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Bank size, competition and risk in the Turkish banking industry

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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. The main result of the paper indicates 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 a 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

The Turkish banking system was historically a closed system, heavily regulated, protected from external competition and conservative in terms of innovations before 1980. The government announced a financial liberalization program, which ended

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50 years of protectionism, in 1980. The main objective of the program was to generate a competitive, efficient and sound banking system. Hence, the system witnessed continuous legal, structural and institutional changes in 1980s. The main feature of the Turkish experience, as in other emerging economies, was that the liberalization program was introduced before the achievement of macroeconomic stability and development of legal and regulatory frameworks. Macroeconomic instability reflected in high inflation rates, volatile economic growth rates, fragility in the financial system, the government intervention in the debt markets, and highly skewed income distribution produced two serious financial crises in 1994 and 2001.[1] The economy contracted significantly, particularly in 2001 and several banks became insolvent.[2] A new economic stabilization program was announced in April 2001 in order to restore macroeconomic stability.[3] The banking restructuring program was an integral component of the new program and introduced in May 2001 (Yildirim 2014). The main aim of the program was to improve the regulatory and supervisory framework in the system.[4]

The Turkish government also signed a new stand-by agreement with the IMF in February 2002 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. In addition, authorities, taking the support of international organization, continued with the process of reforming the regulatory and supervisory frameworks. One of the important regulatory changes during the period was the abandonment of the full coverage deposits insurance system in 2004. Moreover, a new banking law in accordance with EU directives and international standards was introduced by the Banking Regulation and Supervision Agency and enacted in 2005.[5]

In this process, the number of banks declined significantly due to the purging of the weaker banks from the system and the mergers and acquisitions. At the same

[1] Losing control in financing fiscal deficits produced the financial crisis of 1994. The government interventions in the domestic debt market were the main reason of the crisis. The Turkish economy shrunk by 6 % and the inflation rate hit three digit levels. Moreover, the value of US dollar nearly doubled against Turkish lira and the Central Bank reserves decreased significantly. Three banks became insolvent and a full coverage deposit insurance system was introduced to restore financial stability.

[2] The problem started with the exchange rate-based stabilization program of 1999. The main aim of the program was to control inflation, correct macroeconomic fundamentals and decrease the fragility of the financial system. After some initial success, the Turkish economy suffered a liquidity crisis in November 2000. However, the country got into a deepening crisis period that reached to its peak with the abandonment of the pegged exchange rate regime in February 2001.

[3] The Turkish economy shrunk by 7.5 % and the Turkish lira depreciated around 11 % in real terms. As in the case of 1994 crisis, most of the Central Bank reserves eroded in managing the crisis. Banking system was the most affected by the crisis because of the high level of foreign currency dominated liabilities. Total assets of the system decreased about one-third in US dollar terms.

[4] 20 banks were taken over by the Savings Deposit Insurance Fund (SDIF) due to the weak financial positions during the period 1999–2003.

[5] The Banking Regulation and Supervision Agency (BRSA), which was founded in September 2000, changed its main objective from supervision to restructuring and rehabilitation. The main duties of the BRSA during the crisis period were strengthening the private banks' capital structures, restructuring the state-owned banks, resolving the banks taken over by the SDIF, and improving the quality of supervision in the banking system (Al and Aysan 2006).

time, foreign presence in the system also increased. The new regulatory and supervisory environment in the system, the commitment of the single party government to the ongoing reform process, the favorable macroeconomic conditions through the successful monetary and fiscal policies, and future growth prospect changed the perceptions about Turkey and contributed significantly to the entry decisions of foreign banks into the system (Akin et al. 2009). Attracted by these favorable conditions, foreign banks acquired controlling stakes in Turkish banks or made strategic partnership agreements. The system exhibited a strong growth performance in the post-restructuring period due to the favorable macroeconomic conditions and better institutional environment. For instance, the ratio of total assets to GDP increased from 61 % in 2002 to 93 % in 2012 (BAT 2012).[6] In addition, the system demonstrated considerable resilience during and in the aftermath of the recent global financial crisis and had higher profitability and capitalization levels than the BRICS and CEE countries (Yildirim 2014).

A closer look at some system-related statistics show that the competitive conditions and market structure in the system have been affected by these developments. The total number of banks in the system has decreased from 67 in 2001 to 44 in 2012 (−34 %) while the total number of branches have increased from 6983 in 2001 to 10,111 in 2012 (+45 %). At the end of 2012, the shares of state-owned banks, privately-owned Turkish banks and foreign-owned banks in the total assets of depository banking are 30.3, 55.4 and 14.3 %, respectively. Moreover, market concentration has increased from 58 % (five largest banks, according to total assets) in 2002 to 62 % in 2012. As for the size distribution 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.[7] The number of banks with above asset sizes in 2002 was 1, 6, and 39, respectively (BAT 2002, 2012). These statistics show that the number of large banks in the Turkish banking system has increased significantly in recent years. However, more than half of the commercial banks in the banking system have an asset size below $10 billion.

