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Michalak, Tobias / Uhde, André

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The nexus between monetary policy, banking market structure and bank risk taking

Tobias Michalak[1] & André Uhde[2]

Abstract:

Using a sample of stock-listed bank holding companies located in Western Europe over the period from 1997 to 2008 this paper provides empirical evidence that an increase in short-term interest rates as well as an extended period of expansionary monetary policy has a negative impact on European stock-listed banks' soundness as measured by the Expected Default Frequency. Against this background and in order to evaluate interactions between the risk-taking channel of monetary policy and the competitiveness of a country's banking market we find a negative impact of an increase in competition in the loan market – proxied by the Boone-indicator – on financial soundness. Referring to the structural-conduct performance (SCP) paradigm, this paper provides further evidence that an increase in concentration in the banking market spurs financial soundness.

JEL classification: E43, E44, E52, E55, G01, G28

Keywords: risk-taking channel, competition, concentration, bank soundness, European banking

[1] Dr. Tobias Michalak, Ruhr-University Bochum

[2] Prof. Dr. André Uhde, University of Paderborn, Department of Taxation, Accounting and Finance, D-33098 Paderborn, andre.uhde@wiwi.upb.de (corresponding author)

1. Introduction

Two years after the collapse of the U.S. investment bank Lehman Brothers the health of the global financial system seems to have recovered. However, the risks in the financial system still persist due to the fragile nature of the recovery and the ongoing restructuring of banks and sovereign balance sheets. In this context, the U.S. subprime mortgage crisis from mid-2007 triggered several phases of financial market turbulences, and in particular, several phases of unprecedented disruptions in the Credit Default Swap (CDS) market (IMF, 2010). In response to these unprecedented circumstances, a general reassessment of risks associated with structured finance instruments and European government bonds is observed across the whole financial community.

Under the framework of a "flight to quality", the resulting lack of market liquidity during the height of the U.S. subprime mortgage crisis in combination with the upcoming uncertainty among investors has provoked a decrease in the fair value of financial instruments and a downward tendency of equity prices across European financial markets with an implied volatility of equity price indices being well above the levels experienced in recent periods of financial market turbulence (BoE, 2007). A fortiori, central banks in major financial markets were forced to act as lenders of last resort by providing large amounts of liquidity to protect from further distortions, already before the collapse of Lehman Brothers on September 15, 2008 (BoE, 2007; BIS, 2007). To date, the International Monetary Fund (IMF) values the total bank write-downs and loan loss provisions at approximately 2,276 billion USD (IMF, 2010), probably constituting a serious threat of systemic fragility. The latter is supported by failures in valuating complex securitization instruments, poor transparency in structured finance markets and weak forces of market discipline, which in total have exposed the financial system to a serious funding and confidence crisis (IMF, 2010, 2009, 2009a, 2008, 2008a, 2007).

Referring to these findings, recent theoretical and empirical studies suggest that the excessive risk taking was encouraged by the excessively low level of short-term interest rates over the period preceding the global financial crisis (e.g., Taylor, 2009; Calomiris, 2009). In particular, the extended period of expansionary monetary policy may have contributed to an excessive credit expansion and thus ultimately to a boom-and-bust cycle in equity valuations and in the housing market. Recently, various authors suggest that monetary policy decisions are not necessarily neutral from a financial stability point of view (Delis and Kouretas, 2010; Altunbas et al., 2010; Gambacorta, 2009; Diamond and Rajan, 2009, 2006; Adrian and Shin, 2009; Allen et al. 2009; Taylor, 2009; Calomiris, 2009; Borio and Zhou, 2008). In this context, Borio and Zhu (2008) point out the so called "risk-taking channel" of monetary policy, which operates in at least three different dimensions. In particular, their analysis of the "risk-taking channel" focuses on (a) the impact of low levels of short-term interest rates on valuations, income and cash flows (Adrian and Shin, 2009), (b) the nexus between low levels of short-term interest rates and target rate of returns – the "search for yield" – (BIS, 2004; Ryan, 2005), and finally (c) the communication policy and reaction function of the monetary authority.

With regard to the second aspect of the "risk-taking channel" (b), it is also suggested that a continuously increasing competitive pressure in banking markets in combination with a credit expansion may force banks to increase profit margins by softening their lending standards and increasing their risk exposure to fulfill capital market expectations (Keeley, 1990; Dell' Ariccia and Marquez, 2006; Peydrò and Maddaloni, 2010).

Again this background and to identify possible interactions between the "risk-taking channel" and the competitiveness of a country's banking market, this paper investigates the nexus between low levels of short-term interest rates, monetary policy decisions, the banking market structure and financial soundness using a dataset of stock-listed bank holding companies for Western Europe (EU-9) plus Switzerland over the period from 1997 to 2008. Our study is close in spirit to the empirical investigation of the nexus between interest rates, monetary policy decisions and bank risk-taking provided by Altunbas et al. (2010). However, to the best of our knowledge, this is the first study that empirically investigates the interaction between the "risk taking channel" of monetary policy and the competitiveness of a country's banking market while employing the new empirical industrial organization approach to banking. In particular, using a unique dataset of bank-year observations in the EU-9 plus Switzerland over the period from 1997 to 2008, we calculate the Boone-indicator and the Lerner-index proposed by Boone (2008) and Lerner (1934), respectively, to proxy the competitiveness of a country's banking market. Moreover, referring to the structure-conduct-performance (SCP) paradigm, we extend our analysis by investigating the impact of the national banking market concentration on financial stability. Finally, we complement previous empirical studies by performing a large variety of robustness checks and sensitivity analyses.

The remainder of the paper is organized as follows. Section 2.1 presents the theoretical background, while Section 2.2 reports previous empirical studies on the relationship between monetary policy and banking stability. Section 3 introduces our empirical methodology. While Section 3.1 presents the data set, Section 3.2 describes our empirical model. The empirical results are presented and discussed in Section 4 and illustrated within Appendices A and B. Finally, Section 5 concludes.

2. Related literature

2.1. Theoretical background

Economic theory provides several predictions that *monetary policy decisions* are not neutral from a *financial-stability* perspective. In particular, recent theoretical and empirical studies suggest a trade-off between an extended period of low short-term interest rates and financial soundness (Delis and Kouretas, 2010; Altunbas et al., 2010, Gambacorta, 2009; Diamond and Rajan, 2009, 2006; Adrian and Shin, 2009; Allen et al. 2009; Taylor, 2009; Calomiris, 2009; Borio and Zhou, 2008). In this context, Borio and Zhu (2008) introduce the so-called "risk-taking channel" of monetary policy, defined as the short- and long-term impact of changes in monetary policy rates (short term interest rates) on either risk perception and/or risk tolerance in the banking industry, and finally on banks' overall risk exposure. In particular, their analysis of the "risk-taking channel" of monetary policy focuses on three different aspects (see also Altunbas et al., 2010; Gambacorta, 2009): (a) the impact of low levels of short-term interest rates on asset valuations, income and cash flows (see also Adrian and Shin, 2009), (b) the nexus between low levels of short-term interest rates and the target rate of returns – the "search for yield" – (see also BIS, 2004; Ryan, 2005) and (c) the communication policy and reaction function of the monetary authority.

Referring to the first aspect, it is well accepted that monetary policy decisions affect financing conditions and capital market expectations. Thus, it is emphasized that a low level of short-term interest rates stretching over an extended period of time may boost asset and collateral values as well as incomes. In turn, an increase in asset and collateral values may have a direct influence on the banks' estimates of probabilities of default, loss given default and implied market volatilities. As a consequence, an increase in asset and collateral values may thus lead to a reduction in risk perception and/or an increase in risk tolerance (Adrian and Shin, 2009).

The second aspect – the nexus between low levels of short-term interest rates and sticky target rate of returns – predominantly depends on the banks' investment policy, and in particular their incentive to bear more risk to fulfill capital market expectations and/or contractual agreements as well as regulatory and institutional constraints (Gambacorta, 2009). Accordingly, a number of psychological and behavioral aspects are assumed that determine the banks' "search for yield" and risk-taking behavior (e.g., the so called "money illusion"). In this context, Ryan (2005) points out that an extended period of low short-term interest rates accompanied with an associated decline in the volatility of short-term interest rates, may release the banks' overall portfolio risk and hence encourages an increase in risk taking (behavior). Moreover, it is additionally emphasized that extended periods of low short-term interest rates provoke a decrease in spreads between the lending and deposit rates, which ultimately determines the banks' "search for yield". In this context, it is also underlined that a continuously increasing competitive pressure in banking markets in combination with a credit expansion, may force banks to increase profit margins by softening their lending standards and increasing their risk exposure to fulfill capital market expectations (Keeley, 1990; Dell' Ariccia and Marquez, 2006; Maddaloni and Peydró, 2009).

However, relevant theoretical and empirical studies are not conclusive about the relationship between *banking market competition* and *financial stability* (Schaeck and Čihák, 2008; Schaeck et al., 2006; Beck et al.; 2006; Boyd and De Nicoló, 2006; Carletti and Hartmann, 2003). Theoretical predictions concerning the impact of the banking market structure on the "search for yield" theory are in line with theoretical models and empirical findings predicting that in a more competitive environment with higher pressures on profits, banks may have higher incentives to take more excessive risks, finally resulting in higher financial fragility. In addition, banks are anticipated to earn fewer informational rents from their relationship with borrowers in competitive markets, which may reduce their incentives to properly screen borrowers, also increasing the risk of fragility (e.g. Beck, 2008; Allen and Gale 2004, 2000). In contrast, however, a higher competitive pressure may also deter excessive risk-taking behavior by the bank's management (see, for example, the "*charter value hypothesis*", Keeley, 1990). Accordingly, to the extent that higher market competition keeps banks from operating in too risky lines of business, banking systems with a higher competitive level are assumed to be more stable (Boyd and De Nicoló, 2006; Carletti and Hartmann, 2003).

Moreover, relevant theoretical and empirical literature also provides countervailing predictions concerning the interaction between the "*risk taking channel*" of *monetary policy* and the *competitiveness* of a country's *banking market*. On the one hand, it is likely that the impact of monetary policy decisions and the corresponding changes in the short-term interest rates on bank soundness may itself depend on the underlying banking market structure and, in particular, the interaction between the banking market structure and the interest rate pass-though mechanism (process) of market rates (e.g. Leuvensteijn et al., 2008, Gropp et al., 2006, De Bond, 2005; Maudos and Fernández de Guevara, 2004, Corvoisier and Gropp, 2002, Borio and Fritz, 1995; Cottarelli and Kourelis, 1994). On the other hand, however, it is also emphasized that the causality running from the banking market structure to short-terminterest rates and finally to banking stability is not clear since it is not obvious if the banking market structure itself depends on monetary policy decisions, interest rates and finally the bank's financial soundness (see also Amel and Liang, 1997). Hence, from a theoretical and empirical point of view it is obvious that the banking market structure may affect the monetary policy transmission mechanism and, in particular the interest rate pass-through process of market rates and finally financial fragility (see also Leuvensteijn et al., 2008)

Finally, referring to the last aspect (c), the impact of monetary policy decisions on financial soundness depends on the communication policy and reaction function of the monetary authority and, in particular, the ability of central banks to manage inflation and short-term-interest rate expectations. In this context, a higher transparency and predictability of monetary policy should reduce "ex-ante" uncertainty concerning changes in inflation and short-term interest rates, which in turn should reduce uncertainty about intermediate- and long-term interest rates as well as financial market prices. However, relevant economic theory provides countervailing predictions concerning the relationship between the communication policy and reaction function of the monetary authority and banking stability. On the one hand, it is suggested that higher transparency concerning the stance of monetary policy should strengthen a bank's ability to anticipate future inflation and interest rates, and finally strengthen a bank's capability to reprice assets and liabilities (Blinder et al., 2008; Blattner et al., 2008). On the other hand, however, it is assumed that a low level of short-term interest rates in combination with a higher predictability of monetary policy decisions and, in particular, the market anticipation of an extended period of low short-term interest rates, could facilitate risk-taking incentives – the "search for yield" (Borio and Zhou, 2008).

2.2. Empirical evidence

Empirical literature with a special focus on the relationship between short-term interest rates, monetary policy decisions and financial stability is rather scarce. To begin with, using micro-level data of the Credit Register of the Bank of Spain for 350 commercial, savings and cooperative banks in Spain over the period from 1984 to 2006, Jeménez et al. (2009) provide empirical evidence that an extended period of expansionary monetary policy is inversely related to a bank's credit risk in the medium run supporting the "search for yield" theory. Thus, the authors suggest that banks may increase their risk exposure by softening their lending standards during longer periods of low short-term interest rates. Moreover, and in contrast, they provide further evidence that low short-term interest rates reduce default rates of outstanding loans in the short-run.

