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Article

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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Determinants of European bank risk during financial crisis

Wiem Ben Jabra^{1*}, Zouheir Mighri¹ and Faysal Mansouri¹

Abstract: This paper examines the determinants of European bank risk-taking during major financial crisis. Using a sample of banks from 26 countries over the period 2005–2015, we examine the nature of the relationship between bank risk, bank characteristics, regulatory, institutional and macroeconomic variables. We use a dynamic panel data modeling structure to capture the potential discrepancies in risk-taking behavior. We subdivide our sample into two sub-samples (East Europe and West Europe countries). We show that macroeconomic and regulatory variables seem to have non-negligible impact on bank risk-taking attitudes. We document that the relationship between bank risk, internal and external factors differs across samples.

Subjects: Economics, Finance, Business & Industry; Econometrics; Finance; Banking; Credit & Credit Institutions

Keywords: credit risk; insolvency risk; financial crisis; dynamic panel data; GMM; East Europe; West Europe

JEL classifications: G15; G21; G25; G28

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PUBLIC INTEREST STATEMENT

The main purpose of this article is to improve the explanatory determinants of credit and insolvency risk behavior in the European banking industry during the financial crisis. The author's objectives include highlighting the role played by the bank bank-specific and macroeconomic variables in explaining the risk excess. This study is considered the first of its kind conducted in the context of the financial crisis. We use a panel data of 26 European countries over the period 2005–2015. We subdivide our sample into two sub-samples (East Europe and West Europe countries). The empirical findings show that the relationship between bank risk, microeconomic, macroeconomic and institutional factors differs across samples.

1. Introduction

The eruption of the 2008 banking crisis and the subsequent great recession have stimulated interests in the analysis and understanding of bank stability. The 2007 subprime crisis, widespread rapidly to most international financial markets, has led to the outbreak of a major global financial turmoil. This major crisis has impacted heavily several international banking industries and led to bankruptcy movement of major international financial institutions such as Lehman Brothers, Bear Stearns, and Merrill Lynch. Several factors have contributed to the emergence of this major financial turmoil in particular financial innovations, executive greedy behavior and a lack of control and supervision. Indeed, due to a deliberate financial liberalization policy, banks have been engaged in a fierce competition characterized by the adoption of new financial products, a sharp credit growth and a savage increase in bank executive compensations.

As a consequence, this major financial crisis, characterized by higher uncertainties, has resurrected the debate about the prevalence of regulatory policy and appropriate regulatory measures to stabilize the system. The recent global financial crisis has emphasized the importance of the early identification of riskier banks, as this allows for solving the problems at a lower cost (Baselga-Pascual, Trujillo-Ponce, & Cardone-Riportella, 2015). A better understanding of the determinants of bank risk is needed due to the bank bailout costs associated with the current global financial crisis and the large output losses experienced in several European countries. As stated by Baselga-Pascual et al. (2015), an improved understanding of the determinants of bank risk in the euro area is important for regulators and supervisors interested in benchmarking and validation issues related to the new EU banking rules. However, they may also be of interest to a wide range of financial market participants, including borrowers, shareholders, and bondholders.

Indeed, academics and policy-makers alike have been increasingly interested in the study of the determinants of bank risk-taking behavior (credit risk and insolvency risk). The extent to which banks are vulnerable to risks has been found to be related with a variety of factors, including the banks' own characteristics such as capitalization and size (Afonso, Santos, & Traina, 2014; Baselga-Pascual et al., 2015; Berger & DeYoung, 1997; Chen, Jeon, Wang, & Wu, 2015; Drakos, Kouretas, & Tsoumas, 2014; Foos, Norden, & Weber, 2010; Williams, 2014), bank regulation (Agoraki, Delis, & Pasiouras, 2011; Barth, Caprio, & Levine, 2004; Laeven & Levine, 2009), competition (Agoraki et al., 2011; Beck & Demirgüç-Kunt, 2013; Boyd & De Nicoló, 2005) and the deposit insurance coverage (Angkinand & Wihlborg, 2010; Demirgüç-Kunt & Detragiache, 2002).

Measurement of bank risk can encompass a variety of dimensions. Since policy makers are primarily concerned about bank failures, we consider bank risk related to the bank's probability of default. Therefore, we use two well-known accounting-based proxies of bank risk: the non-performing loan ratio (NPLr) and proximity to default (*Zscore*). The NPLr is defined as the proportion of non-performing loans to gross loans and expresses the quality of a loan portfolio. It has been usually used in the literature as a measure of bank soundness (Agoraki et al., 2011; Baselga-Pascual et al., 2015; Berger & DeYoung, 1997; Delis & Kouretas, 2011; Drakos et al., 2014; Festić, Kavkler, & Repina, 2011; Williams, 2014). A higher (lower) value for the NPLr indicates a higher (lower) probability of the bank defaulting. As a complementary indicator, we use the *Z-score*, which has also been frequently used in the empirical literature to reflect a bank's probability of insolvency (Agoraki et al., 2011; Baselga-Pascual et al., 2015; Demirgüç-Kunt & Huizinga, 2010; Drakos et al., 2014; Köhler, 2015; Konishi & Yasuda, 2004; Laeven & Levine, 2009; Williams, 2014).

The *Zscore* metric is defined as the number of standard deviations that a bank's return on assets must fall below the mean for the bank to become insolvent. According to Delis and Staikouras (2011), a higher *Zscore* indicates that a bank is farther from default. Bikker and Metzmakers (2005) and Laeven and Majnoni (2003) suggested that the *Zscore* is a better measure of bank risk than the NPLr since non-performing loans are traditionally backward looking and highly pro-cyclical. Delis and Staikouras (2011) stated that this criticism does not concern the *Zscore* as much since changes in bank riskiness are captured through the variance component of this index. Besides, Agoraki et al. (2011)

argued that the *Zscore* represents a more universal measure of bank risk that captures more than credit risk alone.

This interest lies in the need to insure financial stability and optimal bank management. Reinhart and Rogoff (2010) point out those non-performing loans (NPLs) may be considered as indicators of the eruption of a major banking crisis. They have analyzed the determinants of non-performing loans and have made recourse to explanatory variables such as the level of non-performing loans and bank specific characteristics. It is well-known that bank risks depend largely on the interaction of several factors such as regulatory, macroeconomic, and structural conditions prevailing in the economy as argued in Laeven and Levine (2009); Barrell, Davis, Karim, and Liadze (2010), among others. Salas and Saurina (2002) used macroeconomic as well as microeconomic variables to explain non performing loans of Spanish Commercial and Savings banks from 1985 until 1997.

They found that bank-specific factors may serve as early warning indicators for future changes in non-performing loans (NPLs). The influence of macroeconomic environment on bank risk-taking remains a major issue that has been thoroughly investigated.

