RISK AND COMPETITIVENESS IN THE ITALIAN BANKING SECTOR

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Abstract

In this paper, we analyse the relationship between risk and competition in the Italian banking sector over the period from 2006 to 2010. We employ OLS and panel estimators to estimate the impact of the Lerner index, a measure of bank market power, on the Altman Z-score, a proxy of the insolvency probability. Our results are consistent with the traditional charter value paradigm and reject the new risk-shifting paradigm proposed by Boyd-De Nicolò (2005). We find that the relationship between bank risk and competition becomes more tightening during the financial crisis. Our results are robust to different definitions of crisis and different specifications.

JEL Classification: G01, G21, G33

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1. INTRODUCTION

The debate on the competition-risk nexus is long running and recurs in every financial crisis. Padoa-Schioppa (2001, p.14) stated that "the legislative reforms adopted in most countries as a response to the banking and financial crises of the 1930s shared one basic idea which was that, in order to preserve the stability of the banking and financial industry, competition had to be restrained." Until the late 1970s, regulatory entry restrictions in the credit market (e.g. the US, Italy) originated the belief that limited competition was necessary to provide bank owners with better profit opportunities that, in turn, promote lower risk-taking and preserve a bank's valuable charters (Keeley 1990; Giannola et al. 2013).

During the 1980s, this belief developed and evolved into the charter value paradigm. According to this theory, the relationship between bank risk and return is asymmetric: banks tend to maximize profits from investments in risky projects (in the event of success), thus taking (ex-ante) excessive risks (Keeley, 1990; Hellmann et al., 2000). This is mainly due to two reasons. The first is that as banks have limited responsibility and typically high leverage, their managers and shareholders have an incentive to choose the bank's asset portfolio, trying to shift risks onto depositors and participate only in the up-side part of this risk taking. The second is that information asymmetries between banks and their depositors and the presence of deposit insurance schemes allow deposit returns to be separated from asset risks. Therefore, the basic idea of the charter value paradigm is that entry restrictions and limited competition provide incentives for bank owners to avoid excessive risk-taking (Marcus 1984). In other terms, monopoly rents in imperfectly competitive credit markets

make banks relatively conservative, with positive repercussions for financial stability. However, an increase in banking competition, such as that introduced by financial liberalization and technological progress in the 1990s, reduces profits and encourages banks to take excessive risks. In brief, the charter value paradigm posits that banking competition feeds financial instability and suggests that increased competition may have reduced banks' incentives to act prudently with regard to risk taking.[1]

The crucial hypothesis to obtain a positive competition-fragility nexus is that banks control directly and completely the risk level of their asset portfolio, especially loans. Recently, Boyd and De Nicolò (2005) reformulated this hypothesis by assuming that banks set the lending rate whereas firms choose the risk level of financed investment projects and hence of bank assets (i.e. moral hazard). Using a traditional Cournot's oligopoly model with information asymmetries about the risk level of firms' investment projects, Boyd and De Nicolò (2005) show that firms exploit the limited responsibility and seize opportunities to shift firm's risk onto banks: they climb the risk-return curve, achieving a higher part than that achievable in the case of self-financing. In this so called risk-shifting paradigm, the greater the banks' market power, the higher the rate of interest applied by banks and the greater the firms' incentive to implement risky projects. If loan defaults are perfectly correlated, the bank risk increases. However, when fiercer banking competition lowers lending rates, the entrepreneur's cost of borrowing decreases and the success rate of the entrepreneur's investments increases. The final outcome is a reduction in the credit risk faced by banks. In sum, this risk-shifting paradigm conflicts with previous theoretical findings and suggests a positive relationship between banking competition and financial stability.

[1] Further arguments in favour of the competition-fragility nexus are that fiercer bank competition also disincentives relationship lending and borrower screening, again increasing banking risk (Boot and Thakor 1993, Allen and Gale 2004, Dell'Ariccia and Marquez, 2006).

It has recently been shown that the charter value and risk-shifting paradigms can be reconciled by relaxing the crucial assumptions of Boyd and De Nicolò's (2005) model. This produces a non-monotonic U-shaped relationship between bank risk and competition. For example, Martinez-Miera and Repullo (2010) assume the imperfect correlation in loan defaults and allow the simultaneous presence of good and bad loans. A reduction in rates of interest due to fiercer banking competition has two effects. On the one hand, it reduces the risk-shifting effect by Boyd and De Nicolò. On the other hand, it lowers intermediation margins on loans. In particular, Martinez-Miera and Repullo assume Vasicek's (2002) distinction between systemic risk factors (i.e. common to all loans) and idiosyncratic risk factors (i.e. specific to each individual loan). They show that in very competitive markets, the effect of low intermediation margins on good loans dominates the risk-shifting effect and further competitors increase the probability of bank failure whereas in very concentrated markets, the risk-shifting effect due to bad loans dominates and a new entry reduces the risk of banks' loan portfolio and, hence, the probability of bank failures.

Hakenes and Schnabel (2011) and Wagner (2010) confirm the convex relationship between bank risk and competition. The former assume that banks are able to choose the level of correlation in loan defaults and show that "a bank's and its entrepreneurs' risk-taking are complementary to each other" (p.3). The risk complementarity effect makes the overall impact on bank risk and financial stability ambiguous and allows capital regulation to affect the competition-risk nexus by changing the intensity of banking competition. Wagner (2010) argues that "while borrowers may determine the riskiness of their firms, it is banks who decide how much risk they ultimately want to take on" (p.72) and allows a risk choice for both firms and banks. On the one hand, an increase in banking competition, as measured by a fall in switching costs for entrepreneurs, erodes the bank charter values (*margin effect*). On the other, lower lending interest rates reduce the entrepreneur's

incentives to take risk which, in turn, makes banks safer (*risk-shifting effect*). But, if banks can switch over entrepreneurs, they will anticipate the reduction in firm risks and will finance higher-risk-profile entrepreneurs to return to the optimal level of risk.

Different theoretical predictions make the relationship between bank risk and competition an empirical issue. In this paper, we examine the competition-risk nexus in the Italian banking sector from 2006 to 2010, a period including the 2008-2010 financial crisis. The focus on Italy and global crisis period is interesting for different reasons. The first is that even if Italy is a country of small firms financed by small banks, its banking system is crucial due to the relative backwardness of stock and corporate bond markets (De Bonis et al. 2012). This means that there are no too-big-to-fail banks that could bias our results and there are no relevant alternative financial resources that could mitigate the risk-shifting effects. The second is that, to our knowledge, there are no previous papers focusing on the competition-risk nexus among Italian banks. [2] The third is that the inclusion of both good and bad times in the sample period takes account of ex-post risks observed in accounting data whereas the charter value and risk-shifting paradigms model ex-ante risks. Control for a global shock that hits across banks allows a reduction in potential biases due to a non-random realization of risks that is not captured by the observed variables. In other words, the shock of the financial crisis is so intense and generalized that when we control for its effect on estimates, the impact of potential omitted variables becomes negligible and estimates are more accurate and consistent. Moreover, in crisis periods it is likely that incentives to shift risks from firms to banks, such as in Boyd and De Nicolò's model, and from banks to depositors, such as in the charter value paradigm, tend to intensify. It is interesting to verify whether this behaviour strengthens, mitigates or reverses the

[2] In particular, the Italian government intervened marginally in favour of the banking system during the global financial crisis [Fratianni and Marchionne 2010].

relationship between banking competition and risk.