Subsequently, Ioannidou et al. (2009) confirm empirical findings by Jimenéz et al. (2009) using micro-level data of the public credit register of Bolivia for Bolivian banks over the period from

1999 to 2003. In addition, they provide evidence that the "risk-taking channel" not only affects the loan origination proxied by the quantity of new loans but also the pricing of new loans. In particular, their analysis reveals that expansionary monetary policy increases the risk-taking appetite of banks and the likelihood that banks do not adequately price these additional risks.

Using quarterly balance sheet data of 643 stock-listed bank holding companies in the EU-15 plus the U.S. between 1998 and 2008, Altunbas et al. (2010) provide empirical evidence that an extended period of low short-term interest rates and, in particular, a period of short-term interest rates below a benchmark level, has a positive impact on financial fragility, supporting the "search for yield" theory. Moreover, their analysis reveals that the effectiveness of the "risk-taking channel" of monetary policy still holds when they control for changes in business expectations, differences in the regulatory framework and finally changes in bank competition.

Finally, Delis and Kouretas (2010) examine the effect of low short-term interest rates on bank stability using a large dataset of quarterly and annual balance sheet data from Western European banks over the period from 2001 to 2008. In line with Altunbas et al. (2010), they find that low short-term interest rates increase bank risk-taking substantially. In addition, their empirical analysis reveals that, ceteris paribus, the impact of the "risk-taking channel" of monetary policy on financial soundness is larger for low-capitalized banks and that the increase of credit risk is significantly higher for banks with high off-balance-sheet items.

3. Empirical methodology

3.1. Data and sources

Notes on variables and data sources are presented in Table 1 (*Dynamic Panel Regression*) and Table 2 (*The Boone-indicator and the Lerner-index*). Tables 3 to 6 report descriptive statistics for the entire set of included variables. The corresponding correlation matrix is provided in Table 13.

3.1.1. Bank soundness

Our empirical analysis focuses on consolidated balance sheet data from 65 stock-listed bank holdings[1] across the EU-9[2] plus Switzerland over the period from 1997 to 2008 following the introduction of the "*Single Banking License*" in 1997 in Europe. Banks' consolidated balance sheet data are retrieved from the BankScope database, which is compiled by FitchRatings and provided by Bureau van Dijk.

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[1] To ensure a high degree of comparability in accounting standards we exclusively include stock-listed banks (see also Altunbas et al. (2010)). Nevertheless, from a macroeconomic point of view our sample of 65 stock-listed banks is still highly relevant for Europe, as it represents around 46.5 percent of total lending and 44.3 percent of total assets as compared to the entire European banking sector.

[2] The initial sample comprises the EU-15 plus Switzerland. However, we exclude countries with less than 20 bank year observations, since the estimations of the Boone-indicator and the Lerner index require a minimum of 20 bank year observations. Accordingly, the EU-9 comprises Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Spain and the United Kingdom.

We employ the banks' distance to insolvency as a proxy for financial soundness by including the *Expected Default Frequency* (Risk Neutral Default Probability) as our dependent variable. The *Expected Default Frequency* is the probability, expressed as a percentage, that the market value of a bank's assets will be lower than a distress barrier within a given time horizon. This indicator has become a popular measure of bank soundness in related empirical work on financial stability (e.g., Huang et al. 2010; Altunbas et al. 2010).

We calculate the *Expected Default Frequency* using a step-by-step (two-step) approach. To begin with, we employ the *Merton framework* (1974, 1973) to calculate a bank's *Distance-to-Default* (DtD). The well-known *Distance-to-Default measure* is build from traditional accounting-based information and combines this information with current and future financial market prices to predict a bank's insolvency risk. The indicator is defined as follows:

$$DtD \equiv \frac{ln\left(\frac{V_A}{DB}\right)+\left(\mu-\frac{1}{2}\sigma^2\right)T}{\sigma_A\sqrt{T}}, \qquad (1)$$

where V_A is the current value of assets, σ_A is the standard deviation of assets, DB is the distress barrier, defined as the face value of short-term liabilities (maturity $\leq$ 1 year) plus half of the amount of long-term liabilities (maturity > 1 year), μ is the drift rate of assets and T is maturity of debt (time horizon). Obviously the *Distance-to-Default* decreases with (a) a decrease in bank asset value, (b) an increase in asset volatility and/or (c) an increase in bank leverage. Building the *Distance-to-Default* this way, it is designed to indicate the number of standard deviations the bank's asset value is away from the default point within a given time horizon (usually one year). The default point in turn is associated with the probability that the market value of a bank's assets falls below the market value of its debt (distress barrier). Thus, a higher (lower) *Distance-to-Default* ratio implies a lower (higher) probability of insolvency risk.

In a second step, we translate the derived *Distance-to-Default* (DtD) of bank *i* at time *t* into a time-variant *Expected Default Frequency* (EDF) based on the risk neutral valuation framework. Accordingly, the *Expected Default Frequency* (EDF) is defined as follows:

$$EDF \equiv N(-DtD) = N\left(-\frac{ln\left(\frac{V_A}{DB}\right)+\left(\mu-\frac{1}{2}\sigma_A^2\right)T}{\sigma_A\sqrt{T}}\right), \qquad (2)$$

with $N(\bullet)$ following a standard normal distribution. Therefore, a higher (lower) ratio of the *Expected Default Frequency* implies a higher (lower) probability of default. Further details and an in-depth technical discussion of the construction of these distance-to-default measures are provided in Appendix B.

3.1.2. The monetary policy indicator

As discussed in greater detail in Section 2 (theoretical background), the direct relationship between monetary policy and bank risk-taking may be generally attributed to two different "transmission channels". First, the impact of *short-term interest rates* on the quality of assets of domestic banks and second, the influence of *short-term interest rates* on the "search for yield". Unfortunately, since it is impossible to separate the bank's investment policy and capital structure decisions associated with changes in the stance of monetary policy from the general operating and strategic "asset-liability-management" as well as the dynamics of bank's portfolio risks, we are not able to empirically control for respective transmission channels in a straight-forward fashion.

Therefore, we initially include the change in the three-month interbank offered rate at the country level (denoted as *interest rate*) to control for the direct impact of short-term interest rates on bank soundness. Subsequently, we employ the difference between the nominal short-term interest rate and the rate implied by different benchmark models to evaluate the stance of monetary policy (see also Altunbas et al. (2010).

In this context, the stance of monetary policy is proxied by three different measures of interest rate gaps. We estimate the different interest rate gaps for each country and each year in our sample for the period from 1997 to 2007. We employ three different interest rate gaps as follows:

(1) The difference between the three-month interbank offered rate and the rate implied by a Taylor rule with interest rate smoothing. Accordingly, the Taylor rule is defined as follows:

$$i_t = (1-\gamma)\left[\alpha + \beta_\pi\left(\pi_t - \pi^*\right) + \beta_y\left(y_t - y^*\right)\right] + \gamma i_{t-1}, \qquad (3)$$

where i_t is the target interest rate (Taylor rate), γ characterizes the degree of interest rate smoothing, α is the natural interest rate[3], π_t is the inflation rate, π^* is the target inflation rate and $y_t - y^*$ is the output gap (the difference between the actual GDP and its long-term potential level). In line with Altunbas et al. (2010), we initially set γ to 0.85, $\beta_\pi = 1.5$ and $\beta_y = 0.5$, and finally π^* to 2.0 percent.

(2) The difference between the three-month interbank offered rate and the rate implied by the standard Taylor rule, which is defined as follows:

$$i_t = (1-\gamma)\left[\alpha + \beta_\pi\left(\pi_t - \pi^*\right) + \beta_y\left(y_t - y^*\right)\right] + \gamma i_{t-1}, \qquad (4)$$

[3] The natural interest rate is estimated by means of a Hodrick-Prescott filter.

Following Taylor (2001, 1993), we set γ to 0.0, $\beta_\pi = 0.5$ and $\beta_y = 0.5$.

(3) The difference between the three-month interbank offered rate and the "natural interest rate" ("benchmark level").

3.1.3. Measures of competition

We employ two time-variant measures of banking market competition and two time-variant measures of banking market concentration. The competitiveness of a country's banking market is proxied by the Boone-indicator and the Lerner-index proposed by Boone (2008) and Lerner (1934), respectively. Moreover, we include the 5-bank concentration ratio and the Herfindahl-Hirschman index to proxy the banking market concentration. Notes on variables and data sources used to calculate the Boone-indicator and the Lerner-index are presented in Table 2. Table 5 reports descriptive statistics for the Boone-indicator, whereas Table 6 presents descriptive statistics for the Lerner-index. Moreover, Figures 1 and 2 more precisely illustrate the development of the Boone-indicator and the Lerner-index on a country level for the EU-9 and Switzerland over the sample period.

3.1.3.1. The Boone-indicator

We initially employ the Boone-indictor to infer the degree of competition of a country's banking market and, in particular, a country's loan market. Boone (2008, 2001) postulates in several theoretical models that efficient firms gain higher market shares as well as higher profits and that this basic effect is positively correlated with the competitive environment in the respective market (i.e., the basic effect is stronger in a more competitive environment with higher pressures on profits). In this context, Boone (2008) suggests the following specification to proxy the profit elasticity of a specific market:

$$ln\left(\pi_{i,t}\right) = \alpha + \beta\, ln\left(\frac{mc_{i,t}}{\sum_j mc_{j,t}}\right), \tag{5}$$

where $\pi_{i,t}$ is the profit of firm i at time t and $mc_{i,t}$ are the marginal costs of firm i at time t. β represents the profit elasticity (i.e., the decrease in profits of firm i at time t, expressed as a percentage, as a result of a one percent increase in marginal costs of firm i at time t). Accordingly, the Boone-indicator (β) is negative and measures the elasticity of firms' profits toward firms' marginal costs. In this context, higher negative values of β indicate more competitive markets.

In line with Leuvensteijn et al. (2007) and Schaeck and Čihák (2008), we employ a step-by-step (two-step) approach to calculate the Boone-indicator for each country and each year from 1997 to 2008 using individual-bank year observations.

To begin with, the marginal costs of loans are obtained by differentiating a translog cost function with two outputs (total loans and other earning assets) by one output (total loans). Following the methodology provided by Schaeck and Čihák (2008), we use a stochastic frontier model to estimate a translog cost function for each country based on individual bank observations with two outputs (total loans and other earning assets), three inputs (labor, funding and capital costs) and three netputs (fixed assets, deposits and equity capital). Hence, the translog cost function is defined as follows:

$$\begin{aligned} ln\,C = {} & \alpha_0 + \sum_{i=1}^{2}\alpha_i\, ln\,Y_i + \frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\delta_{i,j}\, ln\,Y_i\, ln\,Y_j + \sum_{k=1}^{2}\beta_k W_k + \sum_{h=1}^{2}\mu_h\, ln\,E_h \\ & + \frac{1}{2}\sum_{k=1}^{2}\sum_{m=1}^{2}\gamma_{k,m}\, ln\,W_k\, ln\,W_m + \sum_{i=1}^{2}\sum_{k=1}^{2}\rho_{i,k}\, ln\,Y_i\, ln\,W_k + \sum_{i=1}^{2}\sum_{h=1}^{2}\varepsilon_{i,h}\, ln\,Y_i\, ln\,E_h \\ & + \sum_{k=1}^{2}\sum_{h=1}^{2}\lambda_{k,h}\, ln\,W_k\, ln\,E_h + \frac{1}{2}\sum_{h=1}^{2}\sum_{n=1}^{2}\psi\, ln\,E_h\, ln\,E_n + ln\,\nu_c + ln\,\varepsilon_c, \end{aligned} \tag{6}$$

where C are the total costs, Y is a vector of outputs (total loans and other earning assets), W is a vector of inputs (labor, funding and other costs), E is a vector of netputs (fixed assets, deposits and equity capital), ν is the inefficiency term and ε is the error term.[4]

Subsequently, to obtain the marginal costs of loans, we differentiate equation (6) with respect to the bank's total loans L:

$$mc_{i,t} = \frac{\partial C}{\partial L} = \left[\alpha_1 + \delta_1\, ln\,Y_1 + \delta_2\, ln\,Y_2 + \rho_1\, ln\,W_1 + \rho_2\, ln\,W_2 + \varepsilon_1\, ln\,E_1 + \varepsilon_2\, ln\,E_2\right]\frac{C_{i,t}}{L_{i,t}}\,. \tag{7}$$

Finally, we estimate the following linear relationship between an individual bank's market share in the loan market and the bank's marginal costs of loans:

$$ln\left(s_{i,t}\right) = \alpha + \beta\, ln\left(\frac{mc_{i,t}}{\sum_j mc_{j,t}}\right), \tag{8}$$

[4] Total costs and input prices are scaled by one other input price (labour cost) and by one other netput (equity capital).

where $s_{i,t}$ is the market share in the loan market of bank *i* at time *t* and $mc_{i,t}$ are the marginal costs of bank *i* at time *t*. In this context, β represents the Boone-indicator.