This study uses a panel of 280 banks covering the period spanning from 2005 to 2012, which corresponds to a period characterized by excessive volatility in international financial markets, and the occurrence of significant financial and economic events. In this vein, we test the impact of various internal, macroeconomic, regulatory, and institutional variables in order to explore the impact of internal and external environment on the bank risk excess.

This work contributes to the existing literature on the determinants of bank risk-taking behavior in different ways. First, this paper complements the preceding literature by analyzing the bank-specific and macroeconomic factors that influence bank risk of European commercial banks. Second, to control for unobserved heterogeneity as well as for endogeneity issues, we use the generalized method of moments (GMM) estimators, also referred to as the difference GMM and system GMM estimators, developed for dynamic panel data models by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). This sophisticated econometric technique has only been used in recent studies on the determinants of bank risk-taking (Agoraki et al., 2011; Baselga-Pascual et al., 2015; Chen et al., 2015; Delis & Staikouras, 2011; Drakos et al., 2014; Haq & Heaney, 2012; Louzis, Vouldis, & Metaxas, 2012). Third, we show significant and interactive effects of microeconomic and macroeconomic factors on bank risk-taking not only EU banks taken as a whole but also when adopting a regional subdivision namely two sub-samples regions (East Europe and West Europe) to compare differences on factors that may explain bank risk excess between each region. Peripheral countries are included in West European sample. Recent literature provides evidence that peripheral sovereigns are the main source of instability in the European banking industry (Argyrou & Kontonikas, 2012; Beirne & Fratzscher, 2013; Black, Correa, Huang, & Zhou, 2013; De Santis, 2012 and Gorea & Radev, 2014).

Fourth, we exploit the impact of regulatory and institutional environment on the European bank risk-taking. Most authors reviewed macroeconomic environment to the *GDP* growth and the inflation rate as important variables that can be influence the excess of bank risk. Specifically, we include two indexes (political stability and quality of regulation) individually in the models (Kaufmann, Kraay, & Mastruzzi, 2006) which capture different aspects of the institutional environment. We show that these features have a profound influence on the level of bank risk-taking in different European regions and especially on credit risk level.

Fifth, we consider some additional robustness tests that go beyond our main results. We test for robustness of these main results in two ways: we recourse to external data sources for a historical period (2005–2012) and thus we have a sample size that enables us to test for robustness in a panel setting including hence time and country effects. Then, we introduce series of macro institutional indices in our model to test the robustness of the results.

Finally, we have combined both microeconomic and macroeconomic variables to explain the bank risk-taking excess. However, Louzis et al. (2012) used bank specific and macroeconomic variables separately.

In the following section, we propose a literature review of the determinants of bank risk-taking behavior. In section 3, we present our data. Section 4 describes the econometric methodology and empirical model. Section 5 reports the key results relating bank risk-taking to the proposed measures. Section 6 concludes this research.

2. Literature review

Risk-taking behavior in the banking sector has been a central theme in the literature and in particular the behavior of banks in term of risk and information asymmetry. Greuning and Bratanovic (2004) showed that credit risk and insolvency risk are the most important risks of banks. The factors influencing bank risk according to the literature fall into two main groups. First, there is a group of risk determinants that are specific to each bank and that are in many cases, the direct result of managerial decisions. These determinants include capitalization, deposit insurance coverage, size, competition, and regulatory quality. The second group of determinants includes factors relating bank risk to the macroeconomic environment within which the banking system operates, such as economic growth and inflation.

2.1. Bank specific variables

2.1.1. Bank size

The relationship between bank size and bank risk has resulted in a substantial literature. On the one hand, several authors show the existence of a negative relationship between size and risk (Saunders, Strock, & Travlos, 1990). On the other hand, González (2005) found a positive and significant relationship between size and bank risk-taking.

This result is consistent with the “too-big-to-fail” argument, indicating that large banks are encouraged to undertake more risky investments as they naturally possess the benefits of a comprehensive security net. Stiroh (2006) argued that major banks have less risk. In addition, Saunders et al. (1990); Galloway, Lee, and Roden (1997); de Haan and Poghosyan (2012) indicate that regulatory protection occurs especially in the case of large banks, under the “too-big-to-fail” theory. Indeed, large banks are encouraged to take more risks than smaller banks in terms of size. These banks have great potential to diversify and reduce their risk. They may also be more sensitive to market movements than those having small size.

2.1.2. Bank capitalization

The capital turns out to be an important variable in determining bank risk-taking. Prior literature uses the ratio of equity to total assets. High capitalization could be used as a cushion, involving a low risk of insolvency. Then, a capital constraint is one of the most important criteria to obtain a robust financial system. Indeed, capital regulation is crucial in the prudential framework. High capital level generates a decrease in the probability of bank risk. Capital requirements may influence risk-taking in various ways. Bolt and Tieman (2004) show that strict capital requirement leads banks to adopt a strict credit policy. Delis, Tran, and Staikouras (2011) argue that bank capitalization is negatively related to bank risk-taking. This finding seems to be intuitive since higher equity capital, as a consequence of stricter capital requirements, implies more prudent bank behavior. Low bank capitalization leads to an increase in non-performing loans. The justification lies on the moral hazard incentives on the part of banks’ managers, who increase their loan portfolio risk when their banks are delicately capitalized as in Berger and DeYoung (1997), among others.

2.1.3. Competition

Several studies have tried to measure the effect of competition on bank risk behavior. Empirical literature showed that banks with large market power are often associated with low credit risk and low

default probability. Keeley (1990) found that deregulation measures of the US banking system in the 1970s and 1980s have increased competition, leading to increase in failure risk. Boyd and De Nicoló (2005) suggested that allowing for competition in credit markets is likely to increase stability. Furthermore, Allen and Gale (2004) argued that the relationship between competition and stability in banking sector changed considerably. In addition, Barth et al. (2004) and Schaeck, Cihak, and Wolfe (2006) showed that higher competition is often associated with banking stability. Beck and Demirgüç-Kunt (2013) showed that greater competition is generally associated with a larger impact on banks' risk-taking activities.

2.1.4. Deposit insurance coverage

Angkinand and Wihlborg (2010) suggested that the existence of explicit deposit insurance coverage schemes reduce market discipline and encourage banks to take excessive risks. Indeed, it is important to protect banks against risks and massive withdrawals with appropriate deposit insurance systems. Demirgüç-Kunt and Detragiache (2002) analyzed the relationship between deposit insurance and banking crises. They found an increase in the likelihood of crises in economies with deposit insurance system. Caprio and Levine (2002) showed that deposit insurance reduce controlling incentives among depositors and debt-holders. This limited responsibility allows shareholders to retain as much profit as possible while recovering part of their losses from deposit insurance fund.

