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Bank Survival in European Emerging Markets*

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Abstract: We analyze bank survival on large dataset covering 17 European emerging markets during the period of 2007-2015 by estimating the Cox proportional hazards model. We group banks across countries and according to their financial soundness. Our results show that progress in banking reforms positively affects bank survival. The economic impact of various determinants is largest for average banks measured by their soundness. Financial indicators predict bank survival rate with intuitively expected impact that is economically less significant in comparison to other factors. Specifically, ownership structure and legal form are the key economically significant factors that exhibit strongest economic effect on bank survival. We further document importance of banks being listed with respect to their survival. We also show that probability of exit increases after number of directors increases beyond a threshold. The results are robust no matter how bank are grouped, with respect to alternative specifications as well as alternative assumptions on survival distribution.

Keywords: Bank survival; Banking reform; European emerging markets; Survival and exit determinants; Hazards model

JEL Classifications: C14, D02, D22, G33

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1. Introduction

Banks are the key institutions to mediate the funds flow in the economy and their survival is linked with the economic health. Banks are also quite sensitive to the distress, and instability of the banking sector can easily generate large financial and social costs. The features are very relevant to the commercial banking sectors in European emerging markets that developed as part of the economic transformation (Bonin et al., 2005). Their banks were initially subject to harsh conditions related to major economic restructuring (Männasoo and Mayes, 2009). Further adjustments involved adoption of the international accounting standards, proper regulatory supervision, etc. (Bonin et al., 2015). All emerging economies in Europe were also hit by the global financial crisis (GFC) with their banks being in first line. We analyze the bank survival in emerging European markets because a healthy banking industry is a primary objective in these economies as failing banks are costly for economy and directly impact the sovereign risk after the GFC (Brůha and Kočenda, 2018). In our assessment we focus on period from 2007 onwards and analyze what factors can be linked with survival or exit of the individual banks during the GFC and later on. Our aim is to provide a missing assessment as there is no contemporary analysis of the issue covering banks in this large region.

An earlier analysis explaining the bank distress in 19 Eastern European transition economies over the period 1995-2004 was brought by Männasoo and Mayes (2009). They use a complementary log-log (cloglog) hazard model with set of macroeconomic, structural and bank-specific variables to predict vulnerabilities in banking sectors of European transition countries and show that many factors related to bank soundness exhibit dependable distress detection ability. In our analysis we partially overlap with their bank-specific variables used and country sample covered. We differentiate in that we employ more versatile technique that does not require assumptions on the baseline hazard function, provide assessment of bank survival rates (rather than distress predictions), and cover the Global Financial Crisis and European Sovereign Debt Crisis.

There is substantial work exploring characteristics of individual banks that might help in estimating their probabilities to fail or survive. Particularly well covered is the U.S. banking sector. In a seminal paper, Lane et al. (1986) analyzed survival predictions on a moderate sample of the U.S. banks, while Whalen (1991) and Wheelock and Wilson (2000) followed with wider sample coverage. Further additions mapping the U.S. banks

include, for example, Cole and Gunther (1995), Calomiris and Mason (2000), De Young (2003), Cole and White (2012), Berger and Bouwman (2013). Number of developed as well as non-European emerging markets is covered by Evrensel (2008). Emerging markets worldwide are much less covered, potentially because of the fact that the data are not that readily available. Still, the contributions to the literature cover bank failures in various emerging markets including Venezuela (Molina, 2002), Russia, (Carree, 2003), Argentina (Dabós and Escudero, 2004), Colombia (Gonzales-Gomez and Kiefer, 2009), Brazil (Sales and Tannuri-Pianto, 2007; Alves et al., 2014), Nigeria (Babajide et al., 2015), and Middle and Far Eastern countries (Pappas et al., 2017). Our analysis directly contributes to the above strand of literature because while the developed and emerging markets are well covered in general, no multi-country bank survival study is available for banks in emerging European markets so far.

How various bank characteristics affect its survival can be assessed with a flexible survival model that does not require to proxy for failure risk and allows for time-varying failure probability. Specifically, in our analysis we employ the semiparametric Cox proportional hazards model (Cox, 1972); details are provided in Section 2.1. It is a distribution-free technique that is more convenient than other tools since it does not require any distributional assumptions. It is an established technology in empirical survival literature (Manjón-Antolín and Arauzo-Carod, 2008) and has been used in number of studies, including many of those cited above.

We are aware that our sample of 17 countries exhibits some heterogeneity in economic, social, and political characteristics. For robustness of our analysis we divide banks in two principal ways. First, we divide banks according to country groups that reflect geography of the European emerging markets, differences in economic development, as well as former transition experiences. In our partition tactic we loosely follow approach of Brůha and Kočenda (2018) who show that there exist differences among the EU countries in terms of how quality of their banking sectors impact sovereign risk. Second, we divide banks into groups based on their soundness represented by combination of some key financial criteria used in other bank-survival studies (Lane et al. 1986; Pappas et al. 2017; Aliyu and Yusof, 2017). Details on the group composition along with the number of banks covered in specific groups are provided in Section 3.

In our assessment of the bank survival we employ number of qualitatively different types of variables. First, we hypothesize that banking sector development should

exhibit economically significant impact on bank ability to survive as it represents a degree of cultivation and regulation of the industry; importance of the regulatory reform on bank survival was shown by Santarelli (2000). At the same time, the progress in the undertaken banking reforms represents a useful control to account for unobserved country-specific heterogeneity present even after dividing banks into country-based or soundness-based groups. However, Goddard et al. (2009) argue that firm-specific factors are most important in explaining variations in firm performance. We extent the idea to assess the impact of bank-specific characteristics on bank survival. We control for bank-specific factors by employing a number of representative factors representing financial, legal, ownership, governance, performance, and other characteristics of banks. The factors are detailed later on in the data section where we also indicate hypothesized effects that the variables are expected to impart.

Our paper contributes to the existing literature on bank survival by analyzing a large dataset of 12 688 banks and financial institutions from 17 European emerging markets. Our findings are based on estimating the Cox proportional hazards model on banks that are grouped in two qualitatively different sets. The vital result shows that the development of the banking sector is an important factor positively affecting bank survival. Further, we show that financial measures of bank soundness are often helpful factors but ownership structure and legal form are the key economically significant factors that are behind bank survival. These results are robust across bank groups, with respect to alternative specifications, as well as alternative assumptions on survival distribution.

The remainder of the paper is organized as follows. In Section 2, we describe the data and applied methodology. In Section 3, we bring forth extensive and detailed results. Section 4 concludes.

2. Data and methodology

2.1 Data coverage

Our dataset allows us to trace the survival status of a total of 12 688 banks and financial institutions from 17 countries in the Central and Eastern Europe (CEE) and former Soviet Union (FSU) along with the additional bank-specific information detailed later in this section; we use a common term bank as a matter of convenience. From geographical perspective the countries are divided into four groups: (a) Central Europe (CE; 2 190

obs.)—the Czech Republic, Hungary, Poland, and Slovakia; (b) Eastern Europe (EE; 1 294 obs.)—Bosnia, Bulgaria, Croatia, Macedonia, Montenegro, Romania, and Serbia; (c) Baltic countries (BC; 423 obs.)—Estonia, Latvia, and Lithuania; and (d) FSU (8 781 obs.) – Moldova, Russia, Ukraine. In Figure 1 we provide details on the numbers of failed banks per year in each country group along with the dynamics of the exit rate.