According to relevant empirical literature, the causality running from bank's marginal costs of loans to bank's market share in the loan market is not clear since it is not obvious if the marginal costs of loans depends on the bank's market share in the loan market. Hence, reverse causality may arise as a particular case of endogeneity, for example, if a large (monopolistic) bank exhibits lower marginal costs due to the fact that larger banks may have comparative advantages in providing credit monitoring services and/or larger banks may be able to diversify loan portfolio risks more efficiently due to higher economies of scale and scope. As a consequence, and in line with Schaeck and Čihák (2008), we apply instrumental variable techniques using a GMM-style estimator and employ two-period lagged marginal costs of loans as an instrumental variable.

As both theoretical and empirical studies are not conclusive about the impact of banking market competition on financial stability (Schaeck and Čihák, 2008; Schaeck et al., 2006; Beck et al.; 2006; Boyd and De Nicoló, 2006; Carletti and Hartmann, 2003), we expect an ambiguous effect of our competition measures on financial stability.

3.1.3.2. The Lerner-index

Next to the Boone-indicator we further include the Lerner-index as a traditional measure of a bank's market power. The Lerner index measures the price-marginal-cost-difference as the inverse of the price elasticity of demand. In a perfectly competitive market, where the demand curve is perfectly elastic, the Lerner index equals zero. In a monopoly market, the bank will use its market power to set its profit-maximizing output in the inelastic portion of the demand curve and charges a price greater than the marginal cost. In this case, the Lerner index turns toward the value of one. Again, we expect an ambiguous effect of our competition measure on bank soundness.

We construct the time-variant Lerner-index on a country level as follows:

$$Lerner-index_{i,t} = \frac{p_{i,t} - mc_{i,t}}{p_{i,t}}, \tag{9}$$

where $p_{i,t}$ is the output price (interest and non-interest revenues divided by total assets) of bank *i* at time *t* and $mc_{i,t}$ are the marginal costs of bank *i* at time *t*. The marginal costs are obtained by differentiating a translog cost function with one output (total assets) by output. Following the methodology provided by Schaeck and Čihák (2008), we use a stochastic frontier model to estimate a translog cost function for each country based on individual bank observations with one output (total assets), three inputs (labor, funding and capital costs) and three netputs (fixed assets, deposits and equity capital). The translog cost function is defined as follows:

$$ln\,C = \alpha_0 + \alpha_1\, ln\,Y + \frac{1}{2}\alpha_2\, ln\,Y^2 + \sum_{k=1}^{2}\beta_k W_k + \sum_{h=1}^{2}\mu_h\, ln\,E_h + \frac{1}{2}\sum_{k=1}^{2}\sum_{m=1}^{2}\gamma_{k,m}\, ln\,W_k\, ln\,W_m$$

$$+\sum_{k=1}^{2}\rho_k\, ln\,Y\, ln\,W_k + \sum_{h=1}^{2}\varepsilon_h\, ln\,Y\, ln\,E_h + \sum_{k=1}^{2}\sum_{h=1}^{2}\lambda_{k,h}\, ln\,W_k\, ln\,E_h$$

$$+\frac{1}{2}\sum_{h=1}^{2}\sum_{n=1}^{2}\psi\, ln\,E_h\, ln\,E_n + ln\,v_c + ln\,\varepsilon_c \tag{10}$$

where C are the total costs, Y is the output (total assets), W is a vector of inputs (labor, funding and other costs), E is a vector of netputs (fixed assets, deposits and equity capital), v is the inefficiency term and ε is the error term.[5]

Finally, to obtain the marginal cost, we differentiate equation (10) with respect to Y:

$$mc_{i,t} = \frac{\partial C}{\partial Y} = \left[\alpha_1 + \alpha_2\, ln\,Y + \rho_1\, ln\,W_1 + \rho_2\, ln\,W_2 + \varepsilon_1\, ln\,E_1 + \varepsilon_2\, ln\,E_2\right]\frac{C_{i,t}}{Y_{i,t}}. \tag{11}$$

3.1.3.3. The concentration-measure

Referring to the traditional structure-conduct-performance (SCP) paradigm (Berger et al., 2004, 2007), we further include two time-variant measures of banking market concentration. To begin with, the 5-bank concentration is constructed as the fraction of assets of the total banking system's assets held by the five largest domestic and foreign banks per country (Uhde and Heimeshoff, 2009). The Herfindahl-Hirschman Index (HHI) is computed as the sum of the squared market shares of a country's domestic and foreign banks. Calculating concentration ratios in this way addresses the fact that the banking industry is further globalizing and that banks compete not only within national boundaries but also across borders. As both theoretical and empirical studies are not conclusive about the impact of banking market concentration on financial stability (Uhde and Heimeshoff, 2009; Beck et al., 2006; Schaeck et al., 2006; De Nicoló et al., 2004), we expect an ambiguous effect of our concentration measures on financial stability.

3.1.4. Control variables

When examining the relationship between monetary policy, the banking market structure and bank soundness, it is imperative to control for macroeconomic and bank-specific factors as well as the institutional environment (e.g. cross-country differences in the capital market structure and the capital market development) that are likely to affect banking stability, monetary policy, the market structure, or the nexus between these variables, and thus help mitigate omitted-variable biases. We

[5] Total costs and input prices are scaled by one other input price (labor cost) and by one other netput (equity capital).

lagged some of the variables to avoid simultaneity.

Macroeconomic control variables are retrieved from the *World Development Indicator (WDI) database* provided by the *World Bank*. We include well-accepted macroeconomic control variables of rates of real *GDP growth* and *credit growth* to cover a country's macroeconomic development that is assumed to affect the quality of bank assets.

Due to the fact that characteristics of banks in our sample vary across the EU-9 plus Switzerland we employ further bank-specific variables. We employ the bank's one-period lagged *net interest margin* to control for a bank's profitability, the one-period lagged *non-performing loans* as a key measure for credit risk and loan-portfolio quality, the one-period lagged *cost-income ratio* to control for a bank's efficiency and finally, the one-period lagged log of *total assets* as a proxy for the bank's size. We expect a negative sign of the coefficients of *net interest margin* and *total assets* and a positive sign of the coefficients of *non-performing loans* and *cost-income ratio*.

To draw an accurate statistical inference concerning the relationship between monetary policy decisions, the banking market structure and bank soundness we further perform a selection of sensitivity analyses. Due to high correlations between these control variables, and, to avoid simultaneity we include them in turn in separate regressions. In this context, we finally employ the *stock market return* and changes in the *house price index* to control for cross-country differences regarding the capital market structure and the capital market development.

3.2. Empirical model

To test the hypothesis that changes in the stance of monetary policy and the banking market structure affect bank soundness, we use the generalized method of moments (GMM) for dynamic panel data by Arellano and Bover (1995) and Blundell and Bond (1998). Accordingly, we estimate the following dynamic regression model on panel data:

$$y_{i,t} = \alpha + \beta y_{i,t-1} + \sum_{j=0}^{1} \delta_j InterestRate_{k,t-j} + \sum_{j=0}^{1} \phi_j TaylorGap_{k,t-j} + \varphi c_{k,t} + \sum \varpi_j x_{i,k,t} + \varepsilon_{i,t}, \tag{12}$$

where y_{it} represents the *Expected Default Frequency* (EDF) of bank holding *i* in a respective year *t*, *interest rate*$_{k,t}$ is the change in the country-specific three-month interbank lending offered rate at time *t*, *Taylor gap*$_{k,t}$ is the country-specific difference between the three-month interbank lending offered rate and the rate implied by the different Taylor rules at time *t* (as defined in section 3.1.2) and $c_{k,t}$ are country-specific banking market-structure indicators (competition and concentration measures) in a respective year *t*. The vector $x_{k,i,t}$ includes control variables as described above. ε_{it} is an error term and α is the intercept. $\beta, \delta, \phi, \varphi$ and ϖ denote the parameters to be estimated. We further include one-lag of all macroeconomic variables to account for the fact that a country's macroeconomic development may influence the quality of assets of domestic banks with a certain delay. Finally, we further set time dummies to control for time-specific effects.

Estimating a dynamic panel data model, by employing the generalized method of moments (GMM) for dynamic panel data is a consequent strategy for two reasons.[6] First, there are several theoretical and empirical studies indicating a significant level of persistence in bank risk (see, for example, Delis and Kouretas, 2010). If there is persistence in bank risk, a static model may be biased, and the application of a dynamic panel regression model is more appropriate. Second, from a theoretical as well as an empirical point of view, the direction of causality between monetary policy, banking market structure and financial soundness is not clear but is rather assumed to suffer from endogeneity, especially reverse causality. In this context, the GMM-estimator ensures efficiency and consistency, given that the estimated dynamic regression model is not subject to second-order serial correlation and that the instruments employed are valid (see also Delis and Kouretas, 2010). We use the second lags of the dependent variable, the macroeconomic variables, the banking market structure variables and the control variables as instruments in the GMM regression specification. The validity of the instruments is tested using the Hansen's J test statistic of over identifying restrictions, which is robust to heteroskedasticity and autocorrelation. The null hypothesis of the Hansen's J test statistic is that instruments used are not correlated with residuals, i.e. the over identifying restrictions are valid. Moreover, we employ the Arellano-Bond test to control for serial correlation in the first differenced residuals. In this context, the null hypothesis of the Arellano-Bond test statistic is that residuals in the first difference regression do not exhibit serial correlation of order two.

4. Empirical results

We present main empirical results, robustness checks and sensitivity analyses in Table 7 (*Monetary policy, the Boone-indicator and Bank soundness*) and Table 8 (*Monetary policy, the Lerner-index and Bank soundness*). Regression specification (1) reports our baseline regression result assessing the impact of low short-term interest rates, the stance of monetary policy and banking market competition on bank soundness. Regression specifications (2) and (3) comprise different concentration measures to control for the impact of the banking market concentration on the "risk-taking channel" of monetary policy. Regression specification (4) uses a different monetary policy indicator to control for the robustness of our main empirical results. Regression specifications (5) and (6) present empirical results from a selection of sensitivity analyses. Further robustness checks are reported in Table 9 and Table 12. The corresponding correlation matrix is reported in Table 13.

4.1. Baseline findings and robustness checks

4.1.1. Monetary policy, market structure and bank soundness: Boone-indicator estimations

In order to identify possible interactions between the "risk-taking channel" and the competitiveness of a country's banking market the following baseline equation is employed to

[6] Bond (2002) is an excellent survey on dynamic panel data regression models.

assess the impact of low short-term interest rates, monetary policy decisions and banking market competition on a bank's financial soundness:

$$EDF_{i,t} = \alpha + \beta EDF_{i,t-1} + \sum_{j=0}^{1} \delta_j InterestRate_{k,t-j} + \sum_{j=0}^{1} \phi TaylorGap1_{k,t-j}$$

$$+ \sum_{j=0}^{1} \gamma_j GDPgrowth_{k,t-j} + \sum_{j=0}^{1} \varpi_j Creditgrowth_{k,t-j} + \varphi Boone-Indicator_{k,t} + \nu C_{k,i,t} + \varepsilon_{i,t}, \quad (13)$$

where $C_{ki,t}$ are further control variables.

First, the overall level of short-term interest rates is likely to implicitly influence asset quality. While a passing through of increasing short-term interest rates to deposit rates will raise the banks' funding costs, a handing down to lending rates should raise profitability but might let loan repayment be more difficult for borrowers, which may result in higher loan default rates and decreasing asset quality.

As Table 7 reports, the *interest rate* variables enter regression specification (1) significantly positive at the one-percent level respectively, indicating that an increase in short-term interest rates has a negative impact on Western European banks' financial soundness, which is in line with empirical evidence provided by previous empirical literature (Altunbas et al., 2010; Jeménez et al., 2009). In line with Jeménez et al., 2009 we suggest that low short-term interest rates indeed reduce the loan default rates of banks outstanding loans.

The *Taylor gap 1* variables – the difference between the three-month interbank offered rate and the rate implied by a Taylor rule with interest rate smoothing – enter the regression significantly negative at the one-percent level, suggesting that an extended period of expansionary monetary policy and, in particular, an extended period of short-term interest rates below a theoretical benchmark level lead to a reduction in risk perception and/or an increase in risk tolerance. Hence, our result confirms previous empirical findings on this effect provided by Altunbas et al. (2010).

