Determinants of Loan Quality: Evidence from the Tunisian Banking Sector

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Abstract— *This paper uses probit and ordered probit methods to examine the impact of banks' policies in terms of cost efficiency, capitalization, liquidity, activity diversification, credit growth and profitability on the loan quality in the Tunisian banking sector after controlling for the effects of firm-specific characteristics and macroeconomic conditions. Using a data set with detailed information for more than 9,000 firms comprising the portfolios of the ten largest Tunisian banks, we show that banks which are cost inefficient, low capitalized and illiquid are more likely to have a lower quality of loans. However, activity diversification, bank size and profitability do not seem to offer an important contribution in explaining the evolution of loan quality. Finally, our findings highlight the importance of taking into account firm-specific characteristics and macroeconomic developments when assessing the loan quality of banks from a financial stability perspective.*

Keywords— bank specific factors, firm specific factors, loan quality, ordered probit, probit.

I. INTRODUCTION

Exploring the determinants of problem loans is a question of substantial importance for regulatory authorities concerned with financial stability. A growing number of studies have examined the determinants of credit risk especially after the 2007-2008 financial crisis by focusing on several categories of determinants such as macroeconomic factors, bank-specific variables or firm-specific characteristics. Many studies in this field have used one of these categories of determinants ([1], [2], [3]) or two of them, simultaneously, ([4], [5]), in order to explain problem loans determinants.

The majority of studies that investigate the determinants of problem loans try to answer the question of what explains credit default at the firm level ([4]) or attempt to analyze the evolution of non-performing loans (NPLs) taken as an aggregated measure of problem loans at the bank level ([5]). However, little attention has been paid to the question of what explains that a loan has a given quality or status that lies between the two extreme statuses of safe and defaulted loan. Exploring the latter question is of great importance since it may allow banks as well as regulatory and supervisory authorities to undertake the appropriate actions and policies in order to anticipate and mitigate deterioration of the quality of banks' loan portfolios.

The main purpose of this paper is to empirically examine how loan quality is explained by banks-specific variables namely bank's cost efficiency, capitalization, liquidity, activity diversification, profitability and size while controlling for firms-specific factors and macroeconomic conditions.

This study aims to contribute to the literature on loan quality in two ways. The first contribution comes from examining the heterogeneous impact of bank-specific factors on loan quality while controlling for firms' characteristics and macroeconomic conditions. The second contribution to the empirical literature on loan quality stems from considering disaggregated measure of problem loans rather than using the aggregated level of NPLs, by using detailed dataset which contains information on the quality of loans granted by banks to more than 9,000 firms for the period between 2001 and 2010.

Our results show that a high level of bank's cost inefficiency, low bank's capitalization and an increase in liquidity risk are the main factors that reduce the loan quality of banks. When macroeconomic conditions and firm-specific variables are taken into account, the results regarding the impact of bank-specific factors on loan quality improve considerably.

One policy implication of our study for supervisory authorities would be to focus on cost-inefficient, under-capitalized and illiquid banks with potential problem loan increases. Another implication of our study for policy makers would be to consider a macro prudential regulation and supervision instead of relying only on the micro prudential perspective, when analyzing the quality of banks' loan portfolios (for loan losses provisioning, stress tests, banks capitalization requirements, etc).

The remainder of the paper is organized as follow. Section 2 reviews the theoretical and empirical literature. Section 3 describes the dataset and presents the econometric methodology. Section 4 presents the empirical results. Finally, section 5 summarizes our concluding remarks.

II. LITERATURE REVIEW AND HYPOTHESES

One strand of research in the field of financial institution that has received great amount of attention is the issue of problem loans. Many studies on the causes of bank failures have found that failing institutions have higher proportions of non-performing loans prior to failure and that asset quality displays a statistically significant predictor of insolvency ([2]). From this perspective, many studies have examined the determinants of credit risk. We can identify four different groups of credit risk models according to their required inputs.

The first group of models contains models which rely mostly on firm-specific accounting variables ([3], [6], [7]). Under these models, variables regarding several dimensions of firms' financial situation, such as asset growth, profitability, leverage, liquidity, age and size, may account for idiosyncratic risk.

The second group of models contains studies that rely on macroeconomic variables or consider default correlation issues ([8], [9], [10], [11], [12], [13], [14], [15]). The main idea behind these models is that credit risk is built up during expansion phases, when banks apply looser credit standards. However, the most of the risk materializes only during the phases of economic recession.

The third group contains credit risk models which use bank-specific information as explanatory variables ([2], [16]). These models consider that the policies chosen by each bank, in particular in terms of improving cost efficiency, capitalization, activity diversification, liquidity, performance and credit growth have an impact on the evolution of problem loans.

Finally, the fourth group contains models which combine the different types of inputs mentioned above. For example, Reference [4] combines firm-specific variables and macroeconomic conditions to explain the determinants of problem loans (proxied by credit default) in the Portuguese banking sector. Reference [5] uses bank-specific variables and macroeconomic factors, simultaneously, to examine the determinants of problem loans (proxied by non-performing loans) in the Greek banking sector. Reference [17] combines bank-specific variables and macroeconomic information to examine the determinants of non-performing loans of commercial banks in market-based and bank-based economies represented by France and Germany, respectively.

This study tries to examine the impact of bank liquidity, banks' cost efficiency, capitalization, activity diversification, size and performance on the loan quality in the Tunisian banking sector taking into account information on firms comprising the banks' loan portfolios as well as the evolution of the macroeconomic conditions, as a proxy for the systemic risk.

