THE DETERMINANTS OF BANK FAILURES: THE CASE OF BELARUS

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Abstract

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This paper tests empirically the proposition that the probability and timing of bank failure depends on bank-specific factors, general macroeconomic conditions, and political factor. We applied a split-population survival-time model to Belarusian banks that failed during 1992-1999 to show how the interaction of all these factors affects the bank's fragility. This investigation allows us to answer the question how banks should adjust their activity to minimize the risk of failure and how banking regulation should respond to the added risk - if any - of bank failure and what changes in banking structure and regulatory procedure are necessary in order to prevent bank failures. The paper also studies whether there is a significant difference between major contributing factors in bank failures for developing market and developed western economies.

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GLOSSARY

Accounting ratios - relative indicators of the financial position.

Balance sheet - financial report, which reflects assets, liabilities and net worth at a particular date.

Bankruptcy [1] - the state of being unable to pay for debts.

Closure rule - a general criterion for closing banks.

Consolidation - a tendency of the number of banks to shrink and concentration of assets in a small group of banks. Increase of market risk and high level of competition may cause consolidation.

Divestiture - selling the subsidiary's assets by parent bank.

Economic failure - the situation when bank equity become negative.

Income statement - financial report about income and expenses in the particular period.

Insolvent bank - bank which can not cover its liabilities with its assets.

Mergers - a form of corporate when two banks join their operations and become a united firm.

Regulatory interference - an attempt to influence bank behavior by regulators.

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[1] Throughout this paper, the terms "bank failure", "bank closing" and "bankruptcy" will be used interchangeably.

Introduction

The question of bank failure has received much attention in the literature. Literally, from the US banking crisis in 1930's economic researches have addressed the question of causes of bank failure. There are basically two approaches to the explanation of this question and each centers upon a particular problem analyzed. The first group of researchers investigates the probability of failure, while the second mentions the time to failure.

Aanalysis of the probability of failure is based on calculation of regression equations in which regressand is dichotomous and the regressors are the value and trend of selected balance sheet and income variables. Meyer and Pifer (1970) created a model that analyzes bank failure by "matching" each failed bank with comparable solvent bank under similar local and national economic conditions, and determined financial variables, which can potentially lead to insolvency. Thies and Gerlovski (1993) in their work tested the hypothesis that the real estate lending is a major source of insolvency for national and state banks. They conclude that size of real estate loans influence positively the probability of bank failure. Barr, Seiford and Siemens (1994) stated that the crucial element of bank troubles is a managerial quality and created a model, which incorporate this idea and proved that quality of management is a significant factor influences bank's solvency. Hwang, Lee and Lian (1997) determined the most stable factors influence the probability of bank failure and those factors which can be changed over time.

All these models differ in the number of independent variables and usually give significant results. However, the problem is that the solution of failure problem is conditional upon the assumptions made about the nature of bank failure. First, all these models suggest a linear dependence between financial variables and probability of bank failure. Second, they do not consider the influence of general economic conditions in each case of bank failure because under general estimation, coefficients characterizing this influence will be equal for the failed and survived banks, and, therefore, will always be insignificant. And, finally the common feature of all these investigations is that they consider only the probability of failure.

However, not only the likelihood of this event but also the duration or timing of failure is interesting and the second line of researches proposes take a close look to the time to bank failure.

Ho and Saunders (1980) offer a catastrophe model of bank failure to examine under which circumstances the trend toward bank failure is dichotomous or explosive, involving a sudden crush or catastrophe. Although the model is very descriptive and exploratory, an attempt was made to relate the dynamics of failure to the underlying interactions of relevant economic agents. Suggesting a catastrophic character of bank failure, Ho and Saunders present an approach, which is different from others done in this direction.

The major premise underlying other models is that failure or the time path toward failure is continuous; and their authors consider mainly the duration of failure.

