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Bank size, competition and risk in the Turkish banking industry

Abstract:

This paper investigates the impact of bank size and competition on earnings volatility and insolvency risk using quarterly data for commercial banks operating in the Turkish banking industry for the period 2002Q1-2012Q2. Controlling some bank-specific variables that banks may have differences in risk, the results suggests that bank size and earnings volatility are negatively related, suggesting that larger banks are less risky. The results also indicate that competition measured by the Boone indicator increases earnings volatility. The results further suggest that higher capitalized banks, banks with higher share of non-interest income in total income and efficient banks face lower earnings volatility. Finally, insolvency risk measured by Z-score and bank size are positively related suggesting that larger banks are more stable.

Keywords: Bank earnings volatility; Size; Boone index; Turkish Banking.

JEL Classification: G21; G32

1 Introduction

Recent development in banking regulation and the widespread adoption of new banking technologies have had a significant impact on the competition conditions of banking systems of developed and developing countries. Increased competition has been considered the main driving force behind the acceleration in consolidation process in both groups of countries, and it is also raising concerns about increased concentration in the banking sector. Regulatory institutions are concerned whether consolidation process creates threat on the survival chance of small banks in the industry since small banks are a primary source of financing for small business firms. In contrast to large banks, small banks put more emphasis on the long term clientele relationship and tend to choose borrowers whose assets have relatively low credit risk. However, small banks have higher risk since they have fewer diversification opportunities. A few studies in the literature investigate the determinants of differences in behavior of small and large banks for the US and European banking sectors. Future regulations that take into account the differences between small and large banks might decrease financial crisis risk. Hence, the main objective of this paper is to analyze the impact of bank size and competition (and/or concentration) on earnings volatility, controlling some bank-specific variables that banks may have differences in earnings volatility. This paper focuses on the Turkish banking industry and produces new evidence on the differences in risk behavior of large and small banks.

The Turkish banking system, as in most developed and developing countries' banking systems, has experienced a structural reform and liberalization process in the last two decades. The main focus of these efforts was to generate more competitive and efficient banking industry. Unfortunately, the introduction of the liberalization program before the achievement of macroeconomic stability ended up with severe crises in 1994 and 2001. Many banks became insolvent and were taken over by the Saving Deposit Insurance Fund. The Turkish government signed a standby agreement with the IMF that constitutes a financial restructuring program that emphasizes the importance of governmental regulation and supervision to enhance the soundness and stability of the banking system. Hence, a new banking law aiming at improving regulatory and supervisory standards was introduced. Moreover, a new regulatory authority, namely Banking Regulation and Supervision of Turkey was introduced. The rules of game have changed and banks had to decrease their costs and increase their revenues in order to survive and therefore consolidation in the Turkish banking sector became inevitable. As a result, the Turkish banking sector has become more consolidated mainly through Merger and Acquisition activities in the last decade and the share of foreign ownership in the system has increased significantly.

The competitive conditions and market structure in the Turkish banking market have been affected from these developments. For example, total number of banks in the sector have decreased from 67 in 2001 to 44 in 2012 (-52%) while total number of branches have increased from 6,983 in 2001 to 10,111 in 2012 (+45%). Moreover, market concentration has increased from 58% (five largest banks according to total assets) in 2002 to 62% in 2012. As for the commercial bank size in 2012, there were 7 banks with an asset size above $40 billion, 6 banks with an asset size between $10 billion and 40 billion, and the rest with an asset size lower than $10 billion. The number of banks with above asset sizes in 2002 was 1, 6, and 39, respectively. These figures show that the number of large banks in the Turkish banking sector has increased significantly in recent years. However, more than half of the commercial banks in the banking sector have an asset size below $10 billion. Hence, the Turkish banking sector provides a fertile laboratory to examine the differences in behavior of small and large banks since it engaged in a process of structural reform, economic integration and technological change, while the system is witnessing more consolidation. There is only limited number of studies on the differences in risk behavior of large and small banks. Previous research on this issue is mostly on developed markets specifically the US. Hence, investigating the differences between small and large banks for banking markets of developing countries contributes to the related literature significantly. The other contribution of this paper is that the paper uses a new approach introduced by Boone (2000, 2008) to measure of competition. The main idea behind the so-called Boone indicator is that competition enhances the performance of efficient banks and impairs the performance of inefficient banks. Hence, this is the first study using the Boone indicator in the investigation of the relationship between earnings volatility and competition.

The remainder of the paper is organized as follows: Section 2 provides a brief review of related literature. In Section 3, we discuss the methodology and the econometric specification used to estimate the impact of bank size and competition along with some control variables on earnings volatility. The data and empirical results of the estimations are reported in Section 4. The paper's concluding remarks are provided in section 5.

2 Brief Literature Review

The literature on the banking industry is mostly focus on the profitability itself instead of the volatility of earnings. Several empirical studies in the literature have analyzed the relationship between bank size and earnings volatility. For example, Boyd and Runkle (1993) have investigated the relationship between bank size and the earnings volatility using data for 122 US holding companies over the period 1971-1990. They find an inverse and significant relationship between size and the standard deviation of the rate of return on assets (*ROA*). Stiroh (2004), on the other hand, reports no significant effect of size on the return on equity (*ROE*) using data for more than 14,000 banks in the US over the period 1978-2001. De Nicoló (2000) studies 826 banks in 21 industrialized countries over the period 1988-1998 and finds that larger banks take more risks and banks' return volatility increases with size. Stiroh and Rumble (2006) analyze 1816 financial holdings companies in the US over the period 1997-2001. Their results indicate that size is not related to earnings volatility. De Haan and Poghosyan (2012b) examine whether bank earnings volatility depends on bank size using quarterly data for bank holding companies in the US for the period 1995Q1-2010Q2. Controlling for the bank efficiency, diversification and capitalization, they find that bank size reduces banking risk. They also mention that the impact of size on risk is not linear.

