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Institutions and determinants of firm survival in European emerging markets

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Executive Summary

We analyze the impact of institutional quality on firm survival in 15 European emerging markets over the period of 2006-2015. Our dataset comprises 79,591 companies from 15 countries in Central and Eastern Europe (CEE). Firms included in our dataset had to satisfy two conditions: (i) they were in business at the end of 2006 (i.e., before the global financial crisis), and (ii) they provided information about their survival status at the end of 2015. In terms of regional distribution, we work with firms from: (a) Central EU countries (36,743 obs.)—the Czech Republic, Hungary, Poland, and Slovakia; (b) Baltic countries (8,804 obs.)—Estonia, Latvia, and Lithuania; and (c) Balkan countries (34,044 obs.)—Bosnia, Bulgaria, Croatia, Macedonia, Moldova, Montenegro, Romania, and Serbia. Of these firms, we have 19,635 non-survivors.

Table 1. Estimation of the Cox proportional hazards model with alternative IQ variables

Institutional quality	Hazard ratios	Firm-level characteristics	NACE division-level fixed effects	*N*
Rule of law	0.8923***	Yes	Yes	79591
Democracy	0.8485***	Yes	Yes	79591
National governance	0.7009***	Yes	Yes	79591
Civil society	0.8656***	Yes	Yes	79591
Corruption control	0.7663***	Yes	Yes	79591
Banking reform	0.8976***	Yes	Yes	79591
Enterprise reform	0.8550***	Yes	Yes	79591

*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.*

Institutional quality is usually measured through some index. As no index captures all aspects of the quality of institutions, we utilized quite a wide range of institutional variables to control for legal system, democracy, national governance, corruption, and banking and enterprise reforms. As an alternative, we perform a principal component analysis to create a comprehensive institutional quality index formed from our seven measures of institutional quality. Table 1 shows the baseline results of these institutional variables and their impact on firm survival. The estimated coefficients are less than 1, which means that the institutional variable contributes to increased survival probability of firms in the countries included in the research sample. The effect of all these institutional variables is statistically significant, the size of the coefficient describes the economic significance, that is, the magnitude of the effect.

Moreover, our results show that institutional quality (IQ) is a significant preventive factor for firm survival, and it displays diminishing returns as its effect is largest for low-level IQ countries and smallest for high-level IQ countries.

In terms of specific indicators, the level of national governance and the extent of corruption control exhibit the key impacts. In terms of firm-specific controls, indicators of ownership structure and aggregate financial performance are the economically most significant factors associated with increased survival probability of firms in European emerging markets

Institutions and determinants of firm survival in European emerging markets

Eduard Baumöhl[a], Ichiro Iwasaki[b], Evžen Kočenda[c]

Abstract

We analyze the impact of institutional quality on firm survival in 15 European emerging markets. We employ the Cox proportional hazards model with a large dataset of firms during 2006–2015. Our results show that institutional quality (IQ) is a significant preventive factor for firm survival, and it displays diminishing returns as its effect is largest for low-level IQ countries and smallest for high-level IQ countries. In terms of specific indicators, the level of national governance and the extent of corruption control exhibit the key impacts. In terms of firm-specific controls, indicators of ownership structure and aggregate financial performance are the economically most significant factors associated with increased survival probability of firms in European emerging markets.

Keywords: firm survival, institutions, European emerging markets, survival and exit determinants, hazards model

JEL Classification: C14, D02, D22, G33

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1. Introduction

The quality of institutions has been empirically shown to affect economic growth (Hall and Jones, 1999; Acemoglu et al., 2001; Eicher and García-Peñalosa, 2006; Fagerberg and Srholec, 2008; Hasan et al., 2009) and, on a corporate level, institutions have been identified as impacting firm performance (Porter, 1998; Yasar et al., 2011; Faruq and Weidner, 2018; Ghoul et al., 2017; Fidrmuc et al. 2017). Despite the above evidence, the role of institutions has been largely neglected with respect to firm survival (Che et al., 2017). In this paper, we aim to bridge the gap in the empirical research in two ways. First, we contribute to the literature by analyzing how institutional quality affects firm survival probability while controlling for number of financial and other firm-specific characteristics. Second, we analyze firm survival in an under-researched region of European emerging markets where the varying level of institutions represents an important issue (Fan et al., 2011).

North (1993) argues that high-quality institutions are indispensable for economic growth as they facilitate efficient transactions among firms. Johnson et al. (2002) show that nature of property rights and availability of external finance represent distinct channels through which institutions affect firm economic outcomes. Desai et al. (2005) demonstrate that greater fairness and greater protection of property rights increase firm entry, reduce firm exit rates, and that these institutional factors are particularly important in lesser-developed markets. In this respect, Égert (2016) shows that better institutions positively affect firm productivity and that differences in productivity across countries can be explained, to a considerable extent, by cross-country variation in the overall quality of institutions. In terms of productivity, Dosi et al. (2017) show that productivity plays an important role in a firm's ability to survive. The above evidence provides a compelling background motivating our analysis of the nexus between institutions and firm survival.

We analyze firms in emerging European markets for two reasons. First, the impact of institutions on firm survival is likely to be even more important for firms in emerging markets, where the institutional quality is lower than in developed economies (Acemoglu et al., 2005). Second, 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 reform of supporting institutions (Aussenegg and Jelic, 2007; Kočenda and Hanousek, 2012a). Large numbers of new firms were entering the market at that time, and while firms' entry might be quite easy, their survival in the market was often difficult (McDermott, 2004). 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).

In our analysis, we adopted the following research strategy. To analyze the impact of institutions, we assemble a representative set of variables to capture institutional quality in countries under research. In doing so, we control for the extent of rule of law, degree of democracy, development of the civil society and national governance, level of corruption control, along with progress in banking and enterprise reforms; details on institution quality variables are provided in the Data section. With various measures of institutional quality, we can control for cross-country differences in country characteristics, as our sample of 15 CEE countries exhibits some heterogeneity in economic, social, and political features. As an alternative, we perform a principal component analysis to create a comprehensive institutional quality index formed from our seven measures of institutional quality. This step has two advantages: we can analyze the aggregate impact of institutions without omitting any particular institutional variable and avoid correlations existing among different institutional indices reported by Fidrmuc et al. (2017).

In our assessment, we further control for firm-specific and industry-level factors to effectively account for their impact on firm survival. This approach follows Goddard et al. (2009), who argue that firm-specific factors are most important in explaining variations in firm performance. Hence, we employ standard corporate finance variables to capture firm financial performance. We then employ a set of representative controls to account for legal form, ownership structure, corporate governance, and other firm-specific characteristics. The quantitative analysis is done based on the Cox proportional hazards model.

Due to the general lack of works linking institutions with firm survival, we have formulated our key hypotheses based on an analogy to the firm performance literature.[1] Since the quality of institutions is positively linked with productivity, which enhances firms' ability to survive, we expect that better institutions should enhance firms' survival chances. Further, based on the fundamental principle of decreasing marginal returns (Smith, 1950), we also hypothesize that in countries with better institutional quality, the contribution of institutions to firm survival should be smaller than in countries with institutions of lower quality. Finally,

[1] Analyses on the impact of institutions on firm survival are largely missing in the recent literature to the best of our knowledge. We are aware of the analyses of a positive link between property rights protection and firm survival (Che et al., 2017; Zhang et al., 2017) and of a negative link between government corruption and firm survival (Che et al., 2017). Both analyses are performed on data from Chinese firms, though.

we hypothesize potential effects of various firm-specific controls based on the relevant literature reviewed in Section 2.

In our contribution to the existing literature on firm survival we build and use an extensive database of 79,591 companies with their firm-level characteristics from 15 CEE countries. We assess the effect of institutions proxied by several relevant variables that reflect the quality of institutions in the CEE region; in addition, we control for financial performance and other relevant firm-specific factors. Apart from the baseline estimation of the Cox proportional hazards model, we have re-estimated our model on different country groups and different industries. We also account for legal origin, EU membership, differences in bankruptcy law and differences in accounting rules/standards. The main results show that institutional quality is an important factor positively affecting firm survival but that the effect exhibits decreasing marginal returns. Furthermore, we show that ownership structure and aggregate financial performance are key, economically significant factors that increase the probability of firm survival. These results are robust across indicators of institutional quality, country groups, industries, time periods, assumptions on survival distributions, and alternative estimators.

The remainder of the paper is organized as follows. In Section 2, we review the relevant literature and formulate our hypotheses. Section 3 describes the data and applied methodology. In Section 4, we bring forth extensive and detailed results. Section 5 is the conclusion.

2. Literature review

In Section 2, we perform two tasks. We review studies relevant to our analysis and, on its basis, we formulate the hypotheses that we will later test.

2.1 Institutions

Scarpetta et al. (2002) note that firm-level analyses on survival do not generally follow a unified or rigorous model, and until now, there does not exist one. However, firm-level survival analyses share common theoretical elements (Manjón-Antolín and Arauzo-Carod, 2008). First, "creative destruction" is important in determining survival and growth. Second, the set of control variables used in regressions belongs to standard categories in the theory of firms and markets. We follow the above standard in the literature plus add the variables of institutions.

We build the link between quality of institutions and firm survival on the following grounds. First, the idea of a country's institutional quality affecting the local business environment, competition, and firm profitability—and as a direct consequence, firm bankruptcy—is certainly not new. In one of his classic works, Porter (1998, p. 80) states:

"Businesses cannot operate efficiently under onerous regulatory red tape or under a court system that fails to resolve disputes quickly and fairly." Obviously, some aspects of the business environment (for example, the legal system) affect all industries. A closely related topic is corruption, which is widely believed to prevent poor countries from catching up to developed countries (De la Croix and Delavallade, 2009). Finally, economic freedom in general is a significant factor determining overall economic growth (Gwartney et al., 1999).

Further motivation is grounded in empirical evidence. Johnson et al. (2002) show that the nature of property rights and availability of external finance represent distinct channels through which institutions affect firm economic outcomes. Égert (2016) empirically shows that the quality of institutions positively affects productivity of firms in the OECD countries. More-productive firms are intuitively better suited to stay on the market than are less productive firms. This intuition is empirically supported by Dosi et al. (2017) who, based on U.S. firm data, demonstrate that productivity plays a key role in firms' ability to survive and that their productivity is even more important than their profitability. Desai et al. (2005) demonstrate that greater fairness and greater protection of property rights increase firm entry and reduce firm exit rates and that these institutional factors are particularly important in lesser-developed markets. Che et al. (2017) and Zhang et al. (2017) provide direct evidence that level of property rights protection positively affects survival of Chinese firms, while severity of government corruption demonstrates negative impact (Che et al. , 2017).

The above empirical links between institutions and firm survival can be further supplemented indirectly by evidence relevant specifically to the CEE countries under research. Hanousek and Kočenda (2014) show that geographical, cultural, and institutional factors affect trade in primary goods, parts and components, capital goods, and consumer goods among ten new EU members and old EU countries. Since their analysis was conducted on disaggregated data, the impact of institutional factors on firm performance, represented by their bilateral international trade, might be considered potentially impacting their ability to survive in the market as well. A similar analogy can be drawn from the empirical evidence presented in some other studies: Kafouros and Aliyev (2016) showed that domestic firms in 16 CEE economies benefit from improvements in institutional environments; Fidrmuc et al. (2017) showed that high institutional quality related to property rights and trade freedom reduces the share of assets tied up unproductively in the CEE firms; Kapounek (2017) showed that lending activity of private banks is increased by the level of globalization, freedom and openness in many countries, including those in the CEE region.

The above evidence forms the basis for our assessment of the quality of institutions as a determinant of firm survival. We will employ several comprehensive indices that capture various aspects of what we refer to as the "quality of institutions" (although we use this term in a broader sense). Our main research hypothesis is as follows: *The quality of institutions does not have a positive impact on firm survival.*

Institutional quality is usually measured through some index. As no index captures all aspects of the quality of institutions, we utilized quite a wide range of institutional variables to control for legal system, democracy, national governance, corruption, and banking and enterprise reforms. Table 1 contains definitions and descriptive statistics of the variables used in our empirical analysis.