Generally, analysis of duration is a fairly new but rapidly growing area. The first works in the field are dated early 1970s. From that time, researchers tried to build models for the determination and prediction of timing of the event. Bennett and Loucks (1996) proposed a model in order to determine whether political influence affects the length of time from initial undercapitalization until ultimate bank failure. Large number of highly technical researches used the survival function and proportionall hazards models were developed recently. Kiefer (1985) and Lancaster (1990) present a particularly useful information about this approach.

This method is based on the following.

For random variable with probability distribution $f(t)$ the cumulative probability is

$$F(t) = \int_0^1 f(S)dS = \Pr(T \le t).$$

The probability that the variable is of length at least t, is given by the survival function,

$S(t) = 1 - F(t) = \Pr(T \geq t)$.

Probability of failure can be characterized by the hazard rate

$$\lambda(t) = \lim_{\Delta \to 0} \Pr(t \leq T \leq t + \Delta T \geq t) = \lim_{\Delta \to 0} \frac{F(t+\Delta) - F(t)}{\Delta S(t)} = \frac{f(t)}{S(t)}.$$

Roughly, the hazard rate is the rate at which objects are completed after duration t, given that they last at least until t. As such the hazard model gives an answer to our original question about time to failure.

Cox in 1972 presented approach to the proportional hazard model, which became a very popular method of analyzing the effects of covariates on the hazard rate. The model specifies that

$$\lambda(t_i) = e^{-\beta' X_i} \lambda_0(t_i).$$

The function λ_0 is the baseline hazard, i.e. the individual heterogeneity. Cox's partial likelihood estimation allows to obtain β without requiring estimation of λ_0. For the simplest case the partial log-likelihood is

$$\ln L = \sum_{i=1}^{K} [\beta' X_i - \sum_{j \in R_i} e^{\beta' X_j}].$$

The proportional hazard model developed later and contained no constant term became a common choice for modeling survivals, but was applied mostly to the medical and biological research [see Farenwell (1978), Sleeper and Harrington (1990) for review] and comes fairly recently to the economic studies.

In 1995 Cole and Gunther presented a work, in which they used a split-population survival model to separate the determinants of bank failure from the determinants of the survival time of failing banks. They suggest that the factors induce bank failure may be different from those explaining the timing to failure and extend survival model in such a way which allows to estimate jointly both bank failure and the time of failure.

Moreover, this model involves censored data and thus is very convenient to use it in the case of lack of data, particularly in the researches related the transition economies.

This technique was later successfully applied by Gonzales-Hermosillo, Pazarbasioglu and Billings (1996) to the case of Mexican financial crises. Although Belarus does not face a financial crisis now, a series of bank failures from mid 1990's makes it very interesting to analyze the determinants of their failures.

The objective of our research is to develop and estimate a model of bank failure based on the Cole and Gunther proposition which allows to separate the factors influence the probability and timing of failure for the case of Belarusian banks. Taking into account the fact that government plays an active role on the financial market in the post-communist countries, we will also use the idea of dependence bank failure on political factors designed in Bennett and Loucks (1996).

The paper will be built in the following way. In the first chapter I will present Cole and Gunther model and discuss similarities and differences between their and my specifications. The second chapter will contain my estimates of the model for Belarusian data, testing of the model. In this third part I will also compare my results with those obtained for the other data and find possible explanations for the differences. The conclusion follows.

Chapter 1

ECONOMETRIC MODEL

The split-population survival-time model[2]

Despite its advantage in separating probability of failure from time to failure of the financial institution, the split-population survival-time model was rarely used in finance studies due to its estimation complexity. Cole and Gunther (1995) applied this model to case of bank failure to separate the determinants of bank failure from the factors influencing the survival time of failing banks.