2.1.5. Regulatory quality

Delis and Staikouras (2011) found that supervisory intensiveness reduces bank risk-taking and also reinforces the impact of market discipline in reducing bank risk. Nevertheless, Delis and Staikouras (2011) found that capital requirements, even when reinforced with supervisory activity are not effective in reducing bank risk. Furthermore, Klomp and Haan (2012) found that bank regulations act to reduce bank risk conditional upon ownership structure and size, and that these impacts are most apparent for higher risk banks. Likewise, Laeven and Levine (2009) found that the effect of bank regulations on bank risk is conditional on ownership structure. These authors constructed indices representing the existence of regulations as opposed to the quality of their enforcement. In addition, Williams (2013) attributed a positive relationship between bank capital and risk in Indonesia prior to the Asian financial crisis to poor regulatory governance.

2.2. Macroeconomic variables

Männasoo and Mayes (2009) argued that, during more favorable macroeconomic conditions, a positive relationship between GDP growth and risk assets is acknowledged. Louzis et al. (2012) showed that non-performing loans in the Greek banking system are mainly due to the macroeconomic factors, namely GDP growth.

Jimenez and Saurina (2005) examined the Spanish banking sector from 1984 to 2003. They showed that non-performing loans are determined by GDP growth. Salas and Saurina (2002), Rajan and Dhal (2003) and Fofack (2005) showed that real GDP growth rate is negatively associated with credit risk. Salas and Saurina (2002), Bangia, Diebold, Kronimus, Schagen and Schuerman (2002) and Carey (2002) showed that GDP growth has a significant negative effect on NPLs since the macroeconomic developments make economic agents more able to pay back their debt. Quagliariello (2007) and Louzis et al. (2012) argued that an expansionary phase of the economy features is associated with a low level of NPLs. Demirgüç-Kunt and Detragiache (2005) analyzed a sample of 65 of developed as well as developing countries over the period running from 1980 to 1995 using a multivariate Logit model. They showed that inflation is highly significant in increasing the probability of bank risk. Jimenez, Ongena, Peydro and Saurina (2008) used data on Spanish banks for a relatively long period and found that easy monetary policy is associated with higher credit risk. Ioannidou, Ongena, and Peydro (2009) found the same results using monetary policy decision as exogenous variable on the Bolivian banking industry.

3. Data description

We use annual database for commercial banks across 26 European countries over the period spanning from 2005 to 2012. Our data on bank risk determinants are derived from several sources. Bank

variables are obtained from the Bankscope database, which provides both listed and unlisted banks. Since we are only focusing on listed banks, the number of banks is reduced to a significant extent. Mainly, the delisted banks are excluded due to the unavailability of data in Bankscope database. Our final sample included 280 commercial banks (see Table 1). We use information collected from the World Bank database on banking regulation (Barth, Caprio, & Levine, 2001, 2006). Besides, World government indicators (WGI) are used to control for macroeconomic and institutional factors that might affect the level of bank risk excess. In addition, the deposit insurance data are obtained from the comprehensive deposit insurance database (Demirguç-Kunt, Kane, & Laeven, 2008). The variable definitions and the data sources are described in Table 2.

The literature proposes several measures of bank risk-taking. The most commonly used are the credit risk defined as non performing loans to gross loans (NPL/GL) and the insolvency risk (*Zscore*). Therefore, we focus on the ratio of non-performing loans to gross loans as a direct ex-post measure of credit risk (see Salas and Saurina (2002), Barth et al. (2004) and González (2005), among others).

Table 1. Sample composition of European countries

Countries	Banks
Germany	6
Austria	6
Belgium	4
Bulgaria	8
Cyprus	4
Denmark	11
Spain	13
Estonia	4
France	22
Greece	13
Hungary	4
Ireland	6
Italy	64
Latvia	7
Lithuania	6
Luxembourg	2
Netherlands	8
Poland	9
Portugal	8
Czech Republic	8
Romania	8
United Kingdom	28
Slovakia	8
Slovenia	8
Sweden	13
Finland	2
Total	280

Notes: This table presents the sample composition of European countries. The sample includes 280 listed Commercial banks from Germany, Austria, Belgium, Bulgaria, Cyprus, Denmark, Spain, Estonia, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Czech Republic, Romania, United Kingdom, Slovakia, Slovenia, Sweden, and Finland.

Source: Bankscope.

Table 2. Definition of selected variables and data sources

Variables	Description	Original Sources
1	<i>Risk-taking proxies</i>	
1.1	<i>IRISK</i> It is defined as the ratio of Non Performing Loans to Gross loans. A higher ratio indicates an increase in the exposure to credit risk	Bankscope
1.2	<i>LogZscore</i> It is defined as the inverse of the probability of insolvency and is equal to the return on assets plus the capital asset ratio divided by the standard deviation of asset returns. The z-score measure the distance from insolvency (Roy, 1952). We use the natural logarithm of the Z-score which is less skewed and follows the normal distribution. A higher z-score indicates that the bank is more stable	Bankscope
2	<i>Regulatory variables</i>	
2.1	<i>Tier 1 ratio</i> Tier 1 regulatory capital ratio (%) is the core measure of a bank's financial strength from a regulator's point of view. It is composed of core capital, which consists of common stock and disclosed reserves (or retained earnings), but may also include non-redeemable non-cumulative preferred stock	Bankscope (Barth et al., 2001, 2006)
3	<i>Bank specific variables</i>	
3.1	<i>LnTA</i> Bank size : The natural logarithm of total assets	Bankscope
3.2	<i>INSCOV</i> Insurance coverage is defined as the Log (1 + ratio of net insurance/total deposits)	Bankscope Demirguç-Kunt et al. (2008)
3.3	<i>HHI</i> Herfindahl–Hirschman Index is an indicator of competition. It is defined as the sum of the squared shares of bank deposits to total deposits within a given country. Increases in the <i>HHI</i> index generally indicate a decrease in competition and an increase of market power, whereas decreases indicate the opposite	Bankscope
3.4	<i>PROV</i> Loan loss provisions ratio (%) defined as Loan loss provision divided by total loans	Bankscope
3.5	<i>BC</i> Bank capitalization ratio (%) = Total equity divided by total assets	Bankscope
4	<i>Institutional variables</i>	
4.1	<i>PS</i> Indicator that measures the stability of the political environment (political stability)	Kaufmann et al. (2006), WGI
4.2	<i>QR</i> The quality of regulation is an indicator of the quality of banking regulation.	Kaufmann et al. (2006), WGI
5	<i>Macroeconomic variables</i>	
5.1	<i>INF</i> The inflation rate	Bankscope World Development Indicators
5.2	<i>GDP</i> The growth rate of real <i>GDP</i>	Bankscope World Development Indicators

Notes: This table defines different dependent and independent variables used in estimations. Two dependent variables are used to capture bank risk-taking which are: credit risk (*IRISK*) and insolvency risk (*LogZscore*). Bank specific factors include bank size, capitalization, competition, and insurance coverage. *Tier 1 ratio* is included as a regulatory variable. Macroeconomic variables include inflation and *GDP* growth rate. We include political stability and quality of regulation as institutional variables.

