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THE FUNDAMENTAL DETERMINANTS OF BANK DEFAULT FOR EUROPEAN COMMERCIAL BANKS

Wiem Ben Jabra
Department of Management University of Sousse, Tunisia
Laboratoire de Recherche en Economie, Management et Finance Quantitative (LAREMFQ)

ABSTRACT

Using the binomial Logit model on Panel data estimated over 2000–2019 on around 280 European commercial banks, the current paper attempted to examine the determinants of bank default in the context of the current financial crisis. The main objective was to investigate the potential effect of both CAMEL variables (capital adequacy, asset quality, management quality, earnings and liquidity), macroeconomic and institutional environment on the default of European commercial banks. To illustrate the impact of financial crisis, we subdivided the full period into before and during crisis period. Our results indicate the extent to which bank default in the European banking system can be explained not only by CAMEL variables but also by the GDP and SLR variables which are related to both macroeconomic and institutional environments.

KEYWORDS: Bank default, European banking industry, CAMEL variables, macroeconomic and institutional environment, financial crisis, binomial Logit model
JEL classification: G23; G21; C23; C33.

1. INTRODUCTION

The succession of financial crises can be largely explained by the financial liberalization, the bank risk taking excess and financial regulations. Indeed, the global financial crisis clearly indicates the need of understanding the bank default determinants of. Furthermore, investigating the factors underlying the bank default is of a significant importance for regulatory authorities who are seeking financial stability and effective banks' management. Indeed, Cihak and Poghosyan (2009) showed that an important centralization of the banking regulation in the European Union generates an increase of bank defaults. Furthermore, studies on the determinants of bank default in the European countries are still scarce. The pioneer study was achieved by Beaver (1966) and Altman (1968). They empirically identified the main factors of banking problems in the European countries.

The literature has signaled the fact that some specific characteristics of banks are linked to bank default. Thus, several studies showed that the bank default is expected to be proxies by the CAMEL[1] variables (Capital adequacy, Asset quality, Management quality, Earnings and Liquidity).

[1]CAMEL variables include: C: Capital adequacy; A: Asset quality; M: Management quality; E: Earnings; L: Liquidity.

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Working on a sample of US commercial banks, Kolari et al. (2000) and Estrella and Prestiani (2000) showed that these variables are the main factors of bank default. In the same vein, Laviola et al. (1999), Logan (2001), Agoraki et al. (2011), Haselmann and Wachtel (2007; 2010) Juurikkala et al. (2011) conducted a study on the Italian, English, Russian and CEE banking systems, respectively, and confirmed the same findings. However, they have not examined the impact of the macroeconomic and institutional environment on bank defaults.

The current paper dealt with the bank default from three viewpoints. First, unlike the majority of previous studies which focus on bank default, the present study investigated the factors determining bank default, namely CAMEL variables, macroeconomic and institutional variables. Therefore, our aim was to account for the macroeconomic and institutional environment and main banking factors (CAMEL variables) affecting banks default. Second, we considered the European banking system as a benchmark for our study of this default. We focused on the Eurozone because these countries have to coordinate their economic and fiscal policies closely because the recent financial crisis had important impact on the structure and profitability of banks.

Indeed, an improved understanding of the European determinants of bank defaults is important for regulators and supervisors as well as the financial market participants such as borrowers and shareholders.

Finally, the present study emphasized two types of variables: the CAMEL and macroeconomic and institutional variables. Methodologically, referring to Arenas' (2008) baseline model indicating the CAMEL variables only, we examined the extent to which the addition of the macroeconomic and institutional variables contributes to the explanatory power of the model. The focus on external determinants goes hand in hand with hypotheses already displayed in the literature. Assuming that the fundamental determinants of bank default are made up of CAMEL variables, this approach allows the isolation of macroeconomic environment features as they have an effect on bank default.

The present paper adopted a panel data set comprising 280 European commercial banks over 2000 – 2019 period. We analyzed the effect of the recent global financial crisis by subdividing the entire sample period into two subsamples: pre-crisis period (2000–2006) and during crisis period (2007–2019). This paper extends on the studies of the literature in several ways. First, our study involved several factors that were not previously considered using European data.

Second, we achieved two other contributions: First, we estimated our baseline model only by the CAMEL variables. Second, we analyzed whether the incorporation of the macroeconomic and institutional variables affects the bank default. Third, we examined whether our basic results change when we subdivide the analysis period (2000-2019) into pre- crisis period (2000-2006) and while

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crisis period (2007-2019) to include the recent global financial crisis.

The rest of the paper is structured as follows. Section 2 provided a selective review of previous theoretical and empirical literature. Section 3 described the econometric modeling and data. Section 4 detailed the estimation results and section 5 revealed our main deduced conclusions.

2. Literature review and research hypotheses

Heffernan (2003) once stated that bank default is explained by specific and macroeconomic bank factors, which are specifically the CAMEL variables. However, there are mixed results about the significance of external variables used to explain bank default.