In this paper, we perform two separate tests. The first estimates the impact of banking competition on risk. In line with results from other countries (see next section), we find a positive relationship between bank market power and risk supporting the charter value paradigm. Instead, our results provide no evidence for a U-shaped competition-risk nexus. The second test estimates whether this relationship changes during the global financial crisis. Our findings show clearly that the crisis reinforced the existing competition-risk nexus in Italy and the charter value paradigm became predominant after the beginning of the financial crisis: Italian banks that were more greatly affected by competition (with less market power) are also those banks that supported larger risks after the failure of Lehman Brothers.

The paper is organised as follows. Section 2 reviews the empirical literature on the relationship between competition and stability in the banking sector. The empirical model and variables are described in Section 3. The next section presents the dataset and descriptive statistics. Findings and robustness analysis are discussed respectively in Sections 5 and 6. Conclusions and some policy implications are drawn in the last section.

2. LITERATURE REVIEW

Conflicting theoretical predictions on the relationship between banking competition and stability have fed an increasing empirical literature. However, these studies are not conclusive because they have used different samples, risk measures and competition proxies to discriminate between the charter value and risk-shifting paradigm. In particular, empirical evidence from cross-country analyses supports both paradigms. For example, Beck et al. (2006) estimate the impact of banking concentration on the probability of a crisis. The relationship is negative, statistically significant and very robust in line with the charter value

paradigm. Schaeck and Cihak's (2010) results also confirm this paradigm: banking competition incentivises capital holdings, thus compensating for potentially higher risk taken by banks.[3] Instead, Boyd et al. (2006) and De Nicolò and Loukoianova (2007) provide support for the risk-shifting paradigm. They estimate a model of banking industry with heterogeneous banks and find that the banking concentration feeds risk, and its impact is stronger respectively when they take in account for asset composition and bank ownership (private vs state-owned and foreign vs domestic). Soedarmono et al. (2012) and Liu et al. (2012) confirm this result using Asian and South East Asian banks, respectively.

Contrasting with previous contributions, Berger et al. (2009) seek to reconcile empirically opposing theoretical predictions using a quadratic model. They argue that banks with market power take higher risk on their loan portfolio, charging a higher interest rate but, at the same time, they reduce the overall risk level by applying other risk-mitigating techniques (e.g. more equity capital or smaller loan portfolios). They apply GMM estimates with robust clustered standard errors to a dataset of 8,235 banks from developed countries and find an inverted U-shape relationship between bank risk and the degree of market power in line with Martinez-Miera and Repullo's (2010) model. Similar results are obtained by applying the Boone indicator, a new proxy for competition, to Latin America banks (Tabak et al. 2011).

These mixed empirical results could depend on the high variability in the competition-risk nexus. Country-specific factors determine the intercept of the competition-stability relationship, that is the level of bank risk. But an excessively high variability suggests that the same factors could interact with the slope of this relationship. In this case, they shape the competition-risk nexus and become determinant in finding support for the charter value or the

[3] Similar results are obtained by Turk-Ariss (2010) for 10 Latin America countries.

risk-shifting paradigm. To test this hypothesis, recent papers have controlled for heterogeneities at the national level using multi-country data. In particular, they focus on country-specific factors such as macro-economic conditions, regulation and supervision. For example, Beck et al. (2011) assume a linear model in which banking competition as measured by the Lerner index, a proxy of market power, is related to bank soundness as measured by Altman Z-score, a (inverted) proxy of bank risk. Their results show clearly that the charter value paradigm dominates the risk-shifting hypothesis.

All previous papers rely on cross-country data to fine-tune the estimate of the relationship between banking competition and stability. But there are three drawbacks in this approach. The first is that estimates are affected negatively by the set of countries and the period under investigation and results are sensitive to countries and years included in the sample. For example, Schaeck and Cihak's (2010) and Berger et al.'s (2009) datasets cover the 1999-2005 period, but they include 10 and 23 developed countries respectively; De Nicolò and Loukoianova (2007) consider 133 developing countries during the 1993-2004 period; the dataset consists of 69 developed and developing countries from 1980 to 1997 in Beck et al. (2006) and 79 from 1994 to 2009 in Beck et al. (2011). The second is that the cross-country estimates identify an average relationship, but it could be very different for a single country. For example, Beck et al. (2011) find a positive relationship between banking competition and risk but they also document a significant cross-country heterogeneity in the competition-stability relationship. The third is that the cross-country approach does not explain the high *within* variability in the relationship between bank competitiveness and stability. It is confirmed by a relatively low fit of all specifications to the data.

The limits in the cross-country approach have renewed the interest on single country analysis. This approach has long-running evidence in favour of the charter value paradigm. The US state branching liberalisation in the 1980s increased the overall bank risk (Keeley

1990). Loan loss provisions rose during the deregulation in the 1990s (Dick 2006). Also Demsetz et al. (1996) and Brewer and Saidenberg (1996) obtain results consistent with the charter value paradigm. In Spain, financial liberalisation eroded banks' market power, leading banks with lower charter values to experience higher credit risk (Salas and Saurina 2003). Jiménez et al. (2010) test the quadratic relationship suggested by Martinez-Miera and Repullo (2010) by introducing a squared term of banking competition, but find support only for the charter value paradigm. In Germany, a reduction in the pricing power of an individual bank due to fiercer competition increased the probability of default of that bank over the 1994-2010 period (Kick and Prieto 2013). Also Buch et al. (2013) confirm the negative impact of the market power on bank risk.

Fewer papers lend support to the risk-shifting paradigm. Boyd and Runkle (1993) do not find a lower probability of failure among large US banks even if their asset returns are more volatile. Boyd and Graham (1996) confirm this finding for the period from 1987 to 1994, but not from 1971 to 1986. More direct evidence is provided in contributions by Jayaratne and Strahan (1998) and Boyd et al. (2006). The former show that the US state branching liberalisation in the 1980s lowered loan losses. The latter use a cross-section of US banks in 2003 and find that the probability of bank failure is positively and significantly related to banking concentration. In brief, even if empirical country studies seem to support the charter value more than the risk-shifting paradigm, there is no conclusive evidence for either a stability-enhancing or a stability-undermining role of competition.

To our knowledge, there are no specific analyses on the competition-risk nexus in Italy. Angelini and Cetorelli (2003) analyse the evolution of competitive conditions in the Italian banking industry. They focus on the impact of the consolidation process on competition over the 1983-1997 period and find that competition was relatively unchanged until 1992 but improved substantially thereafter. Although they control for various potential

determinants of the estimated trend in bank markups, they do not explain the drop in the competitive condition indicators after 1992. Italy has a small banking system within a small financial system, but its banks are central to the financing of firms. From the 1930s to 1990s, the Italian banking system was dominated by a large number of banks operating in local oligopolies: banks were geographically well established and it was impossible for competitors to penetrate new markets. From 1990 to 2010, branching liberalisation led to an increase in the number of branches from 16,600 to 33,600 whereas mergers and acquisitions reduced the number of banks from 1,200 to 800 (De Bonis et al. 2012).

3. EMPIRICAL APPROACH

3.1 Empirical Equations

We propose two separate tests. The first aims to uncover the impact of bank competition on bank stability; the second to identify changes in this relationship over the crisis period.