This ratio represents risk excess and is denoted by *IRISK*, as follows:

$$IRISK_{i,t} = NPL_{i,t} / GL_{i,t} \tag{1}$$

where $NPL_{i,t}$ and $GL_{i,t}$ denote non-performing loans and gross loans of bank i in period t , respectively. Moreover, the ratio of non-performing loans to gross loans is a commonly measure used in the literature as a proxy for bank default risk (see Covitz, Hancock, & Kwast, 2004). Purnanandam (2007) argued that banks with large non-performing loans face the risk of high probability of default. Consequently, they have more incentives to hedge their interest rates. Then, a high value of non-performing loans is an indicator of quality deterioration of bank loan portfolio. In this situation, banks with bad loan portfolios are increasingly urged to hedge their interest rates which may reduce their subsequent risk of overall failure.

In this paper, we use a second dependent variable, which is given by *Zscore* indicator. This measure of bank risk-taking is used to assess the level of exposure to insolvency risk in financial entities (Blaško & Sinkey, 2006; Boyd, Graham, & Hewitt, 1993; García-Marco & Robles-Fernández, 2008; Hannan & Hanweck, 1988; Konishi & Yasuda, 2004; Nash & Sinkey, 1997). A lower value of *Zscore*, indicates a higher probability of insolvency. This indicator considers risk of failure to be essentially dependant on the interaction of the income generating capacity, the potential size of return shocks, and the level of capital reserves available to absorb sudden shocks (García-Marco & Robles-Fernández, 2008). The *Zscore* is expressed as follows:

$$Zscore_{it} = \left[\frac{\sigma_i (ROA_{it})}{E_i (ROA_{it}) + CAP_{it}} \right]^2 \quad (2)$$

where ROA_{it} is the return on assets of bank i in period t , E_i indicates expected value, σ_i indicates standard deviation, and CAP_{it} is the averaged ratio of equity capital to total assets for the entity i in period t . Recent literature on risk-taking uses extensively the *Zscore* variable (see Konishi and Yasuda (2004); Laeven and Levine (2009); Angkinand and Wihlborg (2010); Houston, Lin, Lin, and Ma (2010); Delis et al. (2011); Forssbæck (2011); Agoraki et al. (2011), among others).

According to García-Marco and Robles-Fernández (2008), the *Zscore* indicator reveals the degree of exposure to operating losses, which reduces capital reserves that could be used to offset adverse shocks. Besides, these authors argue that entities with low capital and a weak financial margin relative to the volatility of their returns will score high on this indicator. This indicator is a measure of weakness or strength of financial institutions since it assigns great importance to their solvency and profitability record. Referring to Laeven and Levine (2009) among others, we use the natural logarithm of the *Zscore* as the insolvency bank risk (*LogZscore*). According to Roy (1952) and Boyd et al. (1993), among others, *Zscore* represents a measure of a bank's distance from insolvency, which is defined as a situation in which losses exceeds equity. A higher *Zscore* level indicates that bank is more stable.

The dependent variables are represented by the insolvency risk (*LogZscore*) and the non-performing loans ratio (*IRISK*). To analyze the effect of bank specific variables, we include bank size (*LnTA*), loan loss provisions ratio (*PROV*), bank capitalization ratio (*BC*), insurance coverage (*INSCOV*), and the bank competition (*HHI*). To assess the effect of bank regulation on bank risk, we use the capital regulatory index (*Tier 1 ratio*). As macroeconomic variables, we use the growth rate (*GDP*) in order to measure the level of economic development. In addition, we use the inflation rate (*INF*) as major macroeconomic determinant. Referring to Kaufmann et al. (2006) and the world government indicators (*WGI*), we use two institutional variables such as political stability (*PS*) measuring the stability of the political environment and the quality of bank regulation (*QR*). This indicator measures the ability of the government to formulate and implement regulations that promote competition in the market and the private sector development.

4. Econometric methodology and empirical model

4.1. Econometric methodology

We recall that dynamic models are characterized by the presence of one or more lagged endogenous variables among the explanatory variables.

The general dynamic panel data model may be expressed as follows:

$$\left\{ \begin{array}{l} y_{i,t} = \sum_{k=1}^p \alpha_k y_{i,(t-k)} + \beta'(L)X_{i,t} + \eta_i + v_{i,t} \\ t = q + 1, \dots, T; i = 1, \dots, N \\ \varepsilon_{i,t} = \eta_i + v_{i,t} \end{array} \right. \quad (3)$$

where the subscripts i and t denote the cross sectional and time dimension of the panel sample, respectively; $y_{i,t}$ indicates individual i observed in period t ; $y_{i,t-k}$ is an observation on the same series for the same individual in the k previous periods; $\beta(L)$ is the $1 \times k$ vector of associated polynomials in the lag operator; $X_{i,t}$ is the $k \times 1$ vector of explanatory variables other than $y_{i,t-k}$; η_i are unobserved individual-specific time-invariant effects which allow for heterogeneity in the means of the $y_{i,t}$ series across individuals; q is the maximum lag length in the model, and $v_{i,t}$ is a disturbance term which is assumed to be independent across individuals.

A general dynamic panel data specification is given by:

$$y_{i,t} = \alpha y_{i,t-1} + \beta(L)X_{i,t} + \eta_i + v_{i,t} \quad (4)$$

with $|\alpha| < 1$, $i = 1, \dots, N$ and $t = 1, \dots, T$.

Equation (4) is estimated using the Generalized Method of Moments (GMM) as proposed by Arellano and Bond (1991) and generalized by Arellano and Bover (1995) and Blundell and Bond (1998). The GMM estimation of Arellano and Bond is based on the first difference transformation of Equation (4) and the subsequent elimination of individual specific effects:

$$\Delta y_{i,t} = y_{i,t} - y_{i,t-1} = \alpha \Delta y_{i,t-1} + \beta(L)\Delta X_{i,t} + \Delta \varepsilon_{i,t} \quad (5)$$

$\forall i = 1, \dots, N; t = 3, \dots, T; |\alpha| < 1$

where Δ is the first difference operator.