2.1. Internal factors: CAMEL variables

Wheelock and Wilson (2000) analyzed the factors that may affect the bank default, particularly in the United States. They used the "competing-risks hazard" and "time-varying covariates" models. They found that banks with low capitalization, poor loan portfolios quality and low profits have a higher default risk. Bongini et al. (2000) found that the ratio of loan loss reserves to capital and the loan growth rate are the important predictors of defaults and crises of East Asia. The behavior and management capacity importance for the banks survival were also highlighted by Pifer and Meyer (1970) and Wheelock and Wilson (2000).

2.1.1. Capital

The recent credit crisis highlights the importance of better understanding the determinants of bank difficulties in an environment where the bank capital is very low (Festic et al. 2011). The capital is of great importance in financial institutions. Berger (1995) explained this role by analyzing the evolution of the capital ratio in the United States. A capital-related standard is essential for the regulatory authorities to distinguish between troubled and sound banks. Therefore, a capital regulatory reform is required due to the difficulties faced by banks. The role of bank capital is increasing in most countries with the adoption of the Basel Accords in 1988.Karlyn (1984) defines the capital adequacy in terms of capital-deposit ratio because the primary risk is depository derived from the sudden and considerably large scale of deposit withdrawals. Indeed, the results on the relationship between bank capital and bank default are mixed. Kim and Santomero (1988) showed that the equity to total assets ratio may increase or decrease the default of banks. Catanach and Perry (1996) showed the importance of the equity to total assets ratio to predict defaults of American savings (Savings and Loans). Therefore, Martin (1977), Lane et al. (1986), Keeley and Furlong (1989; 1990), Thomson (1992), Bongini et al. (2000) and Estrella et al. (2000) found that bank capital is assumed to be a good and significant indicator of a bank default. However, Kim and Santomero (1988) and Rochet (1992) concluded that the introduction of capital constraint may increase the probability of bank's default. Sheldon (1995) found that a high level of capital for 479 Swiss banks over 1987-1993 period increased

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their difficulties. However, Boyd and Graham (1988) found opposite results. Bichsel and Blum (2004) studied the bank default of 19 Swiss banks during the 1990-2002 period and concluded that bank capital has no effect.

2.1.2. Asset quality

Bank asset quality is considered important in determining banks difficulties. According to Grier (2007) "poor asset quality is the major cause of most bank failures". The most important asset category is the loan portfolio; the greatest risk facing the bank is the risk of loan losses derived from the delinquent loans. The credit analyst should carry out the asset quality assessment by performing the credit risk management and evaluating the loan portfolio quality using a trend analysis and peer comparison. Among the asset quality indicators, we can cite the financial ratios of credit, since most banks' activities consist of credits. Frost (2004) stressed that the asset quality indicators highlight the use of nonperforming loans ratios (NPLs) which are the asset quality proxy, and the allowance or provision to loan losses reserve. Demirguc-Kunt (1989) and Barr and Siems (1994) suggest that asset quality is a key and significant factor of bank difficulties. Thomson (1991) and Wheelock and Wilson (2000) showed that a low quality of bank assets increases the probability of bank default. As for Gonzalez-Hermosillo et al. (1997), they considered that the credit risk ratio increases a bank default and consequently minimizes the possibility of survival. A more practical analysis of the various determinants of excessive risk-taking by the bank led to the establishment of the bank default model, which aim was to distinguish between sound and troubled banks. This was archived either the Multivariate Discriminant Analysis (ADM) (Sinkey 1975 and Altman et al. 1977) or the logistic approach (Martin 1977). Some observers note that credit expansion is strongly associated with banking crises (Gavin and Hausman, 1996; Hardy and Pazarbasioglu, 1998; Kaminsky and Reinhart, 1999 and Demirguc-Kunt and Detragiache, 1998). Pantalone and Platt (1987), Powo (1997) and Llewellyn (2002) showed that the excessive risk-taking is the main cause of bank defaults.

2.1.3. Management quality

The role of management quality to explain the soundness of banks is well documented in several studies (Pifer and Meyer 1970 and Wheelock and Wilson 2000). The bank management has clear strategies and goals in directing the bank's domestic and international business, and monitoring the collection of financial ratios consistent with management strategies. Management quality is basically the capability of the board of directors and management, to identify, measure, and control the risks of an institution activities and to ensure the safe, sound, and efficient operation in compliance with applicable laws and regulations (Uniform Financial Institutions Rating System 1997)

Grier (2007) suggested that management is considered to be the single most important element in the CAMEL rating system because it plays a substantial role in a bank's success. Banks are well managed if they perform well and are less exposed to risk. Thomson (1991) showed that bank management

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affects the probability of bank default using the bank credit to directors and employees to total assets ratio. Barr et al. (1994) suggested that a bad management quality is positively and significantly related to bank failure. The importance of the management behavior and capability to the survival of banks has also been emphasized (Meyer and Pifer1970; Wheelock and Wilson 2000).