In the first test, a risk measure of bank i at time t, $Risk_{it}$, is regressed on an intercept, c, a set of control variables at the bank level, X_{it}, and two interest variables: a proxy of the competition level, $Competition_{it}$, capturing the market power of bank i, and a dummy $Crisis_t$ controlling for the financial crisis. All independent variables are lagged one period to avoid causality problems except the dummy *Crisis*. The test is formalised as follows:

$$Risk_{i,t} = c + \beta \cdot Competition_{i,t-1} + \gamma \cdot Crisis_t + \lambda \cdot X_{i,t-1} + u_{i,t}, \quad (1)$$

where u denotes a well-behaved error term. In this framework, the focus is on *Competition* whereas *Crisis* is only a control variable. $\beta<0$ supports the risk-shifting paradigm of the competition-stability model in which banks with market power apply higher increases in interest rates to firms making their defaults more likely and, hence, the banking sector as a

whole weaker. Instead, $\beta>0$ is consistent with the charter value paradigm: according to the competition-fragility view, a higher market power reduces the banking competition that, in turn, decreases bank risk, making the banking sector more stable. When β is statistically not different from zero, there is no dominant paradigm. As previous studies on other countries find a negative banking competition-stability relationship, we expect the bank market power to affect bank stability in Italy positively. In particular, our null hypothesis for the first test is $\beta>0$ (HYP1).

The second test checks whether the competition-stability relationship was affected by the financial crisis. We estimate the following equation:

$$Risk_{i,t} = c + \beta \cdot Competition_{i,t-1} + \gamma \cdot Crisis_t + \delta \cdot Competition_{i,t-1} \cdot Crisis_t + \lambda \cdot X_{i,t-1} + u_{i,t}. \quad (2)$$

The only difference with respect to equation (1) is the introduction of an interactive term between *Competition* and *Crisis*. It identifies the marginal impact of the financial crisis on the competition-stability relationship. A statistically insignificant δ or $\delta=0$ shows that the crisis does not change the competition-stability relationship and the same relationship holds before and during the crisis. A significant $\delta>0$ is consistent with the charter value paradigm and indicates that the erosion of profit margins during the financial crisis made banks with lower market power riskier than in the standard pre-crisis period. A significant $\delta<0$, instead, suggests that the financial crisis promotes the risk-shifting paradigm. As the financial crisis raised the systemic risk and led firms to herding behaviour in terms of risk-taking, a higher correlation in loan defaults increases the risk of banks charging higher interest rates and supports the risk-shifting paradigm during the financial crisis. Consistent with our previous hypothesis, our null hypothesis for the second test is $\delta>0$ (HYP2).

3.2 Dependent Variable

We follow the main empirical literature in measuring our main variables, that is *Risk*, *Competition* and *Crisis*.

We use a firm default index based on accounting data, Altman Z-score, as a proxy for bank risk. Altman Z-score measures the distance from insolvency (Roy 1952). It can be calculated from data found in a company's annual report and is equal to a weighted combination of five financial ratios (Altman 1968). The first, the working capital to total assets T_1, measures liquid assets in relation to firm size. The second, T_2, is the ratio of retained earnings to total assets. It reflects the accumulated value of the firm due to its age, earning power and past performance. T_3 indicates earnings before interests and taxes to total assets. It measures the firm's profitability. The price fluctuation is captured by the market-to-book value T_4. The last ratio T_5 is a standard measure for total asset turnover, the ratio of sales to total assets. It captures the managers' ability to generate cash flows. Equation (3) describes Altman Z-score as a weighted sum of these factors:

$$Zs = 1.2 \cdot T_1 + 1.4 \cdot T_2 + 3.3 \cdot T_3 + 0.6 \cdot T_4 + 0.99 \cdot T_5. \quad (3)$$

Altman's weights in (3) are standard for listed firms. But they are very well-established in the literature so that the same weights are commonly employed also for SME firms (Noth 2011). By design, the Z-score is an index of firm stability, and not of firm risk: a higher Z-score indicates a lower probability of firm insolvency and, hence, greater firm stability. Recently, Laeven and Levine (2009) introduced a modified Z-score dividing the sum of firm's ROA and equity ratio by the standard deviation of ROA over a rolling time window. This measure cannot be driven exclusively by changes in the level of capital and profitability as it could be for the conventional Z-score (Schaeck and Cihak 2010). Despite this potential advantage, we

prefer to use the original Altman Z-score because our sample period is very short and the modified Z-score implies, at least, the loss of initial and final year. In brief, we apply (3) to our sample of Italian banks to determine a yearly bank-specific Altman Z-score, our measure of bank risk.

3.3 Interest Variables

Competition can be measured by concentration measures like the Herfindahl index or concentration ratio. There are two drawbacks in these measures. The first is that they provide an index at the banking sector level and not a bank-specific measure of competition. The second is that standard concentration measures not only perform poorly but are also considerably inferior to (microeconomic) market power proxies (Berger and Udell 1995, Schaeck et al. 2009). Market share is the simpler market power proxy but it is biased by the presence of too-big-to-fail banks. Claessens and Laeven (2004) and Schaek et al. (2009) measure market power using Panzar and Rosse's H-statistic. However, we employ the Lerner index in line with most of the recent literature (Carbo-Valverde et al. 2009, Koetter and Wedow 2010, Noth 2011, Beck et al. 2011). The Lerner index is a proxy for current and future profits stemming from pricing power and captures the bank's ability to generate large spreads between revenues and costs. This index presents at least four advantages with respect to alternative measures: 1) it is a measurable market power indicator that varies at the bank level; 2) it captures not only the impact of pricing power on the asset but also the funding side of the bank; 3) it fits well with the theoretical model; and 4) it does not require the geographical market to be defined (Beck et al. 2011). The last point is particularly relevant to country analysis because branch distribution is a poor proxy of the geographical market in which each bank operates.

The Lerner index is calculated as follows:

$$LERNER_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \quad (4)$$

where $P_{i,t}$ is average revenue proxied by the ratio of total operating income to total assets. We apply the procedure in Beck et al. (2011) to obtain marginal cost *MC*. First, we estimate the following translog cost function (Berger et al. 2009):

$$lnC_{i,t} = \square_0 + \square_1 lnQ_{i,t} + \square_2 (lnQ_{i,t})^2 + \sum_{j=1}^{3} \beta_j \, ln\omega_{i,t}^{j} + \sum_{j=1}^{3}\sum_{k=1}^{3} \beta_{j,k} \, ln\omega_{i,t}^{j} ln\omega_{i,t}^{k} + \sum_{j=1}^{3} \gamma_j \, ln\omega_{i,t}^{j} lnQ_{i,t} + \square_{i,t} \quad (5)$$

subject to:

$$\sum_{j=1}^{3} \beta_j = 1, \ \sum_{j=1}^{3} \gamma_j = 0, \ \sum_{j=1}^{3} \beta_{j,1} = 0, \sum_{j=1}^{3} \beta_{j,2} = 0, \sum_{j=1}^{3} \beta_{j,3} = 0 \quad (6)$$

where $C_{i,t}$ is total operating costs, bank output $Q_{i,t}$ is proxied by the total assets, and input price ω_1, ω_2 and ω_3 refer respectively to fixed assets, labour and borrowed funds; see Table 1, panel A for details on the construction of these variables. The restrictions impose homogeneity of degree one in input prices. Marginal cost *MC* is the derivative of total cost function *C* with respect to bank output Q. It is equal to:

$$MC_{i,t} = \frac{C_{i.t}}{Q_{i.t}} \left(\widehat{\square}_1 + 2\widehat{\square}_2 lnQ_{i,t} + \sum_{j=1}^{2} \widehat{\gamma}_j ln \frac{\omega_{i,t}^{j}}{\omega_{i,t}^{3}} \right) \quad (7)$$

Similarly to Berger et al. (2009) who estimate (5) by country to control for cross-country heterogeneity, we apply OLS to (5) year by year over the period from 2006 to 2010 to control

for potential shocks due to the financial crisis. Alternatively, we add time dummies to (5) and estimate the translog function over the whole period. Results are reported in Table A.2 in the Appendix. Then, we determine the Lerner index using (4). Note that as the Lerner index measures the market power, it is an inverse proxy of banking competition.