Institutions are the rules of the game in societies that induce economic growth (North, 1990); as such, the quality of institutions is different in specific countries, and its impact on firm survival might differ as well. Acemoglu et al. (2005) also argued that institutions play a vital role in explaining differences in economic growth among countries. Hence, following Fan et al. (2011), we also focus on a possible unequal effect of institutional quality on firm survival in different countries based on differences in the existing levels of their institutional quality.

2.2 Firm-specific factors

In Table 1, we further listed our firm-specific controls. Table 1 shows that the limited liability company is the most numerous legal form of firm in our sample. Further we examine the joint-stock company, partnership and cooperative types; other corporate legal forms are less frequent and are grouped into one category. A firm's corporate legal form is quite likely to play a significant role in its survival, as confirmed by Harhoff et al. (1998), who found that German firms with limited liability have (as opposed to their counterparts with full liability) higher growth but also higher insolvency rates.

Apart from institutional quality and corporate legal form, we are interested in firms' ownership structure and corporate governance, which are both often neglected in the survival literature. Several studies have addressed the impact of ownership concentration on firm performance. However, as shown in a meta-analysis of 42 studies (Wang and Shailer, 2015), in emerging markets, the literature contains conflicting and inconclusive empirical results. In fact, there are two theoretical hypotheses that explain both a positive relationship between large shareholders and firm failure (the alignment hypothesis; see Shleifer and Vishny, 1986) and a negative relationship between large shareholders and firm failure (the expropriation hypothesis; see Claessens et al., 2000).

Within the ownership structure, we introduce two controls on state and foreign ownership. First, in emerging European markets, the state retained some control even after privatization programs were largely completed (Kočenda and Hanousek, 2012b). Furthermore, state ownership tended to be more prevalent in certain industrial sectors (e.g., energy). It is also plausible that states, with their implicit guarantee and/or for political reasons, prolong the existence of some strategic firms. Finally, in countries with weak institutions and/or poor investor protection, residual state ownership can enhance value in partially privatized firms by providing monitoring and protecting dispersed minority shareholders from exploitation by controlling private owners (Megginson, 2016). Second, with respect to the ownership structure, it has been well-documented (since the 1980s in the literature on industrial organization) how foreign direct investments affect market dynamics. Generally speaking, two outcomes are possible: (i) foreign ownership increases overall sector efficiency, causing less efficient domestic firms to exit, or (ii) a spillover effect transmits higher productivity to domestic firms, allowing them to survive even with increased competition (Franco and Gelübcke, 2015). Again, empirical findings are not that persuasive. For example, Taymaz and Özler (2007) found that foreign ownership does not significantly impact the survival of domestic firms. However, after the recent global financial crisis, Alfaro and Chen (2012) showed that foreign firms had better survival chances than their local counterfactuals with similar economic characteristics. However, this result does not hold in non-crisis periods. After the transition from central planning to market orientation, in economies such as those in our sample, we expect foreign ownership to increase the probability of firm survival.

Within the category of corporate governance, we will consider two main factors: the number of board directors and employment of an international audit firm. The composition of boards of directors has been studied extensively, since the agency theory explains why the separation of ownership and control can be an efficient form of economic organization (e.g., Fama, 1980). Early on, the literature did not offer full consensus on the relationship of the number of board directors and firm performance. Daily and Dalton (1994) confirmed that there are differences in proportions of affiliated directors between bankrupted and non-bankrupted firms. The extensive meta-analysis of Dalton et al. (1998) also showed evidence for a positive relationship between board size and performance. However, later empirical findings tell us a different story. Results of Boone et al. (2007) indicate that board size varies across firms and has a changing nature over time due to specific characteristics of individual firms. Coles et al. (2008) challenged the idea that one board size could possibly fit all firms. For example, small and large firms have dramatically different board structures (Linck et al., 2008).

The body of research on audit quality and its impact on firm performance increased significantly after the Enron-Andersen affair. Some indication that audit quality may have declined in the 1990s was provided by Francis (2004). After the financial crisis, Aldamen et al. (2012) found in a sample of US listed firms that a smaller (more experienced) audit committee is more likely to be positively associated with firm performance. Recent findings of Bajra and Čadež (2018) suggested that the formal existence of an audit committee in large EU listed firms is a necessary but not a sufficient condition for enhancing the quality of financial reporting. As noted by Fan et al. (2011, p. 207), "there are important organizational and behavioral differences between firms in emerging markets and those in developed ones." Thus, what holds true for large firms from developed markets (US, EU) might not necessarily be true for CEE countries. Further, Sucher and Kosmala-MacLullich (2004) raised a concern about the nature of auditors' independence in transitional economies.

Most research in the bankruptcy and firm survival literature focuses on financial and business variables (Kumar and Ravi, 2007). Although we are deviating from the mainstream literature by employing a wider set of possible firm survival determinants, we employ several standard financial control variables. Return on assets (ROA) and gross margin represent financial performance and are naturally key determinants with hypothesized positive effects on firm survival (Görg and Spaliara, 2014). Even though the CEE countries have particular characteristics specific to emerging markets, solvency, measured as a ratio of shareholders' funds to total assets, should be positively associated with firm survival (Guariglia et al., 2016). Linkage with capital market represents a firm's ability to access external funds and should have a positive impact on firm growth and survival (Musso and Schiavo, 2008).

The last two variables included in our models are firm size and age. A large body of empirical studies challenged Gibrat's Law (Gibrat, 1931), which assumed that firm growth is independent of its size. Geroski (1995) found that both firm size and age are positively related to firm survival, convincingly refuting Gibrat's Law. We may refer to this refutation as a "stylized result." However, Agarwal and Audretsch (2001) showed that this result contradicts the theory of strategic niches proposed by Porter (1979). They suggested that both views are actually correct, but firm survival depends on industry life cycle and its technology intensity. Therefore, even smaller firms could remain small and take advantage of their size in the mature phase of the life cycle and in high-tech industries. Results of Agarwal and Gort (2002) also indicated that small firms are positively related to hazard rates, as opposed to firm age. Finally, Klepper and Thompson (2006) state that larger and older firms fail less often, but they also

argue that the impact of age and size on a firm's exit may emerge due to other important determinants that were not included in an empirical specification in the first place.

Our review of the related literature is far from exhaustive.[2] One of our main conclusions is that conflicting results are common in the governance literature and in the literature on firm survival and bankruptcy. In our analysis, we aimed to present results relevant to firms in emerging markets and to eliminate some discrepancies with our comprehensive assessment.

3. Data and methodology

3.1 Data coverage

Our dataset comprises 79,591 companies from 15 countries in Central and Eastern Europe (CEE). Firms included in our dataset had to satisfy two conditions: (i) they were in business at the end of 2006 (i.e., before the global financial crisis), and (ii) they provided information about their survival status at the end of 2015. In terms of regional distribution, we work with firms from: (a) Central EU countries (36,743 obs.)—the Czech Republic, Hungary, Poland, and Slovakia; (b) Baltic countries (8,804 obs.)—Estonia, Latvia, and Lithuania; and (c) Balkan countries (34,044 obs.)—Bosnia, Bulgaria, Croatia, Macedonia, Moldova, Montenegro, Romania, and Serbia. Of these firms, we have 19,635 non-survivors. The number of failed firms in the analyzed period, along with the exit rate, is captured in Figure 1 with detailed counts for country groups, industries and years. We consider failed firms to be those with the explicit status of dormant/inactive,[3] in liquidation/bankruptcy, and/or dissolved. In addition, micro and small firms represent a minority in the dataset. Firms with 50 or more employees are represented by 51,302 observations, which is more than two-thirds of our sample. Firms with 25 or more employees are represented by 74,599 observations, which is approximately 94% of our sample. Hence, the effect of institutions is analyzed mainly on medium and large firms.

[Figure 1 here]

Figure 1. Number of failed firms and exit rate by region, industry, and year

The entire set of company-specific variables that can be considered firm survival determinants is extracted from the Bureau van Dijk's Orbis database; the main advantage of the

[2] For further reading, please see relevant reviews, such as Santarelli and Vivarelli (2007), and Manjón-Antolín and Arauzo-Carod (2008).

[3] Of the 19,635 failed firms, there are 1,574 dormant/inactive firms. These firms never re-emerged in the subsequent years and, thus, are not (i) "sleeping" and ready to be made firms or (ii) residual state firms that have been dissolved after privatization (and assigned bad loans and assets.) Hence, these dormant/inactive firms in the dataset can be truly regarded as non-survivors.

Orbis database is that it also retains data for inactive firms. Firm-specific variables cover various areas, from standard financial indicators to more subtle firm characteristics. They characterize firms from the perspective of their legal form (joint-stock company, limited liability company, partnership, or cooperative), ownership structure (number of large shareholders, foreign ownership, or state ownership), corporate governance (number of board directors, non-linear effect of number of board directors, and use of the international audit firm), firm financial performance (ROA, gross margin, and solvency ratio), linkage with capital market (listed company), firm size and age.[4]

We account for the diversity of firms in terms of their size and country of origin by employing market-adjusted values of their financial performance (ROA, gross margin, and solvency ratio), size and age, in the spirit of Barber and Lyon (1996). Adjustment is done in the form of the distance from industry median based on Eisenberg et al. (1998; p. 41), as the Barber and Lyon (1996) approach is primarily applicable towards the ROA. The definitions and descriptive statistics of all firm-level variables are provided in Table 1. Further, in Table A.7, we provide a correlation matrix to show that correlations between pairs of explanatory variables are low in general and that multicollinearity among explanatory variables does not hamper our results.

We further compile a set of several indices that capture various aspects of the institutional environment and institutional quality (IQ). The Rule of Law index published in the Worldwide Governance Indicators of the World Bank database captures perceptions of the extent to which agents have confidence in and abide by the rules of society, in particular, the quality of contract enforcement, property rights, the police, and the courts, and the likelihood of crime and violence (info.worldbank.org). The Rule of Law index provides a country's score on a scale of -2.5 to 2.5 and is commonly used to capture the degree of institutional quality across countries (Kočenda and Poghosyan, 2018). We also use four ratings obtained from the Freedom House (freedomhouse.org), section Nations in Transit, to capture progress and setbacks on: democracy, national governance, civil society, and corruption control. All ratings are based on a scale from 1 to 7, with 1 representing the highest and 7 the lowest level of progress in a specific area. The ratings follow a quarter-point scale and are assessed by the report authors, a panel of academic advisors, and a group of regional expert reviewers. As explained in the methodology section of the Freedom House, based on the conditions of democratic institutions in the different regime classifications, the continuous values of the ratings provide an inherent

[4] A limited number of observations to cover a sufficiently large number of firms precludes use of more financial indicators that can be used as proxies for asset structure, capital structure, and cash holdings. Nonetheless, we believe that the standard financial indicators we include in our analysis provide sufficient financial characteristic of firms.

meaning. Finally, we employ two additional indices from the European Bank for Reconstruction and Development (EBRD) to capture enterprise reform (EBRD index of enterprise reform) and banking reform (EBRD index of banking sector reform). Both indices are published as transition indicators on a scale of 1 to 4+, based on the judgment of the EBRD's Office of the Chief Economist about country-specific progress during transition.

All the above institutional quality variables are arbitrarily scaled—that is, they are ordinal measures. Since we work with three different scales, we normalize the indicators so that they provide comparable impact of the institutional quality independently of their original scale. Due to potential multicollinearity problems, we estimate our models with each IQ variable separately. However, we also include in our estimation a first principal component extracted from seven individual IQ variables. We call this synthetic IQ variable a "Comprehensive IQ index." Additional details and descriptive statistics are presented in Table 1.[5]

Finally, in addition to the above covariates, we gathered data to account for several systemic impacts that we cover in more detail later in Section 4.5, where we perform and report results of robustness checks.