2.1.4. Earning

According to Grier's (2007) opinion, a consistent profit not only builds the public confidence in the bank but also absorbs loan losses and provides sufficient provisions. It is either for necessary a balanced financial structure and helps provide reward to shareholders. Thus, consistently healthy earnings are essential to the sustainability of banking institutions. Profitability ratios measure the ability of a company to generate profits from revenue and assets. Profitability is regarded as a prior measure of asset risk and is assumed to be negatively related to bank default. Thomson (1991) and Gonzalez Hermosillo et al. (1997), Bongini et al. (2000) and Wheelock (2000) highlighted an important relationship between earnings and the probability of bank defaults. They used the return on assets (ROA) as the most significant indicator of bank profitability. They argued that high profitability in terms of ROA decreased the probability of bank default. In addition, the source as well as amounts of banks' earnings (Wheelock and Wilson 2000; Martin 1977; Thomson 1992; Bongini et al.2000) have been shown to be significant to the probability of bank default.

2.1.5. Liquidity

An adequate level of liquidity is crucial for financial institutions because they try to diversify their portfolios and / or increase their liquid assets to reduce their risks. There should be adequacy of liquidity sources compared to present and future needs, and availability of assets readily convertible to cask without undue loss. The fund management practices should ensure that an institution is able to maintain a sufficient level of liquidity to meet its financial obligations in a timely manner, and to be capable of quickly liquidating assets with minimal losses. (Uniform Financial Institutions Rating System 1997)

Logan (2001) showed that a high level of liquidity reduced the probability of default. This result is similar to Wheelock and Wilson's (2000) findings. Arena (2008) showed that the high ratio of liquid assets to total assets generates a low probability of default bank in Latin America and East Asia. In addition, Lane et al. (1986) and Bell et al. (1990) showed a negative relationship between liquidity and bank default.

Rudolf (2009) emphasizes that "the liquidity expresses the degree to which a bank is capable of fulfilling its respective obligations". Banks make money by mobilizing short-term deposits at lower interest rate, and lending or investing these funds in long term at higher rates, so it is hazardous for banks to mismatch their lending interest rates. Similarly, Lane et al. (1986); Bell et al. (1990) showed

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that bank default has been shown to be significantly greater when a bank is illiquid.

Table 1

H1: *The European Bank default is explained by CAMEL variables.*

2.2.External determinants

In this sub-section, we discussed the external factors which may affect the bank default. These factors are related to macroeconomic and institutional environments.

2.2.1. Macroeconomic and institutional environments

Rojas-Suarez (1998) and Bonjini et al. (2000) found that bank defaults of developing countries increase with macroeconomic shocks. King et al. (2006) showed that bank defaults are related to GDP growth and inflation rate. The results of previous studies on the roles of these variables are mixed. On the one hand, favorable conditions may help banks to achieve good results. On the other hand, economic growth may encourage banks to invest in very risky assets, which increases their risk of default.

A high growth rate is associated to a high probability of default. Indeed, a period of stability generates a high level of capital of banks due to low costs of capital on the financial market. However, a period of financial distress causes the absorption of capital by losses and an excessive risk undertaken by banks. Arena (2008) studied the impact of economic growth (measured by the GDP variable) as a macroeconomic indicator on the probability of bank default. They concluded that it significantly reduced the bank default of 300 banks in 17 countries of Central and Eastern Europe. Männasoo and Mayes (2005) showed a significant role of GDP growth in reducing the probability of insolvency and distress of banks. Other macroeconomic factors are used in the literature such as the real interest rate (Gonzalez- Hermosillo et al. 1997) and the exchange rates volatility (Arena, 2008). Caprio and Klingebiel (2003) found that a high level of inflation affects the solvency of banks and leads to bank default.

Demirguc-Kunt and Detragiache (1998) studied the determinants of bank defaults in the world between 1980 and 1994 using the Logit model. They found that bank defaults are more important in countries with a low GDP growth rate, high levels of real interest and inflation rates and presence of an explicit deposit insurance system. Institutional factors also have an important impact on bank defaults. Indeed, Rodrik et al. (2002; 2003) highlighted the role ofthe institutional environment on detecting bank defaults. However, Mehrez and Kaufmann (2000) argued that the financial liberalization is a major factor of bank default probabilities.

H2*: The European Bank default is justified by the macroeconomic and institutional environments.*

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After reviewing the macroeconomic determinants and the main CAMEL variables as determinants of bank default, it sounds interesting to empirically validate our hypotheses in the case of the European banking system.

3. Econometric modeling and Data

In this section we discussed the econometric methodology and data separately.

3.1.Data

The data set consists of panel dataset from Bankscope. Our work focused on 26 European countries[2] and 280 commercial banks over the period spanning from 2000 to 2019. Indeed, we used information collected from the World Bank database on banking regulation (Barth et al. 2001; 2006). Besides, Kaufmanns indicators (Kaufmann et al, 2006) and the world government indicators (WGI) were used to control for macroeconomic and institutional factors that might affect the European bank defaults. We subdivided the full period into pre- crisis period (2000-2006) and while-crisis period (2007-2019).

3.2.Empirical model

To estimate the European bank default determinants, we introduced two components of the macroeconomic and institutional environments. We considered a simple dichotomous model in which the dependent variable takes a value of 0 or 1.