According to the recent literature, the financial crisis erupted in 2008 (Laeven and Valencia, 2012; Fratianni and Marchionne, 2013b) when the 2007 subprime crisis caused the first bank failures and bailouts (e.g. Northern Rock on 22 February 2008, Bear Stearns on 14 March 2008, Lehman Brothers 15 September 2008). Hence, our dummy *Crisis* is equal to 1 for 2008, 2009 and 2010, 0 otherwise. However, even if the Lehman Brothers' failure is widely believed to be a watershed in the crisis, the effects on the economy could be observed on bank accounting data only in 2009, the first whole crisis year (Fratianni and Marchionne, 2009, 2010). The bottom of the crisis was in March 2009 and the crisis lasted also in 2010 before switching into a sovereign debt crisis in Europe. For this reason, we consider alternatively dummy *Crisis* being equal to 1 for 2009 and 2010, 0 otherwise.

3.4 Control Variables

Our empirical analysis controls for other bank-specific determinants of the stability-competition relationship. The vector X_{it} consists of six variables characterising the bank's business model (Beck et al. 2011). In particular, the share of wholesale funding in total funding *FUND* captures the funding structure, *LOAN* indicates the loans to assets ratio and measures the assets mix, the revenue composition is measured by the share of non-interest income in total income *NOINT*; the natural logarithm of total assets *ln(TA)* is a proxy for bank size; *CREDIT* is equal to loan loss provisions to interest income and measures the credit risk; and *GROWTH* indicates the annual growth rate in total assets, an indicator of market opportunities and the bank's risk attitude. In addition to these variables, we also include the Tier 1 capital ratio *TIER1* to control for regulatory capital requirements. This variable

captures potential constraints to the banks' business model. As it could be determinant during a crisis, it is a considerable improvement in the specification with respect to the standard approach.

All control variables are lagged one period to avoid causality problems. They take into account the bulk of bank-specific factors. We do not include time dummies because they tend to be collinear with other variables due to the short sample period. We control for potential residual bank effects using panel estimators.

[Insert here Table 1]

4. DATA AND DESCRIPTIVE STATISTICS

Our data set consists of 3,366 observation from 748 banks over the period from 2006 to 2010. We exclude observations with missing values in our interest variables and seven banks due to inconsistently reported data, that is positive interest and financial charges, negative intermediation margin, positive operating costs and negative regulatory capital.

Table 2 reports some descriptive statistics for the Z-score, Lerner index and our seven control variables. *LERNER* is the yearly estimated index but results are very similar using values from the pool estimate with time dummies. Panel A refers to the whole period. All variables have a comparable order of magnitude, except for *ln(TA)* and *TIER1*. The *LOAN* distribution has a tail on the left suggesting that few banks have a low ratio of loans to total assets. Other variables are right-skewed (not reported) with mean much larger than median for *Zs* (0.079 vs 0.059), *FUND* (0.102 vs 0.016), *GROWTH* (0.666 vs 0.068) and *TIER1* (25.633 vs 13.7). Hence, not only do few banks take large risks, but also few banks (not necessarily the same) have a higher share of wholesale funding, grow quicker and show a higher Tier1 capital than other banks.

Stock variables such as *LOAN*, *ln(TA)*, and *FUND* show a low variability due to their higher persistence over time. Also *LERNER* standard deviation is relatively low with respect to its mean, suggesting that the market power changes but only gradually. On the contrary, a coefficient of variation equal to 4 and a range of 15,505 show that *Zs* varies considerably in the sample. Only *TIER1* and *GROWTH* vary more than *Zs*. This great variability could be exacerbated by the short sample period and the attrition problem caused by missing values in control variables.

We split the sample into pre- and post-crisis period: the crisis erupted in 2008 in Panel B and in 2009 in Panel C. We report only mean and median for both the sub-periods and compare them using respectively one-sample mean-comparison test and Wilcoxon rank-sum test. In both the panels, *Zs* and *LERNER* are statistically different in mean and median during the crisis, except for the *Zs* mean. There are differences also in control variables, but they are more statistically significant in Panel C than B, in particular for means. The main message is that the crisis caused a more intense structural break in accounting data in 2009 than in 2008, probably because of a time lag in reported data. We will also consider the crisis starting in 2008 in our robustness analysis but these descriptive statistics corroborate our choice of 2009 as the beginning of the crisis period.

[Insert here Table 2]

The hypothesis underlying our analysis is that bank stability and competition can be measured by Altman's Z-score and the Lerner index respectively. Therefore, we can test the effects of competition by estimating equations (1) and (2). The bank market power parameter β is estimated on yearly data. Our empirical model derives from Beck et al. (2011), who analyse cross-country heterogeneity in the bank competition-stability relationship by applying a OLS and IV estimator to a large sample of banks from 79 countries over the

period from 1994 to 2009. They use variables at the national level as exogenous instruments (see their Table 3, p.49).

We cannot apply an IV estimator to single country data because of the lack of good instruments. On the one hand, national level variables stop being instruments because they are common to all observations. On the other, bank level variables and lagged regressors are poor instruments because accounting variables are not really exogenous instruments since they are strongly correlated, and the short period of our sample exacerbates problems of instrument validity with lagged regressors. For these reasons, we adopt OLS, FE and RE models. The last two estimators take potential bank effects into account.

It is standard to evaluate the relative significance of the FE and RE specifications using Hausman's (1978) statistic $H = N(\beta_{FE} - \beta_{RE})' Var(\beta_{FE} - \beta_{RE})^{-1}(\beta_{FE} - \beta_{RE})$, where N = number of observations, β_{FE} and β_{RE} are, respectively, the coefficients' vector of the FE and RE model, $Var(.)$ is the variance-covariance operator, and H has a chi-squared distribution. Under the null hypothesis (i.e. high p-values), both estimators are consistent, but the RE model is more efficient than FE. Under the alternative hypothesis (i.e. low p-values), FE is consistent whereas RE is not. However, as the Hausman test relies on asymptotic assumptions, negative statistics are not an unusual outcome in empirical analyses. Schreiber (2008) shows that the Hausman test could have problems not only in small samples but, under certain conditions, also asymptotically. The short period of our sample (from 2006 to 2010) exacerbates these effects and tends to generate unreliable statistics. As a fallback position, we can rely on the Breusch and Pagan Lagrange-Multiplier (1979) statistic: even if it does not test FEs versus REs directly, it rejects the null hypothesis of zero variance implied by the FE model.

