In particular, the board of directors and the audit committee were identified as determinants with vital roles in reducing the potential exit risk. In addition, these two papers also suggested and partly verified the positive effects of the auditor's reputation and the quality of the external audit on firm survival.

Business organization is also regarded as an influential factor of firm survival. A series of studies regarding industrial organization provides evidence that the business network and diversification of a firm tend to keep the firm alive, *ceteris paribus* (Staber, 2001; Agarwal and Gort, 2002; Kimura and Fujii, 2003; Kosova and Lafontaine, 2010). This is because these two factors can potentially allay business risk caused by external

shocks. Thus, we also expect that the degree of business networking and diversification is positively related to firm survival in the new EU countries.

The list of related studies is far from exhaustive but quite clearly shows that the results are highly sample dependent. Thus, to establish the effect of governance on firm survival, in particular, it is beneficial to update, from time to time, the empirical results using the latest data coming from different industries and different countries.

All survival determinants under our consideration are summarized in **Table 1**, along with their expected effects. The effects are based on the summary of the prevailing effects found in the existing empirical literature surveyed above. To quantitatively assess the effects of firm survival determinants, we formulate a general hypothesis, H_0: A specific determinant does not affect firm survival. The formal hypothesis can be understood in terms of a firm's exit probability as well due to our use of the Cox proportional hazards model (Cox, 1972). As such, a firm exhibiting a specific characteristic (determinant) has lower exit probability. More details on the quantitative assessment are provided in Section 3.2.

3. Data and methodology

3.1 Data: Indicators and coverage

In our empirical analysis, we employed data from Bureau van Dijk's Orbis database for 41,496 firms from the new EU member states. We covered firms that satisfied two conditions: (i) they were actually operating at the end of 2006 (just before the GFC erupted), and (ii) they provided their survival status information at the end of 2015.[1] Of these 41,496 firms, a total of 5,682 failed during the examined period (2007–2015); hence, the exit rate was 13.7%. Further, for some companies, ownership and/or financial data were incomplete, and we were not able to trace them from other sources. Therefore, in our estimations, we used a set of 36,498 primarily medium and large firms from the Czech Republic (12,203), Poland (13,836), Hungary (6,976), and Slovakia (3,483).

[1] We obtained these 41,496 companies using Orbis 2006 archive data and checked their survival status by referring to the website database during the second half of 2016. The 2006 archive data contain 10 times more companies in our four countries of interest. However, due to a large number of dropouts after 2007 and other technical reasons, we were not able to trace the survival status of many firms at the end of 2015. However, this issue does not constitute a serious selection bias because an overwhelming majority of the untraceable firms are one-person businesses, micro-enterprises, and small firms. Hence, our empirical evidence relates primarily to medium and large companies, which is in accord with our research strategy.

Further, we collected an adequate set of company-specific variables that can be considered determinants of firms exiting the market. They come from seven different categories: legal form, ownership structure, corporate governance, firm performance, linkage with capital market, firm size and age, and business organization. The collected determinants are widely employed and established in the literature; as such, they allow for the direct comparison of our results with relevant studies performed on firm survival in developed markets. More details about the data are provided in **Table 2**.

In terms of the legal form, we distinguish five categories: joint-stock companies, limited liability companies, partnerships, cooperatives, and other legal forms. These are the key ownership categories, with limited liability companies being the most numerous. Other legal forms is the least represented category in the sample, and, as such, it is considered to be a default category for which we do not report a direct effect. The ownership categories are constructed as mutually exclusive dummy variables.

We capture the most important aspects of ownership structure with four important categories: number of large shareholders, foreign ownership, central state ownership, and regional state ownership. The number of large shareholders characterizes the concentration of control in a firm. From **Table 2**, we see that, on average, firms are dominated either by a single shareholder or a pair of blockholders. As this variable quantifies ownership power, it is not restricted to private ownership only. The state may be included in this category if the government is a dominant shareholder or a blockholder. We created this particular category of ownership control because it was empirically shown that dominant owners and blockholder groups exert important effects on firms' performance in the European context (Hanousek et al., 2012, 2015). Other categories distinguish private foreign ownership from two forms of state ownership, and they are defined as mutually exclusive dummy variables.

In our list of factors, corporate governance is represented by three recognized variables that play a key role, as shown in Shleifer and Vishny (1997). First, we include a number of board directors, as more than one director limits the potential misuse of management power in a company. Second, the number of audit committee/board members (shortened to number of auditors) provides important information on the level of oversight and safety checks within the company. Third, we include a dummy variable for firms that employ an international audit firm in an attempt to further improve their corporate governance or are simply required to do so by law (Sucher and Kosmala-MacLullich, 2004).

Firm survival is intuitively closely related to firm performance (Shiferaw, 2009). We capture this factor with two widely used (financial) performance measures: returns on assets (ROA) and profit margin. ROA percentage is calculated as [(profit before tax/total assets) × 100]. Profit margin is computed as [(gross profit/operating revenue) × 100]. Both measures capture different aspects of firm performance: ROA provides information as to the productivity of a firm's capital, while profit margin shows a firm's relative profitability.

Further, we employ various firm characteristics that elucidate important aspects of firm status. The linkage of a firm with capital market is captured by two factors: a dummy variable for firms listed on capital market and a solvency ratio calculated as [(shareholders' funds/total assets) × 100]. Then, we use the total assets to measure the firm size and number of years a firm has operated to capture its age. Finally, we trace the business organization of firms: the number of subsidiaries is a quantitative factor that defines a firm's network or the extent to which a firm spreads its business activities via its subsidiaries; business diversification is a qualitative factor that captures the variety of activities a firm is engaged in based on operations in different double-digit industries.

3.2 Methodology: Cox hazards model

The effects of various determinants on firm survival will be analyzed using the Cox proportional hazards model (Cox, 1972). The underlying idea behind the model is to estimate the probability that an event of interest will not have occurred by certain time, in our case, firm survival. Assuming that T is a continuous random variable with probability density function $f(t)$ and cumulative distribution function $F(t)$, the probability of surviving beyond the time t is given by the so-called surviving function:

$$S(t) = \Pr(T > t) = 1 - F(t) = \int_0^{\infty} f(x)dx \,. \tag{1}$$

As an alternative, we define a hazard function $h(t)$, denoting the probability of an event (firm exiting the market) during the next small interval of time:

$$h(t) = \lim_{dt \to 0} \frac{\Pr\{t \le T < t + dt \mid t \le T\}}{dt} \,. \tag{2}$$

The survival and hazard functions provide alternative but equivalent characterizations of the distribution of T. Following the procedure of Hosmer et al. (2008), the relationship between $h(t)$ and $S(t)$ can be established as:

$$S(t)=\exp\left(-\int_0^t h(x)dx\right),\ h(t)=-\frac{f(t)}{S(t)}. \tag{3}$$

The Cox proportional hazards model assumes that the baseline hazard $h_0(t)$ depends on time t and a set of relevant covariates x_{in}:

$$h(t\mid x_{i1},\ldots,x_{in})=h_0(t)\exp(\beta_1 x_{i1}+\beta_2 x_{i2}+\ldots+\beta_n x_{in})=h_0(t)\exp(\mathbf{x}^{\mathrm{T}}\boldsymbol{\beta}),\quad h_0(t)>0, \tag{4}$$

where β_1, β_2,…, and β_n are the parameters to be estimated. Specification (4) defines the hazard rate at time t for subject i, which depends on a vector of covariates $\boldsymbol{x}$.

Further, we consider two observations, i and i', that differ in their covariates (x-values), with the following linear representation:

$$\eta_i=\beta_1 x_{i1}+\beta_2 x_{i2}+\ldots+\beta_n x_{in} \tag{5}$$

and

$$\eta_i'=\beta_1 x_{i1}'+\beta_2 x_{i2}'+\ldots+\beta_n x_{in}'. \tag{6}$$

The hazard ratios for these two observations are then independent of time t, and they are defined as:

$$\frac{h_i(t)}{h_{i'}(t)}=\frac{h_0(t)\exp(\eta_i)}{h_0(t)\exp(\eta_{i'})}=\frac{\exp(\eta_i)}{\exp(\eta_{i'})}. \tag{7}$$

Since the baseline hazard $h_0(t)$ depends only on time t, it can take any form, while covariates enter the model linearly. Therefore, the Cox model is a semi-parametric model, and no matter how the survival time T is distributed, estimates from the Cox model are robust.