The endogenous variable in our study is the bank default (DIF), we estimated the probability of a bank default (undercapitalized banks) using a binomial Logit model on panel data.
The model can be specified as follows:

[2]The 26 selected European countries and their corresponding number of banks (in parentheses) include France (22), Germany (10), United Kingdom (28), Italy (64), Spain (13), Belgium (4), Ireland (6), Finland (2), Greece (11), 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).

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$$DIF_{i,t} = \alpha + \beta y_{i,t} + \varepsilon_{i,t} \forall i, t \ (\mathbf{3.16})$$

$$P(DIF) = \frac{\exp^{w}}{1 + \exp^{w}} \qquad (\mathbf{3.17})$$

with

$$w = \alpha + \beta y_{i,t} + \varepsilon_{i,t} \forall i, t (\mathbf{3.18})$$

Where*i* represents banks (1,…,280) ;$y_i$denotes independent variables (i.e., CAMELvariables, macroeconomic and institutional variables);

(C) represents the Capital adequacy,

(A) represents the quality of bank assets

(M) indicates the quality of bank management

(E) indicates the bank profitability

(L) represents the exposure of bank to liquidity risk

The Macroeconomic variable is the gross domestic product as an indicator of a country'seconomic growth (GDP);

The Institutional variable is the legal rights strength index (SLR).

t represents period (2000,…,2019);

α denotes the constant and the residue$\varepsilon_i$has a logistic distribution which mean is0and variance is $\frac{\pi^2}{3}$.

a. Dependent Variables

The dependent variable of bank default (DIF) takes a value of:

- 1 if the bank i is undercapitalized (bank default) at year t, in other words if the capital to total assets ratio is ≤8% (the regulatory capital ratio);
- 0 if the bank i is sound or well-capitalized at year t, if the capital to total assets ratio is >8% (the regulatory capital ratio).

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We used this ratio to show that bank default is essentially based on the importance of capital regulation. Indeed, to protect banks against the insolvency and default risk, they must have a minimum reserve of equity which is a guarantee to progress normally and practice different bank activities. Estrella et al. (2000) showed that several ratios are used to predict bank default such as the capital to income ratio. Generally, the regulatory ratio set by the Basel I accords is 4%. Kolari et al. (2000) used the EWS (Early Warning System) model and the regulatory capital ratio of 5.5% to distinguish between "well-capitalized" and "undercapitalized" US banks. Furthermore, banks have to maintain a level of capital that allows them to protect themselves against risk and unexpected losses. The Basel Accord sets a capital levels> 8% for financial institutions (Cooke ratio: the international ratio of solvability).Regulators in several countries intend to implement the new agreement (Basel II). Several credit institutions in the European Union adopted Basel II in the beginning of 2008.Martin (1977), Lane et al. (1986), Thomson (1992), Bongini et al. (2000) and Estrella et al. (2000) argued that capital measures are significant indicators to absorb losses caused by external shocks. They showed that banks would survived if they had a high equity level. This result is confirmed by Lanine and Vennet (2006) for the Russian banking sector. However, Wheelock and Wilson (2000) concluded that a low capital level generates bank soundness.

b. Independent variables

Reeling of Arena (2008), the bank default (DIF) is explained by CAMEL variables, macroeconomic variables (GDP) and institutional variables (SLR). Demirguç-Kunt (1989) and Barr and Siems (1994) used the early warning models and indicated only the CAMEL variables. Then, we examined the extent to which the addition of macroeconomic and institutional variables contributes to the explanatory power of the model.

- **Internal factors: CAMEL variables**

Capital Adequacy Rating(C): represents the Capital adequacy proxied by the equity to total assets ratio (EQ).

Each of the CAMEL model components I was scored from 1 to 5. In the context of capital adequacy, a rating of 1 indicates a strong capital level relative to the financial institution's risk. Meanwhile, the rating of 5 indicates a critical deficient capital level, in which immediate assistance from shareholders or external resources is required. (Uniform Financial Institutions Rating System, 1997)

Asset Quality Rating (A): represents the quality of bank assets proxied by loan loss provisions (LLP) and bank credit risk (IRISK);

Each of the components in the CAMEL rating system is scored from 1 to 5. In the context of asset quality, a rating of 1 indicates a strong asset quality and minimal portfolio risks. On the other hand, a rating of 5 reflects a critically deficient asset quality that presents an imminent threat to the institution viability. (Uniform Financial Institutions Rating System 1997)

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Management Rating (M): indicates the quality of bank management proxied by loans to deposits and short term funding ratio (LDSTF);

Each of components in the CAMEL rating system is scored from 1 to 5. In the context of management, a rating of 1 is assigned to note that the management and board of directors are fully effective. On the other hand, the rating of 5 is applicable to a critically deficient management. Replacing or strengthening may be needed to achieve sound and safe operations. (Uniform Financial Institutions Rating System 1997)