5. FINDINGS

Our main results are presented in Table 3. The dependent variable is the natural logarithm of the Z-score. We apply this transformation to smooth out higher values of the highly skewed Z-score distribution. The interest variable is the yearly Lerner index. In all estimates, we control for *FUND*, *LOAN*, *NOINT*, *lnTA*, *CREDIT*, *GROWTH* and *TIER1* and apply robust standard errors to correct for the effects of heteroskedasticity. The first column reports the OLS estimate. R^2 (0.21) and F test statistics (62.52) show a relatively good fit of our specification to the data. The impact of the Lerner index on Altman Z-score is positive and very significant. $\beta>0$ indicates that when the bank's market power increases, the reduction in banking competition makes banks less risky and, in aggregate, the banking system more stable. This result supports the traditional charter value paradigm and rejects the negative relation between less banking competition and stability proposed by Boyd and De Nicolò (2005). Our first hypothesis (HYP1) is corroborated. The impact of the financial crisis on bank stability is negative and very significant as expected: $\gamma<0$ shows that Altman Z-score has decreased since 2008, suggesting that the financial crisis increases the probability of insolvency and makes the banking system more unstable.

Findings on control variables are mixed. According to our expectations, banks with higher loans to assets ratio (*LOAN*) and loss provisions to interest income (*CREDIT*) are more exposed to risks (lower Z-score). As coefficients are statistically significant at 1 percent level, this indicates that asset mix and credit risk are relevant determinants for bank stability. A higher share of wholesale funding in total funding (*FUND*) or a lower share of non-interest income in total income (*NOINT*) reduces bank risk even if their impacts are statistically significant at 5 percent. Bank risk decreases (higher Z-score) when bank's total assets grow (*GROWTH*) but it is independent from bank size (*ln(TA)*). There are two explanations for this unexpected result. The first is that in a country with a large number of (relatively small) banks, their survivorship depends more on turnover growth than actual size. The second is the

survivor effect: banks that we observe expanded their total turnover successfully during the crisis and took more risk to survive. Contrary to our expectations, Tier1 capital ratio is statistically not significant. In this case, our explanation relies on the fact that Tier1 capital ratio is a threshold requirement and it becomes relevant only if bank regulatory capital is close to the threshold level.

As bank effects could bias the OLS estimate, we apply FE and RE in columns 2 and 3 respectively. The Hausman test fails to match asymptotic assumptions but does not seem to reject FE when we force a result by adjusting the test statistics.[4] On the contrary, the BPLM statistics reject the hypothesis of zero variance of bank effects, a result that is consistent with RE. As statistical tests show mixed results, we report FE and RE estimates. Both support the charter value paradigm confirming our previous result (HYP1): banking competition undermines bank stability whereas the financial crisis increased bank risk. FE estimate (column 2) shows an increase in R^2 and F test statistics (respectively to 0.31 and 299.3) but also changes in sign and significance of control variable coefficients. In particular, *FUND*, *LOAN* and *GROWTH* are not statistically significant. The most important change is the switch of *NOINT* from positive to negative. At the same time, the regulatory capital requirement (*TIER1*) and the bank size (*ln(TA)*) have a negative significant impact on bank stability (even if the former is economically not negligible). On the contrary, the RE estimate is in line with the OLS result except for *FUND* and *NOINT* that are not statistically

[4] Table A.5 reports statistics from Hausman tests. When we force the performance of the Hausman test, we get a negative statistic (H1). We apply five different corrections. First, we include the constant in the specification tested (H2). Then we use only the variance from FE (H3) and only that from RE (H4). Finally, we test fixed versus random effects using a test of overidentifying restrictions on the orthogonality conditions that the regressors are uncorrelated with the idiosyncratic error (Arellano 1993; Wooldridge 2002, pp. 290-91). Unlike the Hausman version, this test extends straightforwardly to heteroskedastic- and cluster-robust versions and is always guaranteed to generate a non-negative test statistic (H5). All corrected Hausman tests (H2-5) report low p-values rejecting RE. As we always had to force the performance of the test to obtain these results, the Hausman test is not really reliable in our sample and we rely on the Breusch-Pagan Lagrange Multiplier test, our second best.

significant. This pattern is in line with the previous literature (Beck et al. 2011) but in our case, the switch in sign and significance of control variable coefficients through methods could also be due to our short sample period. Nonetheless, the coefficients of our interest variables are stable across panel estimators, continue to be very significant and are consistent with OLS estimates.

Columns 4, 5 and 6 report respectively OLS, FE and RE estimates of equation 2. The impact of banking competition on stability is negative (β>0), but the relationship becomes statistically much more intense during the financial crisis. For example, the value of the *LERNER* coefficient increases from 0.55 in 2007 to 1.32 during the crisis (i.e. 0.55+0.77) under FE (column 5). This value compensates for the increase in bank risk due to the crisis (-077). The coefficient of the interactive term is very significant and stable through the methods reinforcing the previous bank competition-stability relationship. Coefficients of control variables are consistent with results from the simple model (columns 1-3). These results corroborate our second hypothesis (HYP2).

In sum, our empirical results support the charter value paradigm for the Italian banking sector, and the financial crisis considerably reinforced the negative bank competition-stability relationship.

6. ROBUSTNESS ANALYSIS

We check the robustness of our findings with three separate exercises. The first estimates our two equations with 2009 as the beginning of the crisis. The reason for switching from 2008 to 2009 has to do with the potential lag in crisis effects on accounting data. In the first exercise, we replicated estimates of Table 3 using the new definition of *CRISIS*. Findings are shown in Table 4. All test statistics are similar. R^2 and F test statistics show a relatively good fit to data whereas Hausman and BPLM tests provide contrasting results about FE and RE. Coefficients

of control variables maintain same sign and significance, except for *ln(TA)* which is not statistically significant also under FE (columns 2 and 5). These findings confirm that loan to total assets (*LOAN*) and loan loss provisions to total interest income (*CREDIT*) are the main determinants of bank risk whereas bank size (*ln(TA)*) is not relevant.

We expect weaker findings using the new definition of *CRISIS* because the switch of 2008 from crisis to pre-crisis period tends to smooth out crisis effects. Consequently, this exercise works against our hypothesis. Although estimates confirm our expectations, we are not able to reject HYP1 in 3 out of 6 cases and HYP2 under all methods. Using the simple model (equation 1), the *LERNER* coefficient is not significant using FE (column 2), but it is positive and statistically very significant using OLS and RE (column 1 and 3). Using the interactive model (equation 2), *LERNER* is positive and statistically significant only using OLS, but the interactive term *LERNER*CRISIS* is positive and significant at 5 percent level under all methods. When we consider the lag in reporting crisis effects on accounting data, we find that the financial crisis makes the negative bank competition-stability relationship emerge more clearly and supports the charter value paradigm.

In the second exercise, we modify equations 1 and 2 to allow for non-linearity in the bank competition-stability relationship and we rerun estimates using a quadratic specification similarly to Berger et al. (2009). Results reported in Table A.3 and A.4 provide no statistical evidence of this relationship. $LERNER^2$ is not statistically significant under any method whereas the positive *LERNER* coefficient tends to lose significance even if it remains positive (except for columns 2 and 5 of Table A.4). The mixed pattern for control variables is confirmed, suggesting that it depends on the method rather than the model specification. These results are in line with the country empirical studies on the bank competition-stability relationship.

In the last exercise, we add and remove control variables to our model to investigate further the validity of our specification. In particular, we remove first *ln(TA)*, then *TIER1* and finally both together. They are poor regressors and could improve test statistics artificially. Then we add the financing cost to income from intermediation activity (cost-to-income ratio) to measure the cost of financing and the coverage derivatives on operative liabilities as a further measure of the credit risk. We introduce these variables separately and jointly to get a better fit of our model specification to data. Both exercises (exclusion of existing control variables and inclusion of new control variable) confirm our previous results. In particular, the financial crisis reinforces the charter value paradigm whereas there is no evidence in favour of the risk-shifting paradigm proposed by Boyd and De Nicolò (2005).