Further, the set of bank-specific variables representing bank survival determinants is assembled from the Bureau van Dijk's Orbis database. The key advantage of the Orbis database is that it retains data also for inactive firms, an important property for survival analysis. Banks and financial institutions included in our dataset strictly 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. Similarly as Chiaramonte and Casu (2017) or Aliyu and Yusof (2017) we classify failed banks as those being liquidated, bankrupt, and/or dissolved. Banks in the category of mergers/acquisitions are not consideredas failed.[1] Bailed-out banks were excluded from the sample.

In the account below, we detail the variables used, along with hypothesized effects that the variables are expected to produce. Positive effect (+) indicates that a factor is expected to increase bank survival chances. The decrease of survival chances is associated with a negative effect (-).

In order to capture the development of the banking sector and progress of individual countries in terms of liberalization and institutional reforms in the banking sector we assembled a set of the data from the European Bank for Reconstruction and Development (EBRD). The EBRD index of banking sector reform is published as transition indicator 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. A score of 1 denotes a marginal reform: merely a formal separation of the central bank and commercial banks. A score of 4+

[1] Since banking sectors in emerging European markest are still in process of catching-up with developed countries, we do not consider banks in the category of mergers/acquisitions as having failed because these transactions are frequently associated with changes in ownership structure rather than bank performance. Lanine and Vander Vennet (2007) show that large Western European banks have targeted relatively large and efficient Central and Eastern European countries (CEEC) banks with an established presence in their local retail banking markets and find no evidence that cross-border bank acquisitions in the CEEC are driven by efficiency motivations.

denotes high reform level similar to the institutional standards and norms of developed market economy. We hypothesize that the progress in banking reform is associated with a positive effect on survival chances. As an alternative proxy to capture the banking system development we employ a financial deepening variable, defined as domestic credit to private sector in percentage of GDP. However, two issues emerge. First, the correlation between the EBRD index and financial deepening is about 0.7. For that, we cannot use both variables simultaneously in one model. Second, financial deepening exhibits quite low variation across countries, with mean and median being relatively close. As such the extent of financial deepening is quite similar among banks in various countries. This might be due to the relative standardization of the banking industry due to the BIS regulations and EU rules (where applicable). In the end, the EBRD index seems to provide a better explanatory power in terms of banking sector progress.

Further, we employ several variables that are frequently used as measures of bank soundness and represent a subset of the CAMELS factors; the variables were also used in earlier as well as recent bank-survival studies (Lane et al., 1986; Pappas et al., 2017; Aliyu and Yusof, 2017).[2] The CAMELS rating provides essential information on the overall condition of a bank in a numerical form (Peek et al., 1999). The expected effects are given by Männasoo and Mayes (2009) and shown below in parentheses. Because we do not have data available on the full set of the CAMELS factors for all banks, the following variables are used as the closest proxies: Capital adequacy (C) proxied with a solvency ratio (-),[3] Asset quality (A) proxied with returns on assets – ROA (+),[4] Earnings (E)

[2] CAMELS is an acronym for Capital adequacy, Asset quality, Management soundness, Earnings and profitability, Liquidity, and Sensitivity to market risk.

[3] We use the Solvency ratio (Shareholders funds/Total assets) as a proxy for Capital adequacy. The Solvency ratio is a capital ratio that reflects a new non-risk based capital measure "Leverage ratio" introduced by the Bank for International Settlements (BIS, 2014). We ackonwledge that Capital quality is typically proxied by Equity/Assets, Tier 1 Ratio, or Total Capital ratio. However, these are not consistently available across our sample.

[4] We acknowledge that ROA is more a profitability indicator, but we employ the indicator in the same way as Betz (2014) for Euroepan banks: Asset quality (A) is represented by return on assets (ROA). Higher returns on assets mean not only better performance of a bank, but the measure also indicates a lower proportion of the non-performing assets (non-performing loans) of the bank, indicating better asset quality and lower credit risk associated with it. No other more suitable proxy (e.g. non-performing loans) for the Asset quality is available in sufficient extent and consistently across the banks in our sample.

proxied with net profit margin (+/-), Liquidity (L) proxied with liquidity ratio (-); the data are not readily available to cover Management (M) and Sensitivity (S) categories.

Because of the necessary transformation process, the banking sector in the countries under research evolved differently than in the rest of Europe. Legal form might play a role with respect to bank survival. Therefore, we differentiate between joint-stock company (+) and limited liability company (+). In terms of the ownership structure we separate the effects of large shareholding with full control over the bank (+), and foreign ownership (+). Finally, we account for the corporate governance by using the number of board directors (+) along with its non-linear effect (-).[5]

In addition, we employ several variables to cover additional bank-specific characteristics: size of the bank represented by total assets (+; De Young, 2003), information whether a bank is listed on a stock exchange, meaning how tightly the bank is connected with capital market (+), and the age of the bank (+).[6]

Additional details and descriptive statistics are presented in Table 1.

2.2 Cox proportional hazards model

We estimate the potential effects of various factors on a bank's failure through a survival model; indicators are reported in Table 1. Survival models bypass the necessity of proxies to capture bank failure risk that might preclude accurate comparison. Further advantage is that, in comparison to the standard logit models, survival models allow for the probability of the bank failure to vary over time. Specifically, we employ the Cox proportional hazards model (Cox, 1972) because the technique does not require assumptions on the baseline hazard function, unlike parametric survival models.[7] This

[5] The hypothesized inverted U-shape pattern between the board size and survival probability is based on the arguments in De Andres and Vallelado (2008; p. 2571) who argue that „larger board facilitates manager supervision and brings more human capital to advise managers. However, boards with too many members lead to problems of coordination, control, and flexibility in decision-making."

[6] The variable of firm age represents the number of years of operation until the end of 2006; it does not account for subsequent years from 2007 onward. Hence, the age does not represent time in ususal sense and the age is not used to sort the data in the estimation process.

[7] Parametric survival models represent an empirical alternative but they require distributional assumptions for the baseline hazard. Differences in distributional assumption thus imply potential problems of misspecification. Sales and Tannuri-Pianto (2007) use exponential distribution to assess banks in Brazil. Evrensel (2008) uses Weibull distribution and provides results for number

feature makes it an effective tool and the most commonly used model in empirical survival literature (Manjón-Antolín and Arauzo-Carod, 2008). The Cox technique uses a time-to-failure as an observable variable.

The Cox proportional hazards model assumes that the hazard denoting the probability of an event (bank exiting the market) $h_0(t)$ depends on time t and a set of relevant covariates x_{in}:

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

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 $\boldsymbol{x}$. Considering two observations, i and i', that differ in their covariates (values of x_i), with the following linear representation:

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

and

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

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

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

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

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

Variables in (5) are defined in the same way as in (1) and ε is a random error.[8]

In our results, we will present each parameter β in the form of a hazard ratio, due to its straightforward interpretation—a hazard ratio indicates how the probability of a bank exiting the market is multiplied when a specific covariate x (e.g., a bank survival determinant in a form of an independent variable) changes by one unit. If an estimate is

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of developed as well as non-European emerging markets. Männasoo and Mayes (2009) employ a complementary log-log to analyze European emerging markets.