Introducing the *Boone-indicator*, this variable enters the regression significantly negative at the ten-percent level, indicating that Western European banks operating under increasing credit market competition are more prone to financial fragility. This result is in line with theoretical models and empirical findings predicting that in a more competitive environment with higher pressures on profits, banks may have higher incentives to take more excessive risks, resulting in an increase in financial fragility. In addition, banks are anticipated to earn fewer informational rents from their relationship with borrowers in competitive markets, which may reduce their incentives to properly screen borrowers, again increasing the risk of financial fragility (e.g., Beck, 2008). Taking this into account and referring to the "risk-taking channel" of monetary policy our result may verify the "search for yield" theory provided by Ryan (2005) and the transmission channel proposed by Dell' Ariccia and Marquez (2006) as well as Maddaloni and Peydró (2009).

Among the macroeconomic control variables, *GDP growth* enters the regression significantly negative at the one-percent level, suggesting that banks' investment opportunities are positively correlated with the business cycle (Laeven and Majoni, 2003). In addition, our results indicate that the banks' investment opportunities rise under economic booms and that borrowers' solvency should be higher under an increasing economic performance. Moreover, the *credit growth* variable exhibits a significantly positive sign in the regression at the one-percent level, suggesting that an excessive credit lending is associated with decreasing capital ratios, which ultimately increases financial fragility (Dell'Ariccia and Marquez, 2006).

With regard to bank-specific control measures the one-period lagged *cost-income ratio* enters the regression significantly positive at the one-percent level, suggesting that a higher operational efficiency has a positive impact on financial soundness. Introducing the one-period lagged *net interest margin*, this variable is significantly negative at the one-percent level in the regression specification, indicating that Western European banks exhibiting a higher level of profitability are more stable. As expected, one-period lagged *non-performing loans* enter the regression significantly positive at the one-percent level, suggesting that a higher asset quality has a positive impact on financial soundness. Finally, the one-period lagged *total assets* variable is significantly negative at the one-percent level in the respective regression specification. Hence, we suggest that larger banks may be able to diversify loan portfolio risks more efficiently due to comparative advantages in providing credit monitoring services (Carletti and Hartmann, 2003; Demsetz and Strahan, 1997) and higher economies of scale and scope in general (Berger et al., 2007; Allen and Liu, 2007).

Referring to the traditional structure-conduct-performance (SCP) paradigm, we further investigate the robustness of our main findings by analyzing the nexus between the banking market concentration and bank soundness in regression specifications (2) and (3). Therefore, we include the 5-bank concentration ratio in regression specification (2) and the HHI in regression specification (3).

As Table 7 reports, both concentration measures enter respective regressions significantly negative at the one-percent level, indicating that banks in more concentrated banking markets are less prone to financial fragility. Corresponding with theoretical arguments and empirical findings provided by related literature on the "concentration-stability" issue, we suggest that larger banks may engage in "credit rationing" more heavily, as fewer high-quality credit investments will increase the return of the singular investment and thus foster financial soundness. Moreover, larger banks may exhibit comparative advantages in providing credit monitoring services and may be able to diversify loan portfolio risks more efficiently due to higher economies of scale and scope.

We are convinced that the *Taylor gap 1* variable is an adequate proxy for the stance of monetary policy. Nevertheless, since we are unable to empirically control for the respective transmission channel of monetary policy in a straight-forward fashion, we substitute the *Taylor gap 1* variable by the difference between the three-month interbank offered rate and the rate implied by the standard Taylor rule (denoted as *Taylor gap 2*) in regression specification (4).

As shown in Table 7, the *Taylor gap 2* variables enter regression specification (4) significantly negative at the one-percent level, whereas the significance of the *interest rate* variables and the competition measure as well as the control variables remain robust reflecting that baseline results are reconfirmed, even when controlling for a different measure of the stance of monetary policy.

4.1.2. Monetary policy, market structure and bank soundness: Lerner-index estimations

To draw accurate statistical inference concerning the relationship between low short-term interest rates, monetary policy decisions, banking market competition and bank soundness, we perform a selection of robustness checks. To begin with, instead of the Boone-indicator we include the Lerner-index as a traditional measure of a bank's market power. In contrast to the Boone-indicator, which primarily sets a focus on interest-bearing activities and especially the competitiveness of the loan market, the traditional Lerner-index proxies the competitiveness of a country's total banking market, including interest and non-interest bearing activities.

Accordingly, we use the following regression specification to assess the impact of low short-term interest rates, monetary policy decisions and banking market competition on bank soundness:

$$EDF_{i,t} = \alpha + \beta EDF_{i,t-1} + \sum_{j=0}^{1} \delta_j InterestRate_{k,t-j} + \sum_{j=0}^{1} \phi TaylorGap1_{k,t-j}$$

$$+ \sum_{j=0}^{1} \gamma_j GDPgrowth_{k,t-j} + \sum_{j=0}^{1} \varpi_j Creditgrowth_{k,t-j} + \varphi Lerner-Index_{k,t} + \nu C_{k,i,t} + \varepsilon_{i,t}, \qquad (14)$$

where $C_{ki,t}$ are further control variables.

As Table 8 reports, our main findings of a negative impact of an increase in short-term interest rates and an extended period of expansionary monetary policy on bank soundness are reiterated even when employing a different competition measure. The *interest rate* variables enter regression specification (1) significantly positive at the one-percent level, while the *Taylor gap* variables enter the regression significantly negative at the one-percent level. In addition, signs of control variables remain robust. Thus, our estimation results confirm our baseline findings that low short-term interest rates indeed reduce loan default rates of banks outstanding loans and that an extended period of short-term interest rates below a theoretical benchmark level leads to a reduction in risk perception and/or an increase in risk tolerance.

However, in contrast to our regression (1) in Table 7, the *Lerner-index* enters regression specification (1) significantly positive at the one-percent level, indicating that Western European banks operating under increasing market competition are less prone to financial fragility. With regard to the "risk-taking channel" of monetary policy, it is suggested that banks operating in a more competitive environment with higher pressures on profits (which finally results in a reduced franchise value) may have higher incentives to "search for yield", resulting in a higher risk exposure and thus financial fragility. However, applying traditional industrial organization theory to banking, an explanation for the positive relationship between banking market competition and bank soundness may be that competition in the banking market deters excessive risk-taking behavior by the bank's management (see, for example, the "*charter value hypothesis*", Keeley, 1990). Accordingly, to the extent that higher market competition keeps banks from operating in too risky lines of business (e.g., complex structured finance instruments like CDOs of CDOs (CDOs-squared)), banking systems with a higher competitive level are assumed to be more stable (Boyd and De Nicoló, 2006; Carletti and Hartmann, 2003).[7] Therefore, against this background, we suggest that the different results concerning the impact of increasing banking market competition on financial stability might be traced back to the fact that the Boone-indicator primarily sets a focus on interest-bearing activities whereas the Lerner-index combines interest-bearing as well as non-interest-bearing activities.

We further investigate the robustness of our main findings by analyzing the nexus between the banking market concentration and bank soundness in regression specifications (2) and (3), Table 8. Therefore, we include the 5-bank concentration ratio in regression specification (2) and the HHI in regression specification (3).

As Table 8 reports, both concentration measures enter respective regressions significantly negative at the one-percent level, indicating that banks in more concentrated banking markets are less prone to financial fragility. This result corresponds to regression specifications (2) and (3), in Table 7, employing the Boone-indicator as a measure of the banking market contestability. Thus, the Lerner-index regressions confirm our baseline result suggesting that an increasing banking market concentration has a positive impact on European banks' financial soundness ("concentration stability view", Boyd et al. 2004; Keeley, 1990).

Finally, we further substitute the *Taylor gap 1* variable (regression specification (2), Table 8) by the *Taylor gap 2* variable in regression specification (4), in Table 8, as a robustness check to avoid possible biases resulting from our definition of the proxy for the stance of monetary policy (see also section 3.1.2).

As shown in Table 8, the *Taylor gap 2* variables enter regression specification (4) significantly negative at the one-percent level, whereas the significance of the *interest rate* variables and the competition measure as well as the control variables remain robust reflecting that baseline results are reconfirmed, even when controlling for a different measure of the stance of monetary policy.

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[7] Additionally, we cautiously suggest that banks moving from traditional lending into fee-earning activities are more prone to financial fragility. Our result is in line with empirical findings provided by Smith et al. (2003) as well as Staikouras et al. (2000) and does not confirm the conventional wisdom in banking that earnings from fee-based business may be more stable than loan-based earnings, and that fee-based activities may reduce bank risk through diversification.

4.2. Robustness checks

By means of regressions (1)-(3), in Table 9, and regressions (1)-(6), in Table 12, we further investigate the robustness of our main regression results. To begin with, we initially investigate the robustness of our main findings by analyzing the relationship between monetary policy decisions, interest rates and bank risk taking. In this context, it is emphasized that the negative impact of an increase in short-term interest rates as well as an extended period of expansionary monetary policy on the banks' financial soundness is likely to suffer from endogeneity between monetary policy decisions, interest rates and the underlying banking market structure with regard to our baseline regression specification (1), in Table 7 and 8 (see also section 2.1). Hence, we first of all address this statistical problem by eliminating the banking market structure variables in regression (1) to control for market structure-specific endogeneity. As shown, even though banking market structure specific variables are excluded, our main finding of a positive impact of an increase in short-term interest rates as well as an extended period of expansionary monetary policy on financial fragility is reconfirmed. Hence, we rule out that our results are driven by market structure-specific endogeneity. Thus, our results finally confirm previous empirical findings on this effect provided by Altunbas et al. (2010) and Delis and Kouretas (2010).

By means of regressions (2) and (3) in Table 9 we further try to validate our hypotheses from our baseline regressions (2) and (3), in Table 7 and 8, suggesting that an increasing banking market concentration has a positive impact on European banks' financial soundness ("concentration stability view"). A priori, the causality running from banking market competition and banking market concentration to banking stability is not clear with regard to our baseline regression specifications (2) and (3), in Table 7 and 8, since it is not obvious if the banking market competition itself depends on the banking market concentration. Hence, to address a likely dependence between the banking market concentration and the banking market competition variable, we again eliminate the banking market competition variable in regression specifications (2) and (3), in Table 9, and include the 5-bank concentration ratio in regression specification (2) and the HHI in regression specification (3). As shown in Table 9, the banking market concentration variables enter regressions (2) and (3) significantly negative at the one-percent level while signs and significances of the monetary policy variables, the interest rate variables and the respective control variables remain robust reflecting that baseline results are reconfirmed even when controlling for a likely dependence between banking market concentration and banking market competition. Thus, we finally suggest that an increasing banking market concentration has a positive impact on European banks' financial soundness (Boyd et al. 2004; Keeley, 1990).

Finally, referring to the different results concerning the impact of increasing banking market competition on financial stability (Regression specifications (1)-(3) in Tables 7 and 8), the competitiveness of a country's banking market is further proxied by the H-Statistic proposed by Panzar and Ross (1987). We estimate the H-Statistic on a bank-level cross-sectionally for each country in our sample and each year for the period from 1997 to 2008. Following Claessens and Laeven (2004) and Schaeck et al. (2006), the H-Statistic is based on revenue equations and measures the degree of market competitiveness by means of the bank's elasticity of interest-bearing and non-interest-bearing revenues with respect to its input factor prices while controlling for a long-run market equilibrium. Therefore, an increase in factor prices (a) will be mirrored by an equal-proportional increase in the interest-bearing and non-interest-bearing revenue under perfect competition (H = 1), (b) will be mirrored by an underproportional increase in the interest bearing and non-interest bearing revenue under monopolistic competition (0 < H < 1) and (c) will not at all be reflected by an increase in the bank's interest bearing and non-interest bearing revenue in the monopoly case (H ≤ 0). Similar to the H-Statistic based on interest- and non-interest-bearing activities, we further include a second modified H-Statistic restricted on interest-bearing activities as a further robustness check.[8]

Introducing the H-Statistic restricted to interest-bearing activities (denoted as *H-Statistic (1)*), this variable enters the regression specifications (1)-(3), in Table 12, significantly positive. This result corresponds with regression specifications (1)-(3), in Table 7, employing the Boone-indicator as a measure of banking market contestability. In contrast, the H-Statistic based on interest- and non-interest-bearing activities (denoted as *H-Statistic (2)*) enters the regression specifications (4)-(6), in Table (12), significantly negative indicating that Western European banks operating under increasing market competition are less prone to financial fragility. Hence, the H-Statistic regressions confirm our results concerning the different impact of increasing total banking market competition and loan market competition on financial stability.

4.3. Sensitivity analyses

Finally, we perform a selection of sensitivity analyses. As a general result, our main findings and implications hold even when controlling for cross-country differences concerning the capital and housing market development. Due to high correlations between single control variables (Table 13) and in order to avoid simultaneity, we include them in turn in separate regressions (regression specifications (5)-(6)) in Tables 7 and 8.