In brief, robustness exercises corroborate our main results. Bank market power reduces risk in the Italian banking sector and, according to the traditional view of the bank competition-stability relationship, it makes the real economy more stable. This relationship seems to hold before the crisis although the results are affected negatively by the methodology. It corroborates our first hypothesis. The relationship became statistically more significant and economically more intense during the recent financial crisis, confirming our second hypothesis as well.

7. CONCLUSIONS

The recent literature on banking has renewed the interest of economists in the competition-risk nexus. The traditional charter value paradigm introduced first by Keeley (1990) posits that there is a trade-off between banking competition and stability and predicts a positive relationship between banks' market power and financial stability. The risk-shifting paradigm proposed recently by Boyd and De Nicolò (2005) suggests that no trade-off exists because fiercer banking competition leads to lower interest rates that, in turn, reduce the probability of

firm default and make banks safer. The standard response to conflicting theoretical predictions is to let the data speak but empirical evidence from cross-country data is ambiguous and many papers have focused on individual countries. In line with this trend, we explore the competition-risk nexus using a panel data set of 677 Italian banks for 2006-2010.

We find that (i) Altman Z-score, our measure of bank soundness, is positively and significantly associated with the Lerner index, our measure of market concentration and (ii) the 2008-2010 financial crisis reinforced the existing relationship in Italy. These findings are robust to different estimators and the potential lag of crisis effects in accounting data whereas we find no support in favour of a quadratic relationship between banking competition and risk. Our results differ from findings obtained by cross-country studies such as Boyd et al. (2006) and Berger et al. (2009) but are in line with the bulk of country studies.

However, our analysis presents some limitations. First, we rely on a specific measure of banking competition, the Lerner index. Yet since we examine the Italian banking sector, we cannot use country-level measures of competition such as the Herfindahl index. Second, we focus on the Altman Z-score, a bank-level measure of stability, and not on indicators of systemic risk. This means that we do not consider links among banks.

The policy relevance of our findings is that governments should allow consolidation of the banking sector in the current financial crisis but without providing support for specific banks. Public intervention in individual institutions would bias the competition-risk nexus, creating implicitly too-big-to-fail banks with a negative impact on the whole economy. We also contribute to the economic literature by confirming the charter value paradigm in Italy and identifying a structural break in the relationship due to the crisis.

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Table 1: Variable definitions

Translog Cost Function		
Determinants		
P	Price of Total Assets	Total operating income to total assets[(a)]
C	Costs of Total Assets	Total operating costs
Q	Firm Size	Total assets
W_1	Fixed Capital	Other operating and administrative expenses to tangible and intangible assets (Input 1)
W_2	Labour	Personnel expenses per employee (Input 2)
W_3	Fund	Interest expenses to total deposit and money market funding (Input 3)
Marginal Costs		
MC	Yearly Marginal Costs	Marginal Cost using Total Assets in the yearly Translog Cost Function
Bank Risk-Competitiveness		
Risk		
Zs	Altman Z-score is an easy-to-calculate index that combines multiple corporate income and balance sheet values to measure the financial health of a company. It is equal to: $$Z_s = 0.012*T_1 + 0.014*T_2 + 0.033*T_3 + 0.006*T_4 + 0.009*T_5$$ The five determinants of Z-scores are: T_1 = Working Capital / Total Assets. It measures liquid assets in relation to the size of the company. T_2 = Retained Earnings / Total Assets. It measures profitability that reflects the company's age and earning power. T_3 = Earnings Before Interest and Taxes / Total Assets. It measures operating efficiency apart from tax and leveraging factors. It recognizes operating earnings as being important to long-term viability. T_4 = Market Value of Equity / Book Value of Total Liabilities. It adds market dimension that can show up security price fluctuation as a possible red flag. T_5 = Sales/ Total Assets. It is a standard measure for total asset turnover (varies greatly from industry to industry).	
Competitiveness		
LERNER	Yearly Lerner Index	Lerner Index estimated using a yearly translog cost function. It is equal to $(P\text{-}MC)/P$
Controls		
FUND	Funding structure	Share of wholesale funding
LOAN	Assets Mix	Loans to Total Assets
NOINT	Revenue Composition	Non-interest income to total income
Ln(TA)	Bank Size	Logarithm of Total Assets
CREDIT	Credit Risk	Loan loss provisions to total interest income
GROWTH	Total Assets Growth	Annual Growth in Total Assets
TIER1	TIER 1 Capital Ratio	TIER 1 Capital Ratio

NOTES: (a) Negative total operating income are excluded (7 observations).

Table 2 – Descriptive statistics

Variable	Zs	LERNER	FUND	LOAN	NOINT	lnTA	CREDIT	GROWTH	TIER1
Panel A: Whole period									
Mean	0.079	0.408	0.102	0.654	0.246	13.078	0.293	0.666	25.633
Median	0.059	0.409	0.016	0.699	0.207	12.827	0.203	0.068	13.7
St.Dev.	0.319	0.129	0.212	0.189	0.216	1.72	0.375	22.176	328.323
Min.	0	0.026	0	0	-3.23	8.545	0	-0.999	-9.982
Max.	15.505	0.93	1	0.989	5.353	19.878	5.827	1103.961	15940
N. Obs.	3199	3144	2573	2576	2576	2576	2576	2611	3357
Panel B: Subsample with crisis starting from 2008									
					Pre-Crisis				
Mean	0.084	0.447	0.1	0.646	0.247	12.989	0.24	0.124	25.462
Median	0.072	0.447	0.015	0.69	0.2	12.704	0.175	0.084	13.265
					Crisis				
Mean [(a)]	0.076	0.381***	0.103	0.656	0.246	13.108	0.31***	0.844	25.748
Median [(b)]	0.047***	0.379***	0.017	0.702	0.209	12.862*	0.218***	0.062***	14.07***
Panel C: Subsamples with crisis starting from 2009									
					Pre-crisis				
Mean	0.08	0.437	0.104	0.65	0.237	13.007	0.242	1.035	22.416
Median	0.068	0.435	0.016	0.693	0.191	12.746	0.174	0.085	13.25
					Crisis				
Mean [(a)]	0.079	0.362***	0.1	0.658	0.255**	13.15**	0.344***	0.297	30.573
Median [(b)]	0.041***	0.359***	0.016	0.704	0.225***	12.915**	0.253***	0.046***	14.432***

NOTES: (a) One-sample mean-comparison test against all other years for mean; (b) Wilcoxon rank-sum test against all other years for medians. *** p<0.01, ** p<0.05, * p<0.1

Table 3 – Linear impact of competitiveness on risk in the Italian banking sector. Crisis starting in 2008.