Table 1. Definitions and descriptive statistics of variables used in the empirical analysis

[Table 1 here]

3.2 Cox proportional hazards model

We estimate the effects of various factors on firm survival with the Cox proportional hazards model (Cox, 1972). Its advantages are described following its formal introduction. The Cox proportional hazards model assumes that the hazard denoting the probability of an event (firm exiting the market) $h_0(t)$ depends on time t and a set of relevant covariates x_{in}:

$$h(t \mid x_{i1},\ldots,x_{in}) = h_0(t)\exp(\beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_n x_{in}) = h_0(t)\exp(\mathbf{x}^{\mathrm{T}}\boldsymbol{\beta}), \quad h_0(t) > 0, \tag{1}$$

[5] Other proxies capturing different aspects of institutional quality might be considered as well. The following studies employ, for example, the anti-self-dealing index (Djankov et al., 2008); the public enforcement indices (La Porta et al., 2006; Djankov et al., 2008); the insider trading rules index (Cumming et al., 2011; Cumming et al., 2015); the legal enforcement index (La Porta et al., 1998); and the disclosure index (La Porta et al., 1998). However, most of these studies do not cover transformation economies and do not provide the data for them. To mitigate the lack of data, we assessed an alternative data source with widely available country coverage. From the Political Risk Services International Country Risk Guide (PRS), we extracted the following six indices capturing additional angles of institutional quality: (1) Voice and Accountability (including Military in politics and Democratic accountability), (2) Political Stability and Absence of Violence (including Government stability, Internal conflict, External conflict, and Ethnic tensions), (3) Government Effectiveness (Bureaucratic quality), (4) Regulatory Quality (Investment profile), (5) Law and order, and (6) Control of Corruption. Correlations of the above indices with our comprehensive IQ index are as follows: 0.670 (1); 0.563 (2); 0.766 (3); 0.907 (4); -0.017 (5); and 0.698 (6). Apart from the Law and Order index (5), correlations among these proxies are high. This means that our comprehensive IQ variable is a good proxy for the overall institutional quality in our set of countries when compared to further relevant alternative measures of institutional quality. However, even the PRS data do not always cover all 15 CEE countries.

where β_1, β_2, …, and β_n are the parameters to be estimated. Specification (1) defines the hazard rate at time *t* for subject *i*, which depends on a vector of covariates ***x***. When we consider two observations, *i* and *í*, that differ in their covariates (values of x_i), with the following linear representation:

$$\eta_i = \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_n x_{in} \tag{2}$$

and

$$\eta_i' = \beta_1 x_{i1}' + \beta_2 x_{i2}' + \ldots + \beta_n x_{in}', \tag{3}$$

then the so-called hazard ratios for these two observations are defined as follows (note that they are independent of time *t*):

$$\frac{h_i(t)}{h_{i'}(t)} = \frac{h_0(t)\exp(\eta_i)}{h_0(t)\exp(\eta_{i'})} = \frac{\exp(\eta_i)}{\exp(\eta_{i'})}. \tag{4}$$

In the Cox model, the baseline hazard $h_0(t)$ depends only on time *t* and, thus, can take any form, while covariates enter the model linearly; further, this survival model bypasses the necessity of proxies to capture a risk of a firm failure that might preclude accurate comparison. For this reason, the Cox model is called a semi-parametric model. Compared to parametric models, the Cox model has an advantageous feature; regardless of how the survival time *T* is distributed, the results obtained from the estimation of the Cox model are robust (Iwasaki, 2014; p. 190). In comparison to the standard logit models, survival models allow for the probability of firm failure to vary over time. The above features form the ground for which the Cox model is the most commonly used technique in empirical firm survival studies (Manjón-Antolín and Arauzo-Carod, 2008) and allow for an easy comparison of our results to those in other studies.

Estimates of parameters β from (2) and (3) are obtained from the maximum likelihood estimation of the logarithmic transformation of specification (1), which is represented by the following linear model:

$$\ln h(t \mid x_{i1}, \ldots, x_{in}) = \ln h_0(t) + \sum_{j=1}^{n} b_j x_{ij} \ . \tag{5}$$

Our estimation strategy follows examples of approaches adopted by Esteve-Pérez et al. (2004), Taymaz and Özler (2007), Iwasaki (2014), or Che et al. (2017). In our results, we will present each parameter β in the form of a hazard ratio, due to its straightforward interpretation. A statistically significant hazard ratio indicates how the probability of a firm exiting the market is multiplied when a specific covariate *x* (e.g., a firm survival determinant in

the form of an independent variable) changes by one unit.[6] If an estimate is over 1, we may consider a determinant (covariate *x*) to be a risk factor, increasing the probability of firm exit. Similarly, if an estimate is below 1, such a determinant (covariate) is considered a preventive factor inhibiting a firm's exit from the market.

Statistically significant estimates below 1 are economically more significant preventive factors if they are further from 1; opposite applies to estimates larger than 1. A following example can serve as a useful illustration of the economic significance meaning. A statistically significant estimate of a hazard ratio denotes percent change in survival probability by a one-unit change of a covariate in question. If we have two estimates of hazard ratios (of two covariates) with values of 0.9 (covariate A) and 0.8 (covariate B), then a unit improvement in these covariates is linked to a 10% (covariate A) and 20% (covariate B) increase in probability of firm survival, respectively, because 1 – 0.9 = 0.1 and 1 – 0.8 = 0.2. Since covariate B is associated with higher survival probability, it is economically more significant than is covariate A.

We understand that an endogeneity issue may arise in the survival analysis under certain conditions (Liu, 2012): if (i) an independent variable is a future variable, (ii) the estimation period is very short, or (iii) the dependent variable is continuous. Under these circumstances, an instrumental variable (IV) method or a two-stage residual inclusion method (2SRI) should be applied (Liu, 2012; Carlin and Solid, 2014). However, as we showed earlier in this section, all independent variables in our analysis are predetermined, which rules out an endogeneity problem arising from simultaneity between dependent and independent variables (Iwasaki, 2014). Further, the estimation period of nine years covers sufficiently long time-span. Finally, the dependent variable is a discrete (binary) variable observed on a yearly basis. On the basis of the above arguments, our survival analysis is not subject to any of the three conditions articulated by Liu (2012). We also acknowledge that many variables that we use to measure institutional quality might be correlated with aggregate macroeconomic conditions or stage of a business cycle. To control for these possibilities, we analyze the effect of institutions over time by estimating the hazards model for several separate periods. In addition, we re-estimated the key version of the baseline model by employing the flexible parametric Accelerated Failure Time (AFT) and Competing Risk (CR) models. More details are provided in Section 4.5.

[6] Statistical significance of hazard ratios against zero is assessed by using the *z*-test as is common in extant literature on firm survival. When a hazard ratio is significant at the 5% level or less, the 95% confidence intervals of a hazard ratio do not include 1, and a hazard ratio is significantly different from 1.

4. Results

4.1 Effects of different measures of institutional quality

Our baseline model contains a full set of firm-specific variables (survival determinants) plus a variable to proxy for institutional quality (IQ); altogether, we have seven IQ proxies. In the first step, we estimate the identical baseline model with each IQ variable separately; the set of all firm-specific variables is also always included. In Table 2, we present the estimated hazard ratios for individual IQ variables to show how different aspects of the institutional environment affect firm survival chances. We do not present estimates for firm-specific variables at this stage; their hazard ratios are consistently similar across different IQ variables.

Results in Table 2 show that the level of national governance and the extent of corruption control exhibit the strongest effect among the IQ proxies. Recall that a (statistically significant estimate of) hazard ratio denotes percentage change in survival probability by one unit change of a covariate in question. For example, the hazard ratio of national governance is 0.7. In other words, a unit improvement in the level of a country's national governance is linked to a 30% increase in firm survival probability (1 – 0.70 = 0.30). Similarly, unit improvement in the extent of corruption control increases firm survival probability by approximately 23% (1 – 0.77 = 0.23). The higher the percentage figure is, the greater the economic effect or economic significance of a specific variable.

The rest of the alternative IQ measures—rule of law, enterprise reform, level of democracy, civil society, and banking reform—are somewhat less economically significant but can also be decisively considered preventive factors lowering the probability of a firm's exit. In many studies, the level of legal protection of private property represents a key aspect of institutional quality (North, 1990; Acemoglu et al., 2001; Besley and Ghatak, 2009). In our case, the Rule of Law Index is an economically significant preventive factor for firm survival. The finding also correlates with the importance of property rights with respect to firm survival in China (Zhang et al., 2017).

Table 2. Estimation of the Cox proportional hazards model with specific IQ variables

[Table 2 here]

As all institutional quality (IQ) variables are highly correlated, we construct a comprehensive IQ index from all seven IQ variables to gauge the aggregate effect of institutions on firm survival. First, we perform a principle component analysis to capture the potential structure behind institutional quality. Its results are presented in Table A.1. All IQ variables exhibit similar

eigenvector values. Furthermore, the results of the principal component analysis show that the first component alone explains more than 92 percent of all variance among the seven IQ variables. Hence, we can confidently say that the first component is a suitable proxy for the aggregate IQ level in countries under research.

We estimate our baseline model with the comprehensive IQ variable, along with all firm-level controls, and present the results in Table 3. At first, we discuss several outcomes related to IQ impact. In the next section, we discuss implications related to firm-specific variables. The estimated hazard ratio associated with the comprehensive IQ variable is 0.95 (column [2] in Table 3), which means that the aggregate effect of institutions decisively helps to lower a firm's exit probability. This aggregate result is consistent with a general argument that institutional quality is mirrored in the level of legal protection of private property (North, 1990; Acemoglu et al., 2001; Besley and Ghatak, 2009) and with specific results of Che et al. (2017) or Zhang et al. (2017), who show a positive effect of property rights protection on firm survival in China.

We re-estimate the baseline model with country fixed effects (and without the IQ index); results are reported in column [1]. When compared to the results reported in column [2] (with the IQ index), we see that the effect of firm-specific variables only slightly differs across both specifications. However, the coefficient associated with the IQ index shows that the level of aggregate institutional quality improves firm survival chances on top of the firm-specific determinants. In this respect, we conclude that the institutional quality measures contain more information than do country unobservables hidden in the fixed effects.

Further, we re-estimate the baseline model to account for the effect of EU membership. Some of the sample countries are not EU members. However, the EU requires certain institutional reforms as entry criteria. Additionally, the EU prevents states intervening (i.e., subsidizing) on behalf of failed firms. It is therefore plausible that firms in some of the non-EU member countries could survive longer despite weaker institutional quality. An alternative argument could be that firms from EU member countries benefit from the EU membership economically (e.g., access to the EU market or receiving more (foreign) investment) and are therefore more likely to survive longer. The effect of the EU membership is reported in column [3], and the EU membership alone can be seen as a preventive factor. However, when EU membership is controlled for, together with the institutional quality (column [4]), its effect becomes statistically insignificant, but the institutional quality is still linked to improved survival probability. The same estimation for non-EU members reveals that firms from outside the EU face a higher probability of exit (column [5]). Finally, we perform additional check and assess the effect of an interaction term between the comprehensive IQ index and the EU dummy

variable (IQ*EU). A significant hazard ratio (0.72208) indicates potential existence of a synergy effect between institutional quality and EU membership on firm survival.

4.2 Effects of firm-specific variables

The corporate legal form of a company appears to be an economically significant preventive factor. The effect should not be overstated, though. Each firm has to be established and function in a specific legal form. Hence, survival probability should be assessed primarily from the perspective of how each legal form enables to deal with profits and losses. In this respect, limited liability and cooperative forms are consequently associated with somewhat higher survival probability than joint-stock company form. This finding is consistent with previous research shown in Esteve-Pérez and Mañez-Castillejo (2008).

With respect to ownership structure, large shareholders and foreign shareholders decrease the probability of firm failure by 9% (coefficient 0.91) and 40% (coefficient 0.60), respectively. On the other hand, the effect of state ownership is statistically insignificant. First, the number of large shareholders characterizes the concentration of control in a firm. In Table 1, we show that, on average, firms are controlled by more than two large shareholders or a pair of blockholders. It seems that less concentrated control improves firm survival probability (and not control in hands of a single dominant shareholder); the result correlates well with similar findings related to firm efficiency and shown in Hanousek et al (2015). Second, the results might imply that foreign ownership increases overall sector efficiency, as suggested by Franco and Gelübcke (2015), because survival probability of foreign owned firms increases.[7] These results are in line with the findings of Alfaro and Chen (2012) but contradict those of Taymaz and Özler (2007).