To begin with, we finally control for cross-country differences concerning the capital and housing market development by employing the annual return of country-specific national blue-chip indices (denoted as *stock market return*) and the annual change in real estate markets (denoted as *house-price index*). We retrieved the history of stock market prices from the *Datastream Database* provided by *Thomson Financial Services*, while country specific house-price indices are obtained from a *Financial Structure Dataset* provided by the *Bank for International Settlements*. As Tables 7 and 8 report, both measures are significantly negative in regression specifications (5) and (6), indicating that a boost in asset prices has a positive impact on Western European banks soundness. Moreover, our results correspond with previous theoretical and empirical literature providing evidence that a boost in asset prices indeed spurs collateral values and thus may finally results in a lower financial fragility (Delis and Kouretas, 2010; Altunbas et al. 2010; Borio and Zhu, 2008). However, with regard to the "risk-taking channel" of monetary policy, it is also suggested that an

[8] Notes on variables and data sources used to calculate the H-Statistic (1) and (2) are presented in Table 10. Table 11 reports descriptive statistics for the H-Statistic (1) and (2). Moreover, Figures 3 and 4 more precisely illustrate the development of the H-Statistic (1) and (2) on a country level for the EU-9 and Switzerland over the sample period.

increase in asset and collateral values may lead to a reduction in risk perception and/or an increase in risk tolerance in the long run (Adrian and Shin, 2009).

5. Conclusion

Using a sample of stock-listed bank holding companies located in Western Europe over the period from 1997 to 2008 this paper provides empirical evidence that an increase in short-term interest rates as well as an extended period of expansionary monetary policy has a negative impact on European stock-listed banks' soundness as measured by the Expected Default Frequency (EDF) while controlling for macroeconomic and bank-specific factors.

In this context, estimation results indicate that low short-term interest rates reduce loan default rates of Western European banks outstanding loans and that an extended period of short term interest rates below a theoretical benchmark level leads to a reduction in risk perception and/or an increase in risk tolerance. Hence, empirical findings support theoretical arguments of the "risk-taking channel" of monetary policy view provided by Borio and Zhou (2008) and confirm empirical evidence from previous panel data analysis by Altunbas et al. (2010) and Delis and Kouretas (2010).

In order to identify possible interactions between the "risk-taking channel" and the competitiveness of a country's banking market this paper further investigates the nexus between the "risk-taking channel", banking market structures and financial soundness. We find that Western European banks operating under increasing loan market competition – proxied by the Boone-indicator – are more prone to financial fragility. Our result is in line with theoretical models and empirical findings predicting that in a more competitive loan market with higher pressures on profits, banks have higher incentives to take more excessive risks, resulting in higher fragility. Moreover, referring to the "risk-taking channel" of monetary policy our result seems to verify the "search for yield" theory provided by Ryan (2006) and the transmission channel proposed by Ariccia and Marquez (2006) as well as Maddaloni and Peydró (2009). In contrast, our results further indicate that an increase in competition in the total banking market – proxied by the Lerner-index – reduces financial fragility. Accordingly, we suggest that a higher banking market competition keeps banks from operating in too risky lines of business.

In addition, referring to the structure-conduct-performance (SCP) paradigm, we extend our analysis by investigating the impact of national banking market concentration on financial stability. Our results indicate that banks in more concentrated banking markets are less prone to financial fragility. Hence, our findings are consistent with the "concentration-stability view" and confirm empirical findings by Schaeck and Čihák (2008); Schaeck et al. (2006) as well as Beck et al. (2006a; 2006b).

Against the background of our empirical results we underline recent empirical results provided by Altunbas et al. (2010) as well as Delis and Kouretas (2010) indicating that monetary policy decisions are not neutral from a financial stability point of view. Moreover, our results suggest that the banking market structure may affect the monetary policy transmission mechanism and, in particular the interest rate pass-through process of market rates and finally financial fragility.

Accordingly, we stress the necessity of establishing the aspect of the interactions between the "risk-taking channel" of monetary policy and the competitiveness of a country's banking market within the stance of monetary policy. This postulation is clearly underlined by the recent U.S. subprime crisis, which has disclosed some important insights regarding the effect of the "risk-taking taking" channel of monetary policy on financial stability.

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Appendix A: Tables and figures

Table 1

Notes on variables and data sources (Dynamic Panel Regression)

Variable	Description	Data Sources
EDF	Expected default frequency of bank *i* in a respective years *t*. Further details and an in-depth technical discussion of the construction of this ratio are provided in Appendix B.	BankScope, Datastream, authors' calc.
Interest rate	Short term interest rate: 3-month interbank offered rate.	Datastream
Taylor gap 1	Difference between the 3-month interbank offered rate and the rate implied by a Taylor rule with interest rate smoothing.	Datastream, World Development Indicators (WDI), IMF, authors' calc.
Taylor gap 2	Difference between the 3-month interbank offered rate and the rate implied by the standard Taylor rule.	Datastream, World Development Indicators (WDI), IMF, authors' calc.
GDP growth	Rate of real GDP cap growth at constant 2000 prices (annual percentage change).	World Development Indicators (WDI)
Credit growth	Proxy for external funding constraints (liquidity-proxy). Delta of the ratio of domestic credit provided by banks to GDP.	World Development Indicators (WDI)
Boone-indicator	Indicator that measures the elasticity of bank's market shares in the loan market toward bank's marginal costs. Higher values indicate less competitive banking markets.	BankScope, authors' calc.
Lerner-index	Indicator that measures the price-marginal-cost-difference. Index ranges from 0 to 1, with larger values indicating less competitive banking markets.	BankScope, authors' calc.
H-Statistic	H-Statistic estimated on a bank-level cross-sectionally for each country in our sample and each year for the period from 1997 to 2008. Higher values indicate more competitive banking markets Further details are provided in Table 3.	BankScope, authors' calc.
Concentration ratio 5	EU-9 plus Switzerland concentration ratios: Fraction of assets of a country's total banking system's assets held by the largest 5 domestic and foreign banks.	ECB statistics, national central banks, authors' calc.
HHI	Herfindahl-Hirschman index computed as the sum of the squared market shares of a country's domestic and foreign banks.	ECB statistics, national central banks, authors' calc.
Net interest margin	Proxy for the bank's profitability. Accounting value of a bank's net interest revenue as a share of its interest-bearing (total earning) assets.	BankScope CN 2035
Cost income ratio	Proxy for the bank's efficiency. Accounting value of the ratio of a bank's overhead costs to its total revenue.	BankScope CN 4029
Non-performing loans	Proxy for the bank's asset quality. Log of the accounting value of a bank's non-performing loans as a share of its total assets.	BankScope CN 2170
Total Assets	Proxy for the bank's size. Log of the accounting value of a bank's total assets.	BankScope CN 2025
Stock market return	Proxy for the first financial accelerator. Annual return of the stock market (national blue-chip index).	Datastream, authors' calc.
House price index	Proxy for the second financial accelerator. Annual change of real estate prices.	BIS

Table 2

Notes on variables and data sources (Boone-indicator and Lerner-index)

Variable	**Description**	**Data Sources**
Boone-indicator	Indicator that measures the elasticity of bank's market shares in the loan market toward bank's marginal costs. Higher values indicate less competitive banking markets.	BankScope, authors' calc.
Lerner-index	Indicator that measures the price-marginal-cost-difference. Index ranges from 0 to 1, with larger values indicating less competitive banking markets.	BankScope, authors' calc.
Total assets	Proxy for the bank's output (Lerner-index). Accounting value of a bank's total assets.	BankScope CN 2025
Gross loans	Proxy for the bank's first output (Boone-indicator). Accounting value of a bank's gross loans.	BankScope CN 5190
Other earning assets	Proxy for the bank's second output (Boone-indicator). Accounting value of a bank's other earning assets.	BankScope CN 2005
Funding costs	Proxy for the bank's first input factor. Accounting value of the ratio of a bank's interest expenses to its total borrowed funds.	BankScope CN 6520, 2030
Labor costs	Proxy for the bank's second input factor. Accounting value of a bank's personnel expenses as a share of its total assets.	BankScope CN 6650, 2025
Other costs	Proxy for the bank's third input factor. Accounting value of the ratio of a bank's other operating expenses to its fixed assets.	BankScope CN 6670, 2015
Fixed assets	Proxy for the bank's first netput. Accounting value of a bank's fixed assets.	BankScope CN 2015
Total deposits	Proxy for the bank's second netput. Accounting value of a bank's total borrowed funds.	BankScope CN 2030
Equity capital	Proxy for the bank's third netput. Accounting value of a bank's equity capital.	BankScope CN 2055

Table 3
Descriptive statistics (Dynamic Panel Regression)

Variable	N	Mean	SD	Min	Max
EDF	595	0.7439	2.7097	0.0001	32.0776
Interest rate	780	3.5536	1.2719	0.26	7.625
Taylor Gap 1	780	-0.3800	1.1092	-3.3557	1.6126
Taylor Gap 2	780	-0.4679	1.1406	-3.9875	2.0824
GDP growth	780	5.1706	7.9122	-13.3519	22.6879
Credit growth	685	4.8416	8.4462	-11.4261	87.2626
Boone-indicator	780	-1.4244	0.9376	-6.0204	-0.0202
Lerner-index	780	0.2070	0.0541	0.0649	0.5557
H-Statistic (1)	780	0.4195	0.1821	0.0099	0.9684
H-Statistic (2)	780	0.6379	0.1752	0.1184	0.9853
Concentration ratio 5	768	40.7070	19.6571	17	87
Herfindahl-Hirschman-Index	768	569.4974	526.252	114	2168
Net interest margin	743	1.9190	0.9434	-0.2	6.7
Cost income ratio	743	0.6491	0.2033	0.2326	3.3108
Non-performing loans	637	4220.0	5094.1	17.2	38309.4
Total assets	743	284414.8	375309.1	2891.0	2591558.0
Stock market return	780	5.2711	25.7713	-61.2045	60.8951
House price index	780	209.5276	89.4023	78.94	413.08

Table 4
Descriptive statistics (Country level – Dynamic Panel Regression)

Variable	EDF	Interest rate	Taylor gap 1	Taylor gap 2	Natural rate gap	GDP growth	Credit growth	Boone-indicator	Lerner-index	H-Statistic (1)	H-Statistic (2)	Concentration ratio 5	HHI	Net interest margin	Cost income ratio	Non-performing loans	Total assets	Stock market return	House price index
Austria (3)	0.0514	3.2899	-0.0142	-0.0258	-0.1171	4.8843	0.5855	-1.0512	0.2066	0.3182	0.5391	43.32	538	1.7742	0.6626	3897	102856	8.9879	220.94
Belgium (2)	0.8829	3.3201	-0.1738	-0.2436	-0.1266	5.1050	-2.6130	-2.1832	0.1693	0.4752	0.5355	77.40	1697	1.1721	0.6110	2210	314616	4.1448	259.45
Denmark (3)	0.1287	3.7103	-0.1955	-0.9661	-0.0311	5.2333	14.1142	-2.3040	0.2885	0.1856	0.3755	66.92	1191	2.1456	0.6046	410	93766	8.8237	170.14
France (5)	1.3210	3.2831	-0.1920	-0.2806	-0.1279	4.8387	2.4776	-1.1589	0.1861	0.4140	0.4969	47.02	604	0.9708	0.7143	7467	563780	6.5767	178.19
Germany (9)	1.0447	3.2734	0.0929	0.5532	-0.1202	3.8258	-1.0343	-1.3328	0.1615	0.4351	0.5687	20.73	161	0.9766	0.7265	5960	378209	9.0023	95.27
Italy (16)	0.3661	3.4806	-0.6826	-0.6138	-0.2425	5.0373	3.9224	-1.0247	0.2011	0.3958	0.4985	27.50	245	2.6204	0.6468	4658	109064	1.7363	177.73
Netherlands (5)	1.2737	3.2776	-0.3351	-0.5982	-0.1071	6.1241	5.9750	-1.9331	0.1970	0.6500	0.7182	83.40	1799	1.5874	0.7280	4670	414912	2.6707	264.73
Spain (9)	0.2384	3.3413	-0.8232	-1.7612	-0.2205	5.4937	10.0608	-1.7550	0.2380	0.3806	0.4601	41.20	467	2.7279	0.5280	1116	122273	8.3682	282.14
Switzerland (3)	1.2694	1.5081	0.0228	0.5123	-0.2016	3.7319	0.5358	-0.6963	0.2614	0.3725	0.4895	76.00	1508	0.8719	0.8446	3767	551786	7.7069	105.75
UK (10)	1.1101	5.0792	-0.4310	-0.3401	-0.1425	6.5042	8.1813	-1.6422	0.2120	0.4695	0.5747	31.79	326	1.9762	0.5856	5507	443328	2.2712	315.50
Total (65)	0.7439	3.5536	-0.3900	-0.4679	-0.1669	5.1706	4.8416	-1.4244	0.2070	0.4195	0.6379	40.70	569	1.9190	0.6491	4220	284415	5.2711	209.53