Estimates of parameters β are obtained from the maximum likelihood estimation of the logarithmic transformation of specification (4), which is represented by the following linear model:

$$\ln h(t \mid x_{i1},\ldots,x_{in}) = \ln h_0(t) + \sum_{j=1}^{n} b_j x_{ij} + \varepsilon_j \ . \quad (8)$$

Each parameter β represents a hazard ratio that we will interpret in the same way as did Iwasaki (2014). Specifically, a hazard ratio indicates how the probability of a firm exiting the market is multiplied when a specific covariate (e.g., firm survival determinant in a form of an independent variable) changes by one unit. If an estimate is over 1.0, we may consider a determinant (covariate) to be a risk factor causing the firm exit. Similarly, if an estimate is below 1.0, such a determinant (covariate) is considered a preventive factor inhibiting firm exit from the market.

All determinants (covariates) employed in our analysis are summarized in **Table 2**, along with their descriptive statistics.

4. Results

Figure 1 captures the number of failed firms during the analyzed period, 2007–2015. There was a sharp increase in failed firms after the crisis year of 2007, which was visible in all countries. The effects of the crisis began to materialize in late 2008 and 2009. The exogenous shock of the global financial crisis affected the new EU countries with a time lag, allowing domestic firms to adapt to new conditions or to diminish (Kovac et al., 2016). A decline in GDP growth was recorded in 2009 in all new EU countries, except Poland; this evidence correlates with the fact that post-crisis analyses of firm and industry levels in the EU consider 2009 to be an initial post-crisis year (Hanousek et al., 2015, 2017). Another drop in economic activity resulting in negative GDP growth occurred in 2012, but only in the Czech Republic and Hungary; although the other two countries experienced stagnation. This has also been translated into higher exit rates of new EU firms.

To give a better perspective, in Appendix **Table A.1**, we show the number of failed firms during the analyzed period by industries, along with Nelson-Aalen cumulative hazard functions and Kaplan-Meier survivor functions. The highest exit rate and hazard function are found in the Arts, entertainment, and recreation industry, which is not surprising, considering the highly cyclical nature of this business. In absolute terms, the highest number of firm failures was in the largest industries, i.e., Manufacturing, Wholesale and retail sales, and Construction, where a total of 3,775 failed firms were detected by the end of 2015.

In the next subsections, we will discuss the results we obtained from using the Cox proportional hazards model. **Table 3** presents the overall results and findings for each country separately, and **Table 4** contains estimations of firm survival in different industries, divided into four groups according to NACE Rev. 2 classification: Agriculture, forestry, and fishing (Section A), Mining and manufacturing (Sections B–E), Construction (Section F), and Services (Sections G–S).

4.1 Legal form

When all countries are analyzed jointly, a company's legal form is a significant factor affecting firm survival. However, in terms of statistical significance, the results differ across countries. In Slovakia, only the *Limited liability* form is a significant factor, and it decreases the probability of survival as the estimated hazard ratio is over 1. A lack of statistical significance associated with a legal form hints that other factors are more important in driving the ability to survive in the Slovakian business environment. In Hungary and Poland, the legal form of *Joint-stock company* is a significant preventive factor as it lowers the probability of a firm exiting the market; this is in opposition to Czech firms, for which all legal forms represent a risk factor.

When all countries are analyzed jointly, the results correspond to those of Esteve-Pérez and Mañez-Castillejo (2008), who concluded that limited liability firms survive longer. However, this does not hold for in the Slovakian and Czech environments. This finding is in line with a strand of previous findings that limited liability firms have higher insolvency rates than those under full liability (Harhoff et al., 1998). Such a discrepancy clearly demonstrates that determinants of firm survival may have different effects in various countries.

Results for specific industries are a little bit more straightforward (see **Table 4**): we identify a positive impact on firm survival for *Partnership* across all industries, for *Joint-stock company* in all but Construction, for *Limited liability* in Agriculture and Mining and manufacturing, and for *Cooperative and association* forms in all industries except Construction.

4.2 Ownership structure

The *Number of large shareholders* is a significant preventive factor in all countries, suggesting that, in new EU member countries, concentrated ownership tends to tighten the monitoring of top management and, consequently, to mitigate the risk of management failure. The same applies to *Foreign ownership* as a determinant lowering the probability of firm exit in the Czech Republic, Hungary, and Poland; statistical insignificance

precludes a judgement for Slovakian companies. Both types of findings are fully in line with the recent analysis of firms' efficiency in the EU: Hanousek et al. (2015) specifically showed that (i) firm efficiency increases when a majority owner must account for the presence of strong minority shareholders, and that (ii) foreign majority owners improve firm efficiency in companies where minority shareholders hold a substantial fraction of the firm's equity. Both results offer direct support for our findings that a reasonable number of large shareholders along with foreign ownership are factors contributing to firm survival, as more efficient firms are likely to be better protected against exit as well.

This is good news for the new EU countries and their foreign direct investments because the above results are in line with many empirical studies from the past, suggesting that the business and legal environment is becoming more like those of the developed world. Successful governance systems in developed countries provide significant legal protection with an important role for large investors (Shleifer and Vishny, 1997; La Porta et al., 2000), making firms with large shareholders less prone to unexpected financial distress.

Further, we found that *Regional state ownership* is a preventive factor in Czech and Polish companies. Surprisingly, *Central state ownership* is a significant risk factor for Czech companies. This is a disturbing result because, in a large meta-analysis, Iwasaki and Kočenda (2017) showed that domestic owners were mostly not able to outperform state ownership in Czech companies during the post-privatization period. That result would indicate heightened exit risk for firms under domestic control.[2]

Practically the same results are obtained from estimations of individual industries, i.e., ownership structure is a preventive factor for all industries, although the *Number of large shareholders* in Agriculture is not significant, and *Foreign ownership* is not significant in the Construction industry.

4.3 Corporate governance

Hazard ratios are significant for both the *Number of board directors* and its squared term. The results show that the relationship between the variable and firm survival exhibits an inverted U-shaped pattern: i.e., the probability of exit for firms with larger boards is low,

[2] Kočenda and Hanousek (2012) showed that state control resulted in the decline and even negative corporate performance of firms where the state was engaged through various means of control. On the other hand, state ownership and control in the Czech Republic decisively declined after 2001 in favor of domestic, foreign, or mixed ownership. Hence, post-crisis firm survival development should be affected by state control to much lesser extent than before.

and then it increases to reach a peak and eventually prompts an increase in the probability of failure as the board gets larger. This finding is in line with outcomes based on the meta-analysis of Dalton et al. (1998).

The effect of the *Number of auditors* is significant only in the case of Hungary. However, the hazard ratio shows that the number of the audit committee members exhibits a positive effect because it increases the probability a firm will survive. More interestingly, if a firm employs an *International audit firm*, this significantly increases the probability of the firm's exit in the Czech Republic, Poland, and Slovakia. Especially for Slovakian companies, the magnitude of this effect is very large. Few research studies, such as that of Sucher and Kosmala-MacLullich (2004), indicate that "there are also much broader issues which impact on and question the nature of auditor independence in transitional economies." Their analysis is based upon a review of Czech law, professional regulation, and media coverage. It is also complemented by interviews with audit practitioners, regulators, and financial statement users in the Czech Republic. Sucher and Kosmala-MacLullich (2004) concluded that, in the new EU countries (after their transition from centrally planned to market economies), a plethora of laws and regulations has been adopted to facilitate auditors' independence. Still, socioeconomic and cultural backgrounds appear to prevail over any formal safeguards executed to foster professional integrity and competence in the region.

We also offer an alternative interpretation of the result. The international auditors market in the new EU countries is monopolized by the Big Four auditing firms.[3] The Big Four auditors serve large and medium-sized firms, while small firms are beyond their reach. Following past auditing scandals, international auditors might be safeguarding themselves by being more cautious in issuing "no objection" statements. Such an attitude would exert more pressure on audited firms that might not be in the best shape in the first place. Recent empirical evidence suggests that Big Four auditors do not necessarily provide higher quality audits, as these depend to a large extent on client characteristics (Lawrence et al., 2011).