Earning Ability Rating (E): indicates the bank profitability proxied by the return on assets ratio (ROA), the return on equity ratio (ROE) and the net interest margin ratio (NIM); Each of the components in the CAMEL rating system is scored from 1 to 5. In the context of earning, a rating of 1 reflects strong earnings that are sufficient to maintain adequate capital and loan allowance, and support operations. On the other hand, a rating of 5 indicates consistent losses and a distinct threats to the institution's solvency through the erosion of capital. (Uniform Financial Institutions Rating System 1997)

Liquidity Rating (L): represents the exposure of bank to liquidity risk proxied by liquid assets to total assets ratio (LIQASS);

Each of the components in the CAMEL rating system is scored from 1 to 5. In the context of liquidity, a rating of 1 represents strong liquidity levels and well-developed funds as the institution has access to sufficient sources of funds to meet present and anticipated liquidity needs. On the other hand, the rating of 5 signifies critical liquidity deficiency, and the institution requires immediate external assistance to meet liquidity needs. (Uniform Financial Institutions Rating System 1997).

- External determinants

Macroeconomic variable: The Macroeconomic variable is the gross domestic product as an indicator of a country's economic growth (GDP);
Institutional environment: The Institutional variable is the legal rights strength index (SLR). It measures the legal system efficiency and ranges between 0 and 10. It should be noted that the high value indicates that the country laws are favorable to increase bank credit access;

4. Empirical findings

In order to study the determinants of the European bank default, on the one hand, we first investigated the impact of the financial crisis by separating the time-span into two sub- periods: pre- and while-crisis; then, we analyzed the impact of the CAMEL as well as the macroeconomic and institutional variables on this default. We adopted the binomial Logit model on the Panel data as developed by Martin (1977). The descriptive statistics on the different used variables in this analysis are reported in

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Table 4. We note that the high standard deviations of bank default (0.061) before the crisis (2000-2006) compared to (0.023) during the crisis period (2007-2019) indicate the existence of substantial cross-sectional variation in the European commercial banks default levels he. This result confirms the high number of bank defaults in 2007 year (see Table 2), caused by the extent of the financial crisis and its effect on banks stability. Table 5 presents the correlation matrix of the main study variables. As shown in Table 5, the correlation coefficients are usually very small (less than 0.3), indicating a weak association between the variables. Table 6 reports the estimation results for the baseline model with the CAMEL variables (EQ;LLP;LDSTF; IRISK; ROA; ROE; NIM and LIQASS) and other models incorporating macroeconomic and institutional variables (GDP, SLR) over the full period spanning from 2000 to 2019, pre-crisis period (2000-2006) and while crisis period (2007-2019).

Besides, our findings show that various variables have different results on the bank default. The fixed and random effects regression was used for each model. The Akaike Information criterion (AIC) was also applied to distinguish the most relevant model to predict the probability of bank default. Indeed, Amemiya (1981) argued that the Akaike information criterion (AIC) is an important index that gives an idea about the model performance and explains the bank default. The values of this indicator have to be low to be able to judge whether the model is of good quality or not. It is worth noting that most of the variables used in our model are statistically significant and have the expected signs. The fixed effect on the Panel data model reflects the individual heterogeneity of each bank. The dependent variable (DIF) varied from one bank to another.

Besides, the addition of the fixed effect is attributed to the number of banks which are not in default (Greene, 1997; Demirguç-Kunt and Detragiache, 1998). This minimizes the number of banks included in our sample.

The explanatory power of the model is significant when the external variables are included. We can conclude that the macroeconomic and institutional environments are crucial to predict bank defaults. The estimated coefficients are statistically significant and are compatible with the theoretical arguments mentioned in Section 2. It can be noted that the (AIC) indicator related to the fixed effects model is lower than in the case of the model (I)where the CAMEL variables are included. We then remark that the capital adequacy variable (EQ), asset quality variables (LLP, IRISK) and earning variable (ROA) are negatively related to the dependent variable (DIF) for the whole period. However, the (AIC) indicator value for the fixed effects model before the crisis period (2000-2006) is lower than that of the model with CAMEL variables (78<79.6). We may therefore conclude that before the crisis period, the CAMEL variables represent significant indicators of the European bank default. Furthermore, the incorporation of (GDP) and (SLR) variables in the baseline model does not affect the pre-crisis period results. During this period, several variables change the relationship with the bank default variable (DIF). We find a positive and significant relationship between the return on assets

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(ROA) variable and bank default (DIF) which indicates that banks in default have a high level of return on assets before the crisis. This result is consistent with the findings of Gonzalez Hermosillo et al. (1997) and Bongini et al.

(2000) for the European banking industry. However, it contradicts the findings of Thomson (1991), Barr et al. (1994), Logan (2001), Lanine and Vennet (2006) and Arena (2008). The performance indicator (ROE) is found to be significant and positively related to the bank default. This means that a rise in bank equity increases the bank default probability. The return on equity variable (ROE) is the net income to equity ratio. It increases if the bank equity decreases (if the denominator decreases, the ratio increases). Therefore, even if any banking system goal is to improve the profitability of banks operating in the area (an indicator of a bank strength), it must necessarily be accompanied by an adequate amount of equity. This result seems to be very interesting because it highlights the issue of optimal amount of capital that banks have to hold.