[8] In (5) an unobserved heterogeneity is not controlled for, similarly as in Männasoo and Mayes (2009) because the banking is a relatively standardized industry due to being subject to numerous similar regulations and rules of the BIS and the EU (when applicable).

over 1, we may consider a determinant (covariate *x*) to be a risk factor, increasing the probability of bank's exit. Similarly, if an estimate is below 1, such a determinant (covariate) is considered to be a preventive factor inhibiting a bank's exit from the market. Statistically significant estimates below 1 are economically more (less) significant preventive factors if they are further from (closer to) 1, respectively. Our estimation strategy follows examples of approaches adopted recently by Esteve-Pérez et al. (2004), Taymaz and Özler (2007), and Iwasaki (2014).

We acknowledge that under certain conditions an endogeneity issue may arise in the survival analysis. This happens if: (i) an independent variable is a future variable, (ii) the estimation period is very short, or (iii) the dependent variable is continuous (Liu, 2012). 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 Subsection 2.1, all independent variables in our analysis can be considered as being predetermined, which minimizes the endogeneity problem arising from simultaneity between dependent and independent variables (Iwasaki, 2014). In addition, our estimation period cover a relatively long span of nine years. Finally, dependent variable is a discrete (binary) variable as it is observed on a yearly basis. In this respect none of the three conditions voiced by Liu (2012) applies to our analysis.

3. Results

The number of failed banks during the analyzed period is captured in Figure 1. The dynamics of exit rates and Nelson-Aalen estimates of the cumulative hazard functions are similar in the groups of Eastern Europe, Baltic, and FSU countries, where the failures follow an upward trend. Central Europe group differs in that most failures occur shortly after the onset of the global financial crisis and then their numbers decline. These differences further motivate our strategy to first estimate our baseline model for the four distinct country groups.

3.1 Country-groups based estimation

Our estimation results of the Cox proportional hazards model based on country groups are presented in Table 2. The overall results for the whole set of 17 countries show that (i) level of the banking reform is a strong factor associated with better survival chances,

and (ii) majority of the determinants used in the estimation play a positive role with respect to bank survival. The exceptions are insignificant coefficients, and inhibiting factors of total assets and liquidity ratio. The finding might correspond with that total assets include also non-performing loans that are still high in the banking sectors of the European emerging markets (Kapounek, 2017; Nikolopoulos and Tsalas, 2017) and as such their large proportion may negatively affect bank survival. Alternative and more plausible explanation is that larger banks take for granted that they will be bailed out (namely, too big to fail) and so they take more risk. In case of the liquidity ratio the survival non-supportive effect correlates with less than healthy balance between current assets and current liabilities, and resonates well with the former conjecture related to total assets. However, as we show in Figure 1, the dynamics of bank failures differs across country groups, which evokes possibility that factors will differ in their impact as well.

Coefficients associated with the banking reforms indicate the aggregate information on the sizable impact of the banking environment with respect to bank survival in four country groups (e.g., the distance of the coefficient from the threshold of 1 is non-marginal). The strongest effect is detected in the FSU. We conjecture that relatively weak institutional environment paired with specific development of the banking system in Russia, Ukraine and Moldova with high proportion of the state control (Fungáčová and Poghosyan, 2011; Vernikov, 2012) might create conditions where even a small improvement in banking reforms is likely to produce a considerable improvement in bank survival chances. In comparison, the effect of banking reform is positive and statistically significant, but economically less relevant in Baltic and Central Europe groups. The feature most likely reflects less state involvement in the banking system of these countries (Hanousek et al., 2007 Bonin et al., 2015) along with a higher degree of the overall institutional environment in these countries (Fan et al., 2011; Bonin et al., 2015). Smaller effect of the banking sector development on bank survival in both groups also reflect the integration of both groups in the EU structures, including banking ones. Our results can be indirectly compared to those of Männasoo and Mayes (2009) who show that the less advanced transition countries are more dependent upon institutional factors represented by the banking sector reforms. The results are also in line with evidence based on the banking system development proxy – financial deepening exhibits

positive but very low economic impact only in cases of the Eastern Europe and FSU groups.[9]

In terms of the economic effect of various covariates, the corporate legal form of banks and their ownership structure exhibit strong and comparable influence as preventive factors. However, between the two key legal forms, the limited liability correlates consistently with better survival chances than does the joint stock company. Further, larger shareholding seems to be a decisive factor behind higher bank survival, while foreign ownership exhibits statistically insignificant impact (albeit the coefficient values are less than one, indicating otherwise positive impact).

As for the corporate governance, larger boards of directors decrease the probability of bank failure quite significantly in Baltic group (0.293), while in other groups the effect is also beneficial, albeit less economically significant. However, the non-linear effect of the board size is negative as the squared term of the number of board directors is slightly over 1. Thus, the relationship between the board size and probability of bank survival follows an inverted U-shape: i.e., the probability of exit for banks with larger boards is relatively low, but it increases as the board grows excessively large. In our case the turning point in the inverted U-shape varies for banks in different country groups and probability of exit increases when the number of directors exceeds 13 (Central Europe), 3 (Eastern Europe), 5 (Baltic) and 2-3 (FSU). We conjecture that the the "optimal" board size is inversely related to the progress in banking sector development. Our results are in line with De Andres and Vallelado (2008) who document an inverted U-shaped relation between board size and performance on a sample of 69 large commercial banks from six developed countries (during 1995–2005). They show that performance decreases when the number of directors reaches 19.

Bank performance measures indicate a correlation with better chances for survival. However, the economic significance of the ROA and profit margin is rather low as both coefficients are close to the benchmark of one. Moreover, the effect is statistically significant for the full sample and FSU, but not for other country groups. Negligible impact is produced by the liquidity ratio whose coefficients are essentially close to one and statistically insignificant, with the exception of the full sample and the FSU.

[9] The coefficients are 0.98 (Eastern Europe) and 0.97 (FSU); the detailed results are not reported but are available upon request.

In contrast to the performance measures, the factor representing banks listed on a stock exchange exhibits a substantial economic impact. However, the impact should be evaluated carefully since the coefficients are statistically significant only for the full sample and the Baltic group. It is worth mentioning that emerging stock markets in the CEE region were established primarily as vehicles connected to mass privatization schemes and thus, in early 2000's they still substantially differed from the mature Western stock markets in terms of capitalization, information processing etc. (Hanousek et al., 2009). Still to be listed on a local stock exchange, a bank has to comply with numerous criteria that are also linked to its performance, quality, and compliance with rules imposed by a regulator – as such, listed banks are likely to exhibit more resilience towards exist. Our findings is in line with earlier results of Männasoo and Mayes (2009) who show that Eastern European listed banks are strongly and statistically significantly less caught by distress because of their strength, and because their disclosure requirements make them subject to market discipline. Further, several Eastern European banks are also part of financial groups with Western banks so they would have better control mechanisms. Solvency ratio, an important indicator of capital adequacy, can be also regarded as protective factor, albeit with much less economic significance than being listed on a stock exchange. In addition, the solvency is not statistically significant in Eastern Europe and Baltic groups.

Bank specific characteristics show that size is a small risk factor for bank survival in the FSU, slightly higher risk factor in the Baltic group, but it is rather preventive factor in the Central Europe group. In general, firm size is usually considered to be a preventive factor (e.g., Geroski, 1995, 2010), which intuitively is straightforward, as it is expected that larger firms have lower hazard rates of exiting than smaller firms. Nevertheless, banks in the CEE and FSU regions are still quite distinct from those of developed countries (Brůha and Kočenda, 2018) and higher proportion of the lower-quality assets might be a reasonable explanation behind part of the findings. A bank's age, on other hand, can be regarded as mildly preventive factor. The result is intuitive as the older financial institutions can be regarded as more stable, provided that they exhibit a sound standing.