In terms of corporate governance, larger boards of directors exhibit positive effect, albeit the economic impact is low. The effect is not straightforward, though. Since the squared term of the number of board directors is slightly over 1, the relationship between this variable and probability of firm survival appears to have an inverted U-shaped pattern. As a result, the probability of exit for firms with larger boards is low, but it increases to reach a peak and eventually prompts an increase in the probability of failure as the board grows larger. The findings are robust with respect to board size as the Orbis database reports the board size even

[7] Although, it should be noted, that the same factors affecting firm survival may affect foreign investors' choice to invest in the firms. The self-selection makes determination of causation between survival and foreign investment more difficult: do firms survive longer because of foreign investors or do foreign investors choose firms with higher probability of the survival? In our empirical setting we are not able to rule out this self-selection bias. However, we believe the former is the case, as Hanousek et al. (2015) show that foreign majority owners improve firm efficiency; and more efficient firms are likely to have better survival chances.

for micro and small firms (including zero directors); thus, all observations with missing information on board size were excluded from our analysis.

Further, from a corporate governance perspective, using an international audit firm increases the probability of the firm's exit. This result might come as a surprise at first glance because international auditors are often associated with superior services. However, the international auditors' market in most of the 15 CEE countries is monopolized by the Big Four auditing firms.[8] Recent empirical evidence suggests that Big Four auditors do not necessarily provide higher quality audits, as these audits depend to a large extent on client characteristics (Lawrence et al., 2011). However, the negative impact has a more down-to-earth explanation that is grounded in current auditing standards and practices. International auditors are used to perform audits of the financial statements in firms according to the International Financial Reporting Standards (IFRS), which are dominated by a sense of caution and discretion; the IFRS are issued by the IFRS Foundation and the International Accounting Standards Board (IASB). Based on the set of the International Standards on Auditing (ISA), the auditors accentuate that accounting units (firms) include all risks in their financial statements (according to ISA 315 and ISA 330) that could affect the ability of a firm to continue its operation (i.e., going concern basis according to ISA 560).[9] In doing so, the auditors press the firms to create reserves and provisions without regard to whether they are tax-deductible. Such reserves and provisions are substantially higher than firms considered needed in the past. Thus, the auditors require presentation of the financial statements in a fair and truthful manner that is not affected by external factors. In effect, application of the accounting estimates, including fair value accounting estimates, and related disclosures in an audit of financial statements (according to the ISA 540) lead to the requirement not to overvalue the assets and not to undervalue the liabilities. Ultimately, strict application of the standards leads to a decrease in the financial performance of firms, and such financial performance is even lower in firms that are in a worse economic position in the first place. We acknowledge that there might also be other factors at work. However, we believe that a legitimate application of the IFRS by international audit firms might effectively result in lowering the survival chances of the (internationally audited) firms.

Three financial performance indicators (ROA, gross margin, and solvency ratio) are consistently linked to improved probability of firm survival. Moreover, when we assess coefficients associated with these determinants jointly, then such aggregate financial

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

[9] When preparing financial statements, management shall make an assessment of an entity's ability to continue as a going concern unless management either intends to liquidate the entity or to cease trading, or has no realistic alternative but to do so. For details, see International Accounting Standard 1: Presentation of Financial Statements (IAS 1), adopted by the IASB.

performance exhibits larger impact than does that of corporate governance. Individually, solvency ratio is linked to a 6% improvement in survival probability, which is higher than ROA (4%) and profit margin (3%). The result is intuitively correct since higher solvency ratio indicates higher ability of self-financing. Hence, a firm's lower dependence on debt and its financial stability in the long run are likely more important factors with respect to firm survival than is strictly profit-making strategy (indicated via profit-linked indicators). These results are consistent with previous evidence brought, for example, by Görg and Spaliara (2014), Musso and Schiavo (2008), and Guariglia et al. (2016).

Whether a firm is listed on a stock exchange is shown to be an indicator lowering survival probability. The fact that being listed is a risk factor might be due to some specific conditions in the countries under research. During the transformation process from centrally planned to market-oriented economies, national stock exchanges ended up with excessively large numbers of listed firms as a result of mass privatization schemes. Thus, emerging stock markets in the CEE region contain firms that are not necessarily the most efficient and profitable ones. In the worst case, firms might even be subject to asset stripping, documented previously by Johnson et al. (2000), when firm managers, investment funds as owners, and other majority shareholders expropriate resources of the companies at the expense of other (minority) shareholders. Moreover, as Iwasaki (2014) noted, the recent global financial crisis caused severe damage to listed and bond-issuing companies through a significant capital crunch and/or unrealized losses on assets. Clearly, none of the above conditions promotes firm survival.

Firm size is a risk factor for firm survival, although with a negligible economic effect (a hazard ratio only slightly over the threshold of 1). Firm size is usually considered a preventive factor (e.g., Geroski, 1995, 2010). This observation is intuitively straightforward, as it is expected that larger firms have lower hazard rates of exiting than do smaller firms (Klepper and Thomson, 2006). Nevertheless, markets in the CEE region are still quite distinct from those of developed countries. The obtained result might well resonate with such specifics, since our finding is indirectly supported by Hanousek et al. (2015), who show that larger EU firms can be associated with less efficiency in general. In addition, Kosová and Lafontaine (2010) show that survival of franchised chains decreases with the chain size. Although their result is not directly comparable with ours, it demonstrates that a negative effect of size on firm survival is not entirely implausible.

Finally, firm age can be associated with improved survival probability. The effect is consistent with earlier findings (Geroski, 1995; Klepper and Thompson, 2006), and its magnitude is in a similar range as that of corporate finance indicators.

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

[Table 3 here]

4.3 Differences in institutional quality and firm survival

The group of 15 CEE countries in our sample exhibits some degree of heterogeneity in terms of their economic and political development. The differences among countries also apply to the institutional environment. In Table A.2, we present the values of employed IQ variables that illustrate the institutional quality differences among countries. These differences are summarized by the values of the comprehensive IQ index introduced in Section 4.1.

Based on the comprehensive IQ index, we divided 15 CEE countries into three country groups according to their comprehensive IQ index levels: high (Czech Republic, Estonia, Hungary, Latvia, and Slovakia), mid-level (Bulgaria, Croatia, Lithuania, Poland, and Romania), and low (Bosnia, Macedonia, Moldova, Montenegro, and Serbia). Grouping the countries based on institutional quality indirectly accounts for potential differences in internal factors (tax system, etc.) among countries, as those with a similar level of institutional quality are expected to exhibit a similar level of development of various internal factors. We then re-estimate the Cox model for each country group and present our results in Table 4. Again, we see that the quality of the institutional environment is a factor that is associated with improving a firm's chances of survival. Hence, evidence presented in Tables 3 and 4 enables us to reject our key hypothesis, as the institutions are shown to be a contributing factor to firm survival.

We can go even further in our inferences based on the values of the coefficients associated with the comprehensive IQ indicator. It is evident that the economic significance of institutions is highest in countries with a low quality of institutions, where a marginal increase in IQ has a strong impact on firm survival. In contrast, in countries with a high IQ, a marginal increase in IQ causes a much smaller effect. Thus, estimation results indicate the presence of diminishing returns from improvement in country-level IQ. The result carries a strong implication: since the effect of institutions on firm survival visibly changes with the level of institutional quality, the effort to refine institutions brings more fruit to developing economies than to developed ones.

Finally, when we compare the results presented in Table 3, the effect of firm-specific control variables remains, in principle, the same. Ownership structure plays a vital role in strengthening the probability of firm survival. Foreign ownership significantly helps firms to survive in all three country groups, although the effect is larger for low- and middle-IQ countries; the impact of state ownership is, again, statistically insignificant. Other statistically significant preventive factors that remained unchanged from our baseline estimation are the number of board directors (its squared term is still slightly higher than 1), ROA, gross margin, solvency ratio, and firm age. Firm size is still a risk factor, but its economic significance is less than negligible. Exceptions, where the effect of control variables differs across groups of countries and with respect to Table 3, are covariates: joint-stock companies, cooperatives, international audit firms, and listed companies. However, these few exceptions are not materially important.

Table 4. Estimation of the Cox proportional hazards model by the level of institutional quality

[Table 4 here]

4.4 Breakdown of firm survival by industry

As argued by Audretsch and Mahmood (1995), business survival rates may vary across industries. For this reason, we estimate our baseline model irrespective of the country in which a firm operates but instead for different industries. According to NACE Rev. 2 classification we form four groups: agriculture, forestry, and fishing (Section A); mining and manufacturing (Sections B–E); construction (Section F); and services (Sections G–S). Estimation results are available in Table 5.

First, our comprehensive IQ index is statistically significant for all industries except services. In agricultural industries, it became an even much more economically significant preventive factor, as opposed to our previous results.

All other results remained practically the same, although some variables are now not statistically significant, preventing us from drawing some general conclusions. This point is true even for industries that are well-represented in our sample, i.e., with more than 30,000 observations (Sections B–E and Sections G–S). Ownership structure and corporate governance factors still appear to lower the probability of firm exit. The same holds for the ROA, gross margin, and solvency ratio. As in the previous results, firm size or whether a firm is listed does not improve survival probability.

Table 5. Estimation of the Cox proportional hazards model in different industries

[Table 5 here]

4.5 Robustness checks

To verify the validity of our results, we performed various robustness checks. Some can be drawn from previous subsections, while others are based on new estimations. In Table 2, we report results of the Cox proportional hazards model with alternative measures of institutional quality and show that the results are robust with respect to different IQ indicators. Furthermore, because of the variety of IQ variables, we constructed a synthetic IQ indicator and showed that the beneficial impact of institutions is robust with respect to the level of the institutional environment in different country groups (Table 4) and across different industries (Table 5). The country grouping is robust with respect to individual IQ variables because the comprehensive IQ indicator is highly correlated with individual IQ variables, and country ranking remains stable irrespective of differences in individual IQ variables. More details are provided in Table A.2.

In Table 2, we further show that the impact of firm survival determinants is robust across both EU and non-EU members. On the other hand, EU membership improves firm survival probability, while non-EU membership decreases it. However, when EU membership is controlled for together with institutional quality, its effect becomes statistically insignificant.

Apart from the EU membership, there are other country-specific factors for which we control. One is potential differences in accounting rules/standards. The differences in the accounting systems exist because accounting practices tend to reflect the particular legal and cultural environment in which they are developed (Alexander et al., 2007). Differences in the emerging European markets can be traced along the geopolitical lines that form the groups of the Central European, Balkan, and Baltic countries. With the economic and integration process, the countries in our sample gradually adopted reporting practices in accord with the international financial reporting standards (IFRS). As of now the IRFS are used for large companies in all countries in our sample and are even adhered to by large numbers of small companies. Nevertheless, we account in two ways for potential differences in accounting rules/standards that were still present around the financial crisis when our sample begins. First, the differences are to an extent captured by country fixed effects (Table 2). Second, we form three additional country groups as discussed above. In Table A.3 (columns [1]–[3]), we report that the impact of institutional quality differs slightly depending on the country grouping. The key observation is that in Balkan countries, institutional quality helps to improve

survival probability more than in Central Europe or Baltic groups where accounting rules at the beginning of our research period were closer to the standards in continental Europe. However, potential differences in accounting rules/standards do not affect the impact of covariates, as the results for firm-specific controls remain the same.

Other factor reported to be important in the finance and law literature (La Porta et al., 1998; Beck et al., 2003; Djankov et al., 2008) is a legal origin (German, French, and Scandinavian civil law). Our sample contains post-transition countries that after recovery from the wreckage of socialist law reverted to the legal system in place before 1945. Similarly to Aussenegg et al. (2018), we follow the La Porta et al. (1998) classification of legal origin. We gathered the data (from Andrei Shleifers's webpage: https://scholar.harvard.edu/files/shleifer/files/data_for_web.xls) and control for either German or French legal origin in the set of our countries (there is no country with Scandinavian legal origin). In Table A.3 (columns [4]–[5]), we report that the impact of institutional quality differs slightly depending on the legal origin. In countries with French legal origin, institutional quality helps to improve survival chances somewhat more than in countries with German legal origin. Results for firm-specific variables remain practically the same (not reported but available upon the request).