With respect to different industries, our results for the *Number of board directors* (and its squared term) and employing an *International audit firm* are quite strong and remain significant across all industries (one exception is the Construction industry, where employing an international audit firm is not a significant factor).

[3] Deloitte, Ernst & Young, KPMG, PricewaterhouseCoopers

4.4 Firm performance

In our models, we control for financial efficiency by including two indicators of firm performance: Returns on assets (*ROA*) and *Profit margin*. They are two key indicators employed in the extensive literature that uses financial variables to study firm survival. Our results show that these two covariates are positively correlated with firm survival in most of the new EU countries, except for Slovakian companies, where the estimated hazard ratios are not significant, although the sizes of the coefficients are very similar to those of other countries. Evidence in the existing literature of a positive relationship between good financial health and firm survival is quite convincing (Tsoukas, 2011), and our results in this regard are in line with empirical findings from other countries.

Results for industries are not that strong; higher *ROA* lowers the probability of firm exit in Services and Mining and manufacturing, while *Profit margin* lowers it only in Agriculture.

4.5 Linkage with capital market

Joint stock companies listed on a local stock exchange are more closely monitored than the rest. Whether a firm is *Listed* or not only matters in the case of Poland, where the stock market is the largest in the entire Central and Eastern European region in terms of the number of listed companies, liquidity, and market capitalization. However, our results suggest that Polish listed companies have a lower probability of surviving than non-listed firms. In developed markets, the opposite should be true. For example, Tsoukas (2011) showed that traditionally used measures of financial development significantly influence firm survival. The finding corresponds to the fact that larger and more liquid stock markets enhance firms' survival chances due to their access to capital. *Solvency ratio* (computed ratio of shareholders' funds and total assets) exhibits a straightforward effect, as it improves firms' survival chances in all countries and in all industries as well. Overall, access to external financial resources has a positive effect on the growth of firms (Musso and Schiavo, 2008).

Our results should be viewed in light of some specifics posed by the new EU stock markets. Stock markets in these countries have been established as vehicles to support the privatization process of state-owned enterprises when former command economies began pursuing market reforms (Megginson and Netter, 2001). As such, they ended up with a large number of listed companies, but with insufficient liquidity (Bonin and Wachtel, 2003; Baumöhl and Lyócsa, 2014). Despite the fact that the new EU stock markets being researched have been the most liquid as well as the largest in terms of

market capitalization in the region (Égert and Kočenda, 2007), these markets are still less suited to providing capital and might exhibit properties different from those of developed stock markets elsewhere. As such, a firm being listed on an emerging stock market does not necessarily need to exhibit a higher probability of survival as compared to evidence from developed markets. Moreover, as noted by Iwasaki (2014), the global financial crisis caused considerable damage to listed and bond-issuing companies through a significant capital crunch and/or unrealized losses on assets.

4.6 Firm size and age

We have mentioned that company size and age might already be considered stylized facts and they should have a positive effect on firm survival (Geroski, 1995; Buehler et al., 2006; Esteve-Pérez and Mañez-Castillejo, 2008). However, our results indicate that in new EU member countries, the probability of exit for larger firms is higher than for smaller ones; this result holds for all industries except Agriculture, where the coefficient is not significant. Based on the information presented in **Tables 3** and **4**, this result is clearly not specific to a country or industry, as none of the coefficients indicates an opposite effect.

This finding is indirectly supported by Hanousek et al. (2015) who found that larger EU firms can be associated with less efficiency in general. Less efficient firms are then naturally prone to increased exit risk that might be driven by higher bureaucracy, higher communication costs, and a greater resistance to change in large firms as compared to smaller firms. Thus, *Firm size* (the natural logarithm of total assets) comes as a determinant with an opposite effect on firm survival than one would expect based on the results of other empirical studies analyzing companies from different countries. As such, our findings underline the necessity of conducting firm survival research on firms from emerging markets.

Further, the *Age* of a firm appears to be a statistically insignificant factor across countries. This finding resonates with the results of Hanousek et al. (2015), who reported that the age of EU firms only negligibly affects their efficiency. In terms of industries, firm age shows some positive effects for improving the survival of firms operating in Service activities.

4.7 Business organization

A firm might spread its business activities via its subsidiaries. The number of subsidiaries, then, defines the extent of the *Business network* variable. This factor is shown to lower the failure probability in the Czech Republic and Poland; hazard ratios in the other two

countries are not significant. With respect to industries, this is also the case for Agriculture, Mining and manufacturing, and Services. *Business diversification* helps firms survive in the Czech Republic, but it is not a significant factor in other countries. For firms in Agriculture, diversification also lowers the probability of their exit, which is a reasonable result, given the highly cyclical and weather-dependent nature of this industry.

4.8 Robustness check

We performed two additional exercises to assess the robustness of our results presented in Sections 4.1–4.7. We re-estimated the Cox hazards model with different assumptions on survival distribution, including the exponential, Weibull, Gompertz, log-normal, log-logistic, and generalized gamma distributions. Further, we considered some aspects of the firms as potentially relevant for our survival analysis. For example, La Porta et al. (1999) used 20% as a threshold for control of a company. This widely accepted threshold theoretically allows for a maximum of 5 large shareholders. From this perspective, our variable *Number of large shareholders*, indicating a total number of dominant and block shareholders, should not exceed 5 in order to not lose its implication of control. Hence, we eliminated all firms with more than 5 large shareholders. Another case relates to the age of the firms. For example, some firms, especially among Hungarian agricultural and service companies, date their beginning to before World War 2. For the sake of a robustness check, we also eliminated such old firms. Finally, following the same logic, we also eliminated firms with an excessive number of board directors and subsidiaries. The above procedure resulted in a reduction of the sample by 1,534 firms. We re-estimated all of the models, including those with different assumptions of survival distribution, based on a reduced data set. The results of our robustness check are presented in Appendix **Tables A.2** to **A.5**. The outcome of this exercise is that our main results are robust with respect to the reduction of the data sample conditioned on some firms' characteristics, as the main results are practically the same.

5. Conclusions

We analyzed the issue of firm survival after the global financial crisis in four new EU member states (Czech Republic, Hungary, Poland, and Slovakia), employing a large and detailed firm-level data set. Based on the Cox hazards model, we detected a number of firm survival determinants. We confirmed the validity of several determinants in accord with earlier literature. At the same time, we also found several firm-specific determinants

that affect the probability of survival in the new EU firms. Our main results may be summarized as follows.

First, significant preventive factors exist that increase the probability of firm survival in at least three of the four countries in our sample. The *Number of large shareholders*, *Number of board directors*, and *Solvency ratio* improve firm survival probability for firms in all four countries. *Foreign ownership* and *ROA* both increase firm survival in all countries except Slovakia. On the other hand, the legal form of the *Limited liability* company is a significant preventive factor only for Hungarian firms.

Second, we identified several significant risk factors that lower the probability of firm survival and, thus, increase the probability of firm exit across the countries. In terms of corporate governance, a board of directors that is too large seems to be detrimental because the squared term of the *Number of board directors* lowers firm survival probability in all four new EU countries. Two other factors negatively impact firm survival in three countries except Hungary: *Firm size* and when a firm employs an *International audit firm*.

Third, several other determinants exhibit a specific influence on firms in each of the countries studied. This fact emphasizes that differences in business conditions are important when studying firm survival. Hence, we believe that studying the new EU member states and their transformed economies provides several useful insights for practitioners and policy makers. Some of our results are in line with other studies in this area of research. However, we have also found some specific impacts that contradict even some of the stylized facts about firm survival. One strikingly surprising result is that employing an international audit firm lowers the survival probability of new EU companies.