3.2 Estimation based on criteria of bank soundness

Country groups introduced in previous section represent a useful way to distinguish among banks depending on differences in quality of the banking sectors evidenced for the European countries (Brůha and Kočenda, 2018). However, such division does not necessarily allow assessment based on economic standing of individual banks. In the next step we provide an alternative point of assessment: we divide banks into four groups according to their financial soundness evaluated by the subset of the CAMELS criteria.

We proceed in the following way. Initially, we perform a principle component analysis (PCA) to capture potential structure behind the bank soundness in terms of the available CAMELS factors. Solvency ratio possesses the highest eigenvalue (1.3) followed by the ROA (0.9). The results of the PCA show that first two components explain about 75 percent of all variance among the factors. We are aware that the new variables (the components) do not have the same interpretation as the original CAMELS factors. However, they might show some resemblance and for that we form groups of banks based on solvency and ROA, factors with the highest eigenvalues. First, we create two groups to distinguish between highly sound banks (high solvency and high ROA) and poorly sound banks (low solvency and low ROA). Further, we create two intermediate groups of banks performing well in only one of the two criteria (high solvency and low ROA; low solvency and high ROA).

With the above formed groups we perform new round of estimation and present the results in Table 3. The level of banking reform is decisively contributive factor with a substantial economic impact on bank survival. Moreover, the effect is stronger for banks with low ROA (and either high or low solvency) as the coefficients are less than 0.5. The result stands in contrast to two groups of banks with high ROA where the coefficients are above 0.5. The result indicates that for banks with lower asset quality (proxied by ROA) the progress in banking reform might partially work as a safeguard against their failure. A side effect of such result might be a potential preservation of less competent banks operating in, and possibly also due to, otherwise improved banking environment. An alternative assessment based on the financial deepening (as a proxy for banking system development) exhibits positive but economically negligible effect on survival of the low solvency banks. Coefficients are 0.98 for both high and low ROA groups and are not reported in separate tables as the effect of other factors does not change.

Further results show that both types of legal form can be regarded as exit-preventive factors with a comparably similar economic effect. However, they differ with respect to

the soundness of a bank. Joint-stock legal form exhibits greater impact on banks with low solvency as the coefficients are lower than those of the high-solvency banks. On the other hand, limited liability legal form exhibits greater impact on the intermediate groups of banks failing to perform well in either solvency or ROA, i.e. banks in the middle of soundness. Overall, limited liability legal form is associated with better survival chances of best or fairly performing banks, while joint-stock legal form improves survival chances of the banks with poor soundness.

Ownership structures play a positive and economically significant role in strengthening the probability of bank survival. Large shareholding economically surpasses the effect of the foreign ownership, and it is also more leveled across the groups of banks. The improved chances of bank survival under the large owner can be taken as an indirect support of the agency theory in that concentrated ownership structure might lead to better survival chances via higher firm efficiency allowed through a superior monitoring of managers (Shleifer and Vishny, 1997; Hill and Snell, 1989). Foreign ownership is shown to be preventive factor specifically for weaker banks. In contrast, it shows to have a detrimental effect on the fittest banks in terms of asset quality (ROA) and capital adequacy (solvency). We conjecture that the effect is plausibly due to the frequent transfers of funds from daughter banks in emerging markets to foreign mother banks in developed countries, a practice documented in number of countries in our sample (EBRD, 2006) and applied not only to the banks (Brada and Tomšík, 2009). Such transfers naturally endanger survival chances. An alternative explanation stems from the risk-taking behavior: Drakos et al. (2016) show that higher capitalized foreign-owned banks in European emerging markets behave quite aggressively when interest rates are low. Hence, higher exit probability of the best-performing banks with foreign ownership shown in Table 3 might well be due to their increased risk appetite.

Effect of the corporate governance can be properly assessed only for high-ROA banks where pairs of coefficients associated with the board of directors' size are statistically significant. Larger boards of directors decrease the probability of bank failure to some extent, that is, however, less economically significant than previous factors of legal form and ownership. The non-linear effect of the board size is negative as the squared term of the number of board directors is slightly over 1. Hence, the link between the board size and bank survival chance is captured in an inverted U-shaped pattern: i.e., the banks benefit from larger boards but the probability of bank failure increases as the

board gets excessively large. For banks with high solvency and high ROA the probability of exit increases when the number of directors exceeds 14, while the number varies between 9 and 10 for banks characterized by with low solvency and high ROA; statistically insignificant coefficients preclude calculation of the optimal size for remaining two groups, though. The two results lean toward hypothesis that favors advantages of monitoring and advising stemming from larger boards, at least in banks with high ROA. The pattern again corresponds well with the related outcome of De Andres and Vallelado (2008) who, in a sample of large international commercial banks, find an inverted U-shaped relation between bank performance and board size.

Banks with high capital adequacy (solvency) improve their survival chances from being listed on a stock exchange; coefficients are statistically insignificant for low solvency banks. This is especially important in case of banks with low ROA who benefit from the stock-market-status despite of potentially lower quality of their assets. Still, for banks to be stock listed, a compliance with regulator-imposed criteria is a strict condition and listed banks are likely to have better survival chances. As earlier, the finding is in line with earlier results of Männasoo and Mayes (2009) who show that listed banks in Eastern European economies are quite resilient to distress, benefiting from disclosure requirements and market discipline.

The rest of the factors we tested exhibit mostly only marginal effects since associated coefficients are close to one. Small failure-preventing effect is associated with profit margin, solvency ratio, and firm age, while minor impact of decreasing survival chances is linked with liquidity ratio and firm size. Statistical insignificance of some coefficients precludes more detailed evaluation.

In addition to the detailed and factor-specific results discussed above, an interesting pattern emerges from the aggregation of the above findings. The economic impact of specific determinants differs across the groups. The largest economic impact of specific factors concentrate in the intermediate bank groups with high solvency/low ROA and low solvency/high ROA, relative to other two groups. The pattern is based on statistically significant coefficients; an interesting fact is that the pattern does not change even (i) when we consider statistically insignificant coefficients or (ii) if we merge two middle groups into one and re-estimate the model. The key take from this result is that in terms of the bank soundness, the banks in the middle benefit most as the specific determinants exhibit most contributive effects towards their survival. Smallest economic effect is

detected for the low solvency/low ROA group. Our explanation of this pattern is based on the central principle of decreasing marginal returns (Smith, 1950): for banks with a high status, the contribution of various factors should be lower than for banks in lower-rank groups. The banks in a group characterized with the lowest soundness seem to be beyond the reach of the decreasing marginal returns' principle and they are left as candidates for potential exit.

3.3 Robustness checks

In order to verify the validity of our results, we performed various robustness checks. First, earlier in Table 3 we report results based on grouping the banks according to the combination of two criteria: solvency and ROA. In order to avoid any unwanted impact, we re-estimated our specification without the solvency and ROA factors. The value of the coefficients for the rest of the covariates altered only marginally, and did not change in terms of their direction or statistical significance (Table A1). As we already stated, we further re-estimated the model in which the two middle groups of banks (high solvency/low ROA and low solvency/high ROA) were merged together. The values of the coefficients tended to be averages reported for the original two groups but, more importantly, did not alter in terms of their statistical significance or their economic impact (results are not reported but they are readily available upon request).