Survival-time model explains duration, which is the time to failure in our study, over a given observation period. The likelihood function for the standard parametric survival-time model can be written as

$$L = \prod_{I=1}^{N} [f(t_i)]^{Q_i} [S(t_i)]^{(1-Q_i)}, \qquad (1)$$

where $f(t)$ is the density function of the time to failure and $S(t)$ is the survival function, which is equal to $P(T \geq t)$, the probability that the random duration T equals or exceeds the value t. The indicator variable Q equals one for uncensored observations and equal zero otherwise. Here, Q equals zero both for banks that left the sample for reasons other than failure and for banks that survived over the entire sample period. The number of banks in the sample is denoted as N.

The standard model given in Equation (1) may be inappropriate in a context of bank failure. Because $S(t)$ approaches zero as time as risk becomes large, the standard survival-time model assumes implicitly that each bank ultimately fails. This assumption results in a misspecification if risk

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[2] According to Cole and Gunther (1995)

differences among banks imply that only a limited number of banks actually fail. As a result it cannot identify any differences that may exist between the determinants of bank failure and the factors influencing the timing of failure. If the population of banks is split into two groups, one composed of banks that eventually fail and the other composed banks that survive, then failure and the timing of failure might depend on different forces.

A useful generalization of a standard model allows the probability of eventual failure to be less than one. Let

$$P(F = 1) = d, \tag{2}$$

where F is a binary variable that equals one for banks that ultimately fail and zero otherwise. The appropriate density for a failure in period t is equal to $df(t)$, where $f(t)$ now is understood to be the density function of the time to failure conditional on $F = 1$. Similarly, the probability attached to a censored observation is equal to the sum of the probability of survival, $(1-d)$, and $dS(t)$, where again $S(t)$ now is defined conditional on $F = 1$. The likelihood function in Equation (1) then is generalized as

$$L = \prod_{I=1}^{N} [df(t_i)]^{Q_i} [(1-d) + dS(t_i)]^{(1-Q_i)}, \tag{3}$$

where the probability of failure, d, is a parameter to be estimated.

The split-population model given in Equation (3) is made operational by specifying a particular distribution for $f(t)$ and $S(t)$. A useful selection criterion is the hazard function, $h(t) = \frac{f(t)}{S(t)}$, which gives, for banks that ultimately fail, the probability of failure in period t conditional on survival to that period. In the present context, the log-logistic distribution is a likely candidate, because it can generate a hazard which first rises and then falls, as might be expected during a period of banking difficulties. The log-logistic specification is given by

$$S(t) = \frac{1}{[1 + (lt)^p]}, \text{ and} \tag{4}$$

$$f(t) = \frac{\lambda p(\lambda t)^{p-1}}{[1+(\lambda t)^{p}]^{2}}, \tag{5}$$

where $\lambda > 0$ and $p > 0$ are the defining parameters. Substitution into Equation (3) gives the specific likelihood function.

In addition, both the probability of eventual failure and the timing of failure can be made to depend on bank-specific characteristics. In this regard, it is convenient to introduce covariates by specifying

$$\lambda = e^{-\beta' X}, \text{ and} \tag{6}$$

$$\delta = \frac{1}{(1+e^{\alpha' X})}. \tag{7}$$

Equation (6) allows $f(t)$ and $S(t)$ to depend on a vector of bank characteristics, X, such that a positive coefficient implies a direct relationship between a given characteristics and survival time. Similarly, Equation (7) specifies a logistic model for the probability of eventual failure, which is equivalent to the standard logit model, applies to the probability of survival. In Equation (7), a positive coefficient indicates a direct relationship between a given characteristic and the probability of survival. Substitution of Equation (4) through Equation (7) into Equation (3) results in the complete likelihood function.

Data and test preliminaries

The data set used in this research consists of banking sector data, macroeconomic data and political data and covers period from 1992 to 1998. The sample examined comprises 41 banks, of which 15 failed during the sample period. Bank is classified as failed when it was self-liquidated or closed by regulators.