In Equation (5), the lagged depended variable, $\Delta y_{i,t-1}$ is by construction correlated with the error term, $\Delta \varepsilon_{i,t}$, imposing a bias in the estimation of the model. Nevertheless, $y_{i,t-2}$, expected to be correlated with $\Delta y_{i,t-1}$ and not correlated with $\Delta \varepsilon_{i,t}$ for $t = 3, \dots, T$, may be used as an instrument in the estimation of Equation (5), given that $\varepsilon_{i,t}$ are not serially correlated. This suggests that lags of order two and more, of the dependent variable verify the following moment conditions:

$$E[y_{i,t-s}\Delta \varepsilon_{i,t}] = 0 \quad (6)$$

$\forall t = 3, \dots, T; \forall s \geq 2$

A second source of bias stems from the possible endogeneity of the explanatory variables and the resulting correlation with the error term. In the case of strictly exogenous variables, all past and future values of the explanatory variable are uncorrelated with the error term, implying the following moment conditions

$$E[X_{i,t-s}\Delta \varepsilon_{i,t}] = 0 \quad (7)$$

$\forall t = 3, \dots, T; \forall s$

The assumption of strict exogeneity is restrictive and invalid in the presence of reverse causality i.e. when $E[X_{i,s}\varepsilon_{i,t}] \neq 0$ for $t < s$. For a set of weakly exogenous or predetermined explanatory variables, only current and lagged values of $X_{i,t}$ are valid instruments and the following moment conditions can be used:

$$E[X_{i,t-s}\Delta \varepsilon_{i,t}] = 0 \quad (8)$$

$\forall t = 3, \dots, T; \forall s \geq 2$

The orthogonality restrictions described in Equations (4)–(8) provide the underpinnings of the one-step GMM estimation, which produces, under the assumption of independent and homoscedastic residuals (both cross sectional and over time), consistent parameter estimates. The two-step GMM estimator (Arellano & Bond, 1991), used to estimate residuals in order to construct a consistent variance–covariance matrix of the moment conditions, may impose a downward (upward) bias on standard errors (*t*-statistics) due to its dependence to the estimated residuals. This situation may lead to unreliable asymptotic statistical inference as argued in Bond and Windmeijer (2002) and Windmeijer (2005). This is particularly true in samples with relatively small cross section dimension (see Arellano & Bond, 1991; Blundell & Bond, 1998).

We test the overall validity of instruments by implementing Sargan specification test, which is asymptotically distributed as chi-square, under the null hypothesis of valid moment conditions (see Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998). Furthermore, we assess the fundamental assumption of serially uncorrelated errors, ε_{it} by testing the hypotheses that $\Delta\varepsilon_{i,t}$ are not second order auto-correlated.

4.2. Estimation method

We adopt a two step dynamic panel data methodology of as proposed by Arellano and Bond (1991); Blundell and Bond (1998). The GMM technique is used to address the issues of endogeneity, heteroskedasticity, autocorrelation in the data and to monitor individual and time specific effects. The main challenge of this research is to find a valid estimation method. The bank risk heterogeneity caused by the economic or social factors may induce biased estimation unless a special estimation technique is used. Reviewed as a whole, the data signal both cross-sectional (different banks) and longitudinal (different years) characteristics. This type of data can be treated as panel data, which is a specific term to describe a set of data consisting of multiple sites, and periodically observed over a certain time frame.

Panel data models have been mainly used in areas of economics and social studies and the techniques of estimating this type of model have been continuously developed by econometrics. One of the advantages of using the panel data model is that it allows cross-sectional heterogeneity, which is common in bank risk-taking industry. The failure to correct the problems of the heterogeneity, which includes the persistence of bank risk industry and the endogeneity, which is a dynamic mechanism of bank risk, may lead to inconsistent coefficients. To deal with these issues, the dynamic panel data (DPD) models are adopted in this paper. By inclusion of a lagged-dependent variable, the panel data models can allow for dynamic effects (Merkl & Stolz, 2009; Salas & Saurina, 2002). To account for the persistence of bank risk industry, this paper introduces lagged-dependent variables, extends panel data model easily to models with predetermined or endogenous explanatory variables or instruments. Specifically, dynamic panel model relies on first-differencing or related transformations to eliminate unobserved individual-specific effects, uses lagged values of endogenous or predetermined variables as instrument variables for subsequent first-differences, and can be expected to perform well in situations where the series are close to be autoregressive.

The panel data approach is preferred to operate a richer and more reliable and robust results by comparing the analysis of time series information. A simple linear regression has drawbacks. It does not take into account the problem of persistence as described by Berger, Bonime, Covitz, and Hancock (2000). To specify whether the instruments are valid, we also adopt the specification test suggested by Blundell and Bond (1998). Mainly, we use the Sargan test of over-identifying restrictions, which examines the validity of the instruments. The Sargan test and the second order autocorrelation test (AR2) are the most important criteria used for the estimation and validation of the instruments. Indeed, the Sargan test verifies the independence between the instruments and the residuals (over-identifying restrictions) of the equation which is an essential condition for the validity of instruments. If the null hypothesis of the Sargan test, for validly over-identifying restrictions, cannot be rejected, then the instrumental variables are valid. On the contrary, if we reject the null

hypothesis, then the instrumental variables are inappropriate. The second test examines the hypothesis that the errors exhibit no second-order serial correlation.

4.3. Empirical model

As explained in previous sections, both the bank credit risk and bank insolvency risk are persistent and dynamic processes, and are related to their previous conditions. The inclusion of historical bank risk (lagged-dependent variables) information allows the model to capture the dynamic trend of its performance and further to improve model accuracy. At first, this paper focuses on estimation methods for the simple $AR(1)$ model:

$$IRISK_{i,t} = \alpha_0 + \alpha_1 IRISK_{i,t-1} + \alpha_2 H_{i,t} + \alpha_3 I_t + \eta_i + v_{i,t}, \quad \forall i, t \quad (9)$$

$$\log(Zscore_{i,t}) = \beta_0 + \beta_1 \text{LogZscore}_{i,t-1} + \beta_2 H_{i,t} + \beta_3 I_t + \eta_i + v_{i,t}, \quad \forall i, t \quad (10)$$

where $IRISK$ is a proxy for the credit risk; α_0 and β_0 are constant; LogZscore is a proxy for bank insolvency risk, respectively, on series for bank i in time t , $IRISK_{i,t-1}$ and $Zscore_{i,t-1}$ denote the one period lagged credit and insolvency risks, $H_{i,t}$ indicates the internal bank factors; I_t are some external bank factors, η_i is an unobserved bank specific time-invariant effect which allows for the heterogeneity in the $IRISK_{i,t}$ series across banks, and $v_{i,t}$ is a disturbance term.

Several empirical studies have used this measure of bank credit risk (Agoraki et al., 2011; Angkinand & Wihlborg, 2010; Brissimis, Delis, & Papanikolaou, 2008; Delis et al., 2011; González, 2005; Louzis et al., 2012). This measure determines the quality of bank assets. The second measure represents a more universal measure of bank risk-taking and reflects the insolvency risk position. A key assumption throughout this paper is that the disturbance $v_{i,t}$ is independent across banks. The number of banks for which data are available (N) is assumed to be large whilst the number of time periods for which data are available (T) is assumed to be small, and asymptotic properties are considered as N becomes large with T fixed.

The individual effect (η_i) is treated as being stochastic, which here implies that it is correlated with the lagged-dependent variables ($IRISK_{i,t}$ and $Zscore_{i,t-1}$) unless the distribution of η_i is degenerate. Initially, this study further assumes that the disturbance ($v_{i,t}$) is serially uncorrelated. These jointly imply that the explanatory variables $IRISK_{i,t-1}$, $Zscore_{i,t-1}$ are positively correlated with the error term ($\eta_i + v_{i,t}$) due to the presence of the individual effects, and this correlation does not vanish as the number of individuals in the sample gets larger. In consideration of the issue of this model, this paper uses the method illustrated in Bond (2002). Besides, following Roodman (2009) suggestion, time dummies are included in this model.