Further, we re-estimated the Cox proportional hazards model for different periods for which we also adjusted the number of analyzed (failed and survived) banks. The results show that the progress in banking reform does not improve survival chances during the global financial crisis and shortly afterwards (2007-2010); the effect is strongest during the crisis itself (2007-2008). Otherwise, the banking reform improves survival chances during the rest of the research period and its effect is stronger (Table A.2). The same set of results was obtained when we re-estimated the model with the financial deepening variable (not reported in a separate table). The effect of the firm-specific controls is largely time-invariant and corresponds to the effects reported earlier.

Finally, we re-estimated alternative hazards models with different assumptions on survival distribution. These include the exponential, Weibull, and Gompertz distributions. The results presented in Table A.3 show that effects of the banking reform bank-specific controls are invariant with respect to assumptions of survival distribution. The survival associated effects also corresponds to those reported earlier.

4. Concluding remarks

Commercial banking sectors in European emerging markets developed as part of the economic transformation during the 1990's and did not reach sufficient level of maturity until well into 2000's when the financial crisis swept the global financial markets. Since healthy banking sector is a prerequisite for economic development in any country, knowledge of the bank survival determinants in emerging European markets represents valuable information for industry and policy makers.

We analyze bank survival on large dataset covering 17 European emerging markets during the period from 2007 to 2015 by estimating the Cox proportional hazards model. We analyze banks across country groups. We also sort banks according to their soundness and profitability.

Our results show that progress in banking sector development positively affects bank survival chances. On other hand, even less sound banks might benefit from improved banking environment. We also show that the effect of survival determinants is economically more significant for banks that exhibit average level of their soundness and less significant for the best performing banks. The pattern indicates the existence of the diminishing marginal returns of the bank characteristics on their survival rate that is linked to bank soundness.

Financial indicators are helpful factors to assess bank survival rate and they exhibit intuitively expected impact. However, their effect, in terms of economic significance, is smaller in comparison to other factors. Specifically, ownership structure and legal form are the key economically significant factors that exhibit strongest economic effect in explaining bank survival rates. Further, it seems to be quite economically significant whether a bank is listed on a stock market or not, and the fact is most important for high solvency banks and those in Baltic states. Finally, we also document the existence of the inverted U-shape link with respect to the board size in groups of banks; for the positive impact of the board size we provide the threshold numbers of directors when probability of exit increases. These results are robust across bank groups, with respect to alternative specifications as well as alternative assumptions on survival distribution.

The above results offer direct policy implications to further cultivate institutional environment in the European emerging markets. Such cultivation requires to deepen

protection of ownership rights and to improve legal framework along with the corporate law enforcement. We also show that the economic impact of specific determinants on survival rates is largest for banks that stand in the middle between champions and losers in terms of their soundness. In this respect, our findings are helpful in that they also identify factors that might be used in early warning system and viability assessment of the banks. Such policy related result is especially useful because most of the banks in emerging markets naturally exhibit average performance.

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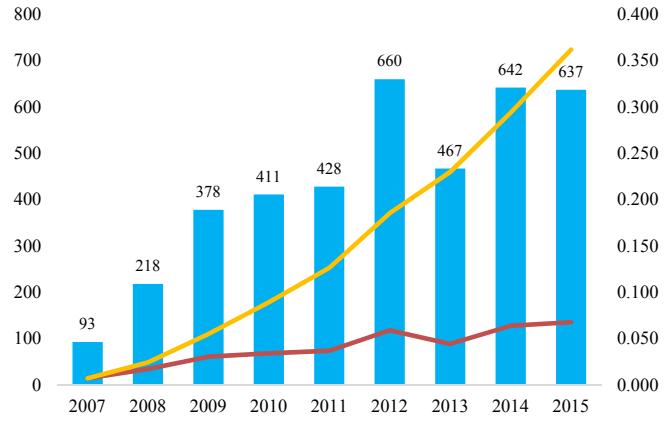
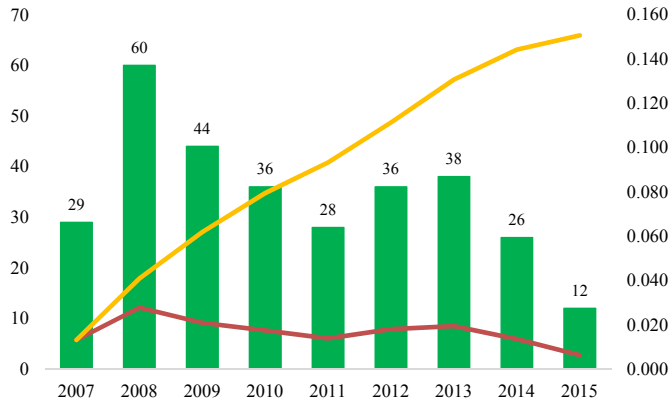
Figure 1. Number of failed banks, exit rate, and Nelson-Aalen estimate of the cumulative hazard function by country group and year, 2007–2015

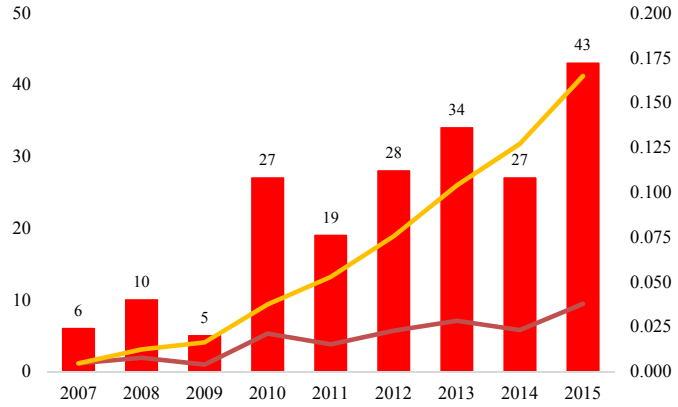
(a) All 17 countries (N=12688)



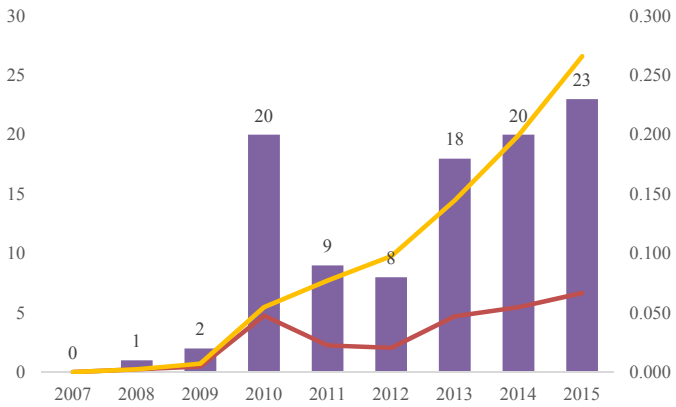
(b) Central Europe (N=2190)



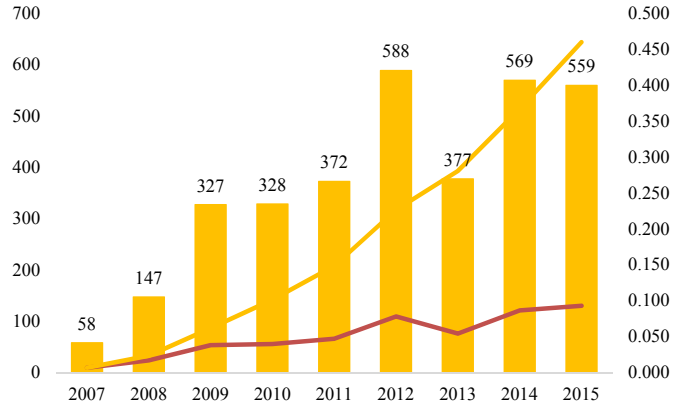
(c) Eastern Europe (N=1294)