Bank specific data for each reporting period (or calendar year) comes from two sources. The first one is the year-end balance sheet and the second is income statement reported to the National Bank of the Republic of Belarus. The size of the bank is measured by bank assets, the financial information was summarized into 9 operational ratios in order to capture bank-specific effects.

Indicators of macroeconomic dynamics are derived from International Monetary Fund database, Ministry of Statistics of the Republic of Belarus and TACIS estimation for Belarus. Including dummy variable for government intervention as independent variable controls the different regulatory enforcement across banks. Political risk is measured by the Euromoney Confidential index of political risk, and speed of market reforms is proxied by the speed of privatization.

Variables used in the model specification are presented in Table 1 and a little discussion is necessary.

SIZE: the size of the bank is measured by the logarithm of gross bank's assets. This variable is used to assess whether relatively large banks are more likely to survive because, for example, they are better able to diversify risk. The reason that shutting down larger bank organization is more complex and time consuming may delay ultimate failure. We expect a negative relationship between asset growth and probability of failure and positive relationship with the survival time.

Table 1 Definition of variables introduced into the model as the determinants of the probability of failure and survival time.

Variable		Expected sign	
		Probability of failure	Survival time
Bank Size: SIZE	Logarithm of gross assets	-	+
Profit Margin: NPF	Net income divided by total operating income	-	+
Equity Multiplier: EM	Ratio of average assets to equity capital	+	-
Consumer Loans: CLOAN	Ratio of consumer loans to average assets	+	-
Other Loans: LOAN	Ratio of other loans to average assets	+	-
Security Operations: SEC	Ratio of security operations to average assets	+/-	+/-
Currency Operations: CUR	Ratio of currency operations to average assets	+/-	+/-
Equity Investment: INV	Ratio of equity investments to average assets	+	-
Non-Performing Loans: NPLOAN	Ratio of loans past due and prolonged to average assets	+	-
Salary Expenses: SAL	Ratio of salaries and employee benefit to average assets	-	+
Government Intervention: GOV	=0 if yes =1 if no	+/-	+/-
GDP:	Real GDP growth	-	+
Inflation: INFL	Average year inflation	+	-
Exchange Rate: ERATE	Exchange rate depreciation	+	-
Discount Rate: IRATE	Discount rate of the National Bank	+	-
Political risk: RISK	Euromoney Confidential index of political risk	-	+
Speed of Reforms: REF	Speed of privatization is used as 'proxy'	-	+
Dummy: D	=0 before 1996 =1 after 1996	+	-

NPF: indicates bank's profitability. In general, sustained level of profitability enable bank to boost capital and improve its economic viability, thus being negatively related to probability of failure and positively to the survival time.

EM: used as the indicator of bank's riskiness and has positive expected sign for the probability of failure and negative for the survival time.

A number of variables are included into the model to capture the effect of asset composition, including CLOAN, LOAN, SEC, and CUR.

NPLOAN: ratio of non-performing loans measures the credit risk. We expect a positive impact on the probability of failure and negative impact on the survival time.

SAL: ratio of salary expenses is introduced to identify the problem of moral hazard. We expect the negative influence of salary expenses on the probability of failure.

Since considerable historical and recent evidence exists that bank solvency depends upon the level of economic activity (see Bordo, Redish and Rockoff (1995) and Kryzanowski and Roberts (1993)), we include a number of macroeconomic variables to control general market conditions.

RISK: relates to perceptions of the degree of political risk and ranges between 10 (low risk) and 0 (high risk), and the low political risk is expected to influence positively on banks' performance.

D: since after 1996 the financial market has deteriorated in the result of change in legislation and regulation strengthening we introduced dummy variable and expect it to be significant and have positive sign for the probability of failure and negative for the survival time.