5. Empirical results

In this paper, we find some interesting and consistent findings. Descriptive statistics on the different variables used in this analysis are reported in Tables 3 and 4. We note that the mean $IRISK$ and mean LogZscore are 6.202 and 2.873 (global sample) and 5.914 and 3.167 (south Europe), respectively. The standard deviations are 8.167 and 1.034 (global sample) and 8.387 and 1.111 (south Europe), respectively. Note that the high standard deviations of credit and risk variables indicate the existence of substantial cross-sectional variation in the bank risk levels of European commercial banks. These summary statistics are similar to those reported by Laeven and Levine (2009), in looking at a smaller sample (287 banks in 33 countries). They report a mean LogZscore of 2.85 and a standard deviation of 0.99. The macroeconomic variables (GDP and Inflation rate) reflect both crisis and normal periods. In particular, their minimum and maximum values suggest the volatility of the country's economy during the study period. The same conclusions are observed for the mean $IRISK$ and the mean LogZscore of the East and West banks regions.

Table 3. Summary statistics (Full sample full period)

Variables	Min	Max	Mean	Std. dev	Skewness	Kurtosis
<i>IRISK</i>	0.000	95.900	6.202	8.167	3.820	24.253
<i>LogZscore</i>	-1.275	5.986	2.873	1.034	-0.333	3.516
<i>LnTA</i>	-2.302	14.605	8.917	2.262	0.264	3.122
<i>FP</i>	-0.195	100.000	8.977	6.704	4.589	44.349
<i>PROV</i>	0.000	100.000	178.482	17.716	1.639	6.562
<i>INSCOV</i>	-2.448	346.386	21.256	41.344	3.126	14.420
<i>Tier 1 ratio</i>	3.210	203.700	12.768	10.344	7.392	92.668
<i>GDP</i>	-17.730	11.200	1.332	3.804	-0.868	6.049
<i>HHI</i>	0.000	1.000	0.231	0.316	1.247	3.102
<i>INF</i>	-4.482	15.403	2.795	2.023	2.151	11.980
<i>PS</i>	0.620	0.900	0.737	0.057	0.267	2.501
<i>QR</i>	0.500	1.000	0.898	0.120	-1.666	4.997

Notes: This table presents summary statistics for credit and insolvency risk and bank internal and external factors, respectively. Results are for 280 commercial banks across 26 European countries during full period (2005–2012).

Min: minimum; Max: maximum. The 26 European countries include France (22 banks), Germany (6), United Kingdom (28), Italy (64), Spain (13), Belgium (4), Ireland (6), Finland (2), Greece (13), Cyprus (4), Netherlands (8), Slovenia (8), Lithuania (6), Estonia (4), Austria (6), Portugal (8), Denmark (11), Latvia (7), Sweden (13), Czech Republic (8), Poland (9), Romania (8), Bulgaria (8), Slovakia (8), Hungary (4), and Luxembourg (2).

Empirical results are rather robust as shown in Tables 5–7. We conclude some interesting and consistent findings. Firstly, bank size has a negative and significant effect on credit risk. Indeed, the increase in bank size generates a decrease in credit risk. This result implies that banks with larger sizes are not considered in controlling the insolvency risk in the global sample of European banks. This relationship is similar to that found by Salas and Saurina (2002) and Hu, Li, and Chiu (2004). Salas and Saurina (2002) found a negative relationship between bank size and non-performing loans and argued that bigger size allows for more diversification opportunities. Hu et al. (2004) showed that bank size is negatively related to non performing loans of commercial banks in Taiwan. Besides, bank capitalization has a significant negative effect on credit risk. This result is likely due to the fact that capitalization decisions of European banks are generally based on the credit risk absorption objective (Aggarwal & Jacques, 2001; Murinde & Yaseen, 2004; Rime, 2001; Van Roy, 2003). This finding is similar to that found by Rajan and Dhal (2003) who argued that a high level of capital detention should minimize the probability of bank credit risk.

However, we note a positive impact on the insolvency risk. Indeed, Kanatas and Besanko (1996) and Koehn and Santomero (1980) showed that a high level of capitalization ratio increases insolvency risk. Several recent theoretical studies focus on the effect of competition on bank risk-taking with mixed predictions (see e.g. Allen & Gale, 2000; Boyd & De Nicoló, 2005). The bank competition index (*HHI*) seems to be an important factor in reducing the exposure to credit and insolvency risk. Indeed, this index has a negative but insignificant effect on credit risk. This result is similar to that given provided by Agoraki et al. (2011). Results show that provisions and insurance coverage are associated with a higher level of credit and insolvency risk. This finding is similar to that of Hasan and Wall (2004) who show existence of a positive relationship between non performing loans and provisions for a sample of banks from 24 countries between 1993 and 2000. The positive relationship between insurance coverage and bank risk-taking is consistent with the empirical evidence in Kane (2000), Cull, Senbet, and Sorge (2001), Demirgüç-Kunt and Detragiache (2002) and Laeven (2002).

The coefficients of macroeconomic, regulatory, and institutional variables remain negative and have a significantly impact on credit risk, while those coefficients remain positive and significantly influence the insolvency risk. Some other macroeconomic variables, such as *GDP* growth rate and inflation rate, have a strong negative effect on the level of non-performing loans. Results for East

Table 4. Summary statistics (East Europe and West Europe regions)

Variables	Min	Max	Mean	Std. dev	Skewness	Kurtosis
<i>East Europe</i>						
IRISK	0.070	95.900	9.314	11.657	2.951	14.446
LogZscore	-1.275	4.781	2.666	0.971	-0.224	3.404
LnTA	2.537	10.641	8.079	1.296	-0.312	3.142
FP	-0.195	25.744	9.578	3.498	1.308	6.010
PROV	-0.653	187.209	13.046	11.301	12.527	181.388
INSCOV	0.002	132.677	0.151	17.536	2.713	12.945
Tier 1 ratio	4.600	84.860	2.083	9.020	5.135	34.867
GDP	-17.730	11.200	2.945	5.478	-1.501	5.795
HHI	0.000	0.999	4.299	0.244	2.027	6.375
INF	-1.083	15.403	0.745	2.967	1.296	4.931
PS	0.640	0.850	0.857	0.043	0.428	2.807
QR	0.500	1.000	0.867	0.107	-1.199	3.832
<i>West Europe</i>						
IRISK	0.000	65.750	4.976	6.070	3.589	22.287
LogZscore	-1.107	5.987	2.910	1.052	-0.393	3.569
LnTA	-2.303	14.605	9.214	2.453	0.049	2.775
FP	0.354	100.000	8.766	7.518	4.440	38.486
PROV	-30.846	194,940.200	241.613	5,686.806	30.431	1,002.744
INSCOV	-2.448	346.387	24.687	46.540	2.738	11.295
Tier 1 ratio	3.210	203.700	12.755	10.769	7.816	101.116
GDP	-6.906	7.800	0.737	2.759	-0.791	3.295
HHI	0.000	1.000	0.263	0.336	1.028	2.515
INF	-4.482	4.928	2.254	1.131	-0.910	7.095
PS	0.620	0.900	0.734	0.061	0.316	2.351
QR	0.500	1.000	0.913	0.120	-1.972	5.964

Notes: This table presents summary statistics for credit and insolvency risk and bank internal and external factors, respectively. Results are for East Europe and West Europe regions.