(d) Baltic states (N=423)



(e) Former Soviet Union excluding Baltic states (N=8781)



Number of failed banks (left axis)

Exit rate (right axis)

Nelson-Aalen estimate of the cumulative hazard function (right axis)

Source : Illustrated by the authors

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

Variable name	Definition	Predicted impact on firm survival [a]	Descriptive statistics		
			Mean	S.D.	Median
Banking reform	2006 value of the EBRD index of banking sector reform	+	3.059	0.484	2.7
Financial deepening	Domestic credit to private sector (in % of GDP)	0	37.040	9.834	31.000
Joint-stock company	Dummy variable for open joint-stock companies	+	0.220	0.414	0
Limited liability company	Dummy variable for limited liability companies	+	0.444	0.497	0
Large shareholding	Dummy for firms with a dominant and block shareholder(s)	+	0.754	0.431	1
Foreign ownership	Dummy for ultimate ownership of foreign investors	+	0.046	0.210	0
Number of board directors	Number of recorded members of the board of directors	+	1.996	2.690	1
Number of board directors ^{2}	Squared number of recorded members of the board of directors	-	11.219	66.050	1
ROA	Return on total assets (%) [b]	+	5.704	19.886	1.830
Profit margin	Profit margin (%) [c]	+	4.866	22.588	2.715
Liquidity ratio	Liquidity ratio (%) [d]	+	2.704	7.134	1.000
Listed	Dummy variable for listed companies	+	0.022	0.145	0
Solvency ratio	Solvency ratio (%) [e]	+	43.475	39.722	41.650
Total assets	Natural logarithm of total assets in euros	+	11.380	14.725	7.490
Firm age	Years in operation	+	10.759	10.933	9

Notes :

[a] +: Positive impact (i.e., hazard ratio is less than 1.0); -: Negative impact (i.e., hazard ratio is more than 1.0); ?: Unpredictable

[b] Computed using the following formula: (profit before tax/total assets) × 100

[c] Computed using the following formula: (profit before tax/operating revenue) × 100

[d] Computed using the following formula: ((current assets - stocks) / current liabilities) × 100

[e] Computed using the following formula: (shareholder funds/total assets) × 100

Source : Country-level banking reform index and financial deeping ratio were obtained from EBRD (http://www.ebrd.com/home). Firm-level raw data was extracted from the Bureau van Dijk (BvD) Orbis database (https://webhelp.bvdep.com).

Table 2. Baseline estimation of the Cox proportional hazards model

Model	[1]	[2]	[3]	[4]	[5]
Target country	All 17 countries	Central Europe	Eastern Europe	Baltic states	Former Soviet Union [a]
Country-level institutional quality					
Banking reform	0.47885 ***	0.82641 ***	0.56129 **	1.29372	0.19497 ***
	(-11.93)	(-5.92)	(-2.10)	(1.17)	(-9.37)
Legal form (default category: other legal forms)					
Joint-stock company	0.63359 ***	0.91683	0.09669 *	0.13100	0.56166 ***
	(-8.85)	(-0.45)	(-1.91)	(-1.14)	(-10.45)
Limited liability company	0.56681 ***	0.48477 ***	0.42598 ***	0.82500 ***	0.53225 ***
	(-12.69)	(-3.80)	(-3.45)	(-8.69)	(-13.38)
Corporate ownership and governance					
Large shareholding	0.40907 ***	0.63552 **	0.38195 ***	0.69424	0.33429 ***
	(-22.30)	(-2.22)	(-3.53)	(-1.42)	(-24.64)
Foreign ownership	0.89223	0.79034	0.98778	0.53531	1.10729
	(-0.88)	(-0.77)	(-0.04)	(-0.74)	(0.60)
Number of board directors	0.91299 ***	0.81773 ***	1.17620	0.29309 ***	1.10827 *
	(-5.01)	(-3.48)	(0.73)	(-4.99)	(1.86)
Number of board directors^2	1.00297 **	1.00745 ***	0.97445	1.13624 ***	0.97897 ***
	(2.31)	(3.77)	(-0.92)	(3.91)	(-2.86)
Firm performance					
ROA	0.99773 **	0.99484	0.99704	0.99640	0.99811 *
	(-2.13)	(-1.00)	(-0.50)	(-0.36)	(-1.71)
Profit margin	0.99356 ***	0.99568	0.99495	0.99352	0.99349 ***
	(-7.35)	(-0.84)	(-1.25)	(-0.62)	(-7.00)
Liquidity					
Liquidity ratio	1.00621 **	1.00539	1.01404	0.98640	1.00579 **
	(2.43)	(0.23)	(0.85)	(-0.70)	(2.23)
Linkage with capital market					
Listed	0.27906 ***	2.04885	0.56414	0.02020 **	1.02382
	(-3.82)	(0.69)	(-0.79)	(-1.98)	(0.04)
Solvency ratio	0.99514 ***	0.99490 **	0.99522	0.99795	0.99588 ***
	(-10.34)	(-2.12)	(-1.57)	(-0.39)	(-7.86)
Total assets and firm age					
Total assets	1.02042 **	0.86861 ***	1.03208	1.15248 **	1.02605 **
	(2.23)	(-3.23)	(0.72)	(2.00)	(2.48)
Firm age	0.95759 ***	0.96477 ***	0.99458	1.01015	0.96212 ***
	(-10.80)	(-3.36)	(-0.36)	(1.03)	(-7.77)
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes
N	10392	1606	748	274	7764
Log pseudolikelihood	-28769.44	-1482.89	-717.31	-347.27	-24437.41
Wald test (χ^2)	1827.59 ***	182.58 ***	80.84 ***	17612.19 ***	1852.62 ***

Notes : This table contains results from the survival analysis using the Cox proportional hazards model. Table 1 provides detailed definitions and descriptive statistics of the independent variables. 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] Excluding Baltic states

Source : Authors' estimations

Table 3. Estimation of the Cox proportional hazards model by the level of solvency ratio and ROA