C h a p t e r 2

ESTIMATED RESULTS

Maximum likelihood estimation

The parameters of the Split-population survival-time model are estimated in two stages[3]. As described above, first, the value for d and parameters a are estimated using a logit model. The dependent variable for this model takes on the value of one if bank fails and zero otherwise. The estimated values for a are then substituted into Equation (1) taken in the logarithmic form and the maximum likelihood function is then estimated using the specification for the survival function $S(t)$ described above. The specification is given by Equation (8).

$$\ln L=\sum_{i=1}^{n}[-\ln(1+e^{a'X})+Q_i(\ln p t_i^{p-1}-pb'X)-2Q_i\ln[1+(e^{-b'X}t_i)^p]+(1-Q_i)\ln(e^{a'X}+\frac{1}{1+(e^{-b'X}t_i)^p})] \qquad (8)$$

The dependent variables for the survival model are the truncation vector Q and the time of survival of individual banks (the number of years before actual failure).

The empirical findings are presented in Table 2. The results for the probability of failure suggest that bank-specific variables are important determinants of bank failures, while macroeconomic and political variables are not. Regression run with all macroeconomic and political factors is statistically insignificant and not reported here. Signs of all variables are invariant to including additional variables into the model.

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[3] Procedure was first suggested in Gonzalez-Hermosillo, Pazarbasioglu and Billings (1996)

Table 2 The determinants of survival and survival time of Belarusian banks

Variable	Probability of failure	Survival time
C	-7.3637 *** (-3.8542)	-3.4629 ** (-2.5568)
SIZE	0.6432 *** (4.2314)	48.6390 (4.7583)
NPF	-32.054 ** (-2.1017)	1.9758 * (1.6627)
EM	0.0008 (0.1612)	-1.2898 (-0.7029)
CLOAN	0.4905 (0.441366)	0.4465 (0.4632)
LOAN	2.359493 * (1.778543)	1.6827 (1.5888)
SEC	15.24104 *** (2.754689)	-12.5128 ** (-2.4320)
CUR	1.684037 (1.559342)	2.5280 (0.1646)
INV	3.092776 (0.227363)	50.0000 (0.5525)
NPLOAN	0.000247 0.661249	-1.8190 (-1.1815)
SAL	-1.173421 (-0.143123)	2.7619 (0.3532)
GOV	-1.816709 ** (-2.222426)	-1.0887 (1.6437)
GDP	-0.742071 *** (-2.683301)	-0.2279 (-1.0813)
INFL		0.000474 (0.872037)
ERATE		-0.000212 *** (-4.410518)
IRATE		-0.615504 * (-1.939846)
RISK		0.072256 (0.380648)
REF		0.724502 ** (2.278155)
D		-0.158842 (-0.506445)
P	0.95 *** (10.1713)	

z-statistic is given in parentheses

*** significant at the 1 percent level

** significant at the 5 percent level

* significant at the 10 percent level

We should note that the sign of the estimated coefficients suggest the direction of the effect of the variable on the hazard function when the hazard is monotonic, but magnitudes of the effects may also be difficult to interpret in terms of the hazard function. But in some cases, such as log-logistic, in which the hazard is nonmonotonic, even this can be ambiguous. In our case we do get regression-like interpretation.

The signs of the estimated coefficients for the probability of failure correspond to the a priory expectations in all cases for which the signs are unambiguous, with the notable exception of bank size. In contrast to all previous studies, Belarusian banking experience suggests the positive relationship between asset size and probability of failure. We interpret this result as providing an evidence for the view that large banks emerged from former Soviet banks are less mobile due to poor management, unable to compete successfully in the new environment and, therefore, more likely to fail.

Positive coefficient of the net profit margin variable means that higher profitability today reduces the probability of failure in the future. Implicitly, it shows the higher management quality and banks with better management are less likely to be a subject to a significant risk of occasional failure.

With respect to the bank-specific variables, higher values of consumer and other loans, equity investments, security and currency operations increase the probability of failure. These findings correspond to previous studies conducted by Cole and Gunther (1995), Gonzalez-Hermosillo, Pazarbasioglu and Billings (1996), Meyer and Pifer (1970). We found that there is no very significant difference between consumer loans and investments position of failed and survived banks, that can be explained by the fact that Belarusian banks concentrated on short-term commercial loans rather than long-term investments or consumer lending.