There are only a limited number of studies on the differences in risk behavior of large and small banks. Previous research on this issue is mostly on the developed markets, specifically the US. Hence, the main objective of this paper is to analyze the impact of bank size and competition on earnings volatility. Investigating the impact of size and competition on banking risk in the context of a major developing country's banking market would contribute to the related literature because the implications of previous studies on developed countries' banking systems may not be applied to the developing countries' banking systems.[8] The Turkish banking system provides a fertile laboratory specifically for examining whether large banks

[6] The BAT stands for the Banks Association of Turkey. The BAT publishes annual reports called as the "banks in Turkey". The figures have taken from the report published in 2012.

[7] We also checked the inflation adjusted figures with the suggestion of the referee. $40 billion and $10 billion in 2002 correspond to around $51 billion and $12.8 billion in 2012, respectively. There were still 7 banks with an asset size above $51 billion, 5 banks with an asset size between $12.7 billion and $51 billion, and the rest with an asset size lower than $12.7 billion. Hence, this supports the above statement regarding the significant increase in the number of large banks in the system during the sample period.

[8] Haselmann and Wachtel (2007) state that banks behave differently under different institutional settings.

are more stable than small banks, thereby contributing to financial stability since the system engaged in a process of structural reform, economic integration, technological change and consolidation in recent years. The other contribution of the paper is that it uses a new approach introduced by Boone (2001, 2008) to measure competition. This is the first study using the Boone indicator in the investigation of the relationship between earnings volatility and competition.

In this paper, the model parameters are estimated using the GMM method. More specifically, the two-step GMM system estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998) is used. By way of preview, our main empirical results indicate that bank size and earnings volatility are negatively related, suggesting that larger banks are less risky. The results also indicate that competition increases earnings volatility. The results further indicate that bank stability and bank size are positively related suggesting that larger banks are more stable.

The remainder of the paper is organized as follows: Sect. 2 provides a brief review of the related literature. Section 3 discusses the methodology, the econometric specification and data. The empirical results of the estimations are reported in Sect. 4. The paper's concluding remarks are provided in Sect. 5.

2 Brief literature review

The theoretical literature on the relationship between bank competition and stability produces controversial evidence. Two theoretical views have been developed on this relationship. The first view suggests that competition leads to instability. The second view, however, suggests a positive relationship between competition and stability. The competition-fragility view proposed by Keeley (1990) is also called as the "franchise value" paradigm. This view states that higher competition increases bank's risk taking incentives. To support the franchise value paradigm, Allen and Gale (2004) use an agent model proposed in Keeley (1990) and argue that financial crises are more likely to occur in less concentrated banking systems. The main idea behind this view is that excessive competition erodes the franchise value of banks by reducing their monopoly rents and therefore forces them to undertake more risky activities. Boyd et al. (2006) argue that the presence of larger banks in concentrated banking markets might enhance profits and therefore decrease fragility by providing higher capital buffers that protect these markets against external shocks. The alternative competition–stability view states that more competitive or less concentrated banking markets are more stable. The "too big to fail" hypothesis discussed in Mishkin (2006) states that large banks would be recipients of public guarantees or subsidies in case of a financial difficulty and in return they tend to hold less capital buffer. Hence, this may generate a moral hazard problem, encourage risk-taking behavior and intensify financial fragility (Rosenblum 2011). Boyd and De Nicolo (2005) also argue that less competition leads to higher interest rate for loans, which could increase the default possibility due to borrowers' moral hazard. They explain that in the concentrated markets, banks have an incentive to become more risky, therefore during the financial crisis they may have higher

earnings volatility. In addition, Beck et al. (2006) show that bank size is positively correlated with organizational complexity. For instance, monitoring a large bank is more difficult than monitoring a small bank. As bank size increases, transparency may decrease because of expansion across multiple geographic markets and business line. These might decrease managerial efficiency and corporate control, and might increase operational risk (Fu et al. 2014).

The empirical literature on the relationship between competition and stability has also produced mixed results. Boyd et al. (2006) using a panel of 2700 banks from 134 countries provide empirical evidence supporting a positive relationship between banks' market power and banks' failure risk. Beck et al. (2006), using data from 69 countries, find that countries experiencing less market concentration are less likely to suffer a financial crisis. Yeyati and Micco (2007) using data from 8 Latin American countries, find a positive relationship between competition and bank stability. Schaeck and Cihak (2008) investigate the relationship between bank competition and stability using a panel of 3600 banks from ten European countries and 8900 banks from the US over the period 1995–2005. Their results indicate that competition increases bank stability and that more concentrated banking markets benefit from financial stability. Schaeck et al. (2009) use data from 31 systemic banking crises in 45 countries over the period 1980–2005 and indicate that competition decreases the likelihood of a crisis. Berger et al. (2009) use a panel of 8235 banks from 23 industrial countries over the period 1999–2005 and show that banks with market power are more stable. Their result supports the traditional competition-fragility view. Liu et al. (2012) use several bank-specific risk indicators (the ratio of loan-loss provisions to total loans, loan-loss reserves to total loans, after-tax ROA volatility, and Z-score) to examine the relationship between competition and risk for a panel of banks from several countries in South East Asia (Indonesia, Malaysia, the Philippines and Vietnam) over the period 1998–2008. Their result indicates that competition is inversely related to most risk indicators except the Z-score, which suggests that competition does not erode bank stability. The results also suggest that concentration is negatively related to bank risk. Fu et al. (2014) analyze the tradeoff between competition and financial stability using data from 14 Asia Pacific countries. Their results suggest that greater concentration fosters financial fragility.