We also account for differences in the bankruptcy laws. The bankruptcy or insolvency laws were passed in the early 1990s, and they were often soon amended as demanded by economic development during the transformation process. No specific bankruptcy models were suggested for CEE nations, though. Rather, countries created varying bankruptcy codes with respect to the type of privatization schemes adopted (Gerlach, 1998). Because of the strong ties of the bankruptcy law to privatization, the bankruptcy law has been instrumental for the development of legal structures needed for the support of market economies in the CEE countries (Bufford, 1996). Currently, the EU insolvency regime is binding on all EU member states, but national legislation concerning insolvency proceedings remains different across the EU members (Lastra, 2011). Therefore, we control for existing differences in bankruptcy laws based on the time-varying data on "time to resolve insolvency" (in years) from the World Bank's Doing Business project (http://www.doingbusiness.org/). Differences in design and enforcement of the bankruptcy laws might potentially affect survival of firms in different countries, but in Table A.3 (column [6]), we show that, in our case, such an effect is statistically insignificant.

Further, many variables that we use to measure institutional quality might be correlated with aggregate macroeconomic conditions or stage of a business cycle. To control for the economic development over time, we re-estimated the Cox proportional hazards model for

different periods, for which we also adjusted the number of analyzed (failed and survived) firms. We opted for this direct approach, instead of using an additional control (e.g., GDP p.c.), (i) to keep our model parsimonious and (ii) to provide direct results on the effect of institutions over time. Although in the crisis period, our comprehensive IQ index was not statistically significant, our results show that the effect of the institutions does not importantly vary with period analyzed (Table A.4). The effect of the firm-specific controls is largely also time-invariant.

As another robustness check, we explore whether institutions affect firms differently by age and size and estimate the Cox model by firm size (larger versus smaller) and by firm age (older versus younger). The results are reported in Table A.5 and show that our findings are robust against differences in firm size and age. These results also imply that smaller and younger firms are not more exposed to the detrimental effects of weak institutions. With respect to other determinants, employing an international audit firm and firm size are still risk factors, although only for larger and/or older firms.

In terms of methodology, we also re-estimated the key version of the baseline model by employing the Accelerated Failure Time (AFT) and Competing Risk (CR) models, as these models recently penetrated the finance literature (see, e.g., Giot and Schwienbacher, 2007; Hammer et al., 2017). In our study, right censoring occurs when the firm's failure is not observable within the sample period. The above models control for this (using weights) and allow censored observations to enter the regression. We report results in Table A.5. The coefficients from the Cox hazard model and those from the AFT and CR models are not directly comparable. However, based on the coefficient values and signs, we report that all three models deliver qualitatively similar results.

We also re-estimated the Cox hazards model with different assumptions on survival distribution, including the exponential, Weibull, and Gompertz distributions. The results are presented in Table A.6 and show that the effect of the institutions is invariant with respect to assumptions of survival distribution. This point is also largely true in terms of firm-specific controls.

Finally, we have in our dataset 3,129 observations of the firms in financial services (sector K), which is less than 4% of the sample. These firms usually have links to a differently structured balance sheet. As a robustness check, we eliminated these firms from our empirical analysis, but there were no material changes in the estimation results.

5. Concluding remarks

We analyzed the effects of institutional quality on firm survival. We employed the Cox proportional hazards model on a large sample of 79,591 companies from 15 countries in Central and Eastern Europe (CEE) during 2006–2015. Furthermore, we employed an extensive set of firm-specific characteristics as controls, accounted for country-specific differences, and performed a number of robustness checks. Overall, our results are robust with respect to institutional quality indicators, country groups, industries, time periods, assumptions on survival distributions, and alternative estimators.

Assessment of the firm-specific controls brings interesting outcomes. Foreign ownership and ownership structure with several shareholders (i.e. less concentrated control) are the factors with the most significant economic impact on survival probability. Standard corporate finance indicators (ROA, gross margin, and solvency ratio) exhibit also positive and weighty joint impact of their aggregate financial performance, which is in line with earlier evidence. While older firms exhibit higher survival probability, their size appears to be a risk factor, although its economic effect is less than negligible. The corporate legal form and whether the firm is listed provide mixed results, depending on the country group and individual industries. In sum, we show that indicators of ownership structure and aggregate financial performance are the economically most significant factors that are linked to increased survival probability of firms in European emerging markets.

Further, we bring evidence that institutions and their quality play an important role as a preventive factor helping firms improve their probability of survival. In terms of specific indicators, the level of national governance and the extent of corruption control represent the key institutional impacts on firm survival. Other measures—rule of law, enterprise and banking reforms, civil society, and democracy—also decisively affect firm survival, but their impact is smaller.

In addition, we created a synthetic comprehensive indicator of institutional quality based on the principal component analysis of individual institutional measures and assessed the effect of institutions on groups of countries with different levels of institutional quality. We show that the economic significance of institutions is highest in countries with the lowest quality of institutions. Estimation results clearly indicate that returns from improving institutions diminish as the quality of institutions increases. Consequently, the greatest benefits can be expected for firms in those emerging European markets that lag the most in terms of their institutions' development.

A hypothetical question emerges: what happens to firm survival if the institutions in an emerging European market become close to those in a mature European economy? To answer

such economic question, we would need to collect new data after some time elapses and institutional quality across Europe converges. Based on discovered existence of diminishing returns we might conjecture that the role of institutions should still be positive. However, as their quality improves other economic, financial, legal and governance factors should be expected to lead the way.

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Table 1. Definitions and descriptive statistics of variables used in the empirical analysis

Variable name	Definition	Descriptive statistics		
		Mean	S.D.	Median
Rule of law	Normalized 2006 value of the World Governance Indicator of the rule of law	0.345	0.756	0.512
Democracy	Adjusted and normalized 2006 value of the Freedom House index of democracy [a]	0.437	0.645	0.846
National governance	Adjusted and normalized 2006 value of the Freedom House index of national democracy governance [a]	0.357	0.546	0.227
Civil society	Adjusted and normalized 2006 value of the Freedom House index of civil society [a]	0.522	0.731	0.868
Corruption control	Adjusted and normalized 2006 value of the Freedom House index of corruption [a]	0.496	0.541	0.402
Banking reform	Normalized 2006 value of the EBRD index of banking sector reform	0.341	0.795	0.598
Enterprise reform	Normalized 2006 value of the EBRD index of enterprise reform	0.418	0.777	0.291
Comprehensive IQ index	First principal component score of the seven above IQ variables	2.797	1.962	3.658
EU member states	Dummy variable for countries that joined the EU in 2004 and 2007	0.852	0.355	1
Time to resolve insolvency	Normalized 2006 value of the World Bank Indicator of the time to resolve insolvency	0.537	1.302	0.055
Joint-stock company	Dummy variable for open joint-stock companies	0.137	0.344	0
Limited liability company	Dummy variable for limited liability companies	0.470	0.499	0
Partnership	Dummy variable for partnerships	0.268	0.443	0
Cooperative	Dummy variable for cooperatives	0.076	0.265	0
Other legal forms (default category)	Dummy variable for companies with a corporate form other than listed above	0.050	0.217	0
Number of large shareholders	Total number of dominant and block shareholders	2.302	10.225	1
Foreign ownership	Dummy for ultimate ownership of foreign investors	0.084	0.278	0
State ownership	Dummy for ultimate ownership of the state	0.026	0.158	0
Number of board directors	Number of recorded members of the board of directors	2.551	2.704	2
International audit firm	Dummy for firms that employ an international audit firm as external auditor	0.034	0.180	0
ROA	Return on total assets (%) [b, c]	0.378	3.264	0.200
Gross margin	Gross margin (%) [c, d]	0.459	2.739	0.831
Solvency ratio	Solvency ratio (%) [c, e]	0.648	4.816	2.057
Listed companies	Dummy variable for listed companies	0.053	0.224	0
Firm size	Natural logarithm of total assets in euros [c]	3.849	0.944	3.863
Firm age	Years in operation [c]	0.830	2.502	1.414

Note: [a] Computed by 7 minus the value of the original index, which ranges between 1.00 (best) and 7.00 (worst). [b] Computed using the following formula: (profit before tax / total assets) × 100. [c] Industry-adjusted value based on the method proposed by Eisenberg et al. (1998). [d] Computed using the following formula: (gross profit / operating revenue) × 100
[e] Computed using the following formula: (shareholder funds / total assets) × 100. Source: Country-level data from Rule of Law to Enterprise Reform were obtained from the website of World Bank, Freedom House, and EBRD (http://info.worldbank.org/governance/wgi; https://freedomhouse.org/; http://www.ebrd.com/home). Firm-level raw data were extracted from the Bureau van Dijk's Orbis database.

Table 2. Estimation of the Cox proportional hazards model with alternative IQ variables

Institutional quality	Hazard ratios	Firm-level characteristics	NACE division-level fixed effects	*N*
Rule of law	0.8923***	Yes	Yes	79591
Democracy	0.8485***	Yes	Yes	79591
National governance	0.7009***	Yes	Yes	79591
Civil society	0.8656***	Yes	Yes	79591
Corruption control	0.7663***	Yes	Yes	79591
Banking reform	0.8976***	Yes	Yes	79591
Enterprise reform	0.8550***	Yes	Yes	79591

*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.*

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

Model	[1]	[2]	[3]	[4]	[5]
Target industry (NACE Rev. 2 classification)	All industries (Sections A–S)				
Target country	All 15 CEE countries				
Institutional quality					
Comprehensive IQ index		0.95085 ***		0.97264 ***	
		(-5.59)		(-2.91)	
EU membership					
EU member states			0.78490 ***	1.01021	
			(-5.59)	(0.39)	
Non-EU member states					1.27405 ***
					(-5.59)
Legal form (default category: other legal forms)					
Joint-stock company	0.85715 ***	0.86888 **	0.79575 ***	0.86369 ***	0.79575 ***
	(-7.69)	(-2.53)	(-7.61)	(-7.33)	(-7.61)
Limited liability company	0.71912 ***	0.70828 ***	0.71826 ***	0.72265 ***	0.71826 ***
	(-12.63)	(-6.21)	(-12.70)	(-12.42)	(-12.70)
Partnership	1.07912	1.04690	1.07798	1.06972	1.07798
	(1.46)	(1.06)	(1.44)	(1.30)	(1.44)
Cooperative	0.74499 **	0.68824 ***	0.64151 **	0.62124 **	0.64151 **
	(-2.43)	(-5.77)	(-2.34)	(-2.03)	(-2.34)
Ownership structure					
Number of large shareholders	0.91650 ***	0.90827 ***	0.91635 ***	0.91591 ***	0.91635 ***
	(-3.57)	(-3.74)	(-3.55)	(-3.56)	(-3.55)
Foreign ownership	0.60537 ***	0.59459 ***	0.60512 ***	0.60056 ***	0.60512 ***
	(-14.11)	(-14.50)	(-14.13)	(-14.30)	(-14.13)
State ownership	1.00733	1.00454	1.00703	1.00972	1.00703
	(0.03)	(0.06)	(0.46)	(0.07)	(0.46)
Corporate governance					
Number of board directors	0.99044 ***	0.91357 ***	0.99049 ***	0.99223 ***	0.99049 ***
	(-11.80)	(-14.96)	(-11.78)	(-11.43)	(-11.78)
Number of board directors ^{2}	1.00028 ***	1.00094 ***	1.00028 ***	1.00026 ***	1.00028 ***
	(10.19)	(12.07)	(14.16)	(12.84)	(14.16)
International audit firm	1.15652 *	1.14513 **	1.25488 *	1.16804 *	1.25488 *
	(1.81)	(2.33)	(1.83)	(1.78)	(1.83)
Firm performance					
ROA	0.96132 ***	0.96382 ***	0.96131 ***	0.96149 ***	0.96131 ***
	(-7.46)	(-6.90)	(-7.45)	(-7.43)	(-7.45)
Gross margin	0.97262 ***	0.96113 ***	0.97250 ***	0.97143 ***	0.97250 ***
	(-4.51)	(-6.42)	(-4.53)	(-4.71)	(-4.53)
Solvency ratio	0.93489 ***	0.94299 ***	0.93490 ***	0.93548 ***	0.93490 ***
	(-33.01)	(-27.93)	(-32.98)	(-32.41)	(-32.98)
Linkage with capital market					
Listed	1.25067 ***	1.44011 ***	1.25879 ***	1.20812 **	1.25879 ***
	(3.05)	(4.62)	(2.86)	(2.36)	(2.86)
Firm size and age					
Firm size	1.09142 ***	1.01417 ***	1.09162 ***	1.09337 **	1.09162 ***
	(3.51)	(4.88)	(3.35)	(2.55)	(3.35)
Firm age	0.92654 ***	0.95316 ***	0.92660 ***	0.92758 ***	0.92660 ***
	(-20.33)	(-11.96)	(-20.29)	(-19.90)	(-20.29)
Country-level fixed effects	Yes	No	No	No	No
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes
N	79571	79571	79571	79571	79571
Log pseudolikelihood	-172396.30	-170694.42	-170694.42	-172392.01	-170694.42
Wald test (χ^2)	7445.67 ***	9516.39 ***	9516.39 ***	7491.83 ***	9516.39 ***