Model	[1]	[2]	[3]	[4]
Target financial institutions	High solvency and high ROA	High solvency and low ROA	Low solvency and high ROA	Low solvency and low ROA
Country-level institutional quality				
Banking reform	0.56883 ***	0.33805 ***	0.54009 ***	0.46594 ***
	(-4.49)	(-6.74)	(-5.89)	(-6.84)
Legal form (default category: other legal forms)				
Joint-stock company	0.81628 *	0.69841 ***	0.58790 ***	0.56289 ***
	(-1.81)	(-3.09)	(-4.79)	(-6.13)
Limited liability company	0.64218 ***	0.51428 ***	0.52856 ***	0.64777 ***
	(-4.29)	(-6.00)	(-6.63)	(-5.58)
Corporate ownership and governance				
Large shareholding	0.36977 ***	0.49547 ***	0.32140 ***	0.37203 ***
	(-9.39)	(-8.77)	(-13.87)	(-14.92)
Foreign ownership	2.10353 ***	0.86158	0.44308 **	0.85567
	(3.34)	(-0.41)	(-2.38)	(-0.77)
Number of board directors	0.92110 ***	1.02090	0.85030 ***	0.98172
	(-2.89)	(0.30)	(-4.27)	(-0.37)
Number of board directors ^{2}	1.00288 **	0.98236 **	1.00851 ***	0.99878
	(2.27)	(-1.97)	(6.86)	(-0.29)
Firm performance				
ROA	1.00067	0.99507	1.00001	0.99754
	(0.25)	(-1.32)	(0.00)	(-1.23)
Profit margin	0.99175 **	0.99426 ***	0.98616 ***	0.99931
	(-2.32)	(-3.96)	(-4.03)	(-0.41)
Liquidity				
Liquidity ratio	1.01579 ***	1.00679	0.99689	0.99651
	(4.42)	(1.55)	(-0.31)	(-0.49)
Linkage with capital market				
Listed	0.31895 **	0.06960 ***	0.46613	0.73554
	(-2.08)	(-2.61)	(-1.07)	(-0.47)
Solvency ratio	0.99110 ***	0.99527 **	0.99218 ***	0.99473 ***
	(-3.46)	(-2.02)	(-4.23)	(-4.23)
Total assets and firm age				
Total assets	1.01345	1.04377 **	1.04732 **	1.00398
	(0.45)	(1.99)	(1.98)	(0.24)
Firm age	0.98166 *	0.93588 ***	0.96847 ***	0.97733 ***
	(-1.96)	(-9.58)	(-3.95)	(-2.69)
NACE division-level fixed effects	Yes	Yes	Yes	Yes
N	2799	2334	2681	2578
Log pseudolikelihood	-4559.52	-5690.51	-6033.01	-7959.02
Wald test (χ^2)	234.57 ***	418.50 ***	460.42 ***	575.63 ***

Notes : This table contains results from the survival analysis using the Cox proportional hazards model. Table 1 provides detailed definitions an descriptive statistics of the independent variables. 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.

Source : Authors' estimations

Table A.1. Estimation of the Cox proportional hazards model by the level of solvency ratio and ROA

Model	[1]	[2]	[3]	[4]
Target financial institutions	High solvency and high ROA	High solvency and low ROA	Low solvency and high ROA	Low solvency and low ROA
Country-level institutional quality				
Banking reform	0.58586 ***	0.31605 ***	0.51598 ***	0.44644 ***
	(-4.19)	(-6.96)	(-6.34)	(-7.25)
Legal form (default category: other legal forms)				
Joint-stock company	0.81436 *	0.73175 ***	0.60594 ***	0.54558 ***
	(-1.82)	(-2.75)	(-4.50)	(-6.49)
Limited liability company	0.65830 ***	0.54576 ***	0.54533 ***	0.63436 ***
	(-4.03)	(-5.64)	(-6.32)	(-6.00)
Corporate ownership and governance				
Large shareholding	0.38227 ***	0.50521 ***	0.32125 ***	0.36983 ***
	(-9.18)	(-8.38)	(-13.87)	(-15.08)
Foreign ownership	2.04728 ***	0.87623	0.45025 **	0.85618
	(3.19)	(-0.36)	(-2.34)	(-0.77)
Number of board directors	0.92042 ***	1.02290	0.84760 ***	0.97850
	(-2.91)	(0.33)	(-4.40)	(-0.44)
Number of board directors ^{2}	1.00293 **	0.98332 *	1.00854 ***	0.99903
	(2.31)	(-1.91)	(6.87)	(-0.23)
Firm performance				
Profit margin	0.99062 ***	0.99347 ***	0.98511 ***	0.99719 *
	(-3.16)	(-5.03)	(-4.52)	(-1.91)
Liquidity				
Liquidity ratio	1.01099 ***	1.00422	0.99707	0.99580
	(3.13)	(0.99)	(-0.30)	(-0.57)
Linkage with capital market				
Listed	0.30798 **	0.06458 ***	0.46701	0.59331
	(-2.16)	(-2.69)	(-1.04)	(-0.76)
Total assets and firm age				
Total assets	1.01639	1.02152	1.04940 **	0.99010
	(0.61)	(1.04)	(2.27)	(-0.62)
Firm age	0.97918 **	0.93845 ***	0.96595 ***	0.97444 ***
	(-2.14)	(-9.33)	(-4.24)	(-2.99)
NACE division-level fixed effects	Yes	Yes	Yes	Yes
N	2799	2334	2681	2578
Log pseudolikelihood	-4565.53	-5693.58	-6040.31	-7967.99
Wald test (χ^2)	217.77 ***	396.71 ***	450.38 ***	537.07 ***

Notes : This table contains results from the survival analysis using the Cox proportional hazards model. Table 1 provides detailed definitions an descriptive statistics of the independent variables. 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.

Source : Authors' estimations

Table A.2. Estimation of Cox proportional hazards model in different periods

Model	[1]	[2]	[3]	[4] [a]	[5] [a]	[6] [a]
Estimation period	2007–2008	2007–2010	2007–2013	2009–2010	2011–2013	2014–2015
Country-level institutional quality						
Banking reform	2.40620 ***	1.36970 ***	0.64151 ***	1.06495	0.31444 ***	0.25772 ***
	(5.91)	(3.58)	(-6.28)	(0.57)	(-10.19)	(-10.75)
Legal form (default category: other legal forms)						
Joint-stock company	0.56035 ***	0.44276 ***	0.56638 ***	0.40049 ***	0.63472 ***	0.77901 ***
	(-2.68)	(-7.18)	(-8.87)	(-6.88)	(-5.72)	(-2.78)
Limited liability company	0.43731 ***	0.42724 ***	0.52260 ***	0.42144 ***	0.59174 ***	0.68313 ***
	(-4.92)	(-9.95)	(-12.04)	(-8.65)	(-7.68)	(-4.88)
Corporate ownership and governance						
Large shareholding	0.57052 ***	0.60383 ***	0.37930 ***	0.61764 ***	0.25763 ***	0.47557 ***
	(-3.93)	(-6.54)	(-20.22)	(-5.25)	(-21.35)	(-8.84)
Foreign ownership	0.44342	0.54923 **	0.90052	0.60418	1.25586	0.90898
	(-1.35)	(-2.01)	(-0.65)	(-1.47)	(1.19)	(-0.45)
Number of board directors	0.70467 ***	0.74134 ***	0.87154 ***	0.75880 ***	1.20786 **	1.02755
	(-4.38)	(-7.76)	(-6.50)	(-6.53)	(2.36)	(0.31)
Number of board directors ^{2}	1.01010 ***	1.00879 ***	1.00432 ***	1.00804 ***	0.97222 **	0.99534
	(5.20)	(7.83)	(3.62)	(6.18)	(-2.55)	(-0.46)
Firm performance						
ROA	0.99622	0.99499 **	0.99730 **	0.99464 **	0.99885	0.99852
	(-0.91)	(-2.53)	(-2.06)	(-2.40)	(-0.65)	(-0.79)
Profit margin	0.99141 **	0.99224 ***	0.99478 ***	0.99256 ***	0.99640 ***	0.99133 ***
	(-2.49)	(-4.46)	(-4.92)	(-3.78)	(-2.86)	(-5.46)
Liquidity						
Liquidity ratio	1.00466	1.01453 ***	1.00749 **	1.01704 ***	1.00272	1.00356
	(0.49)	(3.65)	(2.49)	(3.95)	(0.66)	(0.78)
Linkage with capital market						
Listed	0.10400 ***	0.25670 ***	0.30601 ***	0.16500 ***	0.39250 **	0.24958 ***
	(-8.31)	(-7.13)	(-2.81)	(-3.78)	(-2.17)	(-2.67)
Solvency ratio	0.99897	0.99617 ***	0.99503 ***	0.99529 ***	0.99443 ***	0.99537 ***
	(-0.56)	(-4.18)	(-8.79)	(-4.45)	(-7.80)	(-5.65)
Total assets and firm age						
Total assets	1.00648	0.98031	1.02533 **	0.96958	1.05075 ***	1.01313
	(0.19)	(-1.16)	(2.28)	(-1.54)	(3.47)	(0.84)
Firm age	0.95143 ***	0.95841 ***	0.95855 ***	0.96119 ***	0.96047 ***	0.95515 ***
	(-4.08)	(-6.41)	(-9.56)	(-5.02)	(-6.69)	(-5.39)
NACE division-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	10392	10392	10392	10166	9544	8215
Log pseudolikelihood	-2005.77	-7550.02	-19281.65	-5529.26	-11621.87	-9426.38
Wald test (χ^2)	58581.79 ***	62895.78 ***	1507.21 ***	81234.78 ***	1034.51 ***	400.86 ***