A few empirical studies in the literature particularly analyze the relationship between bank size and earnings volatility. For instance, Boyd and Runkle (1993) investigate the relationship between bank size and the earnings volatility using data from a panel of 122 US holding banks over the period 1971–1990. They find an inverse relationship between bank size and Z-score and standard deviation of the rate of return on assets. Stiroh (2004), however, reports no significant effect of size on the return on equity 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 holding 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 and the

degree of concentration in the banking system, using a panel of 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.

The question we would like to address in this paper is how bank size and competition (and/or market concentration) affect earnings volatility and bank stability in the Turkish banking system. The motivation of this question arises from the results of previous studies that more volatile earnings can result in an unstable capital structure, hence deterioration of bank's soundness (Couto 2002; Albertazzi and Gambacorta 2009; Bikker and Hu 2002). As seen in the above brief review, the previous research on this issue produced mixed results regarding the relationship between competition, concentration, stability and size. In addition, the most of the previous research is on the banking markets of developed countries. Hence, investigating this issue in the context of a developing country's banking system is one of the main contributions of this paper.

3 Methodology and data

3.1 Empirical methodology

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

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 Competition_{i,t} + \beta_3 Size_{i,t} + \delta_1 Capitalization_{i,t} + \delta_2 Diversification_{i,t} + \delta_3 Inefficiency_{i,t} + \delta_4 Cycle_t + \varepsilon_{i,t} \quad (1)$$

where subscripts $i = 1, \ldots, N$ and $t = 1, \ldots, T$ denote bank and year, respectively. $Y_{i,t}$ is the dependent variable (bank earnings volatility or bank stability, Z-score) and $Y_{i,t-1}$ represents its lagged value. The main idea of including the lagged value of the dependent variable is to measure the possible persistence in risk and stability in the industry. The error term, $\varepsilon_{i,t} = v_i + u_{i,t}$, is assumed to consist of an unobservable bank-specific component (v_i) and a random disturbance ($u_{i,t}$). The bank-specific component is assumed to be stochastic and not correlated with the random component.

The introduction of a lagged dependent variable among the right hand side variables in Eq. (1) might create serious problems. Since $Y_{i,t}$ is a function of v_i, which is a bank-specific effect, $Y_{i,t-1}$ is also a function of v_i. Hence, estimating Eq. (1) with OLS produces biased and inconsistent estimators even if the $u_{i,t}$ are not serially correlated. As for the fixed effects estimator, although the Within transformation cancels out the v_i, $(u_{i,t-1} - \bar{u}_{i-1})$ will still be correlated with $(u_{i,t} - \bar{u}_i)$. This correlation creates a bias in the estimation of the coefficient of the lagged dependent variable, which is not diminished by increasing N, the number of

cross sections. Hence, the lagged dependent variable cannot be independent of the composite error process.

To solve this problem, Arellano and Bond (1991) propose a *difference* GMM estimator for the coefficients in the above mentioned equation, where the lagged levels of the regressors are the instruments for the equation in first differences. However, Arellano and Bover (1995) and Blundell and Bond (1998) demonstrate that the instruments used in the *difference* GMM estimator could be less informative in some cases and suggest to difference the instruments instead of the regressors to make them uncorrelated with the fixed effects. This leads from the *difference* GMM to the *system* GMM estimator, which is a joint estimation of the equations in levels and in first differences. The system GMM estimator avoids the weak instrument problem that the Arellano and Bond (1991) estimator would face and provides a more flexible variance–covariance structure for the moment conditions.[9] Hence, our preferred estimator is the two-step system GMM.[10]

The consistency of the GMM estimator depends on the validity of the moment conditions. For this purpose, the Hansen test is used to test for the over-identification restrictions. The null of Hansen test is that the instruments are valid, not correlated with the error term and that the excluded instruments were correctly excluded from the equation. In addition, first-order and second-order serial correlations in the disturbances should be computed to verify if there are lags which are invalid instruments. The test results require significant first-order serial correlation and lack of second-order serial correlation.

3.2 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 (and/or eight) quarters.[11] The earnings volatility for bank i in year t is specified as follows:

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

where σ represents earnings volatility.

3.3 Bank stability: 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:

[9] Interested readers could refer to Baltagi (2005) for the technical details of the dynamic panel data models.

[10] The System GMM estimator also eliminates the endogeneity problem that might arise due to the possible correlation between the bank-specific effects and the explanatory variables.

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

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

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 both four-quarter and eight-quarter rolling time window 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 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 data set. A higher Z-score implies a lower probability of insolvency (failure), providing a more direct measure of soundness compared to other measures of risk.

3.4 Competition: the Boone indicator

Boone (2001, 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 developed 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:

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

where *ms* and *mc* denote the market shares and marginal costs in the loans market, respectively.[12] 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 and imply 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. To estimate Eq. (4), we need to estimate marginal costs for each bank in the sample. The estimation procedure of marginal costs is explained in the "Appendix".