*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z statistics are reported in parentheses beneath the regression coefficients. 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. Estimation of the Cox proportional hazards model by level of institutional quality

Model	[1]		[2]		[3]	
Target industry (NACE Rev. 2 classification)	All industries (Sections A–S)					
Target country	High IQ countries [a]		Middle IQ countries [b]		Low IQ countries [c]	
Institutional quality						
Comprehensive IQ index	0.95020	*	0.70221	***	0.64251	**
	(-1.84)		(-7.01)		(-2.64)	
Legal form (default category: other legal forms)						
Joint-stock company	0.54917	***	0.98983		1.83425	***
	(-7.86)		(-0.08)		(3.58)	
Limited liability company	0.53339	***	0.94176		0.75843	*
	(-8.18)		(-0.65)		(-1.83)	
Partnership	0.25344	***	0.81339	**	0.26100	***
	(-18.17)		(-2.41)		(-8.15)	
Cooperative	0.35812	***	1.18286	*	0.70306	
	(-6.48)		(1.85)		(-1.00)	
Ownership structure						
Number of large shareholders	0.79724	***	0.79681	***	0.99839	
	(-11.98)		(-10.28)		(-0.97)	
Foreign ownership	0.71676	***	0.56404	***	0.52380	***
	(-5.26)		(-12.49)		(-4.15)	
State ownership	0.88691		1.02824		1.00866	
	(-0.32)		(0.31)		(0.04)	
Corporate governance						
Number of board directors	0.84860	***	0.96970	*	0.95909	*
	(-14.39)		(-1.83)		(-1.73)	
Number of board directors ^{2}	1.00157	***	1.00998	**	1.00140	
	(13.20)		(2.10)		(0.90)	
International audit firm	0.89747	*	1.83834	***	0.46118	
	(-1.66)		(7.13)		(-1.10)	
Firm performance						
ROA	0.95575	***	0.96259	***	0.88735	***
	(-4.50)		(-5.55)		(-5.36)	
Gross margin	0.96123	***	0.98475	*	0.96546	**
	(-3.14)		(-1.90)		(-2.05)	
Solvency ratio	0.94300	***	0.94476	***	0.94858	***
	(-16.39)		(-20.34)		(-7.64)	
Linkage with capital market						
Listed	1.61106		1.26858	***	0.46762	***
	(1.58)		(3.09)		(-7.08)	
Firm size and age						
Firm size	1.01541	***	1.00793	**	1.03278	***
	(2.79)		(2.18)		(3.26)	
Firm age	0.97565	***	0.94084	***	0.96711	***
	(-3.28)		(-11.93)		(-3.12)	
NACE division-level fixed effects	Yes		Yes		Yes	
N	27996		43582		7993	
Log pseudolikelihood	-52865.31		-93334.68		-9869.07	
Wald test (χ^2)	16593.56	***	6000.80	***	93323.77	***

*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z statistics are reported in parentheses beneath the regression coefficients. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.*

[a] *Czech Republic, Estonia, Hungary, Latvia, Slovakia*

[b] *Bulgaria, Croatia, Lithuania, Poland, Romania*

[c] *Bosnia, Macedonia, Moldova, Montenegro, Serbia*

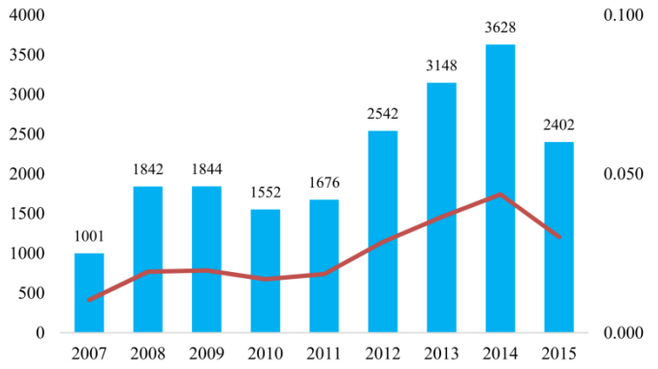
Table 5. Estimation of the Cox proportional hazards model in different industries

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)
Institutional quality				
Comprehensive IQ index	0.80957 ***	0.93944 ***	0.92263 ***	0.99860
	(-3.63)	(-4.80)	(-2.73)	(-0.10)
Legal form (default category: other legal forms)				
Joint-stock company	0.24814 ***	1.03635	1.02766	0.85011 *
	(-6.75)	(0.39)	(0.14)	(-1.89)
Limited liability company	0.25061 ***	0.72162 ***	0.76251	0.82513 **
	(-6.19)	(-3.75)	(-1.42)	(-2.29)
Partnership	0.17243 ***	0.44320 ***	0.67296 *	0.47847 ***
	(-7.94)	(-8.57)	(-1.77)	(-8.96)
Cooperative	0.28739 ***	0.71847 ***	1.10618	0.71192 ***
	(-5.57)	(-3.13)	(0.40)	(-3.53)
Ownership structure				
Number of large shareholders	0.96982	0.89879 ***	0.96667	0.87577 ***
	(-0.86)	(-4.65)	(-0.46)	(-3.60)
Foreign ownership	0.67308	0.51537 ***	0.68165 ***	0.67768 ***
	(-1.31)	(-12.08)	(-2.67)	(-7.64)
State ownership	2.25143 ***	1.03232	0.77481	0.86391
	(2.83)	(0.27)	(-0.72)	(-1.17)
Corporate governance				
Number of board directors	0.85280 ***	0.90771 ***	0.90477 ***	0.89488 ***
	(-5.00)	(-9.91)	(-4.41)	(-11.42)
Number of board directors ^{2}	1.00331 ***	1.00251 ***	1.00274 ***	1.00109 ***
	(4.84)	(9.13)	(2.88)	(11.65)
International audit firm	1.70613	1.20937 **	0.84360	1.12912
	(0.70)	(2.13)	(-0.72)	(1.47)
Firm performance				
ROA	1.01242	0.96912 ***	0.96044 ***	0.94707 ***
	(0.28)	(-3.31)	(-2.87)	(-7.17)
Gross margin	0.88094 ***	0.94581 ***	0.98183	0.98749
	(-3.34)	(-5.53)	(-1.00)	(-1.37)
Solvency ratio	0.96127 ***	0.93821 ***	0.93008 ***	0.95225 ***
	(-2.78)	(-19.68)	(-11.87)	(-14.83)
Linkage with capital market				
Listed	1.23514	1.36338 ***	0.89291	1.83722 ***
	(0.66)	(3.70)	(-0.46)	(4.87)
Firm size and age				
Firm size	1.01685	1.00196	1.03053 ***	1.02022 ***
	(0.85)	(0.45)	(4.20)	(4.15)
Firm age	0.90720 ***	0.97627 ***	0.94057 ***	0.93388 ***
	(-3.74)	(-4.00)	(-5.96)	(-10.84)
NACE division-level fixed effects	Yes	Yes	Yes	Yes
N	3327	31555	9889	34800
Log pseudolikelihood	-3120.83	-59944.71	-23954.42	-65511.45
Wald test (χ^2)	36212.00 ***	3829.54 ***	18148.44 ***	3750.81 ***

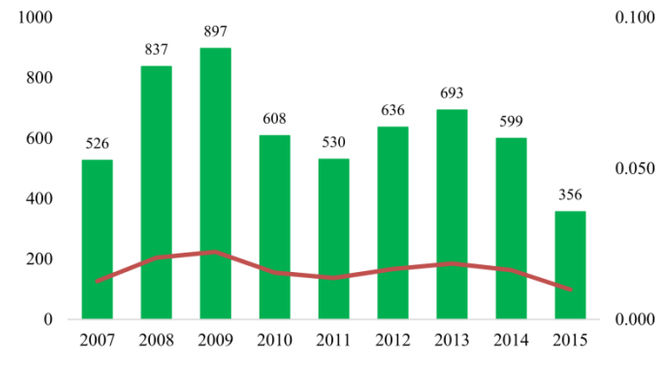
*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z statistics are reported in parentheses beneath the regression coefficients. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.*

Figure 1. Number of failed firms by region, industry, and year

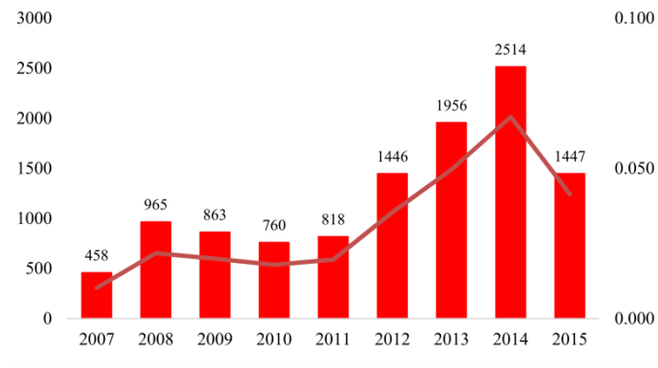
(a) All 15 CEE countries



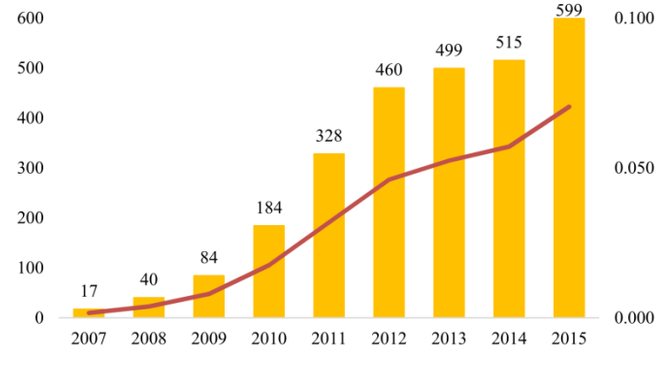
(b) Central European states



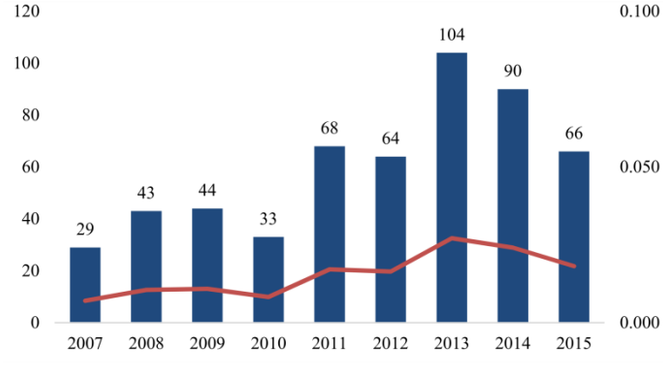
(c) Balkan states



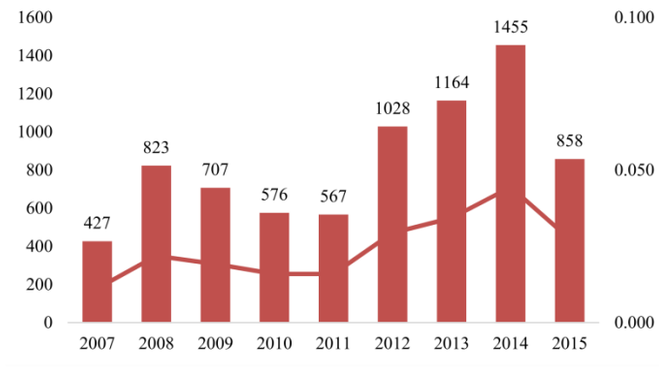
(d) Baltic states



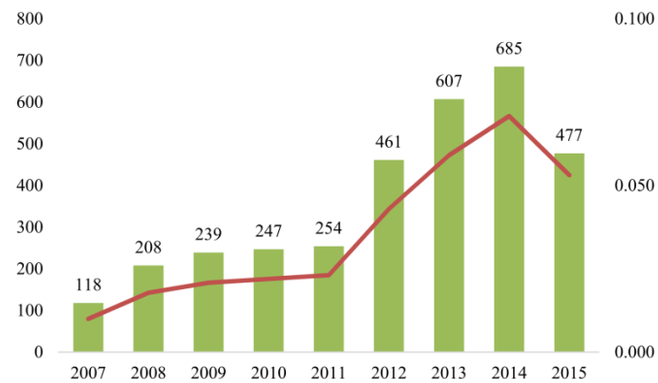
(e) Agriculture, forestry, and fishing (Section A)