Min: minimum; Max: maximum. The East European countries include Romania (8), Lithuania (6), Latvia (7), Bulgaria (8), Estonia (4), Hungary (4), Poland (9), Czech Republic (8), Slovakia (8), Slovenia (8), and Cyprus (4). The West European countries include Greece (13), Spain (13), Italy (64), Portugal (8), France (22), Germany (6), United Kingdom (28), Belgium (4), Ireland (6), Finland (2), Netherlands (8), Estonia (4), Austria (6), Denmark (11), Sweden (13), Czech Republic (8), Poland (9), and Luxembourg (2).

European and West European samples are reported in Tables 6 and 7. We conclude that determinants of bank risk-taking behavior are similar for both East European and West European regions in part the Peripheral countries. There is a considerable and significant impact of both internal and external bank determinants on bank risk excess. This result can be explained by the emergence of financial crisis which has influenced the banking stability and has generated a high level of bank risk, especially in the European banking industry

A large shank of literature dealing analyzing bank risk highlights the importance of external environment and especially macroeconomic and institutional environment to explain the bank risk excess. Also, recent financial crisis has generated renewed interest into how the institutional environment and regulatory environment influence bank risk-taking. Therefore, there is widespread interest in understanding these factors. As it is expected, bank regulatory variables have a significant effect on bank risk-taking which is consistent with previous studies (Demirgüç-Kunt & Detragiache, 2002).

Table 5. GMM system estimation results (Global sample)

	<i>IRISK</i>		<i>LogZscore</i>	
	Estimate	p-value	Estimate	p-value
<i>IRISK</i> _{t-1}	0.855***	0.000		
<i>LogZscore</i> _{t-1}			0.510***	0.000
<i>LnTA</i>	-0.869**	0.027	0.064*	0.094
<i>FP</i>	-0.090**	0.054	0.059***	0.000
<i>PROV</i>	0.000	0.682	0.000***	0.000
<i>INSCOV</i>	0.005	0.420	0.001**	0.023
<i>Tier1 ratio</i>	-0.019*	0.070	0.007**	0.045
<i>GDP</i>	-0.220***	0.000	0.006***	0.001
<i>HHI</i>	-0.961	0.376	-0.059	0.532
<i>INF</i>	-0.113**	0.017	-0.016***	0.000
<i>PS</i>	-11.315***	0.000	0.552***	0.007
<i>QR</i>	-2.014***	0.003	0.118*	0.072
Constant	21.182***	0.000	-0.204	0.604
Sargan test	34.110	0.581	46.593	0.741
AR(1) test	-2.874	0.024	-4.049	0.055
AR(2) test	-1.060	0.289	-0.862	0.389

Notes: Dependent variable is bank risk: *IRISK* and *LogZscore*, respectively. Estimation method is the two-step GMM dynamic panel estimator. The null hypothesis of the Sargan test is that the instruments used are not correlated with residuals (over-identifying restrictions). The null hypothesis of the serial correlation test is that the errors exhibit no second-order serial correlation. Independent variables are bank size (*LnTA*), bank capitalization (*FP*), insurance coverage (*INSCOV*), *Tier 1 ratio*, competition (*HHI*), growth rate (*GDP*), inflation rate (*INF*), political stability (*PS*) and quality of regulation (*QR*). The East European countries include Romania (8), Lithuania (6), Latvia (7), Bulgaria (8), Estonia (4), Hungary (4), Poland (9), Czech Republic (8), Slovakia (8), Slovenia (8), and Cyprus (4).

- *Significance at the 10% level.
- **Significance at the 5% level.
- ***Significance at the 1% level.

For all macroeconomic variables, the estimated coefficients are statistically significant and have the expected sign compatible with the theoretical arguments surveyed in section (2). The coefficients of macroeconomic, regulatory, and institutional variables remain negative and significantly impact on credit risk, while coefficients of these variables remain positive and significant effect on the insolvency risk. As the crisis worsens in the period after 2007, the environment stability is compromised. Results indicate that there is an insignificant impact of the most control and external variables on the insolvency risk. Note that only capitalization, provisions, and quality of regulation have significant effect on this category of risks. This finding means that a higher (lower) level of provisions generates higher (lower) level of insolvency risk (Hasan & Wall, 2004). By estimating the impact of regulatory factors on bank risk such as *Tier 1 ratio*, we note the existence of a variation in the coefficients according to the region and the risk measure. The *GDP* growth and inflation rates have a significantly negative impact on the credit risk. In this vein, a higher *GDP* growth rate lowers credit risk and increases bank soundness.

The relationship between political stability and credit risk as well as between quality regulation and credit risk is positive and highly statistically significant, which means that a strong institutional environment generates higher bank risk excess. Results in Table 2 show that both inflation and *GDP* variables have a significant impact on bank risk-taking excess. First, there is a negative and significant relationship between inflation and the two measures of bank risk-taking. This result contradicts those of Demirguç-Kunt and Detragiache (2005), Jimenez, Ongena, Peydro and Saurina (2008) and Ioannidou et al. (2009). Nonetheless, the *GDP* growth rate is positively and significantly related to

Table 6. GMM system estimation results (East Europe)

	<i>IRISK</i>		<i>LogZscore</i>	
	Estimate	p-value	Estimate	p-value
<i>IRISK</i> _{t-1}	0.698***	0.000		
<i>LogZscore</i> _{t-1}			0.459***	0.000
<i>LnTA</i>	-3.533***	0.000	0.072*	0.061
<i>FP</i>	-0.039	0.783	0.101***	0.000
<i>PROV</i>	0.006	0.548	0.000	0.910
<i>INSCOV</i>	0.065**	0.010	-0.006***	0.000
<i>Tier1 ratio</i>	0.358***	0.000	0.011**	0.019
<i>GDP</i>	-0.239***	0.000	0.011***	0.000
<i>HHI</i>	-1.487	0.582	-0.171	0.108
<i>INF</i>	-0.183***	0.000	0.001	0.724
<i>PS</i>	18.289***	0.002	0.122	0.758
<i>QR</i>	-2.885**	0.058	0.661***	0.000
<i>Constant</i>	19.422**	0.018	-0.873*	0.088
<i>Sargan test</i>	36.519	0.910	28.456	0.751
<i>AR(1) test</i>	-1.672	0.095	-1.846	0.065
<i>AR(2) test</i>	0.162	0.872	1.057	0.291

Notes: Dependent variable is bank risk: *IRISK* and *LogZscore*, respectively. Estimation method is the two-step GMM dynamic panel estimator. The null hypothesis of the Sargan test is that the instruments used are not correlated with residuals (over-identifying restrictions). The null hypothesis of the serial correlation test is that the errors exhibit no second-order serial correlation. Independent variables are bank size (*LnTA*), bank capitalization (*FP*), insurance coverage (*INSCOV*), *Tier 1 ratio*, competition (*HHI*), growth rate (*GDP*), inflation rate (*INF*), political stability (*PS*), and quality of regulation (*QR*). The East European countries include Romania (8), Lithuania (6), Latvia (7), Bulgaria (8), Estonia (4), Hungary (4), Poland (9), Czech Republic (8), Slovakia (8), Slovenia (8), and Cyprus (4).