This paper contributes to the "competition-fragility" literature by applying Boone indicator to the banking system which is an improvement on widely accepted

[12] Market share for bank *i* is defined as $ms_i = \frac{q_i}{\sum_{i=1}^{n} q_i}$, where q_i is the total loans of bank *i*. This measure is calculated for each quarter.

concentration measures, such as the Herfindahl–Hirschmann Index (*HHI*).[13] The theoretical model above can be used to explain why commonly used measure of *HHI* is not a reliable competition indicator. Moreover, the concentration may be due to the consolidation forced by severe competition in the market. Therefore, the concentration index is an ambiguous measure (Leuvensteijin 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 a direct comparison with the previous studies.[14]

3.5 Data

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

Competition: 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, b; 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 the stochastic frontier methodology specified in Eq. (5) in the "Appendix" 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.

[13] The *HHI* is calculated by 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 loans in the market).

[14] The *H*-statistic developed by Panzar and Rosse (1987) is another alternative measure used widely in the banking literature. It is computed as the sum of the estimated elasticities of revenues with respect to input prices. Hence, it provides an aggregate measure of competition. The main disadvantage of this statistic is that it maps the various degrees of market power only weakly and, therefore, cannot be viewed as a continuous variable (Bikker et al. 2012).

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 a positive relationship between diversification and earnings volatility.

GDP growth: We also control economic growth in the regression to check whether economic growth has a significant effect on earnings volatility. GDP growth is expected to be negatively related to banking risk.

Table 1 reports summary statistics of the dependent and explanatory variables. Table 5 in the "Appendix" provides the definition of all variables, the data sources, and the expected sign of the variables. However, Fig. 2 in the "Appendix" shows the evolution of the earnings volatility, bank stability, capitalization, diversification, inefficiency and bank size over the sample period. The positive impact of the recent restructuring process in the Turkish banking system could be observed on earnings volatility, bank stability and size. For instance, earnings volatility decreased sharply during the sample period. We also observe upward trend in bank stability and bank size. Capitalization, diversification and inefficiency, however, fluctuated during the sample period and therefore there is no clear trend for these variables.

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

Variable	Mean	SD	Coefficient of variation
Earnings volatility			
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
Bank stability			
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
Competition and concentration			
Boone indicator	−0.214	0.170	−0.791
HHI	0.092	0.004	0.046
C5	0.596	0.015	0.025
Other bank-specific variables			
TA = total assets	15,151.520	22,266.450	1.469
Diversification	0.197	0.133	0.678
Capitalization	0.135	0.054	0.397
Inefficiency	0.369	0.222	0.600
Macroeconomic variable			
GDP growth	1.253	2.292	1.829

Total assets are in millions of U.S. dollars

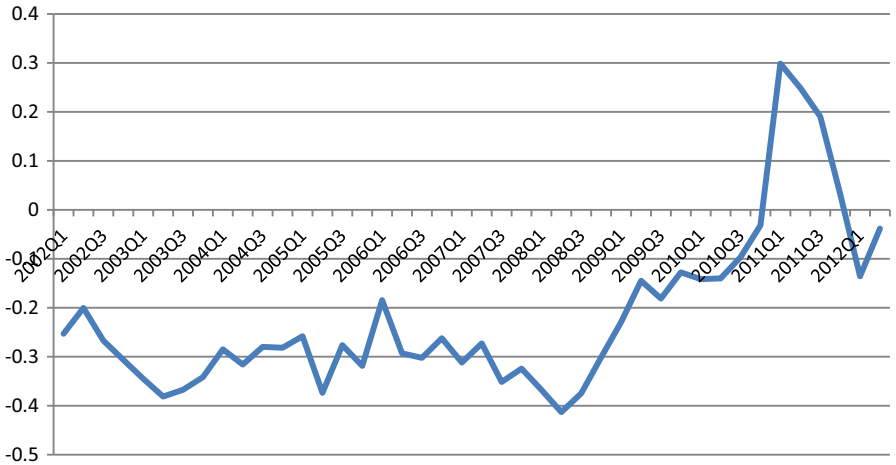

Fig. 1 Boone indicators of the loans market over the period 2002Q1–2012Q2

4 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 explanatory variables on the earnings volatility.

To estimate the Boone indicators, we regress the market shares in the loans market on the marginal costs, which are obtained from the translog cost function specified in Eq. (5) in the "Appendix". The coefficient (β) of marginal costs in Eq. (4) is the Boone indicator.[15] We use quarterly data (2002:Q1–2012:Q2) to investigate the impact of competition and bank size on earnings volatility. Since we have 42 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 the conventional levels except the four quarters of 2011.[16] 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, the volatility of the estimates 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 is not

[15] 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 the conventional significance levels in the estimation of Eq. (4).

[16] Although not reported, the t values of each quarter are available upon request from the authors.

surprising since 2008 coincides with the outbreak of the global financial crisis in Europe. However, Turkey felt deeply the impact of global financial crisis in 2009 and the economy shrunk about 5 %. Banks operating in the 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 system stayed safe and sound in 2009. Moreover, in contrast to 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.