These results give an important information for bank's managers, who can reallocate bank's assets so as to reduce share of unsafe kinds of activities and, therefore, to prevent failure.

We also found that government intervention is a significantly negative determinant of bank's closure, which support Bennett and Loucks (1996) findings.

Negative impact of GDP growth implies that probability of bank failures is negatively correlated with higher level of economic activity.

Splitting population procedure facilitates inference about the separate effects of a given variable and on failure and the timing of failure. And the results from the split-population model pertaining to the relationship between the explanatory variables and bank survival time are of particular importance, because they provide evidence on the factors influencing the timing of bank failure. However, factors, which determine likelihood of failure, differ significantly from the factors, which determine the timing of failure, and survival time can be explained only partially with bank-specific variables.

Coefficient of size here was found positive and significant, which means that regularity cost associated with closure of large banks have extended the survival time of large failing banks.

Similar to the finding of the likelihood of failure, the risk associated with security operations could significantly shorten the expected life of failing bank.

Macroeconomic variables play a pivotal role in influencing the survival time. High real interest rate as well as depreciation of the exchange rate decreases the time of failures. These results are consistent with Gonzalez-Hermosillo, Pazarbasioglu and Billings (1996) results. This finding has important messages for contemporary policy making. It will then be the responsibility of the monetary authorities to act to protect the banking system at large.

Coefficient of reforms takes a positive value reflecting the lengthening of survival time in more developed market.

No evidence was found that change in regulation in 1996 significantly influenced bank failures.

The coefficients of other variables are not statistically significant at the standard levels. Moreover, the signs of variables, which were found insignificant, are not robust to the changes in the model specification.

The estimated results for the split-population survival-time indicates that not all variables, which explains the probability of failure, are useful to explain the timing of failure. This finding facilitates inference about the separate influence of a given variable on failure and the timing of failure.

Testing of the model

An important step in estimating the split-population survival-time model is the evaluation of the appropriateness of underlying distributions, because the assumed distribution has a considerable bearing on the answers.

There is no direct counterpart to the set of regression residuals with which to assess the validity of the specification. The coefficients themselves can be analyzed with the familiar tests, but the assessment of the overall specification is more difficult.

Cole and Gunther (1995) propose to accomplish it by estimating the model of unconditional predicted hazard and comparing its results with those obtained with non-parametric estimate. Unconditional predicted hazard used from the split-population model is the following

$$h^{*}(t) = \frac{\boldsymbol{d}f(t)}{[(1-\boldsymbol{d}) + \boldsymbol{d}S(t)]}, \tag{9}$$

which is estimated using the previously obtained values for $\boldsymbol{d}$ and parameters $\boldsymbol{a}$, $\boldsymbol{b}$, p of density function and survival function.

The non-parametric hazard estimate used here is the number of failures in period t divided by the number of banks at risk in period t, where the number of banks at risk is equal to the number of banks that neither failed nor were censored in prior periods.

Table 3 and Figure 1 shows the nonparametric hazard estimate along with the hazard estimated based on the split-population log-logistic model.

Table 3 Estimated hazard for bank failure

Year	Hazard rate		Residual
	Nonparametric	Split-population model	
1992	0	0,020952	-0,02095
1993	0	0,077748	-0,07775
1994	0,142857	0,148513	-0,00566
1995	0,181818	0,171182	0,010636
1996	0,096774	0,103604	-0,00683
1997	0,035714	0,058278	-0,02256
1998	0,037037	0,04639	-0,00935

As shown the hazard predicted by the split-population model closely follow the shape of the nonparametric hazard that indicates an adequate parametric estimation.