Dependent Variable	ln(Zs)					
Specification	Simple			Interactive		
Estimator	OLS	FE	RE	OLS	FE	RE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Competitiveness						
LERNER	1.3697***	1.1848***	1.2019***	0.8083***	0.5472**	0.6255***
CRISIS	-0.4287***	-0.4435***	-0.4474***	-0.7385***	-0.7742***	-0.7588***
CRISIS*LERNER				0.7207***	0.7694***	0.7229***
Controls						
FUND	-0.2141**	0.0253	-0.0837	-0.2146**	0.0421	-0.0795
LOAN	-0.2647***	0.1961	-0.3846***	-0.2486**	0.2424	-0.3540***
NOINT	0.4106**	-1.0454***	-0.1186	0.4285***	-0.9689***	-0.0845
Ln(TA)	-0.0074	-0.2577**	-0.0086	-0.0069	-0.2666**	-0.0091
CREDIT	-0.3755***	-0.2678***	-0.3861***	-0.3777***	-0.2734***	-0.3904***
GROWTH	0.0005***	-0.0001	0.0004***	0.0005***	-0.0001	0.0005***
TIER1	-0.0001	-0.0000***	-0.0001	-0.0001	-0.0000***	-0.0001
Constant	-2.9293***	0.4378	-2.6284***	-2.7070***	0.7801	-2.4013***
Bank Effects		Yes	Yes		Yes	Yes
Observations	2335	2335	2335	2335	2335	2335
R-squared	0.211	0.310	0.198	0.214	0.315	0.201
Number of banks		677	677		677	677
F-Test	62.52	299.3	715.8	57.16	292.3	741.7
Prob F-Test>F	0	0	0	0	0	0
BPLM			304.9			307.3
Prob BPLM>chi2			0			0

NOTES: OLS, RE and FE estimates using robust standard errors of the impact of the Lerner Index (competitiveness) on Altman Z-score (risk) in the Italian banking sector over the period from 2006 to 2010. Dependent variable: ln(Zs). Interest variable: LERNER. Table 1 summarises variable definitions. The crisis dummy is equal to 1 from 2008 on and 0 otherwise. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Table 4 – Linear impact of competitiveness on risk in the Italian banking sector. Crisis starting in 2009.

Dependent Variable	ln(Zs)					
Specification	Simple			Interactive		
Estimator	OLS	FE	RE	OLS	FE	RE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Competitiveness						
LERNER	1.0300***	-0.0210	0.4684***	0.7136***	-0.3527#	0.1767
CRISIS	-0.3945***	-0.4600***	-0.4377***	-0.6409***	-0.6814***	-0.6482***
CRISIS*LERNER				0.5745**	0.5110**	0.4873**
Controls						
FUND	-0.2059*	-0.1697	-0.0918	-0.2101*	-0.1438	-0.0892
LOAN	-0.2451**	0.1551	-0.3618***	-0.2262**	0.2053	-0.3325***
NOINT	0.4580***	-0.8512***	-0.0275	0.4794***	-0.7771***	0.0064
Ln(TA)	0.0022	-0.1544#	0.0159	0.0019	-0.1594#	0.0151
CREDIT	-0.3508***	-0.1759**	-0.3279***	-0.3532***	-0.1840**	-0.3311***
GROWTH	0.0002**	-0.0003	0.0002*	0.0002**	-0.0003	0.0002**
TIER1	-0.0001	-0.0000***	-0.0001	-0.0001	-0.0000***	-0.0001
Constant	-3.0689***	-0.5385	-2.8104***	-2.9401***	-0.3753	-2.6961***
Bank Effects		Yes	Yes		Yes	Yes
Observations	2335	2335	2335	2335	2335	2335
R^2	0.214	0.327	0.199	0.217	0.331	0.201
Number of banks		677	677		677	677
F-Test	56.50	223.9	708.1	51.13	207.1	706.8
Prob F-Test>F	0	0	0	0	0	0
BPLM			324.7			321.4
Prob BPLM>chi2			0			0

NOTES: OLS, RE and FE estimates using robust standard errors of the impact of the Lerner Index (competitiveness) on Altman Z-score (risk) in the Italian banking sector over the period from 2006 to 2010. Dependent variable: ln(Zs). Interest variable: LERNER. Table 1 summarises variable definitions. The crisis dummy is equal to 1 from 2009 on and 0 otherwise. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Appendix A

Table A.1 – Descriptive statistics of Translog cost function variables

Variable	C	W_1	W_2	W_3	P	MC
Whole period						
Mean	63928.38	1.727	99.75	0.035	0.037	0.023
Median	8733	0.611	68.091	0.03	0.034	0.021
St.Dev.	315846.8	6.648	1306.958	0.045	0.033	0.017
Min.	184	-146.208	0.729	0	0	0
Max.	6875257	129.125	73222.78	1.878	0.774	0.54
N	3357	3344	3350	3351	3357	3312
Subsamples with crisis starting from 2009						
			Pre-Crisis			
Mean	63836.09	1.723	106.775	0.041	0.038	0.023
Median	8047	0.602	66.33	0.036	0.036	0.021
			Crisis			
Mean [(a)]	64070.08	1.732	88.946	0.026***	0.034***	0.023
Median [(b)]	9723.226***	0.625*	70.329***	0.021***	0.031***	0.02
Subsamples with crisis starting from 2008						
			Pre-Crisis			
Mean	61071.94	1.691	69.363	0.037	0.039	0.023
Median	7709.5	0.586	64.563	0.032	0.037	0.021
			Crisis			
Mean [(a)]	65864.08	1.751	120.389	0.034*	0.035***	0.023
Median [(b)]	9399***	0.627**	70.071***	0.027***	0.032***	0.021

NOTES: (a) One-sample mean-comparison test against all other years for mean; (b) Wilcoxon rank-sum test against all other years for medians. *** p<0.01, ** p<0.05, * p<0.1

Table A.2 – Translog cost function

Period:	2006-2010	2006	2007	2008	2009	2010
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Q)	1.3042***	1.1242***	1.2410***	1.4408***	1.2630***	1.1350***
Ln(Q)*Ln(Q)	-0.0260***	-0.0288***	-0.0212**	-0.0196**	-0.0267***	-0.0264***
Ln(Q)*Ln(W_1)	-0.0125***	-0.0366***	-0.0121	0.0113	-0.0087	-0.0283***
Ln(Q)*Ln(W_2)	-0.0028	0.0364	-0.0043	-0.0434**	0.0016	0.0262
Ln(Q)*Ln(W_3)	0.0153**	0.0003	0.0165	0.0321*	0.0071	0.0022
Ln(W_1)	-0.3461***	0.0713	-0.6108***	-0.5490***	-0.2911	0.0841
Ln(W_2)	2.1129***	2.0846**	2.9274***	2.5537***	1.6323***	0.9944***
Ln(W_3)	-0.7668***	-1.1559	-1.3167***	-1.0047***	-0.3412	-0.0785
Ln(W_1)*Ln(W_1)	-0.0899***	-0.1234***	-0.0737***	-0.0482***	-0.1083***	-0.0761***
Ln(W_1)*Ln(W_2)	0.1215***	0.1254***	0.1537***	0.0889***	0.1158***	0.0798***
Ln(W_1)*Ln(W_3)	-0.0316***	-0.0020	-0.0800***	-0.0407**	-0.0075	-0.0037
Ln(W_2)*Ln(W_2)	-0.1939***	-0.2487***	-0.3129***	-0.1729***	-0.1391***	-0.0781**
Ln(W_2)*Ln(W_3)	0.0724***	0.1233	0.1592***	0.0840***	0.0234	-0.0017
Ln(W_3)*Ln(W_3)	-0.0408***	-0.1213*	-0.0791**	-0.0433**	-0.0159	0.0054
Dummy year=2007	0.0196					
Dummy year=2008	-0.0083					
Dummy year=2009	-0.0921***					
Dummy year=2010	-0.1378***					
Constant	-13.1097***	-12.8420***	-15.3276***	-15.1844***	-11.0594***	-8.5127***
Observations	3312	661	681	668	670	632
R2	0.923	0.928	0.927	0.929	0.921	0.919
F-Test	3444	899.5	927.4	948.5	1374	1322
Prob F-Test>F	0	0	0	0	0	0