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Figure 1. Number of failed firms, exit rate, and Nelson-Aalen estimate of the cumulative hazard functions by country and year

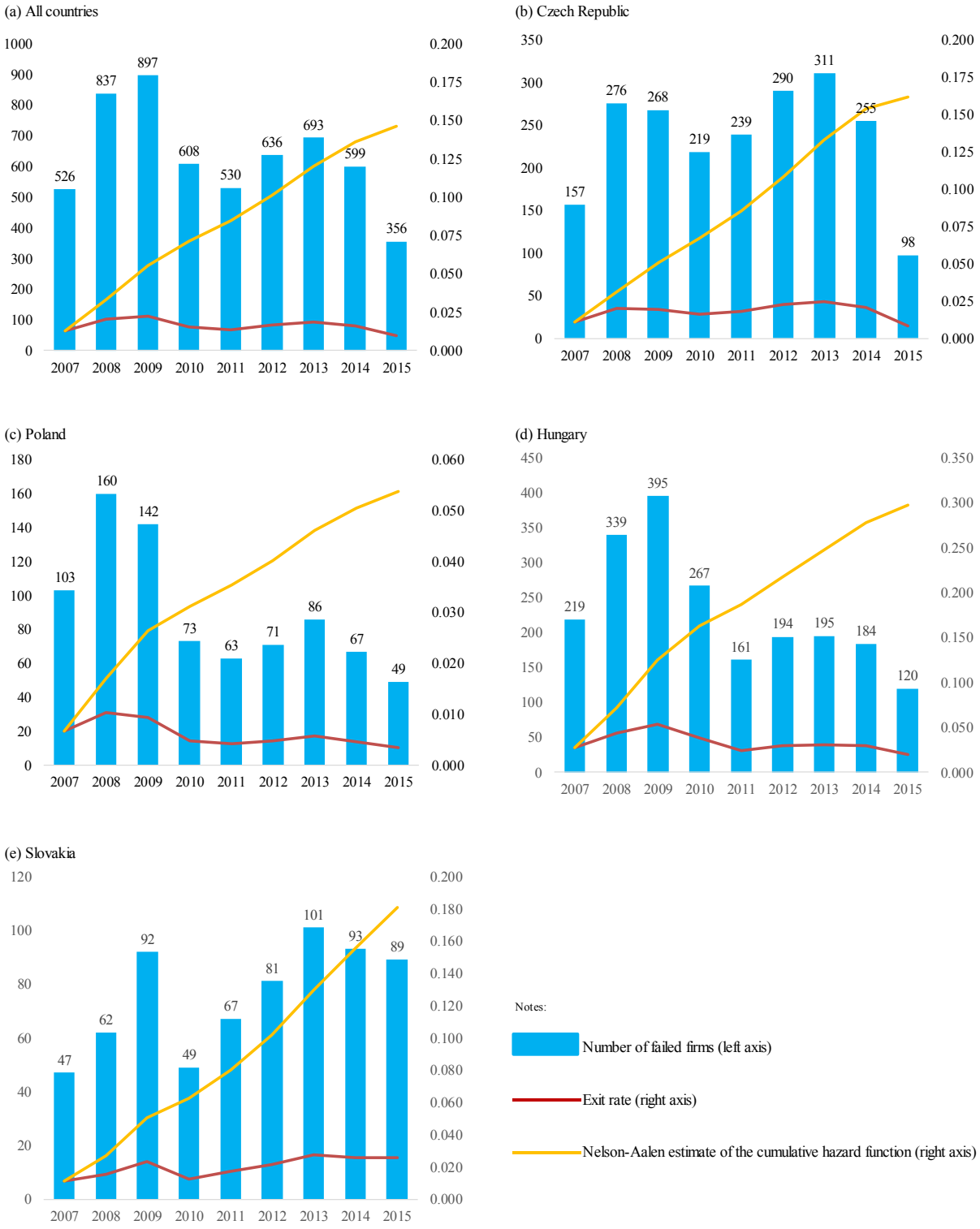

Table 1. Factors and their expected effects on firm survival

Factor field	Factor	Predicted impact on firm survivability
Legal form	Openness of legal form	+
Ownership structure	Ownership concentration	?
	Foreign ownership	+
	State ownership	+
Corporate governance	Number of board directors (squared term)	+ (–)
	Number of auditors (squared term)	+ (–)
	Quality of external audit	+
Firm performance	Financial performance	+
Linkage with capital	Dependence on stock market	+
	Dependence on fund procurement	+
Firm size and age	Firm size	+
	Firm age	+
Business organization	Business network	+
	Business diversification	+

Table 2. Definitions and descriptive statistics of variables used in the empirical analysis

Variable name	Definition	Descriptive statistics		
		Mean	S.D.	Median
Legal form				
Joint-stock company	Dummy variable for open joint-stock companies	0.172	0.378	0.000
Limited liability company	Dummy variable for limited liability companies	0.537	0.499	1.000
Partnership	Dummy variable for partnerships	0.182	0.386	0.000
Cooperative	Dummy variable for cooperatives	0.056	0.230	0.000
Other legal forms (default category)	Dummy variable for companies with a corporate form other than those listed	0.052	0.223	0.000
Ownership structure		1.611	2.110	1.000
Number of large shareholders	Total number of dominant and block shareholders	0.092	0.289	0.000
Foreign ownership	Dummy for ultimate ownership of foreign investors	0.018	0.132	0.000
Central state ownership	Dummy for ultimate ownership of the central government	0.013	0.113	0.000
Regional state ownership	Dummy for ultimate ownership of regional governments	2.510	2.781	2.000
Corporate governance		1.696	1.456	2.000
Number of board directors	Number of recorded members of the board of directors	0.058	0.234	0.000
Number of auditors	Number of recorded corporate audit committee members	7.448	15.017	5.020
International audit firm	Dummy for firms that employ an international audit firm as an external	4.063	10.740	2.860
Firm performance		0.005	0.071	0.000
ROA	Return on total assets (%) [a]	43.727	28.705	44.115
Profit margin	Profit margin (%) [b]	7.583	1.924	7.716
Linkage with capital market		14.539	15.579	12.000
Listed	Dummy variable for listed companies	0.433	2.874	0.000
Solvency ratio	Solvency ratio (%) [c]	5.019	6.115	2.000
Firm size and age		0.172	0.378	0.000
Company size	Natural logarithm of total assets in euros	0.537	0.499	1.000
Firm age	Years in operation	0.182	0.386	0.000
Business organization		0.056	0.230	0.000
Firm network	Number of recorded subsidiaries	0.052	0.223	0.000
Business diversification	Number of operating industries according to NACE Rev. 2 secondary codes	1.611	2.110	1.000

Notes:

[a] ROA is computed using the following formula: (profit before tax/total assets) × 100

[b] Profit margin is computed using the following formula: (gross profit/operating revenue) × 100

[c] Solvency ratio is computed using the following formula: (shareholders' funds/total assets) × 100

Table 3. Determinants of firm survival: Baseline estimation of the Cox proportional hazards model