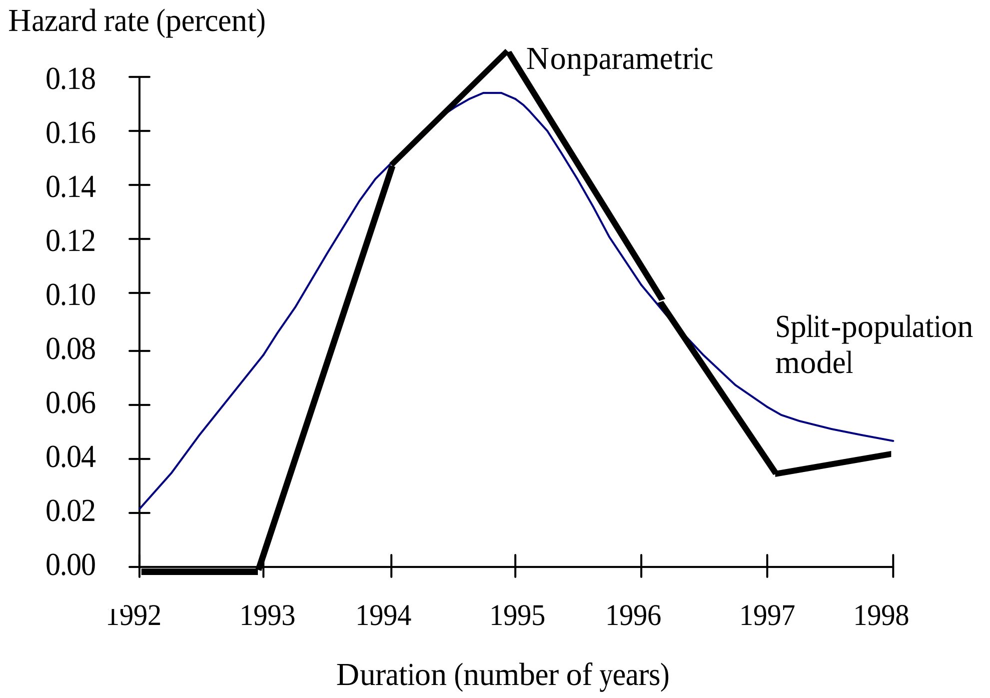

Figure 1 Estimated hazard for bank failure

Conclusion

Rise in bank failures on the developing financial market in the Eastern European countries has necessitated searches for the reasons that lead banks toward a bankruptcy or insolvency. We applied a split-population survival-time model to analyze the determinants of bank failures and survival time for Belarusian case.

The analysis has demonstrated that individual bank factors such as profitability, loan and security operations, quality of bank's management, are very important in explaining the probability of bank failures, but less powerful in the explaining the survival time. In contrast, most macroeconomic and political variables have not a significant influence on the probability of failure, but macroeconomic shocks could shorten the survival time of failing banks. We argue that the state intervention and the intrinsic financial problems are both necessary for failure to occur, and this risk can be reduced with a maintaining reasonable and predicted macroeconomic policy as well as stable political conditions.

We also found a significant difference between basic indicators of bank failures in transition countries and developed economies.

Our results have important implications to bank regulators, bank investors, and other parties concerning with assessing the expected survival time of financially impaired banks. All such individuals must evaluate the risk embedded in bank's activity and thus are aided by an understanding of the factors that influence fa ilure risk.

Since the probability of bank failures mostly depends on intrinsic factors, bank managers can use this information for evaluation of bank's risk position and adjust their policy accordingly.

Taken as given in this paper is the desirability of prudential regulation and also the necessity of supervision adequate to ensure that such regulation are implemented properly. Regarding to this, our findings are very useful for banking sector regulation. A screening procedure based on our results could identify early warning signals and provide ex-ante correction of impending bankruptcies. Based upon the expected survival time bank's managers and regulators can create a strategy when regulatory forces will take effect. Similarly, banks with the shortest survival time will be targeted for prompt closure.

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