2.1 Credit Risk and Bank Liquidity

Many theoretical and empirical papers have examined the relationship between liquidity risk and credit risk in banks ([18], [19], [20]). Reference [20] argues that the recent financial crisis has shown the relevance of the interaction between debt market liquidity and credit risk. This interaction is explained by the channel of the so-called debt rollover risk. In fact, in presence of an illiquid debt market, levered firms face rollover losses which come from issuing new debts at higher costs in order to replace maturing debts. In such case, firms' shareholders support the debt rollover losses, while debt holders are paid in full. This conflict of interest between equity and debt holders, which is similar to the classic debt overhang problem described by Reference [21], implies that equity holders may decide to default earlier.

The aforementioned theoretical development by Reference [20] is valid in the context of well developed financial markets where debt rollover is made by issuing new bonds. Nevertheless, the theoretical reasoning of Reference [20] may be extended to the context of bank-centered financial systems where debt rollover may be done through new bank loans. In such case, illiquid banking sector would have the same effect on credit risk, as the one of illiquid debt market. Thus, deterioration in banking sector liquidity makes it more costly for equity holders to keep their firms alive. As a result, the default probability of credit constrained firms increases.

Reference [18] examines the determinants of non-performing loans for all U.S. commercial banks during the period 1984-2013 and finds that liquidity risks measured by loans-to-assets ratio, significantly increase NPLs. The channel through which

liquidity risk impacts credit risk is banks' excessive credit risk taking behavior when they increase their credit supply. In fact, when banks increase their loans growth measured by loans-to-assets ratio, which reflects an increase in liquidity risk as loans are less liquid than other assets (like government securities), they decrease their lending interest rates and reduce their minimum credit standard. By doing so, banks extend their lending activities toward debtors with a poor quality which leads to an increase of credit defaults by borrowers. However, Reference [19] finds that liquidity risk do not have an economically meaningful contemporaneous or time-lagged impact on credit risk in U.S. commercial banks during the 1998-2010. However, the authors show that the interaction of liquidity risk and credit risk impacts bank stability. Following the aforementioned theoretical and empirical developments, we formulate and test the following hypothesis relating credit risk to liquidity risk:

H.1: There is a negative relation between bank liquidity and future problem loans.

2.2 Credit Risk and Cost Efficiency

Many studies have analyzed the relationship between credit risk and banks' cost efficiency. The latter bank specific factor has been considered in the related empirical literature as one proxy for bank managers' skills in terms of monitoring borrowers, assessment of pledged collateral and credit scoring. This has been known in the empirical literature as the so-called "bad management hypothesis" ([5]). Reference [2] explores a sample of US commercial banks during the period 1985-1994 and finds that decreases in measured cost efficiency lead to an increase in future problem loans. Also, Reference [16] provides an empirical evidence of a negative relationship between measured cost efficiency and futures problem loans in the Czech banking industry within the period from 1994 to 2005.

Reference [5], exploring the drivers of NPLs of nine largest Greek Banks during the period 2003–2009, finds that low cost efficiency is positively associated with increases in future NPLs. One explanation of the negative relation between cost efficiency and problem loans relies on the fact that bad managers do not control and monitor their operating expenses in a sufficient way, which leads to low measured cost efficiency almost immediately. Also, bad managers have poor skills in monitoring borrowers, assessment of pledged collateral and credit scoring (choosing loans with low or negative net present value). These poor practices in terms of borrowers monitoring will be reflected in an increase of the problem loans, but only after some time passes.

More recently, Reference [18] examines the determinants of non-performing loans for all U.S. commercial banks during the period 1984-2013 and finds that greater cost inefficiency significantly increase NPLs. The present study formulates and tests the following hypothesis regarding the relationship between cost efficiency and problem loans:

H.2:''Bad management I'' hypothesis: there is a positive relation between cost inefficiency and future problem loans.

2.3 Credit Risk and Bank's Capitalization

The literature on credit risk has tested the moral hazard hypothesis which relates the quality of banks' loan portfolios to capitalization. Reference [2] finds that, for banks with low capital ratios, decreases in bank capitalization precede increases in problem loans measured through NPLs. Their result supports the evidence that under-capitalized banks may respond to moral hazard incentives by taking increased portfolio risks. According to this hypothesis, banks with relatively low capital increase their loan portfolio leading to a burgeoning number of problem loans which reflects the classical problem of excessive risk-taking when another party is involved in the risk and cannot easily charge for or prevent such risk-taking.

However, Reference [5] finds no support to the moral hazard hypothesis within the Greek banking sector since the solvency ratio taken as proxy for the banks' risk attitude does not have explanatory power for NPLs. Surprisingly, Reference [18] examining the determinants of non-performing loans for all U.S. commercial banks during the period 1984-2013, finds that greater capitalization significantly increases NPLs. The author explains the positive relation between bank capitalization and NPLs by the fact that managers of highly capitalized banks may follow a liberal lending policy under the incentives of the so-called "too-big-to-fail" hypothesis.

Reference [22] argues that the role of capital in the bank– firm relationships is ambiguous. On the one hand, higher bank capitalization level reduces bank's lending activity and, thus, credit risk, and on the other hand, well-capitalized banks have

increased incentives to extend their lending activity to relatively risky borrowers, and this is because holding too much capital leads to an important opportunity cost. Thus, the following hypothesis will be formulated and tested:

H.3: ''Moral hazard'' hypothesis: low-capitalization of banks leads to an increase in problem loans.