Table 5
Descriptive statistics (Boone-indicator)

Variable	Observations	Boone-indicator	Marginal costs	Gross loans	Other earning assets	Funding costs	Labor costs	Other costs	Fixed assets	Total Deposits	Equity capital
Austria	1728	-1.0512	4.9316	1588046	1420953	3.2941	1.9457	115.5115	32579	2187195	143935
Belgium	536	-2.1832	5.9363	8236654	10334636	4.2052	1.5374	284.3104	169406	16240794	667743
Denmark	839	-2.3040	6.6701	3012970	1764438	3.0253	2.8793	193.2448	30494	2576674	236317
France	2694	-1.1589	8.3801	7913930	11449381	6.3695	3.5846	389.8579	148069	13908503	876410
Germany	19308	-1.3328	6.5425	1271702	1217242	3.5115	1.7715	126.6131	26058	1754207	97593
Italy	2210	-1.0247	5.8652	5634627	3035969	3.7827	2.6822	228.2877	147688	5980787	581412
Netherlands	320	-1.9331	8.9115	30945496	20555845	6.0754	1.6328	236.9896	568633	38265500	1980456
Spain	1192	-1.7550	7.3888	9037001	5143392	3.3996	2.0803	147.8585	311845	11334927	911414
Switzerland	3102	-0.6963	5.4834	1582832	2749137	2.5697	2.7564	211.3736	44599	3509162	197724
UK	852	-1.6422	8.4502	20319651	14531171	5.0220	3.8629	484.3226	407107	27247297	1738311
Total	32781	-1.4244	6.5595	3383377	3177113	3.7232	2.1730	177.9682	74433	4852200	309622

Table 6
Descriptive statistics (Lerner-index)

Variable	Observations	Lerner-index	Marginal costs	Total assets	Funding costs	Labor costs	Other costs	Fixed assets	Total Deposits	Equity Capital
Austria	2080	0.2066	5.0161	3569229	5.7451	1.4856	163.2042	34231	2402767	181225
Belgium	488	0.1693	5.2837	25262854	4.4868	1.1322	294.5782	218413	19228594	819783
Denmark	882	0.2885	5.7328	7011846	3.7926	2.0741	270.7370	31154	3260092	309749
France	2644	0.1861	6.1883	27446231	6.1583	1.6727	475.7845	173778	15958455	1079791
Germany	19304	0.1615	5.4120	3079608	3.3798	1.4973	138.5376	25849	1936675	111307
Italy	3226	0.2011	4.9861	8242510	3.8288	1.5233	267.2537	111345	4836455	518420
Netherlands	352	0.1970	5.9179	72418443	6.6295	1.1133	357.9176	606431	47857257	2506140
Spain	1322	0.2380	4.4825	17724343	3.1978	1.2971	159.8586	301437	12059143	1059182
Switzerland	3436	0.2614	4.2888	6052973	2.2321	1.4872	230.5204	41020	3866602	220574
UK	962	0.2120	6.5146	53357020	5.0612	1.5831	570.3501	448228	32976447	2148361
Total	34696	0.2070	5.3033	8807758	3.7601	1.5118	207.3593	78021	5482931	369878

Figure 1
Development of the Boone-indicator during the sample period

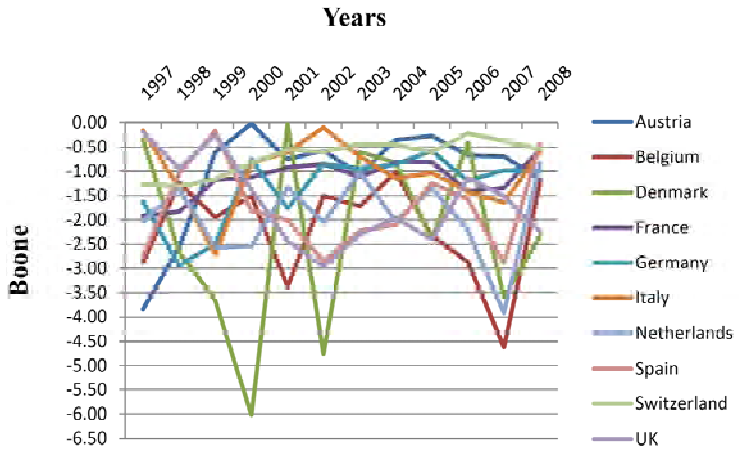

Figure 2
Development of the Lerner-index during the sample period

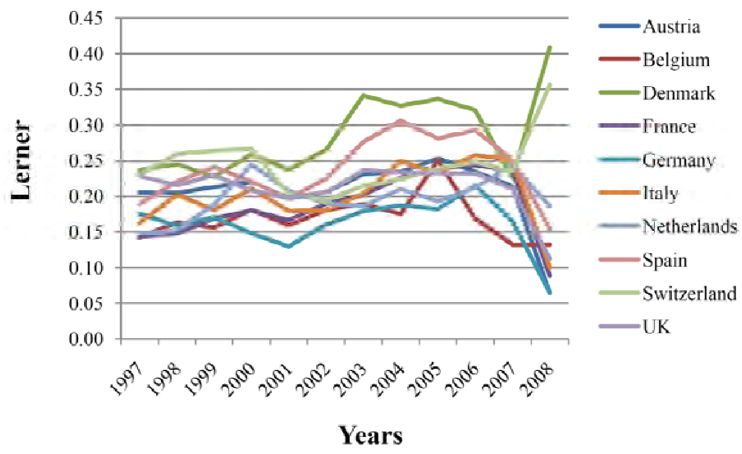

Table 7

Monetary policy, the Boone-indicator and EDF

	(1) EDF	(2) EDF	(3) EDF	(4) EDF	(5) EDF	(6) EDF
EDF (t-1)	0.1381***	0.1066***	0.1219***	0.2077***	0.1188***	0.1292***
	(0.0205)	(0.0196)	(0.0217)	(0.0278)	(0.0213)	(0.0238)
Interest rate	1.0054***	1.3459***	0.9681***	0.5672***	1.6405***	2.4120***
	(0.3020)	(0.3290)	(0.3266)	(0.0600)	(0.3234)	(0.4231)
Interest rate (t-1)	1.5640***	1.7345***	1.7726***	0.6314***	1.1275***	1.5715***
	(0.2434)	(0.2581)	(0.2607)	(0.1031)	(0.3023)	(0.2287)
Taylor gap 1	-2.6613***	-3.0183***	-2.6168***		-3.2182***	-3.6298***
	(0.3698)	(0.3918)	(0.3933)		(0.3749)	(0.4965)
Taylor gap 1 (t-1)	-1.7421***	-1.8295***	-1.8860***		-1.3538***	-1.6284***
	(0.2587)	(0.2577)	(0.2655)		(0.3257)	(0.2523)
Taylor gap 2				-1.2107***		
				(0.1230)		
Taylor gap 2 (t-1)				-1.3882***		
				(0.1232)		
GDP growth	-0.0699***	-0.0595***	-0.0679***	-0.0743***	-0.0455***	-0.0337***
	(0.0143)	(0.0148)	(0.0151)	(0.0155)	(0.0139)	(0.0099)
GDP growth (t-1)	-0.0129	-0.0187*	-0.0187*	-0.0416***	-0.0214**	-0.0386***
	(0.0088)	(0.0103)	(0.0096)	(0.0091)	(0.0088)	(0.0086)
Credit growth	0.0128***	0.0154***	0.0126***	0.0280***	0.0155***	0.0122***
	(0.0047)	(0.0042)	(0.0043)	(0.0045)	(0.0047)	(0.0035)
Credit growth (t-1)	0.0187**	0.0129	0.0182**	0.0186	0.0179**	0.0093
	(0.0072)	(0.0080)	(0.0077)	(0.0065)***	(0.0080)	(0.0085)
Boone-indicator	-0.0740*	-0.0989**	-0.1008**	-0.2892***	-0.1384***	-0.0887**
	(0.0386)	(0.0422)	(0.0420)	(0.0494)	(0.0461)	(0.0408)
Concentration ratio 5		-0.0528***		-0.0283***	-0.0548***	-0.0449***
		(0.0075)		(0.0063)	(0.0092)	(0.0071)
HHI			-0.0145***			
			(0.0030)			
Net interest margin (t-1)	-1.1627***	-1.3564***	-1.2878***	-1.1593***	-1.3478***	-1.3075***
	(0.1962)	(0.1683)	(0.1789)	(0.1370)	(0.1446)	(0.1265)
Cost income ratio (t-1)	4.8941***	5.3781***	5.1616***	2.9243***	4.8028***	3.4647***
	(0.7379)	(0.6209)	(0.7813)	(0.9652)	(0.5912)	(0.8230)
Non-performing loans (t-1)	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Total assets (t-1)	-0.3145***	-0.1041	-0.1574	-0.0721**	-0.0829	-0.1225
	(0.1031)	(0.1135)	(0.1226)	(0.1188)	(0.1125)	(0.1308)
Stock market return					-0.5254***	
					(0.1914)	
House price index						-0.0593***
						(0.0184)
Time dummies	yes	yes	yes	yes	yes	yes
No. of obs.	439	437	437	437	430	430
Sargan test (2nd step)	0.231	0.384	0.291	0.151	0.356	0.441
AR (1)	0.051	0.034	0.042	0.070	0.021	0.046
AR (2)	0.861	0.895	0.870	0.619	0.793	0.828

The dynamic panel model estimated is $EDF_{i,t\ (i=bank,\ j=time,\ k=country,\ c=control\ variables)} = \alpha + \beta_1\ EDF_{i,t-1} + \beta_2\ interest\ rate_{k,t} + \beta_3\ interest\ rate_{k,t-1} + \beta_4\ Taylor\ gap\ 1_{k,t} + \beta_5\ Taylor\ Gap\ 1_{k,t-1} + \beta_6\ GDP\ growth_{k,t} + \beta_7\ GDP\ growth_{k,t-1} + \beta_8\ Credit\ growth_{k,t} + \beta_9\ Credit\ growth_{k,t-1} + \beta_{10}\ Boone\text{-}indicator_{k,t} + \varepsilon_{i,t}$. Specification (2) includes the *Concentration ratio 5* while Specification (3) includes the *HHI*. *Taylor Gap 1* is substituted by *Taylor gap2* in specification (4). Specifications (5) and (6) are further sensitivity analyses concerning the capital market environment. Constant term included but not reported. Standard errors are reported in parenthesis. ***, **, *: statistically significant at the 1, 5 and 10% level.

Table 8
Monetary policy, Lerner-index and EDF

	(1) EDF	(2) EDF	(3) EDF	(4) EDF	(5) EDF	(6) EDF
EDF (t-1)	0.1211***	0.0882***	0.0963***	0.2368***	0.1187***	0.0818***
	(0.0218)	(0.0238)	(0.0216)	(0.0279)	(0.0268)	(0.0142)
Interest rate	0.7660***	1.2007***	0.8022***	0.4264***	1.6702***	2.3148***
	(0.2662)	(0.2856)	(0.2883)	(0.0703)	(0.2919)	(0.4209)
Interest rate (t-1)	1.9696***	2.1515***	2.2231***	0.6943***	1.8971***	1.9215***
	(0.2592)	(0.2836)	(0.2867)	(0.0820)	(0.3423)	(0.2309)
Taylor gap 1	-2.3671***	-2.8632***	-2.4942***		-3.3669***	-3.6193***
	(0.3813)	(0.3759)	(0.4183)		(0.4154)	(0.4902)
Taylor gap 1 (t-1)	-2.1408***	-2.2481***	-2.3478***		-1.6080***	-2.0803***
	(0.2678)	(0.2697)	(0.2835)		(0.3467)	(0.2318)
Taylor gap 2				-1.2169***		
				(0.1169)		
Taylor gap 2 (t-1)				-1.2761***		
				(0.1314)		
GDP growth	-0.0721***	-0.0585***	-0.0670***	-0.0613***	-0.0495***	-0.0271**
	(0.0130)	(0.0150)	(0.0146)	(0.0129)	(0.0143)	(0.0110)
GDP growth (t-1)	-0.0872	-0.0034	-0.0048	-0.0096	-0.0089	-0.0169**
	(0.0122)	(0.0111)	(0.0110)	(0.0081)	(0.0103)	(0.0085)
Credit growth	0.0205***	0.0218***	0.0202***	0.0018	0.0282***	0.0148***
	(0.0046)	(0.0046)	(0.0046)	(0.0047)	(0.0046)	(0.0038)
Credit growth (t-1)	0.0145**	0.0044	0.0092	0.0032	0.0026	0.0015
	(0.0065)	(0.0070)	(0.0073)	(0.0054)	(0.0063)	(0.071)
Lerner-Index	0.0933***	0.0834***	0.0838***	0.0972***	0.1227***	0.0622***
	(0.0281)	(0.0163)	(0.0239)	(0.0218)	(0.0218)	(0.0139)
Concentration ratio 5		-0.0582***		-0.0343***	-0.0654***	-0.0493***
		(0.0084)		(0.0079)	(0.0098)	(0.0073)
HHI			-0.0145***			
			(0.0003)			
Net interest margin (t-1)	-1.0786***	-1.3865***	-1.2806***	-1.0318***	-1.4710***	-1.2825***
	(0.2277)	(0.2177)	(0.2309)	(0.1219)	(0.2188)	(0.1374)
Cost income ratio (t-1)	5.8390***	6.0518***	6.3480***	3.3644***	4.5449***	5.7225***
	(0.8624)	(1.2336)	(1.0438)	(1.1221)	(1.1315)	(0.6992)
Non-performing loans (t-1)	0.0001***	0.0001***	0.0001***	0.0001***	0.0001*	0.0001***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Total assets (t-1)	-0.3007***	-0.0873	-0.1430	-0.1239*	-0.1519	-0.1923
	(0.1152)	(0.1351)	(0.1404)	(0.1409)	(0.1302)	(0.1418)
Stock market return					-0.9021***	
					(0.1675)	
House price index						-0.0591***
						(0.0193)
Time dummies	yes	yes	yes	yes	yes	yes
No. of obs.	439	437	437	437	430	430
Sargan test (2nd step)	0.104	0.226	0.178	0.099	0.376	0.331
AR (1)	0.072	0.071	0.066	0.095	0.058	0.062
AR (2)	0.659	0.701	0.675	0.680	0.544	0.490