Several papers investigate how market concentration affects bank profitability and fragility. On the theoretical front, two different arguments exist. The first argument supports the view that market concentration reduces fragility. The other group argues that a more concentrated banking system enhances bank fragility. Empirical evidence mostly supports the second view. For example, De Nicole *et al*. (2004) reports that more concentrated banking sectors are more fragile based on the data for 100 countries over the period 1993-2000. Boyd and De Nicolo (2005) explain that in concentrated markets banks have an incentive to become more risky, therefore during the financial crisis they may have higher earnings variability. Beck *et al*. (2006) study the impact of concentration and regulation on the likelihood of a systematic banking crisis by using data for 69 countries from 1980 to 1997. Their findings indicate that crises are less likely in economies with more concentrated banking systems. De Haan and Poghosyan (2012b) examine whether bank earnings volatility depends on bank size and the degree of concentration in the banking sector. They use quarterly data for bank holding companies in the US for the period 1995-2010. Their findings indicate that bank size reduces return volatility and the negative impact of bank size on earning volatility decreases with market concentration. Their findings also indicate that larger banks located in concentrated markets have experienced higher volatility during the recent financial crisis.

Some empirical evidence suggests that non-interest income is associated with earnings volatility. For example, Stiroh (2006) evaluates the impact of increased noninterest income on equity market measures of return and risk of US bank holding companies from 1997 to 2004 and reports that activities that generate non-interest income make returns more volatile. DeYoung and Roland (2001) analyze how shifts in product mix affect earnings volatility at 472 US commercial banks between 1988 and 1995. They show that fee-based activities are associated with increased earnings volatility.

The question we would like to address in this paper is how bank size and competition (and/or market concentration) affect earnings volatility in the Turkish banking industry. The motivation of this question arises from the results of previous studies that more volatile earnings can result in unstable

capital structure, hence deterioration of banks' soundness (Couto, 2002; Albertazzi and Gamabacorta, 2009; Bikker and Hu, 2002). As seen in this brief review, the previous research on this issue focused on developed markets particularly the US and Europe. Hence, investigating the differences between small and large banks in the context of a developing county's banking market would contribute to the related literature. Empirical results of this paper would also provide evidence from an emerging market on the differences in risk behavior of large and small banks.

3 Methodology

This study uses following model specification to examine the impact of competition and bank size on earnings volatility in the Turkish banking industry.

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t} + \beta_3 Z_{i,t} + \delta S_{i,t} + \varepsilon_{i,t} \tag{1}$$

where *y*, *x* and *z* represent bank earnings volatility (or *Z*-score), competition (or concentration) and bank size in year *t*, respectively. The above specification also includes a vector of bank-specific and macroeconomic variables. Derivations and calculations of the key variables used in the study are discussed below.

a) Measuring Earnings Volatility

The earnings volatility for bank *i* is defined as the standard deviation of its returns on assets (*ROA*) computed over the last four quarters. As a robustness check, we also compute the standard deviation of *ROA* over the last eight quarters to compute volatility[1]. The earnings volatility for bank *i* in year *t* is specified as follows:

$$\sigma_{(ROA)i,t} = \sqrt{\frac{1}{T+1}\left(\sum_{t=1}^{t-T}\left(ROA_{i,t} - \frac{1}{T+1}\sum_{t=1}^{t-T} ROA_{i,t}\right)\right)^2}, \qquad T = (4, 8) \tag{2}$$

where σ represents earnings volatility.

b) Z-score

The *Z*-score can be interpreted as the number of standard deviations by which returns would have to fall from the mean to wipe out all equity in the bank (Boyd and Runkle, 1993). The score is computed as follows:

$$Z_{i,t} = \frac{ROA_{i,t} + (E/TA)_{i,t}}{\sigma_{(ROA)_{i,t}}} \tag{3}$$

where *ROA* is return on assets, *E/TA* represents the equity to total assets, and σ_{ROA} denotes the standard deviation of return on assets. We use four-quarter and eight-quarter rolling time windows to compute the standard deviation of *ROA* specified in Eq. (2) to allow for time variation in the denominator of the *Z*-score. As discussed in Schaeck and Cihak (2010), this definition of *Z*-score avoids that the variation

[1] We also use the standard deviation of returns on equity (*ROE*) as a proxy for earnings volatility for bank *i* for a robustness check.

in scores within banks over the sample period is exclusively driven by the variation in the levels of equity and profitability. Furthermore, above definition of Z-score, which is computed over the same window length for different banks, is particularly important since we have an unbalanced panel dataset. A higher Z-score implies a lower probability of insolvency (failure), providing a more direct measure of soundness compared other measures of risk.

c) Measuring Competition: The Boone Indicator

Boone (2000, 2008) has proposed a new model to measure the degree of competition. This method is based on the idea that competition enhances the performance of efficient banks and weakens the less efficient ones. This effect is stronger the higher the competition in the market is. To support this quite intuitive market characteristic, Boone develops a broad set of theoretical models and proves that more efficient banks (i.e., banks with lower marginal costs) gain higher market shares. The Boone indicator is estimated by using the following empirical model:

$$\ln(ms_{ilt}) = \alpha + \sum_{t=1,....(T-1)} \beta_t D_t \times \ln(mc_{ilt}) + \sum_{t=1,....(T-1)} \theta_t D_t + \varepsilon_{ilt} \quad (4)$$

where *ms* and *mc* denote the market shares and marginal costs in the loans market, respectively. In this paper, we also measure the quarterly evolution of competition. Hence, we include time dummies, *D*, to control factors common to all banks in the market and specific to each quarter. ε is the disturbance term. The coefficient β denotes the Boone indicator. It is expected that banks with low marginal costs increase their market share (i.e, $\beta < 0$). Hence, a larger negative value of β is an indication of more competitive conditions in the banking market. However, positive values of β are also possible, implying that the higher a bank's marginal costs, the more market share it will earn. In the case of positive β, either the market has an extreme level of collusion or the banks are competing on quality.