2.4 Credit Risk and Bank's Activity Diversification

Banks' choice in term of activity diversification may be related to the evolution of problem loans. Reference [23], using bank size as a proxy for activity diversification as bigger size allows for more diversification opportunities, finds a negative relation between bank size and problem loans for Spanish banks. However, Reference [24] using the ratio of non-interest income (NII) over total income as a proxy for the diversification of banking activities, does not find evidence for such negative relation between diversification and problem loans for the US banking system. Reference [5] using the two proxies for the Greek banks' diversification, finds that when the size is taken into account, neither the size's coefficient has the expected sign nor it is statistically significant. But when the ratio of NII over total income is used as a proxy for banking diversification, the sign of the NII coefficient becomes negative, as expected, however the coefficient is not statistically significant.

Reference [25] argues that banks' strategy in term of activity diversification reflects the trade-off between a loan-oriented asset composition and a high level of income diversification. The authors state that income diversification should lead to an improved risk-return trade-off and thus to an increased stability. Reference [26] argues that an increase in the share of non-interest income over total income leads retail-oriented banks to be more stable when they expand banking operations into non-traditional activities in which they have experience. We use in our study the ratio of non-interest income (NII) over total income as a proxy for banks' activity diversification since it reflects banks' reliance on other types of income, except for credit making, and therefore on diversified sources of income. We expect that diversification lowers problem loans. Thus, the following hypothesis will be tested:

H. 4: ''Diversification'' hypothesis: the ratio of non-interest income over total income is negatively related to problem loans.

2.5 Credit Risk and Bank Size

The ''Too big to fail'' (TBTF) hypothesis has been used as one of the channels relating bank specific factors to problem loans evolution. Reference [27] argues that TBTF banks may have incentives to take excessive risk since the lack of market discipline from the side of the banks' creditors who expect government protection in case of failure. However, Reference [5], using as a measure of bank size the ratio of bank's total assets relative to the whole banking sector's total assets, finds no clear evidence for a differential risk attitude of TBTF banks. Reference [28] uses banks' total liabilities to proxy for the TBTF effect. Reference [18] examines the determinants of non-performing loans for all U.S. commercial banks during the period 1984-2013 and finds that banking industry size significantly increases NPLs. According to this hypothesis, we expect that large banks may increase their leverage too much and grant credits to lower quality borrowers at the expenses of increases in future problem loans. Therefore, using natural logarithm of total assets as a measure of bank size, following Reference [29], we test the following hypothesis:

H. 5: ''Too Big To Fail'' hypothesis: banks' size is positively related to problem loans.

2.6 Credit Risk and Bank's Profitability

The empirical literature on credit risk has argued that bad performance may proxy for lower quality of management skills regarding the lending activity (same reasoning as the "bad management I" hypothesis, taking cost efficiency ratio as a proxy for the quality of management). This suggests a negative relation between past earnings and problem loans. Reference [5] finds a negative relation between performance (measured using ROE) and problem loans (measured by NPLs) for the Greek banking system. Thus, we test the following hypothesis:

H. 6: ''Bad management II'' hypothesis: past earnings are negatively associated with increases in problem loans.

TABLE 1
DEFINITION OF BANK-SPECIFIC VARIABLES AND HYPOTHESES

Variables	Definition	Hypotheses tested	Expected signs
Dependent variables			
Loan default	Takes the value of 1 if there is a credit default and 0 otherwise		
Loan status	Takes the values of : 1 (good loan), 2 (fair loan), 3 (bad loan) and 4 (very bad loan)		
Independent variables			
Bank liquidity	$LIQ_{it} = \frac{Current\ assets_{it}}{Current\ liabilities_{it}}$	H1 : ''Debt rollover'' Hypothesis	(-)
Cost Inefficiency	$INEF_{it} = \frac{Operating\ Expenses_{it}}{Operating\ Incomes_{it}}$	H2 : ''Bad Management I'' Hypothesis	(+)
Capitalization	$CAR_{it} = \frac{Owned\ Capital_{it}}{Risk-Weighted\ Assets_{it}}$	H3 : ''Moral hazard'' Hypothesis	(-)
Diversification	$DIV_{it} = \frac{Non-Interest\ income_{it}}{Total\ Income_{it}}$	H4 : ''Diversification'' Hypothesis	(-)
Size	$SIZE_{it} = Ln(Total\ Assets_{it})$	H5: ''Too Big To Fail'' Hypothesis	(+)
Profitability	$ROE_{it} = \frac{Net\ profit_{it}}{Total\ Equity_{it}}$	H6 : ''Bad management II'' Hypothesis	(-)

III. DATA AND ECONOMETRIC METHODOLOGY

3.1 Data and Variables Definition

To explain loan quality determinants in the Tunisian banking sector, we use in this study three datasets containing bank-specific data, information about firms comprising banks' loan portfolios as well as macroeconomic variables. The dataset containing bank-specific information is drawn from the Thomson Reuters Eikon central databaset. The sample of banks is composed by the ten largest banks of the Tunisian banking sector. During the period of analysis, 2001-2010, these banks accounted, on average, for 84.5% of the total assets of the Tunisian banking sector. To examine the impact of bank-specific information on the evolution of the loan quality, we collected data on banks' liquidity, cost efficiency, profitability, capitalization, activity diversification and size.

We use also a set of contemporaneous and lagged macroeconomic variables in our analysis framework. We take into account GDP growth, unemployment rate, inflation rate and lending rates applied on loans to firms. The information on macroeconomic conditions is drawn from the Tunisian National Institute of Statistics (NIS).