In addition, the findings pointed-out that the relationship between (EQ) variable and bank default (DIF) is significantly negative, indicating that a strong capitalization ensures the financial soundness of banks and reduces defaults.

This finding is confirmed by Molina (2002) and Männasoo and Mayes (2009). The quality of bank assets is measured by (IRISK) and (LLP) variables. The (LLP) variable negative impact on bank default means that European banks increase their reserves when they face an excessive risk. Indeed, a high level of provisions can be a good indicator to detect bank default. The coefficient of the (IRISK) variable is significant and negative at the 10% level over the whole period (2000-2019). However, it is positive during the crisis period (2007-2019) which is in line with the findings of de Gonzalez Hermosillo et al. (1997). The earning indicator (NIM) is found to be significant and positively related to the bank default at the 5% level during the crisis period (2007-2019). The return on assets (ROA) and (LIQASS) variables are negatively and significantly related to bank default at the 10% and 5%levels, respectively over the whole period and the while-crisis period. Table 6 reports the empirical results taking into account the impact of the financial crisis on bank default determinants.

It should be noted that coefficients of different variables included in our model change sign from one period to another. The (LDSTF) variable coefficient is positive and significant at 10% level over the whole period; however, it becomes positive and non-significant during the crisis period. This result means that a high level of this ratio is related to the good quality of bank management. As for the macroeconomic variable (GDP), the estimated coefficients are statistically significant and positive at the 1% level over the whole period and the pre- crisis period; however, they are negative and non-significant during the crisis period. In fact, the slow economic growth negatively affects the bank default.

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Specifically, an increase of one percentage point of (GDP) leads to a decrease of about 0.011 in the bank default over the crisis period. The negative and significant coefficient of the institutional variable (SLR) explains the fact that an efficient legal system generates stronger legal guarantees which can protect the borrowers' rights and facilitate lending. Consequently, the European bank default is sensitive to changes in the legal and institutional environment(s). It is worth signaling that a good environment may lead to a decrease in bank default and encourage banks to be more capitalized. The positive coefficient of the (LIQASS) variable mean that an increase of this ratio may accentuate the bank default. This could be justified by the fact that decision-makers of banks with high liquid assets face several financial problems by incurring a high risk of their portfolios, which leads to a higher bank default in the European banking sector over the crisis period (2007-2019). This result contradicts that of Bell et al. (1990), Calomiris and Mason (2000) and Logan (2001).

Thus, hypothesis H2 is confirmed over the whole period (2000-2019) and even during the crisis period (2007-2019). Furthermore, this hypothesis his not accepted for the pre-crisis period (2000-2006), which means H1 is confirmed during this period.

5. CONCLUSION

In the current study, we adopted the panel data approach and the binomial Logit model to deal with the determinants of bank default in the European banking sector. We used bank- level data for 280 European commercial banks over an yearly period spanning from 2000 to 2019.We considered the impact of the current financial crisis; we subdivided the full period into two sub-periods: the pre-crisis (2000-2006) and the while-crisis periods (2007-2019). We assumed that the fundamental determinants of the bank default are the CAMEL variables. We, then, included the effect of the macroeconomic and institutional variables in order to check the results robustness.

Our findings pointed-out that the relationship between the (EQ) variable and the bank default (DIF) is significantly negative, indicating that a strong capitalization ensures the financial soundness of banks and reduces defaults. This finding is confirmed by the studies of Molina (2002) and Männasoo and Mayes (2009). Furthermore, we remark that the CAMEL variables coefficients remain stable across the different models estimated when introducing the macroeconomic and institutional variables. In addition, these coefficients are similar to those estimated in the baseline model. So, it is proved that the CAMEL variables measures are considered as key indicators of bank defaults. Our findings show that the macroeconomic and institutional variables, more precisely the real GDP growth rate and the strength legal rights (SLR) have a crucial effect on the level of bank default. Consequently, the European bank default is sensitive to changes in legal and institutional environments. It is worth signaling that a good environment may lead to a decrease in bank default and encourage banks to be more capitalized. Furthermore, the incorporation of (GDP) and (SLR) variables in the baseline model

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does not affect the differential quantitative impact of the macro-fundamentals on bank default before the crisis period (2000-2006). In this respect, the authorities should focus on the external factors so that they can alleviate potential bank default increases. Moreover, to avoid future financial instability regulators should take into account the systems of risk management.