Table 2 reports the system GMM regression results from earnings volatility models. At the bottom of the table, we report specification test results for the GMM estimations. The Hansen 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 tests all GMM equations are properly specified. Columns 1–4 of Table 2 indicate the impacts of bank size, competition, and concentration along with some bank-specific variables on *ROA* volatility measured both over a four-quarter and eight-quarter period. This measure is replaced by the *ROE* volatility in Columns 5–8. Table 2 shows that the coefficients of bank size on earnings volatility (*ROA* and *ROE*) are significantly negative at the conventional levels. The negative relation is consistent with the findings in De Haan and Poghosyan (2012a, b) and Boyd and Runkle (1993) but in contrast to the results in Stiroh (2004). Hence, this result suggests that the higher the bank size is, the lower the earnings volatility is. It might also show 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 bank competition proxied by the Boone indicator and earnings volatility is always significantly negative except in the case of *ROA* with the four-quarter rolling window. This result suggests that competition increases earnings volatility given that lower values of the Boone indicator signify more competition.[17] 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 competitive markets are more fragile than less competitive ones (see Boyd and De Nicolo 2005).[18] 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

[17] 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.

[18] 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, they are available from the authors upon request.

Table 2 Estimation results: bank size, competition, concentration and earnings volatility

	ROA volatility: 4 quarters Panel A		*ROA* volatility: 8 quarters Panel B		*ROE* volatility: 4 quarters Panel C		*ROE* volatility: 8 quarters Panel D	
Intercept	0.008*	0.010*	0.083*	−0.026	0.083*	0.101*	0.028**	0.123
	(0.002)	(0.002)	(0.011)	(0.021)	(0.011)	(0.015)	(0.013)	(0.348)
Y_{t-1}	0.794*	0.797*	0.699*	0.857*	0.699*	0.699*	0.761*	0.759*
	(0.013)	(0.038)	(0.055)	(0.020)	(0.055)	(0.005)	(0.005)	(0.004)
Competition (Boone)	−0.000		−0.004**		−0.004**		−0.003***	
	(0.000)		(0.002)		(0.002)		(0.001)	
Concentration (*HHI*)		−0.023*		−0.291		−0.171**		−1.484
		(0.004)		(0.198)		(0.089)		(0.921)
Size	−0.001*	−0.001*	−0.006*	−0.000*	−0.006*	−0.006*	−0.001***	−0.001*
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Capitalization	0.006**	0.005**	−0.081*	0.003*	−0.081*	−0.078*	−0.063*	−0.067*
	(0.003)	(0.002)	(0.007)	(0.001)	(0.007)	(0.009)	(0.015)	(0.014)
Diversification	−0.003*	−0.003*	−0.060*	−0.001**	−0.060*	−0.059*	−0.029*	−0.031*
	(0.001)	(0.001)	(0.004)	(0.000)	(0.004)	(0.004)	(0.006)	(0.003)
Inefficiency	0.000*	0.000*	0.001**	0.000*	0.001**	0.001**	0.017*	0.018*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(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)	(0.000)	(0.000)
AR1 (*p* value)	0.052	0.044	0.033	0.028	0.094	0.089	0.084	0.086
AR2 (*p* value)	0.121	0.118	0.298	0.316	0.256	0.279	0.189	0.204

Table 2 continued

	ROA volatility: 4 quarters Panel A		*ROA* volatility: 8 quarters Panel B		*ROE* volatility: 4 quarters Panel C		*ROE* volatility: 8 quarters Panel D	
Hansen test (*p* value)	20.76	23.11	23.14	22.91	22.94	23.13	21.01	18.96
	(0.801)	(0.789)	(0.708)	(0.691)	(0.742)	(0.798)	(0.736)	(0.673)

*, **, *** Significance levels at 1, 5 and 10 %, respectively. The null hypothesis of the Hansen test is that the usage of the instruments is not correlated with residuals (over-identifying restrictions). *AR*(1) and *AR*(2) refer to the tests for first-order and second-order serial correlation, respectively. All models' coefficients are estimated using the *STATA*. Particularly, we used Roodman's (2009) *xtabond*2 command

risk by placing banks in a better position to absorb losses.[19] 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 the findings of De Haan and Poghosyan (2012a, b). The coefficient of diversification is negative and statistically significant in all regressions, suggesting that banks with a higher share of non-interest income in total income have less volatile earnings. This finding does not support the results of Stiroh and Rumble (2006) and De Haan and Poghosyan (2012a, b). Non-interest income generating activities constitute an increasingly important revenue source for many emerging banking markets, including Turkey.[20] One of the reasons that these activities did not cause returns to be more volatile in Turkey during the sample period could be the stable macroeconomic conditions and new regulatory and supervisory environment. Table 2 also shows that inefficiency coefficients are always positive and significant, suggesting that banks with 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, suggesting that the banking system risk is not affected by its macroeconomic environment.[21]

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 of 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 and Performance model. Table 2 also focuses on the impacts of bank size and concentration along with the bank-specific variables on earnings volatility. The results indicate that the coefficient of banking concentration is negative, but only significant in the case of earnings volatility computed with a four-quarter rolling time window. 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 as in the previous case. The signs of the coefficients of capitalization and diversification are negative

[19] It should be noted that the relationship between ROA volatility and capitalization is mostly significantly positive, implying that higher capitalized banks face higher ROA volatility.

[20] Demirguc-Kunt and Huizinga (2010) show that banks in developing countries have relatively more non-interest income share in total operating income (0.385) compared to developed countries (0.342).