The dataset on loan quality and firms characteristics is drawn from two databases held by the Central Bank of Tunisia (CBT), namely, the Risk Base and the Central Balance Sheet. The Risk Base contains information reported by credit institutions (reporting is mandatory). This reporting aims to share information between credit institutions to facilitate their credit risk assessment and management. This database contains information on loans granted to firms including their classification (status: current or classified assets). The loans classification methodology is the same for all banks since it relies on the criteria set by the CBT. The loans classification is used in this study to build the dependent variables using indicators for loan quality which vary according to the status of the severity of the problem loans taking more than two values. We build also an indicator for loan default dummy variable which takes two values (1 if there is a default and 0 if not).

According to the regulation set by the CBT, banks classify their assets into two groups: current assets and classified assets. Are considered as current assets, the loans for which the integral repayment seems to be ensured. These loans are granted to firms characterized, mainly, by: a) balanced financial situation, b) management and activity prospects judged satisfactory and c) adequate form and volume of loans with regard to the needs of the principal activity and the real capacity of repayment of firms. The second group contains classified assets. Their classification is made with regard to the severity of the problem loan and therefore the risk of loss for banks. There are five classes. Class 1 contains loans for which the repayment seems to be ensured but firms are facing deteriorating financial situation and/or operating in stressed activities. Are classified in class 2, the loans granted to firms facing, mainly, financial difficulties and for which the repayment is becoming uncertain and presenting a reimbursement delay (in principal and/or interest) between 90 and 180 days. Class 3 contains loans granted to firms presenting, mainly, a severe financial distress and for which there is a reimbursement delay (in principal and/or interest) between 180 and 360 days. Are classified in class 4, loans presenting a reimbursement delay (in principal and/or interest) of more than 360 days. Finally, class 5 contains loans presenting a reimbursement delay (in principal and/or interest) of more than 360 days and for which there are a legal proceedings initiated by banks.

For each firm, we have information about to which class its loan belongs. Classes are ranging from class 0 (safe loan: current assets) to class 5 (extreme severity of problem loan). This classification will allow us to examine what factors determine the belonging of the loan quality to the different statuses that may exist instead of simply examine the determinants of the credit default. Though, the classical analysis of the determinants of credit default is also possible. In this case, defaulted loans are those classified in classes ranging from 2 to 5. However the non-defaulted loans are those classified in classes 0 and 1. The credit default is measured as credit and interest which have become overdue for more than three months ([4], [5]).

The Central Balance Sheet contains detailed annual accounting information for a large sample of Tunisian firms. Using the two databases, and considering end-of-year data, as quarterly data are available only for a smaller set of companies, for the period between 2001 and 2010, we have a dataset which contains 40 171 observations. The distribution of the observations amongst the six categories of loan classes (as taken from the regulation on banks' assets classification) is as follow:

TABLE 2
DISTRIBUTION OF LOANS CLASSES (BASED ON REGULATION)

class	Freq.	Percent	Cum.
0	24 519	61.04	61.04
1	4 211	10.48	71.52
2	2 636	6.56	78.08
3	2 292	5.71	83.79
4	3 668	9.13	92.92
5	2 845	7.08	100
Total	40 171	100	

While data is available for the period 2011-2014, we have selected information until 2010. The reason for this is that loans classification methodology was changed in 2011 by the Central Bank of Tunisia which took in early 2011 temporary measures in order to support firms economically affected by the events that accompanied the revolution of January 2011, asking banks to reschedule loans of the affected companies. Banks were also called to do not classify loans rescheduled in classes 2, 3 or 4 and to do not revise the classification of firms attributed at the end of December 2010.

We constructed several ratios and control variables to evaluate each firms' financial situation, namely, their profitability, leverage, external funding cost, liquidity, sales and investment growth. Information is also available regarding the firms' size and age. In variables with significant outliers, we replaced observations which are above the 99th percentile with the value of that percentile (the same procedure was applied to those below the 1st percentile).

One of the main objectives of this study is to examine whether the use of firm-specific variables add an explanatory power when analyzing the relationship between bank-specific factors and the evolution of problem loans. Thus, the intermediate objective is to understand what factors determine the belonging of the loans quality to the different statuses at the firm-level. This can be partly reached by analyzing separately summary statistics for firms with a given loan status at t, comparing them with loan statuses of the remaining firms. The following section presents a description of the methodology followed to construct the dependent variables in this study namely dummy loan default (probit) and loan status (ordered probit).

3.2 Stylized Empirical Facts and Summary Statistics

Firstly, we examine what explains the credit default by dividing our sample into two groups, namely, defaulted firms (classes 2-5) and non-defaulted firms (classes 0-1). The credit default is measured as credit and interest which have become overdue for more than three months. Secondly, we try to explain the determinants of the different loan statuses at the firm-level.