This paper contributes to the "competition-fragility" literature in applying Boone indicator to the banking sector which is an improvement on widely accepted concentration measures, such as the Herfindahl-Hirschmann Index (*HHI*)[2]. The theoretical model above can be used to explain why commonly used measure of *HHI* is not reliable competition indicator. Moreover, concentration may be due to consolidation forced by severe competition in the market. Therefore, the concentration index is an ambiguous measure (Leuvensteijn *et al*., 2011). In this paper, to investigate the impact of competition on earnings volatility we use both the Boone indicator and *HHI* to make direct comparison with the previous studies.

To estimate Eq. (4) we need the computation of marginal cost for each bank and quarter. As marginal costs cannot be directly observed we estimate them by using the translog cost function, which is common in the related literature since it does not require too many restrictive assumptions about the

[2] The *HHI* is calculated using bank total loans as inputs ($HHI = \sum_{i=1}^{n} s_i^2$, where *s* represents the market share of each bank in total assets or deposits or loans in the market)

nature of the technology. The multi-product cost function for a given bank *s* at time *t* can be specified as follows:

$$\ln tc_{st} = \alpha_0 + \sum_{i=1}^{3}\alpha_i \ln y_{ist} + \frac{1}{2}\sum_{i=1}^{3}\sum_{k=1}^{3}\alpha_{ik} \ln y_{ist} \ln y_{kst} + \sum_{j=1}^{2}\beta_j \ln w_{jst} + \frac{1}{2}\sum_{j=1}^{2}\sum_{m=1}^{2}\beta_{jm} \ln w_{jst} \ln w_{mst} + \sum_{i=1}^{3}\sum_{j=1}^{2}\delta_{ij} \ln y_{ist} \ln w_{jst} + \sum_{t=1}^{T-1}\theta_t D_t + \varepsilon_{st} \quad (5)$$

where *tc* is the total cost and *y* denotes three outputs; total loans, other earning assets and non-interest income. The last output is a proxy for bank non-traditional activity[3]. *w* represents two input prices: price of funds and common price of labor and capital. Since personnel expenses are not reported in some quarters we calculate common price for labor and capital (see Hasan and Marton, 2003). The common price is calculated as the ratio between operating costs and total assets. The price of funds is calculated by dividing total interest expenses by total deposits. Both financial and operating costs are included in the estimation of the cost function. In addition, *D,* which represents time dummies for each quarter, is included to capture technological progress, and $\varepsilon = v + u$ is a composite error term where *v* represents standard statistical noise and *u* captures inefficiency. To ensure that the estimated cost frontier is well-behaved, two standard properties of the cost function, symmetry and linear homogeneity, are imposed via parameter restrictions. The linear homogeneity conditions are imposed by normalizing total cost (*tc*) and the price of labor (w_1) by the price of funds (w_2). The symmetry condition requires $\alpha_{ik} = \alpha_{ki} \; \forall \; i, k$ and $\beta_{jm} = \beta_{mj} \; \forall \; j, m$.

The marginal costs for loans (*l*) can be obtained by taking the first derivative of the dependent variable in Eq. (5) with respect to output y_{lst} as follows:

$$MC_{st} = \frac{\partial \ln(tc_{st}/w_2)}{\ln y_{lst}} = \frac{(tc_{st}/w_2)}{y_{lst}}\left[\alpha_l + \alpha_{il} \ln y_{lst} + \sum_{k=1,\ldots,K;k\neq l}\alpha_{ik} \ln y_{ist} + \phi_j \ln(\frac{w_1}{w_2})\right] \quad (6)$$

We also estimate cost efficiency using Jondrow *et al*. (1982) approach. Bank-specific estimates of inefficiency, *u*, can be computed by using the distribution of the inefficiency term conditional on the estimate of the composite error term. The random error term (*v*) is assumed to be normally distributed and the inefficiency term (*u*) is assumed to be one-sided.

4 Data and Empirical Results

Data

Bank level data were obtained from the bank balance sheets published by the Banks Association of Turkey. We use quarterly data on all commercial banks operating in the Turkish banking industry for the period 2002:Q1-2012Q:2. To minimize bias in our results, inputs and outputs are denominated in US dollars (Isik and Hassan, 2003; Asaf, *et al*., 2012). The data were reviewed for reporting errors,

[3] Bank non-traditional activities such as off-balance sheet and non-interest income have commonly been used as an additional bank output in the banking literature in recent years (see for example Lozano-Vivas and Pasiouras, 2010).

inconsistencies, missing values and extreme values. Three banks were dropped from the sample due to the missing values or inconsistencies. However, our sample represents 98% of the total assets of the Turkish banking system.