[21] 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 the conventional levels. In addition, following the suggestion of one of the referees, we also exercised the Chow test to check whether there is a structural break in the relationship between earnings volatility and explanatory variables. For this purpose, the sample period was divided into two sub-periods: 2002:Q1–2007:Q4 and 2008:Q1–2012:Q2 (pre- and post-global crisis period). The test result produced an F-statistic value that was insignificant at the conventional significance levels. Therefore, the null hypothesis which asserted that the model parameters were stable during the sample period was not rejected.

and significant, suggesting that higher capitalized and diversified banks have lower earnings volatility. Overall, these results generally support our earlier findings.

We also estimate Eq. (1) using the *Z*-score as the dependent variable for a robustness check. The Z-Score provides a measure of bank soundness as it indicates 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). Hence, the *Z*-score is inversely proportional to the bank's probability of default.

Table 3 reports the system GMM regression results from bank stability models. Considering the link between bank competition and bank insolvency, the results show that competition proxied by the Boone indicator is always positively and significantly related to bank's insolvency except in the case of *Z-ROE* with the eight-quarter rolling window. This result suggests that higher bank competition leads to decreased bank insolvency risk given that lower values of the Boone indicator signify more competition. As for the bank size, the coefficient of size is positive and significant only in the case of *Z-ROE* with the four-quarter rolling window. This weak finding suggests that larger banks are less risky, in line with our earlier findings that larger banks incur lower earnings volatility. That is, larger banks are less risky. The coefficient for capitalization is always significantly positive, implying that a 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.

We also investigate the impacts of bank size and market concentration (*HHI*) along with the bank-specific variables on the bank insolvency risk measured by *Z-ROA* and *Z-ROE*. Table 3 reports the estimation results. The results show that the coefficient of concentration is statistically insignificant in all cases, suggesting no relationship between insolvency risk and market concentration. The coefficient of size is always positively and significantly related to the insolvency risk except in the case of *Z-ROE* with the eight-quarter rolling window, implying that larger banks have advantages to decrease insolvency risk. The results also show that higher capitalized banks have lower risk. However, diversification has no impact on risk. In general, these results support the earlier findings.

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 Boone indicator. Our main results indicate that there is a mostly 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, suggesting 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

Table 3 Estimation results: bank size, competition, concentration and insolvency (*Z*-score)

	Z-ROA: 4 quarters Panel A		*Z-ROA*: 8 quarters Panel B		*Z-ROE*: 4 quarters Panel C		*Z-ROE*: 8 quarters Panel D	
Intercept	13.638	13.307	−2.536	−89.465	−17.218*	−15.257**	−4.055	17.296
	(24.839)	(22.489)	(15.744)	(94.648)	(5.964)	(6.900)	(3.628)	(32.302)
Y_{t-1}	0.447*	0.452*	0.794*	0.807*	0.472*	0.480*	0.518*	0.553*
	(0.003)	(0.003)	(0.071)	(0.056)	(0.004)	(0.006)	(0.092)	(0.084)
Competition (Boone)	14.812*		2.778**		2.011*		0.313	
	(2.056)		(1.132)		(0.696)		(0.222)	
Concentration (*HHI*)		−125.300		746.706		−5.808		−171.507
		(83.921)		(913.820)		(48.018)		(305.582)
Size	−0.444	3.680***	0.509	1.254*	2.239*	1.709*	0.683	0.265
	(2.989)	(2.090)	(1.718)	(0.460)	(0.719)	(0.573)	(0.421)	(0.466)
Capitalization	92.599**	87.951**	51.405**	60.981*	46.851*	39.708*	18.938*	14.340*
	(40.369)	(36.277)	(20.124)	(16.479)	(6.842)	(6.512)	(4.981)	(2.820)
Diversification	−8.904	3.985	−3.022	−4.944	−3.320	1.325	−0.729	0.673
	(11.252)	(11.186)	(8.514)	(5.070)	(2.597)	(1.913)	(1.356)	(0.956)
Inefficiency	−4.494	−5.645	−6.650	−3.137	−4.095**	−2.348*	−4.417*	4.126*
	(3.474)	(4.701)	(4.658)	(3.225)	(1.163)	(0.678)	(1.163)	(1.321)
GDP growth	−0.282*	−0.147	−2.537	0.137**	−0.024**	0.001	0.070*	0.077*
	(0.086)	(0.062)	(15.744)	(0.068)	(0.012)	(0.013)	(0.009)	(0.008)
AR1 (*p* value)	0.012	0.013	0.058	0.062	0.013	0.016	0.013	0.077
AR2 (*p* value)	0.468	0.322	0.118	0.118	0.529	0.488	0.316	0.131

Table 3 continued

	Z-ROA: 4 quarters Panel A		*Z-ROA*: 8 quarters Panel B		*Z-ROE*: 4 quarters Panel C		*Z-ROE*: 8 quarters Panel D	
Hansen test (*p* value)	23.90	21.76	21.03	23.99	24.47	23.74	25.54	24.91
	(0.846)	(0.751)	(0.683)	(0.765)	(0.881)	(0.845)	(0.661)	(0.831)

*, **, *** Significance levels at 1, 5 and 10 %, respectively. The null hypothesis of the Hansen test is that the usage of the instruments is not correlated with residuals (over-identifying restrictions). *AR*(1) and *AR*(2) refer to the tests for first-order and second-order serial correlation, respectively. All models' coefficients are estimated using the *STATA*. Particularly, we used Roodman's (2009) *xtabond*2 command

have lower earnings volatility and less efficient banks are more vulnerable to risk. To make a direct comparison to the previous studies, we replaced the Boone indicator with an indicator informing about concentration, the Herfindahl–Hirschmann index (*HHI*), in the regression models. The results indicate that the coefficient of banking concentration is mostly negative, but only significant in the case of earnings volatility computed with a four-quarter rolling time window. Hence, there is no strong relationship between earnings volatility and concentration.