Table 1: Significance of CAMEL indicators

Empirical Studies	Economies	C	A	M	E	L
Thomson (1991)	U.S.A	✓	✓	✓	✓	✓
Barr et al. (1994)	U.S.A	✓	✓	✓	✓	✓
Wheelock and Wilson (2000)	U.S.A	✓	✓	✓	✓	✓
Logan (2001)	U.K	✓	✓		✓	✓
Molina (2002)	Venezuela	✓		✓	✓	
Lanine and Vennet (2006)	Russie	✓	✓		✓	✓
Arena (2008)	Latin.A and East.A[3]	✓	✓		✓	✓
Mannasoo and Mayes (2009)	East Europe	✓	✓	✓	✓	✓

Table 2 Variables description and data sources

Classification	*Variable*	*Descriptions*	*Sources*
Capital adequacy	EQ	Equity to total assets	Bankscope
Asset quality	LLP	Loan loss provisions	Bankscope
	IRISK	Credit risk	Bankscope
Management quality	LDSTF	loans to deposits and short term funding ratio	Bankscope
Earnings	ROA	Return on assets	Bankscope
	ROE	Return on equities	
	NIM	Net interest margin	
Liquidity	LIQASS	liquid assets to total assets ratio	Bankscope
Macroeconomic variable	GDP	Real GDP growth rate	World development indicators
Institutional variable	SLR	Strength legal rights	Kaufmann et al. (2006)

Notes: EQ: equity to total assets; LLP: loan loss provisions; IRISK: credit risk; LDSTF: loans to deposits and short term funding ratio; ROA: Return on assets; ROE: Return on equities; NIM: Net interest margin; LIQASS: liquid assets to total assets ratio; GDP: GDP growth rate: SLR: Strength legal rights. The Bureau Van Dijk Bankscope database is the main sourceof the financial statements. Macroeconomic and institutional data were obtained respectively from WDI and Kaufmann et al. (2006).

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Table 3 Descriptive Statistics

Variable	***Full period:2000-2019***		***Before crisis:2000-2006***		***Crisis period:2007-2019***	
	Mean	*Std.dev*	*Mean*	*Std.dev*	*Mean*	*Std.dev*
DIF	0.039	0.193	0.061	0.239	0.022	0.148
EQ	8.842	6.562	9.005	7.146	8.711	6.073
LLP	309.4	1221.726	110.878	384.157	454.860	1558.767
LDSTF	12.336	138.893	8.834	30.192	9.506	36.423
IRISK	6.228	8.304	3.921	6.034	7.930	9.266
ROA	0.554	1.708	1.091	1.370	0.160	1.818
ROE	6.437	38.586	14.050	10.077	0.760	49.337
NIM	2.497	1.745	2.648	1.960	2.388	1.556
LIQASS	0.231	0.193	0.263	0.216	0.207	0.171
GDP	1.275	3.803	3.61	2.390	0.450	3.742
SLR	6.212	2.501	6.140	2.446	6.276	2.542

Notes: Numbers in parentheses are p-values. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. EQ: equity to total assets; LLP: loan loss provisions; IRISK: credit risk; LDSTF: loans to deposits and short term funding ratio; ROA: Return on assets; ROE: Return on equities; NIM: Net interest margin; LIQASS: liquid assets to total assets ratio; GDP: GDP growth rate: SLR: Strength legal rights.

[3]Latin America and East Asia

Table 4 Correlation coefficient matrix

Variables	DIF	EQ	LLP	LDSTF	IRISK	ROA	ROE	NIM	LIQASS	GDP	SLR
DIF	1										
EQ	-0.067***	1									
	(0.005)										
LLP	-0.043***	-0.107***	1								
	(0.048)	(0.000)									
LDSTF	0.003	-0.045***	-0.002	1							
	(0.931)	(0.050)	(0.939)								
IRISK	-0.041*	0.066***	0.050***	-0.012	1						
	(0.090)	(0.007)	(0.024)	(0.603)							
ROA	-0.017*	0.209***	-0.105***	-0.015	-0.153***	1					
	(0.060)	(0.000)	(0.000)	(0.503)	(0.000)						
ROE	0.011	-0.016	-0.051**	0.015	-0.036	0.078***	1				
	(0.962)	(0.486)	(0.031)	(0.497)	(0.109)	(0.000)					
NIM	0.008	0.302***	-0.114***	-0.029	0.137***	0.334***	0.001	1			
	(0.864)	(0.000)	(0.000)	(0.206)	(0.000)	(0.000)	(0.885)				
LIQASS	0.009***	0.039	0.045	-0.019	0.041*	0.033	0.023	-0.191	1		
	(0.001)	(0.119)	(0.100)	(0.417)	(0.084)	(0.195)	(0.243)	(0.000)			
GDP	0.050*	0.008	-0.106***	-0.025	-0.115***	0.313***	0.078***	0.118	0.064***	1	
	(0.065)	(0.519)	(0.000)	(0.266)	(0.000)	(0.000)	(0.001)	(0.000)	(0.006)		
SLR	-0.075***	0.082***	0.098***	-0.004	0.058**	-0 .012	-0.029	-0.033	0.089***	0.152***	1
	(0.002)	(0.001)	(0.000)	(0.840)	(0.01)	(0.991)	(0.179)	(0.245)	(0.000)	(0.000)	

Notes: Numbers in parentheses are p-values. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. EQ: equity to total assets; LLP: loan loss provisions; IRISK: credit risk; LDSTF: loans to deposits and short term funding ratio; ROA: Return on assets; ROE: Return on equities; NIM: Net interest margin; LIQASS: liquid assets to total assets ratio; GDP: GDP growth rate: SLR: Strength legal rights.