Following bank-specific and macroeconomic variables are controlled in the estimation of Eq. (1) to investigate why the earnings volatility of large and small banks may be different:

Bank size: The natural logarithm of total assets is used to control for bank size in the regression and it is tested whether size plays a role in explaining banking risk.

Competition: As discussed above, the Boone indicator and *HHI* are used to control competition in the regression.

Inefficiency: In contrast to the previous papers (see De Haan and Poghosyan, 2012a and 2012b; Shehzad *et al.*, 2010), which use the ratio of bank total non-interest costs to total non-interest income to proxy the efficiency, we estimate inefficiency scores for each bank in the sample using stochastic frontier methodology specified in Eq. (4) since it controls the size of banks during the estimation process. A higher score indicates lower efficiency.

Capitalization: This variable is calculated as the ratio of total equity to total assets and used to control for the relationship between bank fragility and levels of capitalization. Large banks may also be 'too big to fail' and would take more risk since they know that they will be rescued if they experience financial problems. Thus, larger banks enjoy an implicit government guarantee due to their important role in the economy. As a result, they are well covered against external shocks and expand their leverage above prudential limits. Capitalization is expected to be negatively related to banking risk.

Diversification: Large banks may have better diversification opportunities than small banks. Lower diversification may result in higher banking risk. To control banks' diversification, the share of non-interest income in total income of banks is included in the regression. The results of previous studies show positive relationship between diversification and earnings volatility.

GDP growth: We also control economic growth in the regression to check whether economic growth has significant effect on earnings volatility.

Table 1 reports summary statistics of the dependent and key explanatory variables.

Table 1. Descriptive statistics of bank level variables for 2002:Q1-2012:Q2

Variable	Mean	Standard Deviation	Coefficient of Variation
Translog Specification			
y_1 = *total loans*	6705.904	10583.669	1.578
y_2 = *other earning assets*	3771.063	7883.374	2.090
y_3 = *non-interest income*	219.194	366.714	1.673
w_1 = *price of labor and capital*	0.026	0.021	0.814

w_2 = price of loanable funds	0.059	0.046	0.782
tc = total costs (interest expenses + noninterest expenses)	846.521	1314.184	1.552
Earnings Volatility Specification			
ROA Volatility (4 quarters)	0.008	0.008	0.962
ROE Volatility (4 quarters)	0.069	0.097	1.413
ROA Volatility (8 quarters)	0.009	0.007	0.851
ROE Volatility (8 quarters)	0.073	0.091	1.248
Z-ROA (4 quarters)	29.751	35.266	1.185
Z-ROA (8 quarters)	23.628	19.597	0.829
Z-ROE (4 quarters)	6.062	7.206	1.189
Z-ROE (8 quarters)	5.001	4.278	0.855
ta = total assets	15151.520	22266.450	1.469
Boone Indicator	-0.214	0.170	-0.791
HHI	0.092	0.004	0.046
C5	0.596	0.015	0.025
Diversification	0.197	0.133	0.678
Capitalization	0.135	0.054	0.397
Inefficiency	0.369	0.222	0.600
GDP Growth	1.253	2.292	1.829

Note: Costs, loans, earnings, income and assets are in millions of U.S. dollars. *C*5 is a measure of concentration and defined as the share of five largest banks in loans in the sector.

Empirical Results

As discussed before, the Boone indicator is used for a proxy of competition in this study. Hence, we first analyze the Boone indicator and then the impact of competition, bank size and some control variables on the earnings volatility.

To estimate the Boone indicators we regress marginal costs, which are obtained from a traslog cost function specified in Eq. (5), on the market share in the loans market. The coefficient (β) of market

share in Eq. (4) is the Boone indicator[4]. As mentioned in previous section, we use quarterly data (2002:Q1-2012:Q2) to investigate the impact of competition and bank size on earnings volatility. Since we have forty two quarters it is not practical to report all of the estimated Boone indicators in the same table. Hence, the estimates of quarterly β for the full sample are plotted in Fig. 1. The Boone indicators are all statistically significant at conventional levels except four quarters of 2011[5]. As seen in the figure, the quarterly estimates of β fluctuate between -0.185 and -0.413 over the period 2002Q1-2008Q4 and show a small variation during this period. This suggests that there was a small variation in the degree of competition in the banking industry and the level of competition did not decrease despite the reduction in the number of banks in this period. However, volatility of the estimate of β started to increase after 2008. Although β takes positive values in year 2011 they are insignificant in four quarters for that particular year. These results suggest that the Turkish banking industry witnessed a less competitive environment in the loans market after 2008. This result is not surprising since 2008 coincides with the peak time of the global financial crisis. However, Turkey felt deeply the impact of global financial crisis in 2009 and economy shrunk about ten percent in that particular year. Banks operating in the Turkish banking system faced increased balance sheet risks, tightened external funding resources and increased liquidity needs particularly in the last quarter of 2008 and in the first quarter of 2009. However, due to the sound balance sheets, successful risk management by banks and measures taken by the regulatory institutions the Turkish banking sector stayed safe and sound in 2009. Moreover, in contrast to the most of the developed countries, Turkey did not change the deposit guarantee limit during the global crisis period. These developments may have changed the competitive structure of the loans market in Turkey.

[4] The joint determination of cost and performance could be the case in this regression model. Hence, we also tested whether endogenity problem is present in our specification. The results of endogenity test show that marginal costs have been considered as exogenous at conventional significance levels in the estimation of Eq. (4).