TABLE 3
WELCH TEST FOR DEFAULTED AND NON-DEFAULTED FIRMS AND SUMMARY STATISTICS

	Mean values for non-defaulted firms at *t*	Mean values for defaulted firms at *t*	Welch test : Ho: Diff = 0	
			Diff = mean (group1.) - mean (group2.)	Ha: Diff not 0 Pr(ITI >ItI)
ROA	6.77	4.75	2.02	0.0000
Leverage	63.83	72.14	-8.32	0.0000
Liquidity ratio	104.26	89.37	14.89	0.0000
Investmentgrowth	21.28	13.38	7.89	0.0000
Sales growth	18.50	9.50	9.00	0.0000
ExternalFundingcost	24.66	30.95	-6.29	0.0000
Firmage	25.71	23.72	1.98	0.0000
Firm size	20.81	20.98	-.17	0.0000
Number of obs.	28 730	11 441		

Notes. ROA, leverage, liquidity ratio, investment growth, sales growth and external funding cost are displayed in percentages. ROA is defined as Net income over total assets. Leverage is defined as total liabilities over total assets. Liquidity ratio is defined as bank deposits, cash, debt receivables and short-term investments divided by current liabilities. Investment growth is the year-on-year growth of net fixed assets. Sales growth is defined as the year-on-year growth rate of sales. External funding cost is defined as financial expenses over debts and can serve as a proxy for interest rate. Firm size is defined as logarithm of total assets.

A brief analysis of the summary statistics presented in Table 3 for firms with and without credit default in year t, confirms that these two groups of firms are different.

TABLE 4
WELCH TEST FOR FIRMS IN CLASS J AT T COMPARED TO FIRMS IN THE OTHER CLASSES AT T

	Class 0	Welch test : Ho: Diff = 0 Class 0 versus Class 1		Welch test : Ho: Diff = 0 Class 0 versus Class 2		Welch test : Ho: Diff = 0 Class 0 versus Class 3		Welch test : Ho: Diff = 0 Class 0 versus Class 4		Welch test : Ho: Diff = 0 Class 0 versus Class 5	
	Mean values for firms in class 0 at *t*	**Mean values for firms in class 1 at *t***	**Difference**	**Mean values for firms in class 2 at *t***	**Difference**	**Mean values for firms in class 3 at *t***	**Difference**	**Mean values for firms in class 4 at *t***	**Difference**	**Mean values for firms in class 5 at *t***	**Difference**
ROA	7.11	4.81	**2.30*** **	4.55	**2.56*** **	4.70	**2.41*** **	4.28	**2.82*** **	5.58	**1.52*** **
Leverage	63.18	67.61	**-4.43*** **	72.94	**-9.77*** **	71.42	**-8.42*** **	72.42	**-9.24*** **	71.65	**-8.47*** **
Liquidity ratio	106.70	90.05	**16.65*** **	91.02	**15.68*** **	88.50	**18.20*** **	87.05	**19.65*** **	91.53	**15.17*** **
Investmentgrowth	21.66	19.04	**2.62***	16.61	**5.05*** **	13.62	**8.05*** **	14.01	**7.65*** **	9.40	**12.26*** **
Sales growth	18.91	16.09	**2.83*** **	9.54	**9.37*** **	10.40	**8.50*** **	9.17	**9.74*** **	9.20	**9.72*** **
Externalfundingcost	23.42	31.91	**-8.49*** **	31.39	**-7.97*** **	35.09	**-11.67*** **	31.94	**-8.52*** **	25.96	**-2.54***
Firmage	25.39	27.58	**-2.19*** **	22.30	**3.09*** **	23.12	**2.27*** **	23.99	**1.40*** **	25.20	**0.19**
Firm size	20.72	21.37	**-0.65*** **	21.00	**-0.28*** **	21.07	**-0.35*** **	21.07	**-0.35*** **	20.80	**-0.09***
Number of Observations	24 519	4 211		2 636		2 292		3 668		2 845	

	Class 1	Welch test : Ho: Diff = 0 Class 1 versus Class 2		Welch test : Ho: Diff = 0 Class 1 versus Class 3		Welch test : Ho: Diff = 0 Class 1 versus Class 4		Welch test : Ho: Diff = 0 Class 1 versus Class 5	
	Mean values for firms in class 1 at *t*	**Mean values for firms in class 2 at *t***	**Difference**	**Mean values for firms in class 3 at *t***	**Difference**	**Mean values for firms in class 4 at *t***	**Difference**	**Mean values for firms in class 5 at *t***	**Difference**
ROA	4.81	4.55	**0.26**	4.70	**0.11**	4.28	**0.52***	5.58	**-0.77** **
Leverage	67.61	72.94	**-5.33*** **	71.42	**-3.81*** **	72.42	**-4.81*** **	71.65	**-4.04*** **
Liquidity ratio	90.05	91.02	**-0.97**	88.50	**1.55**	87.05	**3.00***	91.53	**-1.48**
Investmentgrowth	19.04	16.61	**2.43**	13.62	**5.43*** **	14.01	**5.03*** **	9.40	**9.64*** **
Sales growth	16.09	9.54	**6.54*** **	10.40	**5.68*** **	9.17	**6.91*** **	9.20	**6.89*** **
Externalfundingcost	31.91	31.39	**0.52**	35.09	**-3.18***	31.94	**-0.03**	25.96	**5.95*** **
Firmage	27.58	22.30	**5.29*** **	23.12	**4.46*** **	23.99	**3.6*** **	25.20	**2.38*** **
Firm size	21.37	21.00	**0.37*** **	21.07	**0.30*** **	21.07	**0.30*** **	20.80	**0.57*** **
Number of Observations	4 211	2 636		2 292		3 668		2 845	