NOTES: OLS constrained estimator. Constraints: (1) $\ln(W_1) + \ln(W_2) + \ln(W_3) = 1$; (2) $\ln(Q)*\ln(W_1) + \ln(Q)*\ln(W_2) + \ln(Q)*\ln(W_3) = 0$; (3) $\ln(W_1)*\ln(W_1) + \ln(W_1)*\ln(W_2) + \ln(W_1)*\ln(W_3) = 0$; (4) $\ln(W_1)*\ln(W_2) + \ln(W_2)*\ln(W_2) + \ln(W_2)*\ln(W_3) = 0$; (5) $\ln(W_1)*\ln(W_3) + \ln(W_2)*\ln(W_3) + \ln(W_3)*\ln(W_3) = 0$. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A.3 – Quadratic impact of competitiveness on risk in the Italian banking sector. Crisis starting in 2008.

Dependent Variable	ln(Zs)					
Specification	Simple			Interactive		
Estimator	OLS	FE	RE	OLS	FE	RE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Competitiveness						
LERNER	1.7439***	0.1607	1.1195*	2.1599**	0.9314	1.3489*
LERNER2	-0.4373	1.2845#	0.0997	-1.5010	-0.2071	-0.7663
CRISIS	-0.4278***	-0.4446***	-0.4476***	-0.4456*	-0.3401	-0.5079**
CRISIS*LERNER				-0.6588	-1.2740	-0.4632
CRISIS*LERNER2				1.5243	2.2594**	1.3132#
Controls						
FUND	-0.1949*	0.0227	-0.0878	-0.1996*	0.0646	-0.0876
LOAN	-0.2720***	0.1836	-0.3837***	-0.2569***	0.2609	-0.3508***
NOINT	0.4101**	-1.0748***	-0.1199	0.4288***	-1.0139***	-0.0878
lnTA	-0.0075	-0.2628**	-0.0086	-0.0070	-0.2800**	-0.0095
CREDIT	-0.3715***	-0.2646***	-0.3868***	-0.3729***	-0.2680***	-0.3908***
GROWTH	0.0005***	-0.0001	0.0004***	0.0005***	-0.0001	0.0005***
TIER1	-0.0001	-0.0000***	-0.0001	-0.0001	-0.0000***	-0.0001
Constant	-2.9998***	0.7063	-2.6119***	-2.9893***	0.8232	-2.5567***
Bank Effects		Yes	Yes		Yes	Yes
Observations	2335	2335	2335	2335	2335	2335
R-squared	0.212	0.311	0.198	0.215	0.319	0.201
Number of banks		677	677		677	677
F-Test	57.54	259.3	720.1	52.69	234.4	796.1
Prob F-Test>F	0	0	0	0	0	0
BPLM			303.1			305.9
Prob BPLM>chi2			0			0

NOTES: OLS, RE and FE estimates using robust standard errors of the impact of the Lerner Index (competitiveness) on Altman Z-score (risk) in the Italian banking sector over the period from 2006 to 2010. Dependent variable: ln(Zs). Interest variable: LERNER. Table 1 summarises variable definitions. The crisis dummy is equal to 1 from 2008 on and 0 otherwise. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Table A.4 – Quadratic impact of competitiveness on risk in the Italian banking sector. Crisis starting in 2009.

Dependent Variable	ln(Zs)					
Specification	Simple			Interactive		
Estimator	OLS	FE	RE	OLS	FE	RE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Competitiveness						
LERNER	1.0687*	-0.3045	0.2078	0.8366	-0.6219	-0.0001
LERNER2	-0.0450	0.3565	0.3142	-0.1312	0.3714	0.2272
CRISIS	-0.3943***	-0.4597***	-0.4383***	-0.5415**	-0.5521**	-0.5418**
CRISIS*LERNER				0.0775	-0.1351	-0.0603
CRISIS*LERNER2				0.5731	0.7608	0.6469
Controls						
FUND	-0.2039*	-0.1702	-0.1053	-0.2192*	-0.1259	-0.1133
LOAN	-0.2458**	0.1511	-0.3587***	-0.2237**	0.2070	-0.3249***
NOINT	0.4579***	-0.8590***	-0.0298	0.4807***	-0.7921***	0.0033
lnTA	0.0022	-0.1564#	0.0158	0.0022	-0.1676*	0.0151
CREDIT	-0.3504***	-0.1754**	-0.3299***	-0.3541***	-0.1862**	-0.3349***
GROWTH	0.0002**	-0.0003	0.0002*	0.0002**	-0.0003	0.0002**
TIER1	-0.0001	-0.0000***	-0.0001	-0.0001	-0.0000***	-0.0001
Constant	-3.0761***	-0.4566	-2.7596***	-2.9720***	-0.2262	-2.6670***
Bank Effects		Yes	Yes		Yes	Yes
Observations	2335	2335	2335	2335	2335	2335
R-squared	0.214	0.327	0.199	0.217	0.331	0.201
Number of banks		677	677		677	677
F-Test	51.66	200.5	712.2	44.60	173.5	729.9
Prob F-Test>F	0	0	0	0	0	0
BPLM			324.5			322.8
Prob BPLM>chi2			0			0

NOTES: OLS, RE and FE estimates using robust standard errors of the impact of the Lerner Index (competitiveness) on Altman's Z-score (risk) in the Italian banking sector over the period from 2006 to 2010. Dependent variable: ln(Zs). Interest variable: LERNER. Table 1 summarises definitions of variables. The crisis dummy is equal to 1 from 2009 on and 0 otherwise. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Table A.5 - Hausman tests: FE vs RE

Model	Linear				Quadratic			
Crisis beginning	2008 (Table 3)		2009 (Table 4)		2008 (Table A.3)		2009 (Table A.4)	
Columns	2 vs 3	5 vs 6	2 vs 3	5 vs 6	2 vs 3	5 vs 6	2 vs 3	5 vs 6
Specification	Simple	Interactive	Simple	Interactive	Simple	Interactive	Simple	Interactive
H1	-25.15	-25.56	-63	12.41	-30.24	-11.25	15.73	56.65
Prob H1>chi2	0.0028	0.0044	0	0.259	0.0008	0.338	0.108	0
H2	103.7	173.5	-26.93	-2.56	154.2	-771.5	37.36	57.06
Prob H2>chi2	0	0	0.0007	0.979	0	0	0	0
H3	1899	-157.2	53.5	-12.11	-302.4	-101.9	65.98	30.24
Prob H3>chi2	0	0	0	0.278	0	0	0	0.0008
H4	1987	-164.6	56.07	-12.69	-316.6	-106.9	69.13	31.67
Prob H4>chi2	0	0	0	0.242	0	0	0	0.0005
H5	90.55	95.32	100.6	104.5	92.41	103.3	100.8	107.6
Prob H5>chi2	0	0	0	0	0	0	0	0

NOTES: All Hausman tests are performed forcing results because asymptotic assumption are not matched. H1 excludes the constant; H2 includes the constant; H3 uses covariance matrices based on the estimated disturbance variance from RE; H4 uses covariance matrices based on the estimated disturbance variance from the FE; H5 is a test of overidentifying restrictions on the additional orthogonality conditions of RE.