[5] Although not reported the *t*-values of each quarter are available upon request from the authors

Figure 1. Boone indicators of the loans market over the period 2002Q1-2012Q2

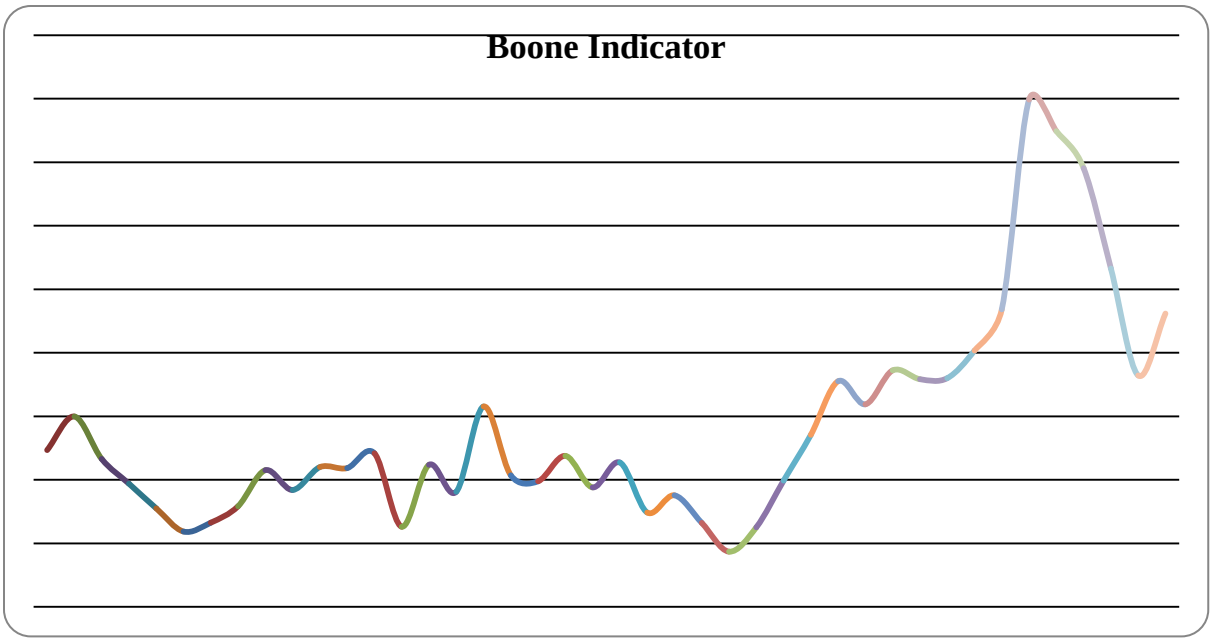

Table 2 reports the regressions results from earnings volatility models with panel fixed effects model and with the system GMM estimator[6]. At the bottom of the table, we report specification test results for the GMM estimations[7]. The Sargan test is a test on whether the instruments are uncorrelated with the error term. The results show that the null hypothesis cannot be rejected. Moreover, the Arellano-Bond test results also show significant *AR*(1) serial correlation and lack of *AR*(2) serial correlation. According to these test all GMM equations are properly specified. Columns 1-4 of Table 2 indicate the impacts of bank size and competition along with some bank-specific control variables on *ROA* volatility measured both over a four-quarter and eight-quarter period. The *ROE* volatility is replaced in Columns 5-8. Table 2 show that the coefficients of bank size on earnings volatility (*ROA* and *ROE*) is significantly negative at conventional levels. The negative relation is consistent with the findings in De Haan and Poghosyan (2012) and Boyd and Runkle (1993) but in contrast to the results in Stiroh (2004). Hence, this result suggests that the higher bank size is, the lower the earnings volatility is and might also shows the relative advantage of large banks in making larger loans of better quality, which makes larger banks more profitable and stable. The table also shows that the relationship between banking competition proxied by the Boone indicator and earnings volatility is generally significantly negative suggesting that competition increases earnings volatility given that lower values of the Boone indicator signify more competition[8]. Hence this result indicates that competition in the banking industry increases bank risk taking and supports the "competition-fragility" hypothesis which argues that smaller banks in more competitive environments are more likely to take excessive risks and therefore

[6] In accordance to the Hausman test, the random effects model was rejected.

[7] The Sargan test is a test on whether the instruments are uncorrelated with the error tem. Moreover, the Arellano-Bond test results also require significant *AR*(1) serial correlation and lack of *AR*(2) serial correlation.

[8] As discussed before the Boone indicator is inversely proportional to competition. That is the more negative the measure is, the more competitive the banking market is.

competitive markets are more fragile than less competitive ones (see Boyd and De Nicolo, 2005)[9]. As for the bank-specific variables, the results show that higher capitalized (or lower leveraged) banks face lower *ROE* volatility and support the conventional view which argues that high levels of capitalization will reduce risk by placing banks in a better position to absorb losses. This result might also suggest the importance of regulating bank capital (Basel II) as a safeguard against excessive risk taking. This finding is in line with findings of De Haan and Poghosyan (2012a, 2012b). The coefficient of diversification is generally negative and statistically significant. This finding implies that banks with a higher share of non-interest income in total income have less volatile earnings and does not support the results of Stiroh and Rumble (2006) and De Haan and Poghosyan (2012a, 2012b). Table 2 also shows that inefficiency is generally positive and significant, suggesting that banks with a relatively higher inefficiency levels face higher return volatility. This result indicates that less efficient banks are more vulnerable to risk. The macroeconomic variable, economic growth, does not show any significance, therefore the banking sector risk is not affected by its macroeconomic environment[10].