	Class 2	Welch test : Ho: Diff = 0 Class 2 versus Class 3		Welch test : Ho: Diff = 0 Class 2 versus Class 4		Welch test : Ho: Diff = 0 Class 2 versus Class 5	
	Mean values for firms in class 2 at *t*	**Mean values for firms in class 3 at *t***	**Difference**	**Mean values for firms in class 4 at *t***	**Difference**	**Mean values for firms in class 5 at *t***	**Difference**
ROA	4.55	4.70	**-0.15**	4.28	**0.26**	5.58	**-1.03*** **
Leverage	72.94	71.42	**1.52**	72.42	**0.53**	71.65	**1.29**
Liquidity ratio	91.02	88.50	**2.51**	87.05	**3.97** **	91.53	**-0.51**
Investmentgrowth	16.61	13.62	**2.99**	14.01	**2.60**	9.40	**7.21*** **
Sales growth	9.54	10.40	**-0.87**	9.17	**0.37**	9.20	**0.34**
Externalfundingcost	31.39	35.09	**-3.70***	31.94	**-0.55**	25.96	**5.43*** **
Firmage	22.30	23.12	**0.82**	23.99	**-1.69*** **	25.20	**-2.91*** **
Firm size	21.00	21.07	**-0.07**	21.07	**-0.07**	20.80	**0.20*** **
Number of Observations	2 636	2 292		3 668		2 845	

	Class 3	Welch test : Ho: Diff = 0 Class 3 versus Class 4		Welch test : Ho: Diff = 0 Class 3 versus Class 5	
	Mean values for firms in class 3 at *t*	**Mean values for firms in class 4 at *t***	**Difference**	**Mean values for firms in class 5 at *t***	**Difference**
ROA	4.70	4.28	**0.41**	5.58	**-0.88** **
Leverage	71.42	72.42	**-0.99**	71.65	**-0.23**
Liquidity ratio	88.50	87.05	**1.45**	91.53	**-3.02** **
Investmentgrowth	13.62	14.01	**-0.39**	9.40	**4.21** **
Sales growth	10.40	9.17	**1.23**	9.20	**1.21**
Externalfundingcost	35.09	31.94	**3.15**	25.96	**9.13*** **
Firmage	23.12	23.99	**-0.87***	25.20	**-2.08*** **
Firm size	21.07	21.07	**0.00**	20.80	**0.27*** **
Number of Observations	2 292	3 668		2 845	

	Class 4	Welch test : Ho: Diff = 0 Class 4 versus Class 5	
	Mean values for firms in class 4 at *t*	**Mean values for firms in class 5 at *t***	**Difference**
ROA	4.28	5.58	**-1.30*** **
Leverage	72.42	71.65	**0.77**
Liquidity ratio	87.05	91.53	**-4.47** **
Investmentgrowth	14.01	9.40	**4.61*** **
Sales growth	9.17	9.20	**-0.03**
Externalfundingcost	31.94	25.96	**5.98*** **
Firmage	23.99	25.20	**-1.21*** **
Firm size	21.07	20.80	**0.26*** **
Number of Observations	3 668	2 845	

On average, firms with credit default are less profitable, more dependent on external funding sources, have higher external funding cost, have lower liquidity ratios, show weaker sales and investment growth and are slightly younger, which is what should be expected as argued by Reference [4]. However, the results suggest that firms with loan defaults are, on average, slightly larger than firms without loan defaults which is not what should be expected as argued in the literature by References [7] and [30]. The literature argues that larger firms are less likely to default due to the systemic effect of firm size on bankruptcy.

We also present in Table 3 the results of a mean comparison Welch test to better examine if the variables selected are in fact different for the two subsamples of firms. For all variables taken into account, the mean values for firms with loan default are statistically different from those observed for firms without loan default. This result allows us to use firm-specific characteristics as variables of control, with bank-specific variables, to explain why some firms default and to test our hypotheses, under a regression analysis framework using probit model.

Since our main objective is to understand what explains the loan quality, we divide our sample into six subsamples, using the loan classification made by banks based on the regulation on assets classification in order to analyze summary statistics for firms with loan status at t, comparing them with the remaining firms. We present in Table 4 the results of a mean comparison Welch test. For all variables considered, the mean values of firm-specific variables for firms in class 0 are statistically different from those observed for firms in all other classes. Welch test reported in Table 4 also suggests that firms in class 1 are, on average, statistically different from firms presenting more severe problem loan (classes from 2 to 5). However, Welch test argues that classes 2, 3 and 4 are not statistically different in the mean values for the variables considered. In fact, firms classified in these three classes seem to be similar in term of profitability, leverage, liquidity, sales growth, investment rate and external funding cost. Thus, these three classes will be considered as one category under a regression analysis framework using ordered probit method. Finally, firms in class 5 are statistically different from those in all other classes.

The Welch test presented in Table 4 allows us to conclude that there are four distinct statuses of problem loan for which there are statistically significant differences in the mean values for the variables taken into account in our study instead of six classes according to the classification made by banks in Tunisia as shown in Table 2. Thus we can classify our 40 171 observations into four categories of loan quality. The classification shown in Table 5 will be considered under a regression analysis framework using ordered probit model.

TABLE 5
DISTRIBUTION OF LOAN QUALITY INDICATOR

Initial loans classification (based on regulation)			**New loans classification (based on Welch test)**			
Loan class	Freq.	Percent	Loan status/quality	Freq.	Percent	Cum.
0	24 519	61.04	1 : good loan	24 519	61.04	61.04
1	4 211	10.48	2 :fair loan	4 211	10.48	71.52
2	2 636	6.56	3 :bad loan	8 596	21.40	92.92
3	2 292	5.71				
4	3 668	9.13				
5	2 845	7.08	4 :very bad loan	2 845	7.08	100.00
Total	40 171	100.00	Total	40 171	100.00	

3.3 Modelling Loan Quality

Probit model is a binary outcome model among the most used in applied economics. In the probit model, the dependent variable is a binary response which takes the value 1 if an event happens and 0 otherwise. In this study, the event to be examined is the credit default.