Model	[1]	[2]	[3]	[4]	[5]
Target industry	All industries (Sections A–S)				
Target country	All countries	Czech Republic	Poland	Hungary	Slovakia
Legal form (default category: other legal forms)					
Joint-stock company	0.65327 ***	2.86710 ***	0.59591 **	0.35931 ***	2.12834
	(-5.57)	(5.02)	(-2.16)	(-9.25)	(1.47)
Limited liability company	0.67624 ***	2.50771 ***	0.91817	1.30244	2.58041 *
	(-5.16)	(5.03)	(-0.40)	(1.58)	(1.78)
Partnership	0.34754 ***	2.41419 **	1.04745	0.25677 ***	1.20830
	(-13.76)	(2.30)	(0.18)	(-16.22)	(0.15)
Cooperative and association	0.36783 ***	1.43530	0.16372 ***	1.16792	2.25291
	(-7.20)	(1.25)	(-5.89)	(0.38)	(1.44)
Ownership structure					
Number of large shareholders	0.76650 ***	0.54919 ***	0.34115 ***	0.97206 **	0.38799 ***
	(-11.77)	(-7.73)	(-11.19)	(-2.31)	(-4.40)
Foreign ownership	0.68413 ***	0.73709 ***	0.66364 ***	0.61259 ***	0.95979
	(-5.93)	(-3.07)	(-2.93)	(-3.25)	(-0.23)
Central state ownership	0.83981	2.91949 ***	0.87527	0.85495	1.72222
	(-1.01)	(2.81)	(-0.68)	(-0.19)	(0.74)
Regional state ownership	0.03442 ***	0.05300 ***	0.05185 ***		
	(-3.36)	(-50.02)	(-2.96)		
Corporate governance					
Number of board directors	0.85260 ***	0.54810 ***	0.70000 ***	0.94882 ***	0.67151 ***
	(-12.83)	(-16.86)	(-5.29)	(-4.41)	(-6.97)
Number of board directors ^2	1.00153 ***	1.02399 ***	1.01296 ***	1.00060 ***	1.01428 ***
	(12.45)	(12.34)	(5.07)	(4.39)	(3.88)
Number of auditors	1.03506	0.97552	1.01087	0.78496 ***	0.72542
	(0.94)	(-0.31)	(0.05)	(-3.55)	(-1.00)
Number of auditors ^2	0.97226 ***	1.03355	0.94547	1.02089 *	0.94541
	(-4.32)	(1.28)	(-0.77)	(1.92)	(-0.20)
International audit firm	1.40018 ***	1.51117 **	2.37369 ***	0.95912	4.00975 **
	(4.41)	(2.08)	(6.93)	(-0.35)	(2.23)
Firm performance					
ROA	0.99105 ***	0.99482 *	0.99211 *	0.99247 **	0.99330
	(-5.61)	(-1.94)	(-1.69)	(-2.54)	(-1.52)
Profit margin	0.99538 **	0.99541	0.99628	0.98937 ***	0.99772
	(-2.19)	(-1.37)	(-0.60)	(-2.71)	(-0.45)
Linkage with capital market					
Listed	1.35186	1.25341	5.56284 **	0.36208	1.31900
	(1.00)	(0.15)	(2.31)	(-1.39)	(0.69)
Solvency ratio	0.99095 ***	0.99138 ***	0.99535 ***	0.98761 ***	0.99286 ***
	(-15.93)	(-9.99)	(-3.07)	(-11.18)	(-3.74)
Firm size and age					
Firm size	1.07296 ***	1.13852 ***	1.14069 ***	1.01468	1.09699 **
	(5.09)	(5.35)	(3.46)	(0.64)	(2.54)
Firm age	0.99660 *	1.00794	1.00101	1.00026	0.99612
	(-1.80)	(1.45)	(0.55)	(0.05)	(-0.48)
Business organization					
Business network	0.95388 ***	0.91211 *	0.69528 ***	1.00258	1.01956
	(-2.95)	(-1.85)	(-2.72)	(0.23)	(0.31)
Business diversification	1.00080	0.98371 **	0.94551	1.00983	1.00768
	(0.20)	(-2.55)	(-0.38)	(1.44)	(0.80)
Country-level fixed effects	Yes	No	No	No	No
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes
N	36498	12203	13836	6976	3483
Log pseudolikelihood	-47083.42	-15483.59	-6215.90	-14267.30	-4187.99
Wald test (χ^2)	41844.85 ***	38499.14 ***	197478.28 ***	21018.78 ***	78022.46 ***

Notes: This table contains the results from a survival analysis using the Cox proportional hazards model. N denotes the number of firms. Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z-statistics are reported in parentheses beneath the hazard ratios. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Determinants of firm survival in different industries

Model	[1]		[2]		[3]		[4]	
Target industry (NACE Rev. 2 classification)	Agriculture, forestry, and fishing (Section A)		Mining and manufacturing (Sections B–E)		Construction (Section F)		Services (Sections G–S)	
Legal form (default category: other legal forms)								
Joint-stock company	0.32748	***	0.65112	***	0.69622		0.71150	***
	(-4.17)		(-3.45)		(-1.24)		(-2.99)	
Limited liability company	0.16741	***	0.58755	***	0.64965		0.89237	
	(-4.85)		(-4.39)		(-1.58)		(-1.01)	
Partnership	0.27288	***	0.28137	***	0.38924	***	0.41867	***
	(-3.33)		(-11.28)		(-3.10)		(-7.20)	
Cooperative and association	0.21264	***	0.45908	***	1.27510		0.24338	***
	(-4.10)		(-3.81)		(0.58)		(-5.45)	
Ownership structure								
Number of large shareholders	0.91586		0.74831	***	0.80264	***	0.74513	***
	(-1.10)		(-7.52)		(-3.98)		(-9.06)	
Foreign ownership	0.22505	*	0.62713	***	1.04028		0.71203	***
	(-1.65)		(-4.82)		(0.14)		(-3.75)	
Central state ownership	0.62336		1.17430		0.47253		0.76270	
	(-0.51)		(0.64)		(-0.72)		(-1.09)	
Regional state ownership	0.02380	***	0.05856	***	0.01770	***		
	(-32.33)		(-2.81)		(-78.18)			
Corporate governance								
Number of board directors	0.73413	***	0.83617	***	0.79733	***	0.84571	***
	(-4.93)		(-8.99)		(-5.07)		(-9.02)	
Number of board directors ^2	1.01051	***	1.00389	***	1.00492	***	1.00156	***
	(4.77)		(10.14)		(3.35)		(9.34)	
Number of auditors	1.14624		1.09421		0.84391		1.04212	
	(0.64)		(1.59)		(-1.60)		(0.74)	
Number of auditors ^2	0.95435		0.95023	***	1.00547		0.98077	**
	(-1.29)		(-4.89)		(0.29)		(-2.00)	
International audit firm	3.58688	*	1.32745	**	1.58485		1.41164	***
	(1.74)		(2.44)		(1.26)		(3.26)	
Firm performance								
ROA	0.99913		0.99032	***	0.99781		0.98913	***
	(-0.06)		(-3.58)		(-0.36)		(-5.21)	
Profit margin	0.98283	*	0.99555		0.99437		0.99690	
	(-1.95)		(-1.39)		(-0.48)		(-1.02)	
Linkage with capital market								
Listed	0.03920	***	1.28722		1.53269		1.63931	
	(-7.67)		(0.61)		(0.56)		(0.84)	
Solvency ratio	0.98421	***	0.98988	***	0.98714	***	0.99349	***
	(-4.27)		(-11.38)		(-5.86)		(-7.98)	
Firm size and age								
Firm size	1.10464		1.09795	***	1.17977	***	1.03513	*
	(1.14)		(4.35)		(3.94)		(1.67)	
Firm age	0.99738		0.99980		0.98661		0.99251	**
	(-0.19)		(-0.10)		(-1.43)		(-2.21)	
Business organization								
Business network	0.82338	**	0.90687	***	1.01809		0.96220	**
	(-2.50)		(-2.60)		(0.56)		(-2.04)	
Business diversification	0.96668	*	1.00898		0.98947		0.99894	
	(-1.69)		(1.38)		(-1.01)		(-0.17)	
Country-level fixed effects	Yes		Yes		Yes		Yes	
NACE division-level fixed effects	Yes		Yes		Yes		Yes	
N	2112		15184		3449		15753	
Log pseudolikelihood	-1157.92		-17727.74		-4257.11		-18605.52	
Wald test (χ^2)	17690.28	***	14295.10	***	8596.55	***	1611.43	***

Notes: This table contains the results from a survival analysis using the Cox proportional hazards model. N denotes the number of firms. Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z-statistics are reported in parentheses beneath the hazard ratios. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Appendix

Table A.1. Breakdown of firm survival status by industry

Table A.2. Estimations with different assumptions about distribution

Table A.3. Determinants of firm survival: Cox proportional hazards model (without outliers)

Table A.4. Determinants of firm survival in different industries (without outliers)

Table A.5. Estimations with different assumptions about distribution (without outliers)