Table 2. Estimation results: Bank size, competition and earnings volatility

	Dependent Variable: *ROA* Volatility (4 Quarters): *Y*		Dependent Variable: *ROA* Volatility (8 Quarters): *Y*		Dependent Variable: *ROE* Volatility (4 Quarters): *Y*		Dependent Variable: *ROE* Volatility (8 Quarters): *Y*	
	Panel A		Panel B		Panel C		Panel D	
	FE	GMM	FE	GMM	FE	GMM	FE	GMM
intercept	0.020*	0.008*	0.437*	0.083*	0.437*	0.083*	0.407*	0.028**
	(0.004)	(0.002)	(0.061)	(0.011)	(0.061)	(0.011)	(0.054)	(0.013)
Y_{t-1}		0.794*		0.699*		0.699*		0.761*
		(0.013)		(0.055)		(0.055)		(0.005)
Competition (Boone)	-0.003**	-0.000	-0.013	-0.004*	-0.013	-0.004*	-0.022**	-0.003**
		(0.000)	(0.020)		(0.020)			

[9] Following De Haan and Poghosyan (2012a) the interaction of competition and size is also added to investigate whether competition conditions the impact of size. Due to the high correlation between the interaction term and Boone indicator, coefficients of key variables were statistically insignificant. Hence, we dropped the interaction term from the regressions. Although not reported, but they are available from the authors upon request.

[10] We also include dummy variables to control for global crisis and foreign ownership in the regression. Our aim was to check whether global financial crisis and foreign ownership have impacts on earnings volatility and insolvency risk. Coefficients of these dummies were statistically insignificant at conventional levels. The results are not reported but available upon request from the authors.

	*			*		*	*	*
	(0.001)			(0.002)		(0.002)	(0.012)	(0.001)
Size (*lnTA*)	-0.002*	-0.001*	-0.037*	-0.006*	-0.037*	-0.006*	-0.033*	-0.001***
	(0.000)	(0.000)	(0.006)	(0.001)	(0.006)	(0.001)	(0.005)	(0.000)
Capitalization	0.008	0.006**	-0.571*	-0.081*	-0.571*	-0.081*	-0.510*	-0.063*
	(0.005)	(0.003)	(0.076)	(0.007)	(0.076)	(0.007)	(0.093)	(0.015)
Diversification	-0.006*	-0.003*	0.030	-0.060*	0.030	-0.060*	0.037	-0.029*
	(0.002)	(0.001)	(0.026)	(0.004)	(0.026)	(0.004)	(0.067)	(0.006)
Inefficiency	0.001*	0.000*	0.003***	0.001**	0.003***	0.001**	0.010	0.017*
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.015)	(0.002)
GDP Growth	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
M1(p-value)	NA	0.052	NA	0.033	NA	0.033	NA	0.084
M2 (p-value)	NA	0.121	NA	0.298	NA	0.298	NA	0.189
Sargan (p-value)	NA	0.801	NA	0.708	NA	0.708	NA	0.736
R-squared	0.25	NA	0.29	NA	0.29	NA	0.35	NA

Notes: *,**, and *** denote significance level at 1%, 5% and 10% , respectively.

Claessens and Laeven (2004) show that concentration cannot be considered as a proxy for competition and argue that concentration has independent effects on performance outcomes in the banking industry. They further found that bank concentration was positively instead of negatively related to competition. However, following De Haan and Poghosyan (2012a) we also use an indicator for market power, *HHI*, which measures the degree of market concentration in the regression models to control for the impact of market structure on earnings volatility. This indicator is often used for testing the Structure Conduct Performance model. As in Table 2, Table 3 is also focus on fixed effects and the two-step system GMM dynamic panel data approaches and reports the impacts of bank size and concentration along with the bank-specific control variables on the earnings volatility. The results indicate that the coefficient of banking concentration is generally negative but only significant in the case of four-quarter using the two-step GMM approach produces. Hence, in contrast to De Haan and Poghosyan

(2012a), this weak result indicates that banks operating in more concentrated banking markets have lower earnings volatility. The estimated coefficient on bank size is always negative and highly significant implying that the higher bank size is, the lower the earnings volatility is. This result supports our earlier findings. The signs of coefficients of capitalization and diversification are generally negative and significant, suggesting that higher capitalized and diversified banks have lower earnings volatility. As for the efficiency, our results show positive relationship between inefficiency and banking risk, implying that less efficient banks have higher earnings volatility. Overall, these results generally support our earlier findings[11].

Table 3. Estimation results: Bank size, concentration and earnings volatility

	Dependent Variable: *ROA* Volatility (4 Quarters): *Y*		Dependent Variable: *ROA* Volatility (8 Quarters): *Y*		Dependent Variable: *ROE* Volatility (4 Quarters): *Y*		Dependent Variable: *ROE* Volatility (8 Quarters): *Y*	
	Panel A		Panel B		Panel C		Panel D	
	FE	GMM	FE	GMM	FE	GMM	FE	GMM
intercept	0.026* (0.004)	0.010* (0.002)	0.019*** (0.010)	-0.026 (0.021)	0.271* (0.068)	0.101* (0.015)	0.123 (0.200)	0.123 (0.348)
Y_{t-1}		0.797* (0.038)		0.857* (0.020)		0.699* (0.005)		0.759* (0.004)
Concentration (*HHI*)	-0.023 (0.048)	-0.023* (0.004)	0.101 (0.075)	-0.291 (0.198)	2.578 (1.517)	-0.171** (0.089)	-2.829 (1.744)	-1.484 (0.921)
Size (*lnTA*)	-0.003* (0.000)	-0.001* (0.000)	-0.002* (0.000)	-0.000* (0.000)	-0.045* (0.016)	-0.006* (0.001)	-0.032* (0.005)	-0.001* (0.000)
Capitalization	0.007 (0.005	0.005**	-0.016** (0.007)	0.003* (0.001)	-0.595**	-0.078* (0.009)	-0.559* (0.103	-0.067* (0.014)

[11] Our results are based on *HHI* with respect to total assets. However, we also estimated the regression including *HHI* with respect to total loans and deposits. The results are very similar those of *HHI* with respect to total assets.