In a second stage and for robustness checks, we use another modeling technique, namely ordered pobit, where we define different levels of problem loans severity by constructing loan quality statuses taking an ordered outcomes raging from 1 to 4.

Using ordered probit model we try to examine the impact of banks' policies in terms of cost efficiency, liquidity, capitalization, activity diversification, size and performance on the evolution of the loan quality in the Tunisian banking sector taking as control variables firm-specific information and macroeconomic conditions.

IV. RESULTS

4.1 Results Obtained Using Probit Models

In Table 6 we present the results obtained using probit models. We start in the first two models by using a set of contemporaneous and lagged bank-specific explanatory variables to examine the impact of banks' policies on problem loans. In model 3, we try to simultaneously examine the role played by macroeconomic developments, together with bank-specific variables, by adding a set of contemporaneous and lagged macroeconomic variables. As unemployment rate is negatively correlated with GDP, we use it in model 4. In model 4, we add a set of firm-specific explanatory variables.

The coefficient of bank's cost inefficiency ratio, in model 1, is positive and significant which implies that increases in bank's measured cost inefficiency at t (in other words decreases in bank's measured cost efficiency at t) lead to future higher default probabilities in bank's loan portfolios (at t+1) which is consistent with the results found by References [2] and [16]. This result supports the ''Bad management I'' hypothesis. In model 2, when we used two lags, the coefficient of bank's cost inefficiency is negative (this is what should not be expected) but not significant.

The coefficient of bank's capitalization (in model 1 and 2) is negative and significant as should be expected. This result supports the "moral hazard" hypothesis which suggests that low capitalized banks have incentives to take excessive risk which leads to higher future credit default probabilities.

TABLE 6
PROBIT REGRESSIONS (DEPENDENT VARIABLE: LOAN DEFAULT)

	Model 1		Model 2		Model 3		Model 4	
Bank specific factors								
Cost Inefficiency (t-1)	0.016***	(3.9)			0.011**	(2.8)	0.017**	(3.1)
(t-2)			-0.002	(-0.34)				
CAR (t-1)	-0.126***	(-12.2)						
(t-2)			-0.112***	(-9.01)	-0.135***	(-9.1)	-0.151***	(-9.3)
Diversification	-0.006	(-1.5)	0.002	(0.53)	0.032***	(5.9)	0.037***	(6.8)
Bank size	-0.022***	(-2.9)	-0.053***	(-5.69)	-0.051***	(-5.1)	-0.053***	(-4.9)
Credit growth	-0.025***	(-15.9)	-0.015***	(-8.26	-0.007***	(-3.3)	-0.007***	(-3.4)
ROA (t-1)	0.019***	(3.9)						
(t-2)			0.035***	(6.55)	0.020***	(2.8)	0.018**	(2.4)
Liquidity (t-1)	-0.042***	(-4.8)	-0.035***	(-4.1)	-0.022***	(-3.3)	-0.019***	(-3.6)
Macroeconomic conditions								
GDP (t-1)					-0.142***	(-7.1)		
Unemployment							0.151***	(-5.5)
Inflation					-0.229***	(-6.7)	-0.255***	(-6.7)
Lending rates					1.669***	(18.9)	1.83***	(19.1)
Firm specific factors								
ROA							-0.004	(1.1)
Leverage (t-2)							0.008***	(5.3)
Liquidity ratio							-0.003***	(-5.4)
Investmen tgrowth							-0.001***	(-2.6)
Sales growth							-0.003***	(-6.3)
Ext. Funding cost (t-2)							0.002***	(3.2)
Firm age							-0.014***	(-3.9)
Firm size							0.227***	(9.4)
Sectors affiliation								
Agriculture							0.639***	(2.7)
Real estate							0.699***	(3.5)
Commerce							0.956***	(5.7)
Tourism							4.287***	(10)
Constant	-4.49***	(-16.7)	-3.87***	(-11.4)	-14.8***	(-16.5)	-20.81***	(-18.2)
Number of obs.	27 733		20 256		18 864		18 864	
Number of firms	7 576		5 609		5 231		5 231	
Pseudo-R^2	0.07		0.09		0.11		0.11	
AIC	17 186.4		12 030.4		10 510.3		10 189.7	
Obs. per group								
Min	1		1		1		1	
Average	3.7		3.6		3.6		3.6	
Max	9		8		8		8	

Notes: z-scores in parentheses. All models estimated using a probit method, where the dependent variable is the dummy loan default. Banks' variables: ROA is defined as Net income divided by total assets. CAR is the capital adequacy ratio. Liquidity is measured by current asets over current liabilities. Cost inefficiency is defined as operating expenses divided by operating incomes. Diversification is defined as non interest income (NII) divided by total income. Bank size is defined as logarithm of total assets. Credit growth is defined as the year-on-year growth rate of credit. Macroeconomic variables: GDP, unemployment and inflation are calculated as annual growth. Lending rate is the annual average of lending rates to firms. Firms' variables are defined below Table 3.

Moreover, bank's activity diversification ratio, measured using non-interest income (NNI) over total income, has a negative coefficient, in model 1, and this is what should be expected according to the "diversification" hypothesis. In model 2 when

we used two lags (for the other explanatory variables), the sign of the diversification coefficient becomes positive. However, in models 1 and 2, the diversification's coefficients are not significant which means that activity diversification does not contribute to explain loan default probability for Tunisian banks. Bank's size has a negative and significant coefficient (in model 1 and 2) which is not what should be expected according to the "TBTF" hypothesis. The coefficient of credit growth is also negative and significant which supports the result found using bank's size as both variables may be used when testing the "TBTF" hypothesis.