The dynamic panel model estimated is $EDF_{i,t\ (i=bank,\ j=time,\ k=country,\ c=control\ variables)} = \alpha + \beta_1\ EDF_{i,t-1} + \beta_2\ interest\ rate_{k,t} + \beta_3\ interest\ rate_{k,t-1} + \beta_4\ Taylor\ gap\ 1_{k,t} + \beta_5\ Taylor\ Gap\ 1_{k,t-1} + \beta_6\ GDP\ growth_{k,t} + \beta_7\ GDP\ growth_{k,t-1} + \beta_8\ Credit\ growth_{k,t} + \beta_9\ Credit\ growth_{k,t-1} + \beta_{10}\ Lerner\text{-}index_{k,t} + \varepsilon_{i,t}$. Specification (2) includes the *Concentration ratio 5* while Specification (3) includes the *HHI*. *Taylor Gap 1* is substituted by *Taylor gap2* in specification (4). Specifications (5) and (6) are further sensitivity analyses concerning the capital market environment. Constant term included but not reported. Standard errors are reported in parenthesis. ***, **, *: statistically significant at the 1, 5 and 10% level.

Table 9
Monetary policy, the Lerner-index and EDF

	(1) EDF	(2) EDF	(3) EDF
EDF (t-1)	0.1162***	0.0862***	0.0988***
	(0.0166)	(0.0162)	(0.0163)
Interest rate	0.9292***	1.2493***	0.9074***
	(0.2937)	(0.3151)	(0.3129)
Interest rate (t-1)	1.7459***	1.9536***	2.0051***
	(0.2388)	(0.2627)	(0.2634)
Taylor gap 1	-2.7452***	-3.1040***	-2.7707***
	(0.3745)	(0.3881)	(0.3963)
Taylor gap 1 (t-1)	-1.9757***	-2.1128***	-2.179***
	(0.2402)	(0.2548)	(0.2528)
GDP growth	-0.0708***	-0.0609***	-0.0696***
	(0.0142)	(0.0153)	(0.0153)
GDP growth (t-1)	-0.0145	-0.0162	-0.0171*
	(0.0900)	(0.0104)	(0.0098)
Credit growth	0.0155***	0.0180***	0.0160***
	(0.0047)	(0.0043)	(0.0044)
Credit growth (t-1)	0.0142**	0.0051	0.0099
	(0.0055)	(0.0059)	(0.0063)
Concentration ratio 5		-0.0522***	
		(0.0077)	
HHI			-0.0135***
			(0.0003)
Net interest margin (t-1)	-1.1699***	-1.4017***	-1.3391***
	(0.2123)	(0.2051)	(0.2131)
Cost income ratio (t-1)	5.6967***	5.9752***	5.9209***
	(0.5086)	(0.7883)	(0.6005)
Non-performing loans (t-1)	0.0001***	0.0001***	0.0001***
	(0.0001)	(0.0001)	(0.0001)
Total assets (t-1)	-0.3330***	-0.0695	-0.1312
	(0.1107)	(0.1357)	(0.1406)
Time dummies	yes	yes	yes
No. of obs.	439	437	437
Sargan test (2nd step)	0.197	0.374	0.313
AR (1)	0.050	0.044	0.047
AR (2)	0.749	0.741	0.734

The dynamic panel model estimated is $EDF_{i,t\ (i=bank,\ j=time,\ k=country,\ c=control\ variables)} = \alpha + \beta_1\ EDF_{i,t-1} + \beta_2\ interest\ rate_{k,t} + \beta_3\ interest\ rate_{k,t-1} + \beta_4\ Taylor\ gap\ 1_{k,t} + \beta_5\ Taylor\ Gap\ 1_{k,t-1} + \beta_6\ GDP\ growth_{k,t} + \beta_7\ GDP\ growth_{k,t-1} + \beta_8\ Credit\ growth_{k,t} + \beta_9\ Credit\ growth_{k,t-1} + \beta_{10}\ Banking\ market\ structure\ variable_{k,t} + \varepsilon_{i,t}$. Specification (1) is estimated without any banking market structure variables. Specification (2) includes the *Concentration ratio 5* while Specification (3) includes the *HHI*. Constant term included but not reported. Standard errors are reported in parenthesis. ***, **, *: statistically significant at the 1, 5 and 10% level.

Table 10

Notes on variables and data sources (H-Statistic (1) and (2))

Variable	**Description**	**Data Sources**
H-Statistic (1)	H-Statistic estimated on a bank-level cross-sectionally for each country in our sample and each year for the period from 1997 to 2008. Higher values indicate more competitive banking markets. H-Statistic (1) comprises bank's interest bearing revenues.	BankScope, authors' calc.
H-Statistic (2)	H-Statistic estimated on a bank-level cross-sectionally for each country in our sample and each year for the period from 1997 to 2008. Higher values indicate more competitive banking markets. H-Statistic (2) comprises bank's interest and non-interest bearing revenues.	BankScope, authors' calc.
Interest Revenues	Proxy for the bank's output (H-Statistic (1)). Accounting value of the ratio of a bank's interest income to its total assets.	BankScope CN 2080
Total Revenues	Proxy for the bank's output (H-Statistic (2)). Accounting value of the ratio of a bank's interest and non-interest income to its total assets.	BankScope CN 2080, 2085
Funding costs	Proxy for the bank's first input factor. Accounting value of the ratio of a bank's interest expenses to its total borrowed funds.	BankScope CN 6520, 2030
Labor costs	Proxy for the bank's second input factor. Accounting value of a bank's personnel expenses as a share of its total assets.	BankScope CN 6650, 2025
Other costs	Proxy for the bank's third input factor. Accounting value of the ratio of a bank's other operating expenses to its total assets.	BankScope CN 6670, 2025
Deposits	Proxy for the bank's first netput. Accounting value of a bank's total deposits.	BankScope CN 2031, 2185
Deposits and money market funding	Proxy for the bank's second netput. Accounting value of a bank's total borrowed funds.	BankScope 2030
Net Loans	Proxy for the bank's third netput. Accounting value of a bank's net loans.	BankScope CN 11090
Equity capital	Proxy for the bank's forth netput. Accounting value of a bank's equity capital.	BankScope CN 2055
Total Assets	Accounting value of a bank's total assets.	BankScope 2025

Table 11
Descriptive statistics (H-Statistic (1) and (2))

Variable	Observations	H-Statistic (1)	H-Statistic (2)	Total Revenues	Interest Revenues	Funding Costs	Labor costs	Other costs	Total Deposits	Deposits and Money Market Funding	Net Loans	Equity Capital	Total Assets
Austria	2080	0.3182	0.5391	199057	174543	5.7451	1.4856	1.2096	2177208	2402767	2005377	181225	3569229
Belgium	488	0.4752	0.5355	1744722	1587766	4.4868	1.1322	0.9952	18798276	19228594	10071998	819783	25262854
Denmark	882	0.1856	0.3755	338847	301043	3.7926	2.0741	1.5922	3250178	3260092	4156408	309749	7011846
France	2644	0.4140	0.4969	1461225	1168760	6.1583	1.6727	1.5089	14110531	15958455	15057328	1079791	27446231
Germany	19304	0.4351	0.5687	139516	132622	3.3798	1.4973	1.1472	1911248	1936675	1825367	111307	3079608
Italy	3226	0.3958	0.4985	465913	369672	3.8288	1.5233	1.4026	4627343	4836455	5188474	518420	8242510
Netherlands	352	0.6500	0.7182	3845259	3295562	6.6295	1.1133	0.9342	45090621	47857257	36901394	2506140	72418443
Spain	1322	0.3806	0.4601	926356	867243	3.1978	1.2971	1.0082	9621427	12059143	11364717	1059182	17724343
Switzerland	3436	0.3725	0.4895	301613	208609	2.2321	1.4872	1.2210	3499454	3866602	4289126	220574	6052973
UK	962	0.4695	0.5747	2440079	1974715	5.0612	1.5831	1.8633	30204925	32976447	23218240	2148361	53357020
Total	34696	0.4195	0.6379	449215	379562	3.7601	1.5118	1.2311	5054539	5482931	4888909	369878	8807758