	)	(0.002)			(0.254)		)	
Diversification	0.006*	-0.003*	0.010*	-0.001**	0.035	-0.059*	0.029	-0.031*
	(0.002)	(0.001)	(0.003)	(0.000)	(0.002)	(0.004)	(0.051)	(0.003)
Inefficiency	0.001*	0.000*	-0.001	0.000*	0.003**	0.001*	0.003	0.018*
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.015)	(0.002)
GDP Growth	-0.000	-0.000	-0.000	-0.000	-0.000	0.000*	-0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
M1(p-value)	NA	0.044	NA	0.028	NA	0.093	NA	0.084
M2 (p-value)	NA	0.118	NA	0.316	NA	0.256	NA	0.189
Sargan (p-value)	NA	0.789	NA	0.691	NA	0.798	NA	0.736
R-squared	0.25	NA	0.39	NA	0.23	NA	0.35	NA

Notes: *,**, and *** denote significance level at 1%, 5% and 10% , respectively.

We also estimate Eq. (1) using the *Z*-score as the dependent variable for robustness check. The *Z*-score proposed by Boyd and Runkle (1993) measures how distant a specific bank is from insolvency and is equal to the number of standard deviations of bank's *ROA* (or *ROE*) must decrease below its expected value before equity is depleted. Hence, the *Z*-score is inversely proportional to the bank's probability of default.

Table 4 shows the results obtained with panel fixed effects and the two-step GMM estimations. Considering the link between bank competition and bank insolvency, the results show that competition proxied by the Boone indicator is positively and significantly related to bank's insolvency. This suggests that higher bank competition leads to decrease bank insolvency risk as measured *Z-ROA* and *Z-ROE* given that lower values of the Boone indicator signify more competition. As for the bank size, coefficient of size is generally positive and significant, suggesting that larger banks are less risky, in line with our earlier findings that larger bank incur lower earnings volatility. That is, larger banks are less risky. The coefficient for capitalization is always significantly positive, implying that high level of capitalization will reduce insolvency risk. The result also shows that income diversification has no

effect on bank insolvency risk. Finally, the results also suggest that less efficient banks are riskier. Overall, these empirical results confirm our earlier findings.

Table 4. Estimation results: Bank size, competition and insolvency *(Z*-score)

	Dependent Variable: *Z-ROA* (4 Quarters): *Y*		Dependent Variable: *Z-ROA* (8 Quarters): *Y*		Dependent Variable: *Z-ROE* (4 Quarters): *Y*		Dependent Variable: *Z-ROE* (8 Quarters): *Y*	
	Panel A		Panel B		Panel C		Panel D	
	FE	GMM	FE	GMM	FE	GMM	FE	GMM
intercept	-23.828***	13.638	-9.952	-2.536	-11.441*	-17.218*	-7.457*	-4.055
	(14.179)	(24.839)	(12.664)	(15.744)	(3.647)	(5.964)	(2.510)	(3.628)
Y_{t-1}		0.447*		0.794*		0.472*		0.518*
		(0.003)		(0.071)		(0.004)		(0.092)
Competition (Boone)	26.580*	14.812*	18.289*	2.778**	5.067*	2.011*	2.903*	0.313
	(7.885)	(2.056)	(2.563)	(1.132)	(1.668)	(0.696)	(0.705)	(0.222)
Size (*lnTA*)	5.682*	-0.444	2.703**	0.509	1.503*	2.239*	1.081*	0.683
	(1.540)	(2.989)	(1.377)	(1.718)	(0.332)	(0.719)	(0.279)	(0.421)
Capitalization	142.719*	92.599**	135.353*	51.405**	52.290*	46.851*	34.744*	18.938*
	(21.844)	(40.369)	(12.258)	(20.124)	(7.056)	(6.842)	(3.616)	(4.981)
Diversification	-13.722*	-8.904	-6.546	-3.022	-0.274	-3.320	-0.118	-0.729
	(4.826)	(11.252)	(5.051)	(8.514)	(1.039)	(2.597)	(1.069)	(1.356)
Inefficiency	-11.065**	-4.494	-6.642*	-6.650	-2.351**	-4.095**	-1.904*	-4.417*
	(4.798)	(3.474)	(2.469)	(4.658)	(1.032)	(1.163)	(0.436)	(1.163)
GDP Growth	-0.343	-0.282*	0.063	-2.537	-0.032	-0.024*	0.020	0.070*

						*		
	(0.317)	(0.086)	(0.147)	(15.744)	(0.059)	(0.012)	(0.057)	(0.009)
M1(p-value)	NA	0.012	NA	0.058	NA	0.013	NA	0.013
M2 (p-value)	NA	0.468	NA	0.118	NA	0.529	NA	0.316
Sargan (p-value)	NA	0.846	NA	0.683	NA	0.881	NA	0.661
R-squared	0.30	NA	0.48	NA	0.37	NA	0.48	NA

Notes: *,**, and *** denote significance level at 1%, 5% and 10% , respectively.