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

both credit and insolvency risks. This means that banks tend to substantially increase their risky assets during the economic booming periods.

The results confirm our findings that stronger macroeconomic and institutional environment induce more bank insolvency risk-taking and reducing bank credit risk-taking. We conclude that bank specific factors such as Bank size (*LnTA*), bank competition (*HHI*), and bank capitalization (*BC*) are significant and related negatively to credit risk. This means that low values of all these variables leads to an increase in credit risk-taking. In this line of research, Salas and Saurina (2002) found a negative relationship between bank size and non-performing loans and argue that bigger size allows for more diversification opportunities. Rajan and Dhal (2003) report similar empirical evidence. Indeed, a high level of capital detention should minimize the probability of bank credit risk.

Moreover, we show that macroeconomic variables, specifically real *GDP* growth rate and inflation rate, have a strong effect and are related negatively to the level of non-performing loans. This data grouping does not provide information on the existence or not of a regional differential in bank risk-taking behavior. Thus, the global analysis assumes the existence of a typical behavior and omit country differences. In the Euro area, monetary policy rates are identical across countries. However, there are significant differences in terms of *GDP* and inflation rate. In this research, we propose a data regional disaggregation in order to analyze regional differences in terms of bank risk attitudes. Statistically, we subdivide our sample into two sub-samples: East Europe and West Europe.

Table 7. GMM system estimation results (West Europe)

	IRISK		LogZscore	
	Estimate	p-value	Estimate	p-value
$IRISK_{t-1}$	0.844***	0.000		
$LogZscore_{t-1}$			0.501***	0.000
<i>LnTA</i>	-0.634**	0.014	0.027	0.497
<i>FP</i>	-0.085**	0.011	0.055***	0.000
<i>PROV</i>	0.000*	0.070	0.000***	0.000
<i>INSCOV</i>	-0.002	0.712	0.001**	0.015
<i>Tier1 ratio</i>	-0.009	0.486	0.005	0.105
<i>HHI</i>	-0.773	0.329	-0.042	0.625
<i>GDP</i>	-0.195***	0.000	0.007***	0.001
<i>INF</i>	-0.034	0.393	-0.034***	0.000
<i>PS</i>	-12.480***	0.000	0.471**	0.031
<i>QR</i>	-2.554***	0.000	0.007	0.918
Constant	19.841***	0.000	0.414	0.326
Sargan test	22.534	0.259	27.985	0.084
AR(1) test	-2.396	0.017	-3.680	0.012
AR(2) test	-1.014	0.311	-1.419	0.560

Notes: Dependent variable is bank risk: *IRISK* and *LogZscore*, respectively. Estimation method is the two-step GMM dynamic panel estimator. The null hypothesis of the Sargan test is that the instruments used are not correlated with residuals (over-identifying restrictions). The null hypothesis of the serial correlation test is that the errors exhibit no second-order serial correlation. Independent variables are bank size (*LnTA*), bank capitalization (*FP*), insurance coverage (*INSCOV*), *Tier 1 ratio*, competition (*HHI*), growth rate (*GDP*), inflation rate (*INF*), political stability (*PS*), and quality of regulation (*QR*). The West European countries include Greece (13), Spain (13), Italy (64), Portugal (8), France (22), Germany (6), United Kingdom (28), Belgium (4), Ireland (6), Finland (2), Netherlands (8), Estonia (4), Austria (6), Denmark (11), Sweden (13), Czech Republic (8), Poland (9), and Luxembourg (2).

- *Significance at the 10% level.
- **Significance at the 5% level.
- ***Significance at the 1% level.

As it is shown in Tables 6 and 7 related to the East Europe and West Europe samples results, we show the same findings as for global sample. We conclude that determinants of bank risk-taking behavior are similar both for East Europe and West Europe. There is a considerable and significant impact of both internal and external bank determinants on bank risk excess. While, macroeconomic and institutional environment play a significant and a strong effect on bank risk. This result can be explained by the emergence of financial crisis during the studied period which influenced banking stability and generates a high bank risk level of financial institutions in the world and especially in the European banking industry.

Results indicate that there is a strong and significant link between bank risk-taking and variables measuring external environment. Tables clearly indicate that both strength institutional and regulatory variables have a profound effect on the level of bank risk-taking. Indeed, we show a negative and significant coefficients of institutional variable (*QR*) which provides information on the quality of banking regulation which means that banks are less exposed to risk excess facing a good banking regulatory quality.

6. Conclusion

Our analysis aims to explore and analyze the fundamental determinants of bank risk-taking behavior in the European banking industry. This research explores how bank internal and external factors influence the level of European bank risk-taking. We use a dynamic panel data approach in a two-step system GMM as proposed by Blundell and Bond (1998). The results found are estimated using heteroskedasticity robust standard errors. We have looked at a sample of 280 banks in 26 European

countries during 2005 to 2012 and using lagged values as instruments. Results suggest that the estimated relationship between different internal and external factors and bank risk-taking are robust. Nonetheless, the results may be heavily influenced by the structure of the banking industry characterized by large size banks. We point out that, bank capitalization and bank size have negative and significant effects on insolvency risk. In addition, a large size of bank minimizes credit risk.

Also, we find that a more competitive environment help banks to diversify and to face low level of bank credit risk, meaning that competition has a negative effect on risk-taking excess. Consequently, most bank specific variables, used in this study, have a significant impact on the whole sample of European bank risk-taking.

Macroeconomic variables (GDP growth rate and inflation rate) have a strong effect on the non-performing loans ratio (see e.g. Barrell et al., 2010; Laeven & Levine, 2009).

By subdividing the whole sample into two sub-samples (East Europe, West Europe; Peripheral countries), we take into account regional differences in terms of bank risk-taking behavior. Results indicate that the impact of bank specific factors differs from one region to another. This may be explained by differences in levels of bank regulation, size of the economy, institutional environment, and financial situation. Specifically, estimation results indicate that the coefficients of macroeconomic variables are fairly stable across different regions. Again, results regarding bank risk-taking are robust for both macro- and micro-measures, and the external environment seems to influence the bank risk-taking excess.

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