Table A.1. Breakdown of firm survival status by industry

NACE Rev. 2 section	Number of operating firms at the end of 2006 (i)	Number of surviving firms through the end of 2015	Number of failed firms										Entire period exit rate (ii/i)	Entire period Nelson-Aalen cumulative hazard function	Entire period Kaplan-Meier survivor function
			Total failures through the end of 2015 (ii)	Breakdown by year											
				2007	2008	2009	2010	2011	2012	2013	2014	2015			
All industries (A–S)	41496	35814	5682	526	837	897	608	530	636	693	599	356	0.137	0.146	0.863
Agriculture, forestry, and fishing (A)	2391	2175	216	24	28	31	11	14	26	37	25	20	0.090	0.094	0.910
Mining and quarrying (B)	236	207	29	2	4	4	5	1	3	3	2	5	0.123	0.130	0.877
Manufacturing (C)	15163	13048	2115	200	361	260	196	203	251	261	240	143	0.139	0.149	0.861
Electricity, gas, steam, and air conditioning supply (D)	548	493	55	0	6	9	6	7	10	7	6	4	0.100	0.105	0.900
Water supply; sewage, waste management, and remediation activities (E)	948	853	95	4	15	17	11	4	11	8	16	9	0.100	0.105	0.900
Construction (F)	3866	3212	654	56	68	103	81	52	81	91	69	53	0.169	0.183	0.831
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	7694	6688	1006	78	135	207	118	96	112	120	89	51	0.131	0.139	0.869
Transportation and storage (H)	1899	1611	288	35	39	53	26	38	20	33	34	10	0.152	0.163	0.848
Accommodation and food service activities (I)	915	781	134	13	18	23	29	13	7	12	15	4	0.146	0.157	0.854
Information and communication (J)	1140	950	190	27	14	45	15	15	25	17	17	15	0.167	0.180	0.833
Financial and insurance activities (K)	398	332	66	5	9	16	3	9	5	3	9	7	0.166	0.179	0.834
Real estate activities (L)	1295	1140	155	14	28	25	20	12	20	21	9	6	0.120	0.126	0.880
Professional, scientific, and technical activities (M)	1681	1457	224	20	36	34	28	19	21	30	24	12	0.133	0.142	0.867
Administrative and support service activities (N)	1535	1290	245	22	29	44	33	22	29	31	26	9	0.160	0.172	0.840
Public administration and defense; compulsory social security (O)	17	13	4	0	2	1	0	0	0	0	1	0	0.235	0.256	0.765
Education (P)	335	322	13	1	3	1	1	0	1	3	3	0	0.039	0.039	0.961
Human health and social work activities (Q)	931	852	79	7	14	10	12	6	8	11	6	5	0.085	0.088	0.915
Arts, entertainment, and recreation (R)	295	214	81	17	22	7	7	14	4	3	6	1	0.275	0.313	0.725
Other service activities (S)	209	176	33	1	6	7	6	5	2	2	2	2	0.158	0.170	0.842
Multiple comparison among the 19 sections															
Chi-square (χ^2) test for independence													222.43 ***		
Cramer's coefficient of association (V)													0.0732		
Log-rank test for equality of survivor functions (χ^2)															229.98 ***

Notes: This table is provided to obtain a better perspective of our data. We do not take into account the backfilling bias, i.e., during the analyzed period, some new firms might be established.

Table A.2. Estimations with different assumptions about distribution

Model	Table 3 Model [1]	[1]	[2]	[3]	[4]	[5]	[6]
Assumptions of survival distribution	Cox proportional hazards	Exponential	Weibull	Gompertz	Log-normal	Log-logistic	Generalized gamma
Legal form (default category: other legal forms)							
Joint-stock company	0.65327 ***	0.65634 ***	0.64800 ***	0.65562 ***	0.48120 ***	0.43664 ***	0.47783 ***
	(-5.57)	(-5.44)	(-5.44)	(-5.43)	(6.86)	(5.47)	(6.80)
Limited liability company	0.67624 ***	0.68018 ***	0.67427 ***	0.67971 ***	0.49818 ***	0.42177 ***	0.49011 ***
	(-5.16)	(-5.03)	(-4.99)	(-5.02)	(7.16)	(6.13)	(7.00)
Partnership	0.34754 ***	0.34785 ***	0.33591 ***	0.34673 ***	1.05109 ***	1.04581 ***	1.04989 ***
	(-13.76)	(-13.57)	(-13.43)	(-13.56)	(14.07)	(13.75)	(14.18)
Cooperative and association	0.36783 ***	0.36861 ***	0.36631 ***	0.36840 ***	0.94932 ***	0.89341 ***	0.94604 ***
	(-7.20)	(-7.13)	(-7.09)	(-7.12)	(8.71)	(7.30)	(8.63)
Ownership structure							
Number of large shareholders	0.76650 ***	0.76383 ***	0.76042 ***	0.76344 ***	0.20236 ***	0.22872 ***	0.20583 ***
	(-11.77)	(-11.74)	(-11.68)	(-11.74)	(9.21)	(11.51)	(10.06)
Foreign ownership	0.68413 ***	0.68129 ***	0.67664 ***	0.68078 ***	0.33460 ***	0.33203 ***	0.33412 ***
	(-5.93)	(-5.93)	(-5.97)	(-5.93)	(6.26)	(6.00)	(6.25)
Central state ownership	0.83981	0.84218	0.84116	0.84217	0.21446 *	0.17007	0.21057
	(-1.01)	(-0.99)	(-0.99)	(-0.99)	(1.66)	(1.19)	(1.62)
Regional state ownership	0.03442 ***	0.03431 ***	0.03414 ***	0.03430 ***	2.07169 ***	2.59485 ***	2.09945 ***
	(-3.36)	(-3.36)	(-3.36)	(-3.36)	(4.36)	(3.40)	(4.25)
Corporate governance							
Number of board directors	0.85260 ***	0.85141 ***	0.84790 ***	0.85105 ***	0.14089 ***	0.15993 ***	0.14067 ***
	(-12.83)	(-12.76)	(-12.75)	(-12.78)	(13.54)	(3.26)	(13.82)
Number of board directors ^2	1.00153 ***	1.00155 ***	1.00159 ***	1.00155 ***	-0.00166 ***	-0.00264	-0.00161 ***
	(12.45)	(12.47)	(12.51)	(12.50)	(-5.09)	(-0.73)	(-5.25)
Number of auditors	1.03506	1.03651	1.03748	1.03665	-0.00561	-0.03284	-0.00765
	(0.94)	(0.96)	(0.97)	(0.97)	(-0.18)	(-1.00)	(-0.24)
Number of auditors ^2	0.97226 ***	0.97187 ***	0.97072 ***	0.97175 ***	0.01991 ***	0.02580 ***	0.02041 ***
	(-4.32)	(-4.32)	(-4.40)	(-4.33)	(3.48)	(4.41)	(3.51)
International audit firm	1.40018 ***	1.39989 ***	1.40093 ***	1.39994 ***	-0.39481 ***	-0.34817 ***	-0.38965 ***
	(4.41)	(4.36)	(4.29)	(4.35)	(-6.04)	(-5.15)	(-5.89)
Firm performance							
ROA	0.99105 ***	0.99095 ***	0.99072 ***	0.99093 ***	0.00791 ***	0.00846 ***	0.00798 ***
	(-5.61)	(-5.60)	(-5.59)	(-5.60)	(5.21)	(5.61)	(5.26)
Profit margin	0.99538 **	0.99531 **	0.99537 **	0.99531 **	0.00492 **	0.00467 **	0.00488 **
	(-2.19)	(-2.20)	(-2.12)	(-2.19)	(2.41)	(2.31)	(2.40)
Linkage with capital market							
Listed	1.35186	1.35490	1.36529	1.35598	-0.27253	-0.26103	-0.27566
	(1.00)	(1.00)	(1.01)	(1.00)	(-1.05)	(-1.03)	(-1.07)
Solvency ratio	0.99095 ***	0.99082 ***	0.99066 ***	0.99080 ***	0.00771 ***	0.00803 ***	0.00775 ***
	(-15.93)	(-15.95)	(-15.90)	(-15.93)	(15.01)	(15.74)	(14.95)
Firm size and age							
Firm size	1.07296 ***	1.07371 ***	1.07631 ***	1.07397 ***	-0.05301 ***	-0.06187 ***	-0.05370 ***
	(5.09)	(5.08)	(5.13)	(5.09)	(-4.39)	(-5.10)	(-4.42)
Firm age	0.99660 *	0.99658 *	0.99643 *	0.99656 *	0.00208	0.00256 *	0.00212
	(-1.80)	(-1.80)	(-1.83)	(-1.80)	(1.56)	(1.71)	(1.58)
Business organization							
Business network	0.95388 ***	0.95398 ***	0.95302 ***	0.95390 ***	0.05074 ***	0.04780 ***	0.05018 ***
	(-2.95)	(-2.91)	(-2.91)	(-2.91)	(3.86)	(3.43)	(3.81)
Business diversification	1.00080	1.00098	1.00112	1.00099	0.00196	0.00109	0.00183
	(0.20)	(0.24)	(0.27)	(0.25)	(0.55)	(0.31)	(0.51)
Country-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	36498	36498	36498	36498	36498	36498	36498
Log pseudolikelihood	-47083.42	-	-16124.97	-16204.42	-15976.23	-16026.01	-15975.67
Wald test (χ^2)	41844.85 ***	9346.38 ***	9232.76 ***	8543.61 ***	6049.29 ***	6063.78 ***	3875.31 ***