We also investigate the impacts of bank size and market concentration (*HHI*) along with the bank-specific control variables on the bank insolvency risk as measured *Z-ROA* and *Z-ROE*. Table 5 reports the estimation results. The results show that coefficient of concentration is always negative and statistically insignificant, suggesting no relationship between insolvency risk and market concentration. The size, as in the previous case, is positively and significantly related to the insolvency risk, implying that larger banks have advantages to decrease insolvency risk. The results also show that higher capitalized and efficient banks have lower risk. However, diversification has no impact on risk. In general, these results support the earlier findings.

Table 5. Estimation results: Bank size, concentration and insolvency *(Z*-score)

	Dependent Variable: *Z-ROA* (4 Quarters): *Y*		Dependent Variable: *Z-ROA* (8 Quarters): *Y*		Dependent Variable: *Z-ROE* (4 Quarters): *Y*		Dependent Variable: *Z-ROE* (8 Quarters): *Y*	
	Panel A		Panel B		Panel C		Panel D	
	FE	GMM	FE	GMM	FE	GMM	FE	GMM
intercept	-31.929 (30.478)	13.307 (22.489)	-3.185 (23.428)	-89.465 (94.648)	-10.864 (7.021)	-15.257** (6.900)	-3.604 (7.420)	17.296 (32.302)
Y_{t-1}		0.452* (0.003)		0.807* (0.056)		0.480* (0.006)		0.553* (0.084)
Concentratio	-	-	-	746.706	-82.412	-5.808	-85.200	-

n (*HHI*)	344.146 (282.804)	125.300 (83.921)	386.519 (240.892)	(913.820)	(55.483)	(48.018)	(66.567)	171.507 (305.582)
Size (*lnTA*)	9.657* (1.424)	3.680*** (2.090)	5.726* (0.739)	1.254* (0.460)	2.211* (0.337)	1.709* (0.573)	1.515* (0.203)	0.265 (0.466)
Capitalization	163.080* (21.554)	87.951** (36.277)	152.995* (13.795)	60.981* (16.479)	56.297* (6.665)	39.708* (6.512)	37.822* (3.869)	14.340* (2.820)
Diversification	-8.742* (6.108)	3.985 (11.186)	-3.920 (3.890)	-4.944 (5.070)	0.794 (1.335)	1.325 (1.913)	0.337 (0.845)	0.673 (0.956)
Inefficiency	-8.327*** (4.990)	-5.645 (4.701)	-4.386*** (2.295)	-3.137 (3.225)	-1.822*** (1.031)	-2.348* (0.678)	-1.506* (0.377)	4.126* (1.321)
GDP Growth	-0.343 (0.317)	-0.147 (0.062)	0.483*** (0.180)	0.137*** (0.068)	0.054 (0.055)	0.001 (0.013)	0.095*** (0.056)	0.077* (0.008)
M1(p-value)	NA	0.013	NA	0.062	NA	0.016	NA	0.077
M2 (p-value)	NA	0.322	NA	0.118	NA	0.488	NA	0.131
Sargan (p-value)	NA	0.751	NA	0.765	NA	0.845	NA	0.831
R-squared	0.31	NA	0.47	NA	0.36	NA	0.47	NA

Notes: *,**, and *** denote significance level at 1%, 5% and 10% , respectively.

5 Conclusions

This paper analyzes the relationship between earnings volatility, bank size and competition (or concentration) for the Turkish banking industry over the period 2002Q1-2012Q2 and uses a new

measure for competition called as the Boone indicator. The result suggests that there was a small variation in the degree of competition in the banking industry over the period 2002-2008 in this period. Although the number of banks decreased in this period the system stayed competitive. However, volatility of the estimates of Boone indicator started to increase after 2008 and the Turkish banking sector became less competitive. These results suggest that the Turkish banking industry witnessed a less competitive environment in the loans market after 2008. This result is not surprising since 2008 coincides with the peak time of the global financial crisis.

Our results indicate that there is a negative relationship between earnings volatility and banks size, suggesting that larger banks have lower risk compared to smaller banks. This negative relationship holds when we use both definitions of earnings volatility (*ROA* and *ROE*). The results also show that competition increases earnings volatility. Hence, this result suggests that competition in the banking industry increases bank risk taking and supports the "competition-fragility" hypothesis. The results further suggest that higher capitalized and diversified banks have lower earnings volatility and less efficient banks are more vulnerable to risk. To make direct comparison to the previous studies we replaced the Boone indicator with an indicator for market power, the Herfindahl-Hirschmann Index (*HHI*), which measures the degree of market concentration in the regression models. The results show that the coefficient of banking concentration is generally negative but significant in two cases. Hence, there is no strong relationship between market concentration and earnings volatility during the sample period.

We also used measures of insolvency (Z-score) as dependent variables for robustness check. A higher Z-score implies a lower probability of insolvency (failure). Our results show that bank size is positively related to Z-score, suggesting that larger banks are less risky. Moreover, the results also indicate that higher bank competition leads to lower bank insolvency risk. Overall, these empirical results confirm our earlier findings.

Finally, our empirical results suggest that larger banks, higher capitalized banks, banks with higher share of non-interest income in total income and efficient banks are more stable. Moreover, fierce competition among banks has negative impact on stability. As a policy implication, our evidence suggests that regulators should continue to strengthen the capital adequacy framework by taking into account efficiency factors. Regulators could also promote merger and acquisition activities among small and medium-sized banks in order to increase their survival chance in the market since as our empirical evidence suggest larger banks more are stable and contribute to financial stability.

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