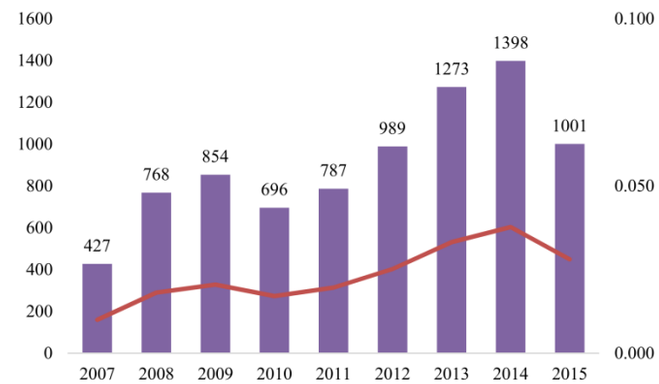
(f) Mining and manufacturing (Sections B–E)



(g) Construction (Section F)



(h) Services (Sections G–S)



Number of failed firms (left axis)

Exit rate (right axis)

Appendix

Table A.1. Estimation results of principal component analysis of the IQ variables

Eigenvalue of the correlation matrix				Eigenvectors of the first component	
Component no.	Eigenvalue	Difference	Cumulative percentage of total variance	Variables	Eigenvector
1	6.4675	6.247	92.39%	Rule of law	0.3872
2	0.2208	0.062	95.55%	Democracy	0.3909
3	0.1589	0.082	97.82%	National governance	0.3787
4	0.0767	0.037	98.91%	Civil society	0.3711
5	0.0397	0.010	99.48%	Corruption control	0.3802
6	0.0298	0.023	99.91%	Banking reform	0.3649
7	0.0065	-	100.00%	Enterprise reform	0.3720

Table A.2. Country score and correlation matrix of IQ variables

(a) Country score

Country	Rule of law	Democracy	National governance	Civil society	Corruption control	Banking reform	Enterprise reform	Comprehensive IQ index
Bosnia	-1.126	-1.062	-1.332	-1.467	-0.269	-1.234	-1.415	-1.712
Bulgaria	-0.461	0.157	0.313	-0.191	0.235	0.480	-0.315	1.988
Croatia	-0.297	-0.755	-0.157	-0.510	-0.772	0.994	0.157	1.326
Czech Republic	1.133	0.835	0.313	1.085	0.487	0.994	0.629	4.354
Estonia	1.576	1.143	1.019	0.447	1.494	0.994	1.258	5.228
Hungary	1.339	0.952	1.019	1.085	0.990	0.994	1.258	5.256
Latvia	0.797	1.026	1.254	0.766	0.990	0.994	0.157	4.523
Lithuania	0.875	0.793	0.784	0.766	-0.017	0.480	0.157	3.658
Macedonia	-1.186	-0.829	-0.392	-1.148	-0.772	-1.234	-0.315	-0.701
Moldova	-1.165	-2.037	-2.272	-1.786	-2.031	-1.234	-1.415	-3.388
Montenegro	-0.754	-0.945	-1.097	-0.829	-1.527	-1.234	-1.415	-1.479
Poland	0.360	0.719	0.078	1.085	0.990	0.480	1.258	4.139
Romania	-0.502	-0.267	-0.157	0.128	-0.017	-0.720	-0.315	1.143
Serbia	-1.185	-0.680	-0.392	-0.510	-0.520	-1.234	-0.944	-0.452
Slovakia	0.595	0.952	1.019	1.085	0.738	0.480	1.258	4.670

(b) Correlation

	Rule of law	Democracy	National governance	Civil society	Corruption control	Banking reform	Enterprise reform	Comprehensive IQ index
Rule of law	1.000							
Democracy	0.905	1.000						
National governance	0.762	0.841	1.000					
Civil society	0.848	0.912	0.677	1.000				
Corruption control	0.732	0.885	0.688	0.807	1.000			
Banking reform	0.840	0.798	0.728	0.669	0.634	1.000		
Enterprise reform	0.813	0.840	0.627	0.880	0.838	0.744	1.000	
Comprehensive IQ index	0.938	0.975	0.829	0.925	0.872	0.861	0.916	1.000

Table A.3. Determinants of firm survival: different country groups and legal origin

Model	[1]	[2]	[3]	[4]	[5]	[6]
Target industry (NACE Rev. 2	All industries (Sections A–S)					
Target country	Central Europe	Balkan states	Baltic states	German legal-origin	French legal-origin	All 15 CEE countries
Institutional quality						
Comprehensive IQ index	0.86224 *	0.73761 ***	0.90012 *	0.96462 ***	0.85790 ***	
	(-1.69)	(-3.10)	(-1.80)	(-3.81)	(-4.32)	
Time to resolve insolvency						0.93781
						(-1.36)
Legal form (default category: other						
Joint-stock company	0.54757 ***	2.00321 ***	2.17547 ***	0.88795 *	1.23911	0.90553 **
	(-8.69)	(5.56)	(2.85)	(-1.88)	(1.20)	(-2.48)
Limited liability company	0.57479 ***	0.80394 **	1.57963 *	0.71971 ***	0.76609 **	0.74346 ***
	(-7.86)	(-2.27)	(1.78)	(-5.10)	(-2.31)	(-4.33)
Partnership	0.88201	1.08093	1.18096	1.40337 *	1.54336	0.44433 ***
	(-1.50)	(0.80)	(0.20)	(1.82)	(0.33)	(-11.99)
Cooperative	0.30706 ***	1.51996 ***	0.69225	0.72880 ***	0.71343 *	0.68653 ***
	(-8.88)	(4.04)	(-0.70)	(-3.86)	(-1.89)	(-4.77)
Ownership structure						
Number of large shareholders	0.77924 ***	0.95248 *	0.66415 ***	0.96586 *	0.77079 ***	0.95661 *
	(-11.61)	(-1.86)	(-10.16)	(-1.82)	(-9.31)	(-1.66)
Foreign ownership	0.70122 ***	0.53787 ***	0.56666 ***	0.63568 ***	0.55967 ***	0.55874 ***
	(-5.67)	(-13.23)	(-4.52)	(-8.89)	(-11.30)	(-12.83)
State ownership	0.52126 ***	1.28024 **	0.24325	0.59586 ***	1.52482 ***	0.75979 ***
	(-3.87)	(2.55)	(-1.34)	(-4.20)	(3.58)	(-2.82)
Corporate governance						
Number of board directors	0.86102 ***	0.95788 ***	0.84199 ***	0.88320 ***	0.94314 **	0.90450 ***
	(-13.03)	(-3.44)	(-8.01)	(-15.56)	(-2.40)	(-13.78)
Number of board directors ^{2}	1.00148 ***	1.00032	1.00211 ***	1.00127 ***	1.00957 ***	1.00102 ***
	(12.73)	(0.41)	(6.92)	(13.99)	(3.06)	(12.13)
International audit firm	1.41971 ***	1.18856	0.76757 **	1.21189 ***	0.72113 *	1.24442 ***
	(4.83)	(0.58)	(-2.36)	(3.08)	(-1.79)	(3.35)
Firm performance						
ROA	0.95371 ***	0.96573 ***	0.95459 ***	0.95354 ***	0.96352 ***	0.93580 ***
	(-4.26)	(-5.04)	(-3.32)	(-6.23)	(-4.95)	(-8.89)
Gross margin	0.96012 ***	0.96315 ***	0.99573	0.94704 ***	0.99254 *	0.96594 ***
	(-2.91)	(-4.89)	(-0.25)	(-6.36)	(-1.84)	(-4.51)
Solvency ratio	0.94829 ***	0.94464 ***	0.93237 ***	0.94394 ***	0.94385 ***	0.94552 ***
	(-14.71)	(-19.91)	(-11.50)	(-20.73)	(-18.15)	(-20.36)
Linkage with capital market						
Listed	1.27398	0.83346 **	17.91804 ***	1.40549 **	1.15459 *	1.24776 **
	(0.79)	(-2.07)	(6.31)	(2.28)	(1.64)	(2.13)
Firm size and age						
Firm size	1.00882	1.01801 ***	1.02898 ***	1.02346 ***	1.00635	1.08070 ***
	(1.49)	(4.82)	(3.67)	(5.27)	(1.62)	(5.42)
Firm age	0.97764 ***	0.94123 ***	0.96157 ***	0.97306 ***	0.92185 ***	0.97549 ***
	(-3.02)	(-11.91)	(-3.45)	(-5.19)	(-13.28)	(-4.77)
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	36734	34034	8803	53104	25932	79571
Log pseudolikelihood	-48238.26	-87180.26	-19279.39	-88336.91	-70805.23	-170694.42
Wald test (χ^2)	3813.27 ***	22057.53 ***	85343.76 ***	31669.44 ***	29297.46 ***	9516.39 ***

*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z statistics are reported in parentheses beneath the regression coefficients. 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. Estimation of the Cox proportional hazards model in different periods

Model	[1]	[2]	[3]	[4]	[5]	[6]
Estimation period	2007–2008	2007–2010	2007–2013	2009–2010	2011–2013	2014–2015
Institutional quality						
Comprehensive IQ index	1.01195	0.98920	0.97365 ***	0.96502 *	0.96526 **	0.86728 ***
	(0.56)	(-0.77)	(-2.62)	(-1.89)	(-2.40)	(-7.57)
Legal form (default category: other legal forms)						
Joint-stock company	0.36283 ***	0.50557 ***	0.72697 ***	0.77747 **	1.08336	2.05500 ***
	(-9.81)	(-8.85)	(-5.31)	(-2.20)	(0.82)	(5.42)
Limited liability company	0.55590 ***	0.64626 ***	0.63438 ***	0.82324 *	0.86147 *	1.49389 ***
	(-5.89)	(-5.95)	(-8.13)	(-1.79)	(-1.67)	(3.00)
Partnership	0.14321 ***	0.25881 ***	0.37102 ***	0.50385 ***	0.69729 ***	1.10292
	(-18.46)	(-17.68)	(-16.63)	(-5.94)	(-3.74)	(0.76)
Cooperative	0.29054 ***	0.41888 ***	0.56310 ***	0.61892 ***	0.88321	1.55765 ***
	(-9.52)	(-8.98)	(-8.08)	(-3.30)	(-1.15)	(3.17)
Ownership structure						
Number of large shareholders	0.39776 ***	0.51342 ***	0.83765 ***	0.61689 ***	0.97378 **	0.97919
	(-19.17)	(-18.22)	(-9.39)	(-9.83)	(-2.45)	(-0.68)
Foreign ownership	0.38418 ***	0.51384 ***	0.62584 ***	0.62639 ***	0.78510 ***	0.54385 ***
	(-7.04)	(-8.74)	(-10.77)	(-5.12)	(-4.59)	(-9.98)
State ownership	0.36614 ***	0.63837 ***	0.98015	0.90959	1.36206 ***	1.01353
	(-2.94)	(-2.62)	(-0.21)	(-0.47)	(2.62)	(0.10)
Corporate governance						
Number of board directors	0.78856 ***	0.80219 ***	0.89140 ***	0.81604 ***	0.95054 ***	0.95450 ***
	(-10.35)	(-15.05)	(-14.83)	(-10.87)	(-5.92)	(-4.69)
Number of board directors ^{2}	1.00228 ***	1.00205 ***	1.00111 ***	1.00183 ***	1.00057 ***	1.00063 ***
	(10.83)	(13.39)	(12.61)	(9.80)	(6.94)	(3.93)
International audit firm	1.71306 ***	1.54874 ***	1.24125 ***	1.45034 ***	0.94844	0.89818
	(4.19)	(4.76)	(3.21)	(3.07)	(-0.54)	(-0.99)
Firm performance						
ROA	0.96453 **	0.96392 ***	0.96801 ***	0.96471 ***	0.97673 ***	0.95575 ***
	(-2.42)	(-3.79)	(-4.99)	(-2.84)	(-2.71)	(-4.96)
Gross margin	0.96316 **	0.96154 ***	0.95513 ***	0.96023 ***	0.95130 ***	0.97272 ***
	(-2.11)	(-3.39)	(-6.01)	(-2.69)	(-4.93)	(-2.66)
Solvency ratio	0.95825 ***	0.95547 ***	0.94368 ***	0.95412 ***	0.93641 ***	0.94211 ***
	(-7.66)	(-12.25)	(-22.66)	(-9.45)	(-18.90)	(-16.30)
Linkage with capital market						
Listed	1.67681 **	1.41993 **	1.33984 ***	1.18463	1.11176	1.55589 ***
	(2.23)	(2.29)	(3.79)	(0.84)	(1.14)	(4.00)
Firm size and age						
Firm size	0.99168	0.98394 ***	1.00062	0.97738 ***	1.01342 ***	1.04466 ***
	(-1.11)	(-3.18)	(0.18)	(-3.33)	(2.78)	(8.53)
Firm age	0.93038 ***	0.91877 ***	0.94411 ***	0.91169 ***	0.96451 ***	0.97067 ***
	(-6.77)	(-11.59)	(-11.71)	(-9.42)	(-5.55)	(-4.28)
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	79571	79571	79571	77398	74706	68817
Log pseudolikelihood	-22418.79	-51466.11	-116899.49	-28755.42	-63810.90	-52796.20
Wald test (χ^2)	471833.69 ***	709776.83 ***	6061.90 ***	878717.87 ***	148440.93 ***	4750.89 ***