Figure 3
Development of the H-Statistic (1) during the sample period

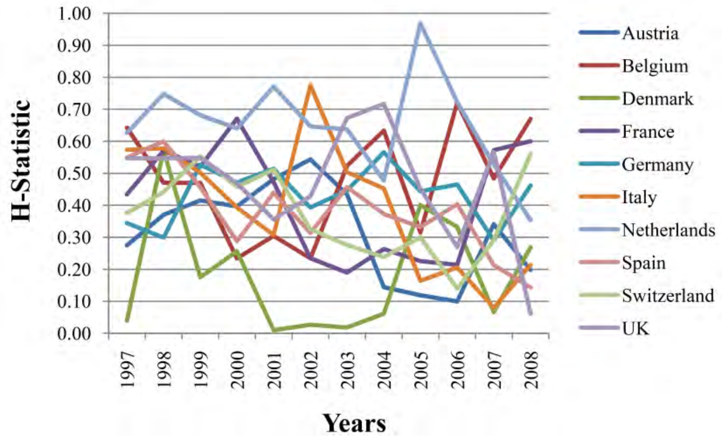

Figure 4
Development of the H-Statistic (2) during the sample period

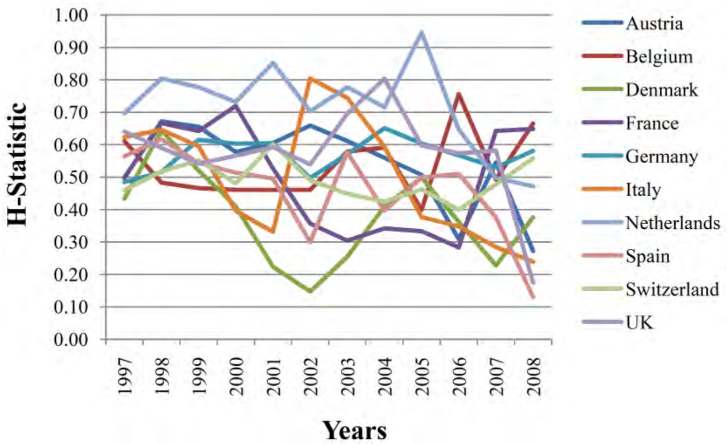

Table 12
Monetary policy, the H-Statistic and EDF

	(1) EDF	(2) EDF	(3) EDF	(4) EDF	(5) EDF	(6) EDF
EDF (t-1)	0.1055***	0.0788***	0.1121***	0.1028***	0.0829***	0.0747***
	(0.0199)	(0.0221)	(0.0269)	(0.0219)	(0.0239)	(0.0232)
Interest rate	0.9813***	1.3292***	1.1656***	1.0499***	1.2947***	1.0473***
	(0.2992)	(0.3215)***	(0.3307)	(0.3106)	(0.3257)	(0.3217)
Interest rate (t-1)	1.7428***	1.9513	1.7272***	1.5744***	1.7877***	1.8717***
	(0.2350)	(0.2597)	(0.2720)	(0.2395)	(0.2479)	(0.2525)
Taylor gap 1	-2.8380***	-3.1808***	-3.0451***	-2.5658***	-2.8694***	-2.6150***
	(0.4031)	(0.3995)	(0.4269)	(0.4171)	(0.4189)	(0.4250)
Taylor gap 1 (t-1)	-1.9029***	-2.0518***	-1.7833***	-1.6622***	-1.8394***	-1.8933***
	(0.2411)	(0.2627)	(0.3006)	(0.2419)	(0.2459)	(0.2477)
GDP growth	-0.0693***	-0.0579***	-0.0605***	-0.0660***	-0.0571***	-0.0633***
	(0.0135)	(0.0151)	(0.0149)	(0.0138)	(0.0147)	(0.0148)
GDP growth (t-1)	-0.0192**	-0.0215**	-0.0338***	-0.0026	-0.0016	-0.0044
	(0.0086)	(0.0103)	(0.0106)	(0.0069)	(0.0084)	(0.0083)
Credit growth	0.0182***	0.0186***	0.0414**	0.0225***	0.0219***	0.0242***
	(0.0044)	(0.0041)	(0.0075)	(0.0052)	(0.0046)	(0.0052)
Credit growth (t-1)	0.0133**	0.0610	0.0195***	0.0133**	0.0072	0.0082
	(0.0054)	(0.0061)	(0.0055)	(0.0053)	(0.0063)	(0.0067)
H-Statistic (1)	0.4326*	0.3769**	0.6862***			
	(0.2284)	(0.1872)	(0.2377)			
H-Statistic (2)				-1.1705***	-1.0838***	-1.4747***
				(0.3043)	(0.2970)	(0.2664)
Concentration ratio 5		-0.0587***			-0.0485***	
		(0.084)			(0.0073)	
HHI			-0.0440***			-0.0147***
			(0.0012)			(0.0003)
Net interest margin (t-1)	-1.1638***	-1.4521***	-1.1300***	-1.2351***	-1.4350***	-1.4285***
	(0.2175)	(0.2038)	(0.2166)	(0.2323)	(0.2267)	(0.2374)
Cost income ratio (t-1)	5.9490***	5.9358***	5.8776***	5.4480***	5.6314***	5.7114***
	(0.7174)	(1.1661)	(1.0970)	(0.8501)	(1.1211)	(1.0539)
Non-performing loans (t-1)	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Total assets (t-1)	-0.2934***	-0.0011	-0.2425*	-0.2833**	-0.1376	-0.1660
	(0.1125)	(0.1445)	(0.1249)	(0.1129)	(0.1304)	(0.1280)
Time dummies	yes	yes	yes	yes	yes	yes
No. of obs.	439	437	437	439	437	437
Sargan test (2nd step)	0.136	0.352	0.200	0.116	0.282	0.192
AR (1)	0.049	0.054	0.058	0.042	0.097	0.095
AR (2)	0.634	0.646	0.499	0.601	0.577	0.510

The dynamic panel model estimated is $EDF_{i,t\ (i=bank,\ j=time,\ k=country,\ c=control\ variables)} = \alpha + \beta_1\ EDF_{i,t-1} + \beta_2\ interest\ rate_{k,t} + \beta_3\ interest\ rate_{k,t-1} + \beta_4\ Taylor\ gap\ 1_{k,t} + \beta_5\ Taylor\ Gap\ 1_{k,t-1} + \beta_6\ GDP\ growth_{k,t} + \beta_7\ GDP\ growth_{k,t-1} + \beta_8\ Credit\ growth_{k,t} + \beta_9\ Credit\ growth_{k,t-1} + \beta_{10}\ H\text{-}Statistic\ (1)_{k,t} + \varepsilon_{i,t}$. Specification (2) includes the *Concentration ratio 5* while Specification (3) includes the *HHI*. H-Statistic (1) is substituted by the *H-Statistic (2)* in specifications (4)-(6). Constant term included but not reported. Standard errors are reported in parenthesis. ***, **, *: statistically significant at the 1, 5 and 10% level.

Table 13
Correlation matrix

	Interest rate	Taylor gap 1	Taylor gap 2	GDP growth	Credit growth	Boone-indicator	Lerner-index	H-Statistic (1)	H-Statistic (2)	Concentration Ratio 5	HHI	Net interest margin	Cost income ratio	Non-performing loans	Total assets	Stock market return	House price index
Interest rate	1.00																
Taylor gap 1	0.31***	1.00															
Taylor gap 2	0.22***	0.62***	1.00														
GDP growth	-0.23***	-0.10***	-0.23***	1.00													
Credit growth	0.19***	0.04	-0.29***	-0.07*	1.00												
Boone-indicator	-0.09**	-0.12***	0.04	0.10***	-0.23***	1.00											
Lerner-index	-0.02	0.28***	-0.10***	0.19***	0.17***	-0.09**	1.00										
H-Statistic (1)	0.13***	-0.05	0.16***	0.03	-0.25***	0.03	-0.14***	1.00									
H-Statistic (2)	0.02	0.16***	0.31***	0.17***	-0.21***	0.03	0.01	0.53***	1.00								
Concentration ratio 5	-0.23***	0.02	-0.18***	0.12***	0.12***	-0.19***	0.22***	0.07**	0.05	1.00							
HHI	-0.22***	0.03	-0.12***	0.11***	0.04	-0.19***	0.15***	0.12***	0.09**	0.94***	1.00						
Net interest margin	0.18***	-0.23***	-0.24***	-0.01	0.10**	-0.01	0.11***	0.04	-0.06*	-0.21***	-0.24***	1.00					
Cost income ratio	-0.21***	-0.13***	0.02	0.02	-0.15***	0.12***	-0.14***	0.07**	0.06*	0.10***	0.13***	-0.22***	1.00				
Non-performing loans	-0.01	-0.02	0.12	-0.01	-0.06	0.09**	-0.23***	0.03	0.00	-0.14***	-0.12***	-0.25***	0.12***	1.00			
Total assets	0.01	0.13***	0.11***	0.08**	-0.04	0.00	-0.14***	0.02	-0.01	0.09**	0.10***	-0.31***	0.17***	0.31***	1.00		
Stock market return	0.03	0.34***	0.40***	-0.08**	0.02	-0.09**	0.30***	0.15***	0.34***	-0.08**	-0.08**	0.03	-0.15***	-0.12***	-0.10***	1.00	
House price index	0.19***	-0.04	-0.45***	0.23***	0.47***	-0.27***	0.25***	-0.03	-0.07*	0.26***	0.20***	0.11***	-0.26***	-0.04	0.11***	-0.10***	1.00

Appendix B: Calculation of the Expected Default Frequency (EDF)

The *Expected Default Frequency* (EDF) is the probability that the market value of a bank's assets will be less than a firm specific distress barrier within a given time horizon. Accordingly, we calculate the theoretical *Expected Default Frequency* (*Risk Neutral Default Probability*) using a step by step (two-step) approach. The procedure used is as follows:

(1) Calculation of the *Distance-to-Default* (DtD) per bank holding i at time t,

(2) Translation of the derived theoretical *Distance-to-Default* of bank i at time t into a time variant *Expected Default Frequency* (EDF) based on the risk neutral valuation framework.

1. Calculation of the Distance-to-Default (DtD)

According to the Merton framework (1973, 1974) the market value of a bank's equity capital can be modeled as a contingent claim on the residual value of its assets. In the event of a default, the bank shareholder receives no returns if the market value of bank assets falls below the market value of bank liabilities. Otherwise the bank shareholder receives the difference between the market value of assets and liabilities. Hence, the contingent claim on the residual value of bank assets can be modeled as a call option on the underlying bank using standard option-pricing models. Corresponding to Black and Scholes (1973), the market value of a bank's assets is assumed to follow a geometric Brownian motion:

$$dV_A = \mu V_A dt + \sigma_A V_A dz \tag{15}$$

where dV_A is the change in the value of assets, V_A is the current value of assets, μ is the drift rate of assets, σ_A is standard deviation of assets and finally, dz is a Wiener process.

More precisely, the market value of assets follows a stochastic process of the following form:

$$ln V_A^T = ln V_A + \left(r - \frac{1}{2}\sigma_A^2 \right) T + \sigma_A \sqrt{T} \varepsilon \tag{16}$$

where V_A^T denotes the asset value at time T (maturity of debt), r is the risk free (one-month interbank offered rate)[a] interest rate and ε is a random component (standard normal distributed) of a firm's return on assets. The distance from the default point (V_A=DB) can be expressed as follows:

[a] We retrieve the one-month interbank offered rate from *Datastream Database* provided by *Thomson Financial Services*.

$$D = \ln V_A^T - \ln DB = \ln V_A + \left(r - \frac{1}{2}\sigma_A^2 \right) T + \sigma_A \sqrt{T} \varepsilon - \ln DB\,. \tag{17}$$

DB represents the distress barrier defined as the face value of short term liabilities (maturity ≤ 1 year) plus half of the amount of long term liabilities (maturity > 1 year).

Rearranging equation (17), we attain

$$\frac{D}{\sigma_A \sqrt{T}} = \frac{\ln\left(\frac{V_A}{DB} \right) + \left(r - \frac{1}{2}\sigma_A^2 \right) T}{\sigma_A \sqrt{T}} + \varepsilon, \tag{18}$$

and finally obtain the following definition of the *Distance-to-Default*:

$$DtD \equiv \frac{D}{\sigma_A \sqrt{T}} - \varepsilon = \frac{\ln\left(\frac{V_A}{DB} \right) + \left(r - \frac{1}{2}\sigma_A^2 \right) T}{\sigma_A \sqrt{T}}\,. \tag{19}$$

The *Distance-to-Default* is designed to indicate the number of standard deviations that the bank is away from the default point within a given time horizon (one year). The unobservable parameters V_A and σ_A can be calculated from the observable market value of equity capital (V_E) as well as the standard deviation of share price returns (σ_E) using Ito's lemma and the following system of equations:[b]

$$V_E = V_A N(d_1) - DBe^{-rT} N(d_2), \tag{20}$$

$$\sigma_E = N(d_1) \frac{V_A}{V_E} \sigma_A, \tag{21}$$

$$d_1 \equiv \frac{\ln\left(\frac{V_A}{DB} \right) + \left(r + \frac{1}{2}\sigma_A^2 \right) T}{\sigma_A \sqrt{T}} = \frac{\ln\left(V_A \exp\left(\left(r + \frac{1}{2}\sigma_A^2 \right) T \right) \right) - \ln DB}{\sigma_A \sqrt{T}}, \tag{22}$$

$$d_2 \equiv d_1 - \sigma_A \sqrt{T} = \frac{\ln\left(\frac{V_A}{DB} \right) + \left(r - \frac{1}{2}\sigma_A^2 \right) T}{\sigma_A \sqrt{T}} = \frac{\ln\left(V_A \exp\left(\left(r - \frac{1}{2}\sigma_A^2 \right) T \right) \right) - \ln DB}{\sigma_A \sqrt{T}}\,. \tag{23}$$

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[b] We retrieve the history of banks' stock prices from *Datastream Database* provided by *Thomson Financial Services*.

2. Calculation of the Expected Default Frequency (EDF)

The *Expected Default Frequency* (risk neutral default probability) is the probability that the market value of a bank's assets will be less than the distress barrier (*DB*) within a given time horizon (1 year). The current probability (p_t) that the market value of assets does not reach the default barrier at time *t* is:

$$p_T = Pr\left\{V_A^T \leq DB \middle| V_A^0 = V_A\right\} = Pr\left\{ln V_A^T \leq ln\, DB \middle| V_A^0 = V_A\right\}. \tag{24}$$

Integrating equations (16) into the equation (24) we obtain:

$$p_T = Pr\left\{ln V_A + \left(r - \frac{1}{2}\sigma_A^2\right)t + \sigma_A \sqrt{T}\varepsilon \leq ln\, DB\right\}. \tag{25}$$

Rearranging equation (25), we attain:

$$p_T = Pr\left\{\varepsilon \leq \frac{ln\left(\frac{V_A}{DB}\right) + \left(r - \frac{1}{2}\sigma_A^2\right)T}{\sigma_A \sqrt{T}}\right\}. \tag{26}$$

Corresponding to Black and Scholes (1973), ε is standard normally distributed. Hence, we obtain the following definition of the *Expected Default Probability*:

$$p_T \equiv N\left(-\frac{ln\left(\frac{V_A}{DB}\right) + \left(r - \frac{1}{2}\sigma_A^2\right)T}{\sigma_A \sqrt{T}}\right). \tag{27}$$