We also used a measure of insolvency (Z-score) as the dependent variable for a robustness check. A higher Z-score implies a lower probability of insolvency (failure). Our results show that bank size is positively and significantly related to the Z-score in four cases, suggesting that larger banks are less risky. Moreover, the results also indicate that competition is always positively and significantly related to bank's insolvency except in the case of *Z-ROE* with the eight-quarter rolling window. Hence, 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 shares of non-interest income in total income and efficient banks are more stable. Moreover, fierce competition among banks has a 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 as our empirical evidence suggests that larger banks contribute to financial stability.

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Appendix

To estimate Eq. (4) we need the computation of marginal costs for each bank and quarter. As marginal costs cannot be directly observed, we estimate them by using a translog cost function, which is common in the related literature since it does not require too many restrictive assumptions about the nature of the technology. The multi-product cost function for a given bank s at time t can be specified as follows:

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

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

Table 4 Descriptive statistics

Variable	Mean	SD	Coefficient of variation
Translog specification			
y_1 = total loans	6705.904	10,583.669	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

Total loans, other earning assets, non-interest income and total costs are in millions of U.S. dollars

activity.[22] w represents two input prices: price of funds and a common price of labor and capital. Since personnel expenses are not reported in some quarters, we calculate a 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:

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

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.

The descriptive statistics of variables used in the translog cost function are reported in Table 4.

[22] 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).

Table 5 Definitions, expected signs and data sources of the variables used in the analysis

Variable	Definition	Expected sign	Data source
Dependent variables			
ROA volatility	4 or 8 quarter standard deviation of return on assets		Income statements (BAT: Banks in Turkey—various issues)
ROE volatility	4 or 8 quarter standard deviation of return on equity		Income statements (BAT: Banks in Turkey—svarious issues)
Bank stability (Z-score: ROA)	Bank stability is proxied by Z-score defined in Eq. (3). In the calculation 4 or 8 quarter standard deviation of return on assets is used		Balance sheets and Income statements (BAT: Banks in Turkey—various issues)
Bank stability (Z-score: ROE)	Bank stability is proxied by Z-score defined in Eq. (3). In the calculation 4 or 8 quarter standard deviation of return on equity is used		Balance sheets and Income statements (BAT: Banks in Turkey—various issues)
Competition and concentration			
Boone	It is a measure of competition and generated from Eq. (4)	Negative/positive	Balance sheets (BAT: Banks in Turkey—various issues)
HHI	Herfindahl–Hirschman index based on bank assets	Negative/positive	Balance sheets (BAT: Banks in Turkey—various issues)
C5	*C*5 is a measure of concentration and defined as the share of five largest banks in loans in the sector	Negative/positive	Balance sheets (BAT: Banks in Turkey—various issues)
Other bank-specific variables			
Bank size	The natural logarithm of total assets	Negative/positive	Balance sheets (BAT: Banks in Turkey—various issues)
Diversification	The share of non-interest income in total income	Negative/positive	Income statements (BAT: Banks in Turkey—various issues)
Capitalization	The ratio of total equity to total assets	Negative	Balance sheets (BAT: Banks in Turkey—various issues)
Inefficiency	It is a proxy of bank inefficiency. Inefficiency scores are generated from stochastic cost frontier specified in Eq. (5) in the "Appendix"	Positive	Balance sheets and Income statements (BAT: Banks in Turkey—various issues)
Macroeconomic variable			
GDP growth	GDP growth rate	Negative	World Development Indicators databases