*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Models [4], [5], and [6] show estimates without the observations of failed firms before the period in question.*

Table A.5. Estimation of the Cox proportional hazards model by firm size and age

Model	[1]		[2]		[3]		[4]	
Target industry (NACE Rev. 2 classification)	All industries (Sections A–S)							
Target firms	Larger firms [a]		Smaller firms [b]		Older firms [c]		Younger firms [d]	
Institutional quality								
Comprehensive IQ index	0.94782	***	0.96093	**	0.96454	***	0.95126	***
	(-4.89)		(-2.37)		(-3.19)		(-3.19)	
Legal form (default category: other legal forms)								
Joint-stock company	0.93659		0.81529	*	0.86476	**	0.82664	
	(-0.96)		(-1.89)		(-2.28)		(-1.47)	
Limited liability company	0.76608	***	0.66753	***	0.69216	***	0.76251	**
	(-3.86)		(-4.03)		(-5.79)		(-2.16)	
Partnership	0.45811	***	0.37792	***	0.39541	***	0.61794	***
	(-11.33)		(-8.90)		(-14.32)		(-3.55)	
Cooperative	0.70210	***	0.58925	***	0.59641	***	1.10500	
	(-4.44)		(-4.65)		(-6.99)		(0.67)	
Ownership structure								
Number of large shareholders	0.95999		0.76645	***	0.94269	**	0.80511	***
	(-1.62)		(-7.99)		(-2.32)		(-3.83)	
Foreign ownership	0.56690	***	0.65304	***	0.63690	***	0.56435	***
	(-12.52)		(-7.17)		(-9.06)		(-10.67)	
State ownership	0.74418	***	2.33214	***	1.04018		0.79476	*
	(-3.05)		(5.65)		(0.41)		(-1.64)	
Corporate governance								
Number of board directors	0.90523	***	0.92186	***	0.91444	***	0.90327	***
	(-13.81)		(-5.72)		(-12.20)		(-8.95)	
Number of board directors [2]	1.00100	***	1.00263	***	1.00102	***	1.00103	***
	(11.89)		(4.06)		(6.87)		(9.80)	
International audit firm	1.27371	***	0.84697		1.25238	***	0.86600	
	(3.74)		(-1.11)		(3.19)		(-1.30)	
Firm performance								
ROA	0.93530	***	0.96979	***	0.94361	***	0.97587	***
	(-8.59)		(-3.92)		(-7.76)		(-3.20)	
Gross margin	0.96124	***	0.98554		0.95979	***	0.97076	***
	(-5.08)		(-1.41)		(-4.90)		(-3.28)	
Solvency ratio	0.94605	***	0.94108	***	0.93677	***	0.95762	***
	(-20.04)		(-18.83)		(-24.89)		(-12.50)	
Linkage with capital market								
Listed	1.20753	*	1.54743	***	1.21574	**	1.73839	***
	(1.89)		(4.05)		(2.14)		(3.33)	
Firm size and age								
Firm size	1.02012	***	0.99357		1.02411	***	0.99952	
	(3.13)		(-0.84)		(6.11)		(-0.11)	
Firm age	0.98187	***	0.91466	***	1.00603		0.89988	***
	(-3.51)		(-14.41)		(0.80)		(-5.29)	
NACE division-level fixed effects	Yes		Yes		Yes		Yes	
N	49227		30344		55867		23704	
Log pseudolikelihood	-89381.27		-70023.37		-99235.22		-60550.67	
Wald test (χ^2)	5765.34	***	18609.75	***	5883.70	***	3215.52	***

*Note: Regression coefficients are hazard ratios. Standard errors are computed using the Huber-White sandwich estimator. z statistics are reported in parentheses beneath the regression coefficients. The Wald test examines the null hypothesis that all coefficients are zero. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.*

[a] *Estimation using observations with firms, size of which is 7.224 or more*

[b] *Estimation using observations with firms, size of which is less than 7.224*

[c] *Estimation using observations with firms, age of which is 9 years or more*

[d] *Estimation using observations with firms, age of which is less than 9 years*

Table A.6. Estimation of Cox model with different assumptions on survival distribution and AFT/CR models

Model	[1]	[2]	[3]	[4]	[5]
Estimator	Exponential survival model	Weibull survival model	Gompertz survival model	Accelerated failure time model	Competing risk model
Institutional quality					
Comprehensive IQ index	0.95108 ***	0.94906 ***	0.94884 ***	0.07279 ***	-0.05213 ***
	(-5.68)	(-5.69)	(-5.72)	(4.02)	(-5.68)
Legal form (default category: other legal forms)					
Joint-stock company	0.87971 **	0.87126 **	0.87724 **	0.05013	-0.13903 **
	(-2.39)	(-2.41)	(-2.31)	(1.37)	(-2.43)
Limited liability company	0.72043 ***	0.70868 ***	0.71359 ***	0.17720 ***	-0.34508 ***
	(-6.07)	(-6.03)	(-5.95)	(4.90)	(-6.05)
Partnership	0.45850 ***	0.44257 ***	0.44741 ***	0.44682 ***	-0.81627 ***
	(-14.20)	(-13.71)	(-13.69)	(11.08)	(-13.74)
Cooperative	0.70038 ***	0.69467 ***	0.70206 ***	0.17882 ***	-0.36637 ***
	(-5.70)	(-5.44)	(-5.33)	(4.13)	(-5.48)
Ownership structure					
Number of large shareholders	0.91179 ***	0.90175 ***	0.90242 ***	0.05973 ***	-0.10316 ***
	(-3.68)	(-3.87)	(-3.86)	(3.70)	(-3.86)
Foreign ownership	0.60042 ***	0.58352 ***	0.58431 ***	0.32180 ***	-0.53796 ***
	(-14.40)	(-14.71)	(-14.67)	(14.35)	(-14.71)
State ownership	1.00110	1.00032	1.00019	0.02414	0.00004
	(0.01)	(0.00)	(0.00)	(0.49)	(0.00)
Corporate governance					
Number of board directors	0.91597 ***	0.91161 ***	0.91204 ***	0.05427 ***	-0.09240 ***
	(-14.87)	(-14.90)	(-14.88)	(13.67)	(-14.91)
Number of board directors ^{2}	1.00091 ***	1.00097 ***	1.00096 ***	-0.00057 ***	0.00096 ***
	(11.91)	(12.29)	(12.33)	(-11.89)	(12.27)
International audit firm	1.14658 **	1.14099 **	1.13948 **	-0.07210 **	0.13238 **
	(2.39)	(2.22)	(2.21)	(-2.01)	(2.23)
Firm performance					
ROA	0.96478 ***	0.96251 ***	0.96271 ***	0.02143 ***	-0.03816 ***
	(-6.88)	(-6.95)	(-6.93)	(6.31)	(-6.95)
Gross margin	0.96183 ***	0.96043 ***	0.96042 ***	0.02400 ***	-0.04030 ***
	(-6.46)	(-6.34)	(-6.36)	(6.32)	(-6.34)
Solvency ratio	0.94419 ***	0.94137 ***	0.94142 ***	0.03569 ***	-0.06030 ***
	(-27.85)	(-28.02)	(-28.03)	(26.53)	(-28.01)
Linkage with capital market					
Listed	1.43353 ***	1.46515 ***	1.46493 ***	-0.21199 ***	0.38132 ***
	(4.61)	(4.76)	(4.75)	(-4.46)	(4.76)
Firm size and age					
Firm size	1.01479 ***	1.01506 ***	1.01540 ***	-0.00955 ***	0.01490 ***
	(5.21)	(5.02)	(5.14)	(-5.38)	(5.01)
Firm age	0.95477 ***	0.95196 ***	0.95228 ***	0.02840 ***	-0.04915 ***
	(-11.78)	(-11.91)	(-11.84)	(11.10)	(-11.92)
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes
N	79571	79571	79571	79571	79571
Log pseudolikelihood	-45074.37	-43239.56	-43736.54	-43221.91	-43212.65
Wald test (χ^2)	9996.48 ***	9354.91 ***	9342.09 ***	7968.87 ***	7634.74 ***

*Note: Standard errors are computed using the Huber-White sandwich estimator. z statistics are reported in parentheses beneath the regression coefficients. In the AFT model, estimated parameters quantify whether the survival time accelerates (if it is positive) or decelerates (if it is negative) for a one-unit change in the covariate values. In the CR model, the hazard of firm failure decreases with negative coefficients and increases with positive. 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.7. Correlation matrix of firm-level variables

	Joint-stock company	Limited liability company	Partnership	Cooperative	Number of large shareholders	Foreign ownership	State ownership	Number of board directors	International audit firm	ROA	Gross margin	Solvency ratio	Listed	Firm size	Firm age
Joint-stock company	1.000														
Limited liability company	-0.549	1.000													
Partnership	-0.172	-0.388	1.000												
Cooperative	-0.108	-0.243	-0.076	1.000											
Number of large shareholders	0.073	-0.034	-0.001	0.012	1.000										
Foreign ownership	-0.025	0.001	0.075	-0.009	0.004	1.000									
State ownership	0.057	-0.179	-0.075	-0.039	-0.011	-0.048	1.000								
Number of board directors	0.288	-0.276	0.005	0.178	0.152	0.078	0.060	1.000							
International audit firm	0.016	-0.008	0.009	-0.021	0.009	0.210	-0.003	0.105	1.000						
ROA	-0.053	0.077	0.037	-0.046	0.013	0.001	-0.041	-0.040	0.009	1.000					
Gross margin	-0.031	0.034	0.066	-0.026	0.022	0.027	-0.039	0.009	0.037	0.496	1.000				
Solvency ratio	0.081	-0.126	-0.018	0.082	0.030	0.012	0.091	0.088	0.023	0.364	0.336	1.000			
Listed companies	0.226	-0.156	-0.055	0.070	0.095	0.018	0.010	0.245	0.025	-0.077	-0.055	0.066	1.000		
Firm size	0.123	-0.157	0.007	0.022	0.035	0.161	0.105	0.236	0.200	-0.068	0.014	0.038	0.134	1.000	
Firm age	0.206	-0.267	0.012	0.166	0.028	0.007	0.099	0.230	0.061	-0.020	0.034	0.254	0.182	0.176	1.000