Notes: This table contains results from a survival analysis using 6 parametric estimators for a robustness check. Models [1] to [3] report hazard ratios, while Models [4] to [6] report regression coefficients. N denotes the number of firms. Standard errors are computed using the Huber-White sandwich estimator. z-statistics are reported in parentheses. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.3. Determinants of firm survival: Cox proportional hazards model (without outliers)

Model	[1]	[2]	[3]	[4]	[5]
Target industry	All industries (Sections A–S)				
Target country	All countries	Czech Republic	Poland	Hungary	Slovakia
Legal form (default category: other legal forms)					
Joint-stock company	0.66711 ***	2.31094 ***	0.58589 **	0.37366 ***	1.98225
	(-5.13)	(4.09)	(-2.18)	(-8.57)	(1.37)
Limited liability company	0.78725 ***	2.55341 ***	0.96598	1.33696 *	3.07918 **
	(-3.05)	(5.14)	(-0.16)	(1.67)	(2.20)
Partnership	0.39025 ***	2.42107 **	1.08741	0.26022 ***	1.51375
	(-11.52)	(2.41)	(0.31)	(-15.20)	(0.33)
Cooperative and association	0.35031 ***	1.10043	0.15007 ***	1.30410	2.02060
	(-7.54)	(0.34)	(-6.11)	(0.65)	(1.28)
Ownership structure					
Number of large shareholders	0.61692 ***	0.41034 ***	0.28960 ***	0.97321	0.28334 ***
	(-20.82)	(-16.42)	(-14.72)	(-1.05)	(-8.20)
Foreign ownership	0.70510 ***	0.80406 **	0.68431 ***	0.58337 ***	1.06403
	(-5.35)	(-2.19)	(-2.68)	(-3.39)	(0.36)
Central state ownership	0.85205	3.20905 ***	0.89282	0.45966	1.93057
	(-0.91)	(2.94)	(-0.57)	(-0.80)	(0.88)
Regional state ownership	0.03594 ***	0.01850 ***	0.05393 ***		
	(-3.31)	(-52.30)	(-2.92)		
Corporate governance					
Number of board directors	0.79527 ***	0.56092 ***	0.68717 ***	0.90243 ***	0.67881 ***
	(-16.50)	(-16.51)	(-5.59)	(-6.59)	(-6.68)
Number of board directors ^2	1.00572 ***	1.02305 ***	1.01418 ***	1.00310 ***	1.01393 ***
	(11.55)	(11.91)	(5.78)	(6.13)	(3.53)
Number of auditors	1.06370 *	0.94133	1.07576	0.81139 ***	0.73283
	(1.65)	(-0.75)	(0.36)	(-2.93)	(-0.98)
Number of auditors ^2	0.96666 ***	1.04260	0.93982	1.01511	0.94205
	(-5.03)	(1.62)	(-0.85)	(1.33)	(-0.22)
International audit firm	1.36540 ***	1.49085 **	2.31767 ***	0.96402	4.42512 **
	(3.94)	(2.02)	(6.75)	(-0.30)	(2.35)
Firm performance					
ROA	0.99188 ***	0.99508 *	0.99246 *	0.99289 **	0.99482
	(-5.04)	(-1.84)	(-1.71)	(-2.33)	(-1.21)
Profit margin	0.99555 **	0.99581	0.99563	0.98851 ***	0.99748
	(-2.07)	(-1.24)	(-0.71)	(-2.84)	(-0.49)
Linkage with capital market					
Listed	0.94995	1.96111	0.01880 ***	0.62197	0.74912
	(-0.13)	(0.46)	(-8.21)	(-0.76)	(-0.58)
Solvency ratio	0.99113 ***	0.99158 ***	0.99507 ***	0.98810 ***	0.99336 ***
	(-15.44)	(-9.78)	(-3.28)	(-10.37)	(-3.51)
Firm size and age					
Firm size	1.07630 ***	1.13569 ***	1.15801 ***	1.02414	1.10356 ***
	(5.23)	(5.30)	(3.90)	(1.01)	(2.71)
Firm age	0.99657 *	1.00694	1.00084	0.99935	0.99729
	(-1.74)	(1.26)	(0.45)	(-0.11)	(-0.33)
Business organization					
Business network	0.94885 ***	0.89977 **	0.67300 ***	1.00628	1.00262
	(-2.95)	(-2.02)	(-2.81)	(0.42)	(0.03)
Business diversification	0.99990	0.98248 ***	0.86489	1.00975	1.00756
	(-0.02)	(-2.73)	(-1.04)	(1.39)	(0.78)
Country-level fixed effects	Yes	No	No	No	No
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes
N	34964	11755	13460	6287	3462
Log pseudolikelihood	-44947.28	-15042.80	-6085.42	-13007.63	-4131.52
Wald test (χ^2)	30294.86 ***	40296.35 ***	181021.39 ***	17758.44 ***	116712.19 ***

Notes: This table contains results from a survival analysis using the Cox proportional hazards model. N denotes the number of firms. Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z-statistics are reported in parentheses beneath the hazard ratios. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.4. Determinants of firm survival in different industries (without outliers)

Model	[1]		[2]		[3]		[4]	
Target industry (NACE Rev. 2 classification)	Agriculture, forestry, and fishing (Section A)		Mining and manufacturing (Sections B–E)		Construction (Section F)		Services (Sections G–S)	
Legal form (default category: other legal forms)								
Joint-stock company	0.35258	***	0.59403	***	0.64537		0.77301	**
	(-3.63)		(-4.09)		(-1.50)		(-2.18)	
Limited liability company	0.31586	***	0.63761	***	0.68000		1.07198	
	(-2.92)		(-3.63)		(-1.41)		(0.59)	
Partnership	0.57705		0.30040	***	0.40800	***	0.48777	***
	(-1.46)		(-10.05)		(-2.88)		(-5.61)	
Cooperative and association	0.21719	***	0.37077	***	1.15297		0.23688	***
	(-3.93)		(-4.88)		(0.34)		(-5.51)	
Ownership structure								
Number of large shareholders	0.49372	***	0.59314	***	0.70077	***	0.61561	***
	(-4.31)		(-13.81)		(-5.46)		(-14.13)	
Foreign ownership	0.26721		0.65407	***	1.11949		0.72559	***
	(-1.50)		(-4.38)		(0.42)		(-3.45)	
Central state ownership	0.60589		1.15372		0.46422		0.83468	
	(-0.54)		(0.56)		(-0.73)		(-0.75)	
Regional state ownership	0.08240	***	0.06516	***	0.01180	***		
	(-33.37)		(-2.70)		(-92.10)			
Corporate governance								
Number of board directors	0.69168	***	0.79225	***	0.78992	***	0.78948	***
	(-5.65)		(-10.69)		(-5.18)		(-11.81)	
Number of board directors ^2	1.01213	***	1.00768	***	1.00516	***	1.00557	***
	(5.33)		(10.50)		(3.48)		(9.09)	
Number of auditors	1.23404		1.10532	*	0.83449	*	1.08044	
	(0.91)		(1.71)		(-1.67)		(1.38)	
Number of auditors ^2	0.94283		0.94627	***	1.00815		0.97338	***
	(-1.54)		(-5.08)		(0.42)		(-2.72)	
International audit firm	3.57816		1.35350	***	1.52793		1.37184	***
	(1.56)		(2.60)		(1.14)		(2.89)	
Firm performance								
ROA	1.00662		0.99131	***	0.99850		0.98977	***
	(0.40)		(-3.16)		(-0.25)		(-4.86)	
Profit margin	0.98066	*	0.99610		0.99484		0.99701	
	(-1.89)		(-1.19)		(-0.44)		(-0.98)	
Linkage with capital market								
Listed	0.01560	***	0.79632		0.93287		1.47126	
	(-75.04)		(-0.39)		(-0.07)		(0.53)	
Solvency ratio	0.98257	***	0.98983	***	0.98740	***	0.99360	***
	(-4.79)		(-11.22)		(-5.71)		(-7.82)	
Firm size and age								
Firm size	1.14678		1.10377	***	1.18421	***	1.04306	**
	(1.51)		(4.54)		(3.98)		(2.01)	
Firm age	1.00238		1.00081		0.98831		0.99226	**
	(0.18)		(0.42)		(-1.23)		(-2.20)	
Business organization								
Business network	0.79611	***	0.91617	**	0.99718		0.96134	*
	(-2.67)		(-2.27)		(-0.07)		(-1.94)	
Business diversification	0.96724	*	1.00968		0.98867		0.99761	
	(-1.72)		(1.44)		(-1.07)		(-0.39)	
Country-level fixed effects	Yes		Yes		Yes		Yes	
NACE division-level fixed effects	Yes		Yes		Yes		Yes	
N	1907		14561		3285		15211	
Log pseudolikelihood	-1004.21		-16920.30		-4095.62		-17829.15	
Wald test (χ^2)	17164.27	***	1647.76	***	11645.30	***	179950.27	***