BAT stands for the Bank Association of Turkey

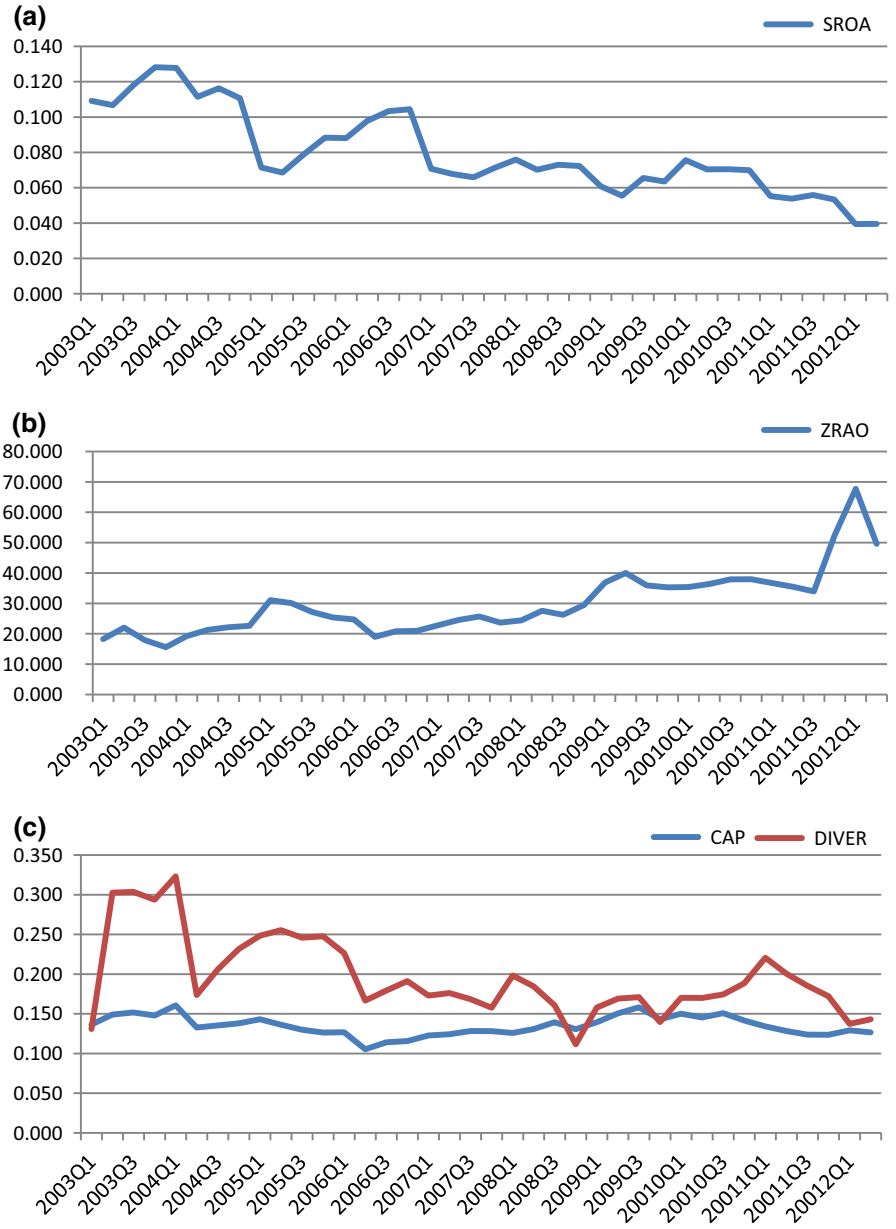

Fig. 2 Earnings volatility (SD), bank stability (Z-score), capitalization, diversification, inefficiency, and size over the period 2003Q1–2012Q1. Standard deviations of earnings (ROA) are computed using a four-quarter rolling time windows. Total assets are in millions of US dollars. **a** Earnings volatility. **b** Bank stability. **c** Bank capitalization and diversification. **d** Bank inefficiency. **e** Total assets

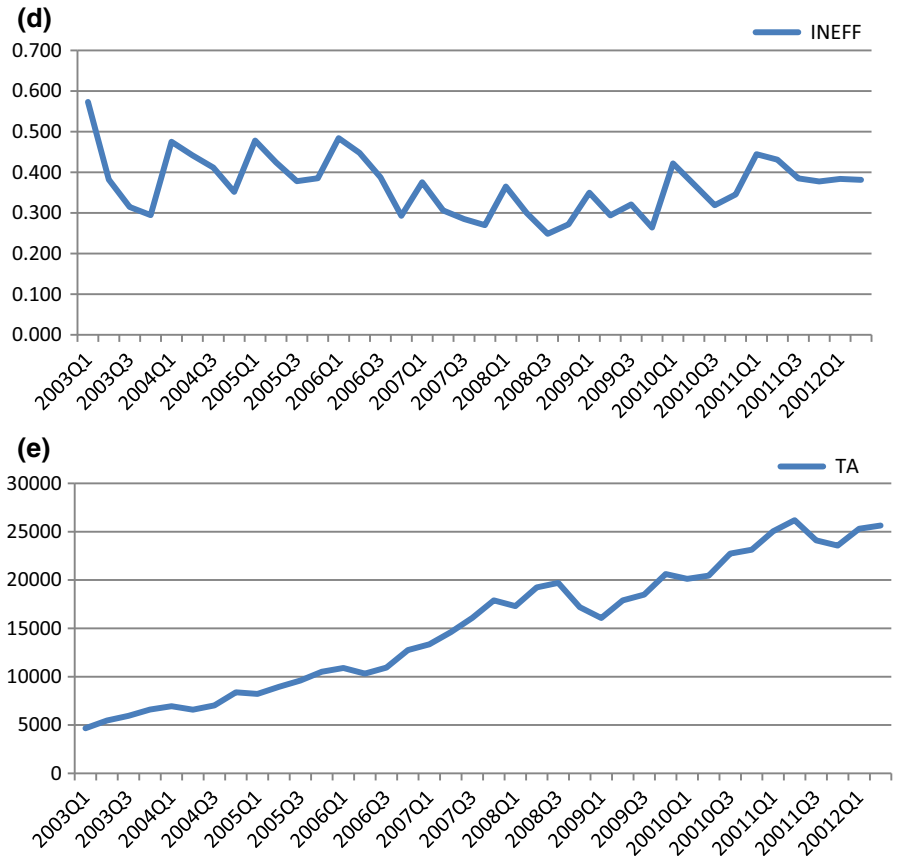

Fig. 2 continued

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