Table 5 Estimation results over full period (2000–2019); before crisis period (2000-2006) and over crisis period (2007-2019)

Variables	DIF. Full sample. Full period				DIF. Full sample. Before crisis				DIF. Full sample. Crisis period			
	Model 1		**Model 2**		**Model 1**		**Model 2**		**Model 1**			**Model 2**
	Random effects	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects
EQ	-0.236***	-0.433***	-0.238***	-0.371***	-0.160**	0.237**	-0.165**	0.311	-0.288*	-0.237	-0.324**	-0.210**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.022)	(0.048)	(0.019)	(0.264)	(0.060)	(0.333)	(0.046)	(0.047)
LLP	-0.004**	-0.006*	-0.003**	-0.004**	-0.007*	-0.004***	-0.007	-0.003	-0.004	-0.006	-0.004	-0.009
	(0.019)	(0.070)	(0.048)	(0.031)	(0.091)	(0.003)	(0.125)	(0.756)	(0.160)	(0.545)	(0.191)	(0.496)
IRISK	-0.061*	-0.083*	-0.054***	-0.062**	-0.068**	-0.296**	-0.087	-0.450	-0.009	-0.020	0.002	0.002*
	(0.069)	(0.063)	(0.004)	(0.014)	(0.015)	(0.034)	(0.159)	(0.146)	(0.831)	(0.731)	(0.961)	(0.098)
LDSTF	0.091**	-0.001	0.000	-0.001*	0.001*	-0.016**	-0.001	-0.015	0.013	0.030	0.010	0.064
	(0.022)	(0.774)	(0.913)	(0.084)	(0.098)	(0.016)	(0.889)	(0.453)	(0.265)	(0.516)	(0.362)	(0.265)
ROA	-0.268**	-0.218	-0.402***	-0.400*	-0.062**	3.101**	0.000	3.257**	-0.419*	-0.436	-0.374	-0.738**
	(0.024)	(0.192)	(0.002)	(0.065)	(0.043)	(0.029)	(1.000)	(0.026)	(0.080)	(0.401)	(0.132)	(0.028)
ROE	0.001**	0.003	0.090**	0.002*	-0.006*	0.051	-0.002	0.055	-0.004	-0.018	-0.005	-0.024
	(0.038)	(0.432)	(0.044)	(0.093)	(0.070)	(0.234)	(0.933)	(0.223)	(0.509)	(0.608)	(0.469)	(0.487)
NIM	0.354***	0.518	0.334**	0.566**	0.162*	-2.987**	0.104	-3.031**	0.371	0.781	0.383	2.347**
	(0.006)	(0.108)	(0.015)	(0.013)	(0.051)	(0.011)	(0.542)	(0.012)	(0.279)	(0.365)	(0.321)	(0.036)
LIQASS	1.119**	0.066	0.832*	-0.405*	0.856**	2.159	0.794	3.218	3.083*	0.100	-0.929	-6.714
	(0.017)	(0.963)	(0.054)	(0.079)	(0.025)	(0.691)	(0.373)	(0.588)	(0.091)	(0.982)	(0.725)	(0.401)
GDP	-	-	0.202***	0.255***	-	-	0.187*	0.349	-	-	0.025	-0.011
			(0.001)	(0.001)			(0.066)	(0.162)			(0.777)	(0.948)
SLR	-	-	-0.349***	-0.086*	-	-	-0.344***	0.000**	-	-	-0.260	0.000***
			(0.001)	(0.084)			(0.005)	(0.018)			(0.268)	(0.004)
Constant	-3.382***	-	-1.737**	-	-2.723***	-	-1.276	-	-6.162**	-	-3.481	-
	(0.000)		(0.029)		(0.000)		(0.159)		(0.049)		(0.189)	
Wald chi2	38.480***	27.370***	32.720***	41.120***	9.510	14.910*	15.590	17.310**	5.640	13.850*	5.330	17.500**
	(0.000)	(0.001)	(0.000)	(0.000)	0.301	(0.061)	(0.112)	(0.044)	(0.688)	(0.086)	(0.868)	(0.041)
Chi BAR 2	82.010***	-	75.320***	-	19.970***	-	16.760***	-	36.360***	-	30.050***	-
	(0.000)		(0.000)		0.000		(0.000)		(0.000)		0.000	
Log likelihood	-262.877	-90.746	-248.165	-81.927	-168.292	-30.994	-162.335	-29.797	598.823	-18.552	(91.580	-15.339
AIC	543.750	197.500	518.340	183.860	354.580	78.000	346.660	79.600	215.640	53.100	205.160	50.680
Obs	1922	326	1916	319	821	105	819	105	1109	71	1105	67

Notes: Numbers in parentheses are p-values. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. EQ: equity to total assets; LLP: loan loss provisions; IRISK: credit risk; LDSTF: loans to deposits and short term funding ratio; ROA: Return on assets; ROE: Return on equities; NIM: Net interest margin; LIQASS: liquid assets to total assets ratio; GDP: GDP growth rate: SLR: Strength legal rights.

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