Notes: This table contains results from a survival analysis using the Cox proportional hazards model. Regression coefficients are hazard ratios. N denotes the number of firms. Standard errors are computed using the Huber-White sandwich estimator. z-statistics are reported in parentheses beneath the hazard ratios. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.5. Estimations with different assumptions about distribution (without outliers)

Model	Table 3 Model	[1]	[2]	[3]	[4]	[5]	[6]
Assumption about survival distribution	Cox proportional hazards	Exponential	Weibull	Gompertz	Log-normal	Log-logistic	Generalized gamma
Legal form (default category: other legal forms)							
Joint-stock company	0.66711 ***	0.67015 ***	0.66284 ***	0.66936 ***	0.44322 ***	0.39704 ***	0.45066 ***
	(-5.13)	(-5.01)	(-4.98)	(-5.00)	(6.27)	(5.58)	(6.31)
Limited liability company	0.78725 ***	0.79392 ***	0.79180 ***	0.79387 ***	0.33715 ***	0.27079 ***	0.35513 ***
	(-3.05)	(-2.92)	(-2.86)	(-2.91)	(4.82)	(3.88)	(5.00)
Partnership	0.39025 ***	0.39085 ***	0.37829 ***	0.38939 ***	0.86381 ***	0.89786 ***	0.84069 ***
	(-11.52)	(-11.34)	(-11.24)	(-11.33)	(11.12)	(11.59)	(10.61)
Cooperative and association	0.35031 ***	0.35077 ***	0.34852 ***	0.35050 ***	0.96717 ***	0.90790 ***	0.97544 ***
	(-7.54)	(-7.47)	(-7.42)	(-7.46)	(9.04)	(7.98)	(9.17)
Ownership structure							
Number of large shareholders	0.61692 ***	0.61308 ***	0.60731 ***	0.61227 ***	0.42373 ***	0.42512 ***	0.42239 ***
	(-20.82)	(-20.74)	(-20.49)	(-20.73)	(23.44)	(21.00)	(23.89)
Foreign ownership	0.70510 ***	0.70176 ***	0.69577 ***	0.70094 ***	0.26275 ***	0.28793 ***	0.25177 ***
	(-5.35)	(-5.37)	(-5.43)	(-5.38)	(4.93)	(5.21)	(4.74)
Central state ownership	0.85205	0.85361	0.85135	0.85344	0.16581	0.13990	0.17000
	(-0.91)	(-0.90)	(-0.90)	(-0.90)	(1.30)	(0.98)	(1.37)
Regional state ownership	0.03594 ***	0.03584 ***	0.03560 ***	0.03574 ***	1.93590 ***	2.49887 ***	1.85062 ***
	(-3.31)	(-3.32)	(-3.32)	(-3.31)	(4.11)	(3.32)	(4.30)
Corporate governance							
Number of board directors	0.79527 ***	0.79395 ***	0.78913 ***	0.79334 ***	0.22197 ***	0.23748 ***	0.22644 ***
	(-16.50)	(-16.38)	(-16.34)	(-16.41)	(14.76)	(14.80)	(15.07)
Number of board directors ^2	1.00572 ***	1.00575 ***	1.00589 ***	1.00577 ***	-0.00680 ***	-0.00749 ***	-0.00729 ***
	(11.55)	(11.51)	(11.60)	(11.53)	(-7.59)	(-8.13)	(-7.83)
Number of auditors	1.06370 *	1.06541 *	1.06819 *	1.06580 *	-0.02372	-0.05570 *	-0.01543
	(1.65)	(1.68)	(1.70)	(1.68)	(-0.74)	(-1.74)	(-0.47)
Number of auditors ^2	0.96666 ***	0.96621 ***	0.96481 ***	0.96603 ***	0.02635 ***	0.03199 ***	0.02491 ***
	(-5.03)	(-5.04)	(-5.12)	(-5.05)	(4.47)	(5.43)	(4.16)
International audit firm	1.36540 ***	1.36497 ***	1.36653 ***	1.36508 ***	-0.35844 ***	-0.34668 ***	-0.36740 ***
	(3.94)	(3.90)	(3.83)	(3.89)	(-5.49)	(-5.09)	(-5.66)
Firm performance							
ROA	0.99188 ***	0.99178 ***	0.99152 ***	0.99175 ***	0.00660 ***	0.00718 ***	0.00633 ***
	(-5.04)	(-5.05)	(-5.07)	(-5.05)	(4.38)	(4.76)	(4.17)
Profit margin	0.99555 **	0.99549 **	0.99559 **	0.99550 **	0.00496 **	0.00474 **	0.00505 **
	(-2.07)	(-2.08)	(-1.98)	(-2.06)	(2.45)	(2.37)	(2.47)
Linkage with capital market							
Listed	0.94995	0.94802	0.95622	0.94896	-0.00433	0.00950	-0.00728
	(-0.13)	(-0.13)	(-0.11)	(-0.13)	(-0.01)	(0.03)	(-0.02)
Solvency ratio	0.99113 ***	0.99100 ***	0.99083 ***	0.99097 ***	0.00764 ***	0.00789 ***	0.00752 ***
	(-15.44)	(-15.48)	(-15.42)	(-15.46)	(15.09)	(15.72)	(14.62)
Firm size and age							
Firm size	1.07630 ***	1.07737 ***	1.08033 ***	1.07774 ***	-0.05918 ***	-0.06739 ***	-0.05708 ***
	(5.23)	(5.25)	(5.30)	(5.25)	(-4.91)	(-5.54)	(-4.72)
Firm age	0.99657 *	0.99655 *	0.99640 *	0.99654 *	0.00175	0.00233	0.00154
	(-1.74)	(-1.73)	(-1.76)	(-1.73)	(1.30)	(1.56)	(1.17)
Business organization							
Business network	0.94885 ***	0.94886 ***	0.94780 ***	0.94873 ***	0.05749 ***	0.05720 ***	0.05838 ***
	(-2.95)	(-2.91)	(-2.90)	(-2.90)	(4.04)	(3.65)	(4.15)
Business diversification	0.99990	1.00011	1.00017	1.00012	0.00303	0.00110	0.00362
	(-0.02)	(0.03)	(0.04)	(0.03)	(0.84)	(0.31)	(0.99)
Country-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	34964	34964	34964	34964	34964	34964	34964
Log pseudolikelihood	-44947.28	-	-15297.33	-15378.10	-15091.51	-15169.80	-15086.70
Wald test (χ^2)	30294.86 ***	10096.49 ***	8836.81 ***	9198.45 ***	6349.33 ***	5636.14 ***	4157.63 ***

Notes: This table contains results from a survival analysis using 6 parametric estimators for a robustness check. Models [1] to [3] report hazard ratios, while Models [4] to [6] report regression coefficients. N denotes the number of firms. Standard errors are computed using the Huber-White sandwich estimator. z-statistics are reported in parentheses. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.