Notes : This table contains results from the survival analysis using the Cox proportional hazards model. Models [4], [5], and [6] show estimates without the observations of firms that failed before the period in question. Table 1 provides detailed definitions and descriptive statistics of the independent variables. 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.

Source : Authors' estimations

Table A.3. Estimation of the Cox proportional hazards model by firm size and age

Model	[1]	[2]	[3]	[4]
Target financial institutions	Larger financial institutions [a]	Smaller financial institutions [b]	Older financial institutions [c]	Younger financial institutions [d]
Country-level institutional quality				
Banking reform	0.45004 ***	0.50768 ***	0.51396 ***	0.45827 ***
	(-9.31)	(-7.28)	(-7.68)	(-8.53)
Legal form (default category: other legal forms)				
Joint-stock company	0.68846 ***	0.63390 ***	0.63678 ***	0.63930 ***
	(-4.92)	(-6.28)	(-6.35)	(-5.93)
Limited liability company	0.62961 ***	0.56098 ***	0.51088 ***	0.60842 ***
	(-6.54)	(-9.68)	(-8.91)	(-8.70)
Corporate ownership and governance				
Large shareholding	0.40798 ***	0.39437 ***	0.43612 ***	0.38436 ***
	(-15.83)	(-16.20)	(-12.80)	(-18.53)
Foreign ownership	0.87805	0.97449	1.18505	0.73322 *
	(-0.86)	(-0.10)	(0.85)	(-1.83)
Number of board directors	0.89957 ***	1.03738	0.85052 ***	0.97158
	(-4.95)	(0.57)	(-4.50)	(-1.08)
Number of board directors ^{2}	1.00374 ***	0.98734	1.00697 **	1.00103
	(3.60)	(-1.56)	(2.42)	(0.59)
Firm performance				
ROA	0.99543 *	0.99945	0.99599 **	0.99836
	(-1.91)	(-0.41)	(-2.37)	(-1.21)
Profit margin	0.99461 ***	0.99229 ***	0.99346 ***	0.99408 ***
	(-4.96)	(-4.34)	(-4.56)	(-5.22)
Liquidity				
Liquidity ratio	0.99800	1.01340 ***	1.01301 ***	1.00142
	(-0.46)	(4.67)	(3.60)	(0.41)
Linkage with capital market				
Listed	0.81302	0.14291 ***	0.22306 ***	0.60756
	(-0.51)	(-3.71)	(-3.72)	(-0.76)
Solvency ratio	0.99757 ***	0.99304 ***	0.99385 ***	0.99653 ***
	(-3.33)	(-10.87)	(-8.89)	(-5.41)
Total assets and firm age				
Total assets	0.99307	1.01159	1.00325	1.02661 **
	(-0.32)	(0.56)	(0.22)	(2.20)
Firm age	0.95266 ***	0.96765 ***	0.96649 ***	0.93429 ***
	(-8.50)	(-5.62)	(-5.24)	(-6.10)
NACE division-level fixed effects	Yes	Yes	Yes	Yes
N	4986	5406	5496	4896
Log pseudolikelihood	-12694.17	-13794.79	-10965.04	-15574.25
Wald test (χ^2)	864.55 ***	1013.47 ***	903.41 ***	877.32 ***

Notes : This table contains results from the survival analysis using the Cox proportional hazards model. Table 1 provides detailed definitions and descriptive statistics of the independent variables. 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, total assets of which is 7.490 or more

[b] Estimation using observations, total assets of which is less than 7.490

[c] Estimation using observations, firm age of which is 9 years or more

[d] Estimation using observations, firm age of which is less than 9 years

Source : Authors' estimations

Table A.4. Estimation of parametric survival model with different distributions

Model	[1]	[2]	[3]
Covariates /Assumption of survival distribution	Exponential	Weibull	Gompertz
Country-level institutional quality			
Banking reform	0.50583 ***	0.44800 **	0.44572 ***
	(-11.90)	(-12.40)	(-12.47)
Legal form (default category: other legal forms)			
Joint-stock company	0.66169 ***	0.61831 ***	0.62034 ***
	(-8.47)	(-8.87)	(-8.82)
Limited liability company	0.59449 ***	0.55217 ***	0.55444 ***
	(-12.44)	(-12.64)	(-12.59)
Corporate ownership and governance			
Large shareholding	0.45057 ***	0.38305 ***	0.38332 ***
	(-22.01)	(-22.30)	(-22.23)
Foreign ownership	0.88307	0.89535	0.89582
	(-0.99)	(-0.83)	(-0.82)
Number of board directors	0.91381 ***	0.91489 ***	0.91567 ***
	(-5.20)	(-4.65)	(-4.59)
Number of board directors ^{2}	1.00295 **	1.00288 **	1.00285 **
	(2.50)	(2.05)	(2.01)
Firm performance			
ROA	0.99798 **	0.99760 **	0.99763 **
	(-2.06)	(-2.13)	(-2.11)
Profit margin	0.99382 ***	0.99322 ***	0.99321 ***
	(-7.59)	(-7.29)	(-7.31)
Liquidity			
Liquidity ratio	1.00579 **	1.00616 **	1.00609 **
	(2.41)	(2.28)	(2.25)
Linkage with capital market			
Listed	0.29676 ***	0.26259 ***	0.26206 ***
	(-3.68)	(-3.95)	(-3.95)
Solvency ratio	0.99563 ***	0.99479 ***	0.99482 ***
	(-10.18)	(-10.48)	(-10.52)
Total assets and firm age			
Total assets	1.01896 **	1.02318 **	1.02362 **
	(2.21)	(2.41)	(2.46)
Firm age	0.95901 ***	0.95599 ***	0.95592 ***
	(-10.80)	(-10.83)	(-10.84)
NACE division-level fixed effects	Yes	Yes	Yes
N	10392	10392	10392
Log pseudolikelihood	-7764.09	-7025.08	-7196.12
Wald test (χ^2)	2025.46 ***	1763.35 ***	1764.70 ***

Notes : This table contains the results from a survival analysis using 3 parametric estimators for a robustness check. Table 1 provides detailed definitions and descriptive statistics of the independent variables. 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.

Source : Authors' estimations