Profitability ratio has a positive coefficient which means that banks with higher profitability at t are more likely to have higher problem loans at t+1 and t+2 (in model 1 and model 2, respectively). These results do not support the "Bad Management II" hypothesis. One explanation of this result would be that bank managers may attempt to manipulate current earnings by choosing a policy of negative NPV and extending credit to lower-quality of debtors in order to convince the market of bank's profitability by inflating current earning at the expenses of future problem loans. Bank liquidity has a negative and significant coefficient (in model 1 and 2) which is what should be expected as a decrease in bank liquidity would be associated with an increase in loan default probability.

The results in model 3 show that lagged GDP growth has a negative impact on loan default probability and this is what should be expected as an expansionary phase of the economy presents relatively low loan defaults rates since firms face a sufficient amount of income to service their debts. Moreover, interest rate on bank loans has, as expected, a positive contemporaneous impact on default probabilities which implies that higher cost of debts is associated with higher probabilities of firms' default. The coefficient of inflation is negative and significant. One explanation of this result is that an increase in inflation rate may lead to a decrease in the weight of the nominal debt within the firms' balance sheet.

When macroeconomic variables are added in model 3, the results for bank-specific variables remain robust except for firm's diversification coefficient which becomes significant. Bank's activity diversification ratio has a positive and significant coefficient and this is not what should be expected according to the "diversification" hypothesis which supposes a negative relation between activity diversification and loan default probability. In model 4, we add firm-specific explanatory variables and sector dummies. The results for bank-specific variables and macroeconomic conditions remain robust. For sectors affiliation, the results suggest that the credit default probabilities of firms operating in sectors like tourism, agriculture, commerce and real estate are higher than those of industrial firms (omitted sector).

4.2 Robustness Checks Using Ordered Probit Models

In order to check the robustness of our results in the previous section, we estimate ordered probit models where the dependent variable is the loan status which proxies for the loan quality by taking four values ranging from 1 (good loan) to 4 (very bad loan).

The results reported in table 7 (models 5 and 6 with one and two lags, respectively) show that the coefficient of bank's cost inefficiency ratio is positive which implies that increases in bank's measured cost inefficiency lead to higher severity of problem loans (poor loan quality) in banks' loan portfolios. This result supports the "Bad Management" hypothesis which has been confirmed using probit method in the previous section.

The coefficient of bank's capitalization ratio is negative and significant as should be expected supporting the "moral hazard" hypothesis (using one lag in model 5 and two lags in model 6). This result confirms the result found using probit method.

In models 5 and 6, bank's activity diversification has a positive and significant coefficient and this is not what should be expected according to the "diversification" hypothesis. Bank's size has a negative and significant coefficient and this is not what should be expected according to the "TBTF" hypothesis. Bank profitability ratio has a negative and significant coefficient, in model 5 and 6 (with one and two lags, respectively) which means that a decrease in firm's profitability leads to a higher severity of problem loans and this result supports the "bad management II" hypothesis. Bank liquidity has a negative and significant coefficient (in model 5 and 6) and this is what should be expected as a decrease in bank liquidity would be associated with an increase in the severity of problem loans.

TABLE 7
ORDERED PROBIT REGRESSIONS (DEPENDENT VARIABLE: LOAN STATUS)

	Model 5		Model 6		Model 7		Model 8	
Bank specific factors								
Cost Inefficiency (t-1)	0.003*	(1.8)						
(t-2)			0.006***	(3.1)	0.007***	(3.5)	0.009***	(6.3)
CAR (t-1)	-0.044***	(-14.9)						
(t-2)			-0.042***	(-12)	-0.035***	(-9.5)	-0.035***	(-9.3)
Diversification	0.005***	(4.4)	0.003**	(2.1)	0.007***	(4.9)	0.007***	(4.7)
Bank size	-0.003*	(-1.7)	-0.007***	(-2.8)	-0.008***	(-3.2)	-0.008***	(-3.2)
Credit growth	-0.014***	(-26)	-0.011***	(-18)	-0.006***	(-9.4)	-0.006***	(-9.1)
ROA (t-1)	-0.007***	(-4.5)						
(t-2)			-0.004**	(-2.3)	-0.014***	(-6.7)	-0.011***	(-5.1)
Liquidity (t-1)	-0.024***	(-10.3)	-0.019***	(-10.2)	-0.015***	(-11.1)	-0.028***	(-11.3)
Macroeconomic conditions								
GDP (t-1)					-0.105***	(-15.6)	-0.104***	(-15)
Unemployment								
Inflation					-0.140***	(-11.7)	-0.147***	(-12)
Lending rates					0.487***	(24.9)	0.552***	(27)
Firm specific factors								
ROA							0.000	(-0.1)
Leverage (t-2)							0.003***	(9.3)
Liquidity ratio							-0.001***	(-4.3)
Investment growth							-0.001***	(-4)
Sales growth							-0.001***	(-9)
Ext. Funding cost (t-2)							0.001***	(7.6)
Firmage							-0.002***	(-3.1)
Firm size							0.072***	(14)
Sectors affiliation								
Agriculture							0.178***	(5.5)
Real estate							0.019	(0.6)
Commerce							0.289***	(12.6)
Tourism							0.721***	(23.9)
Number of obs.	27 733		20 256		18 864		18 864	
Pseudo-R^2	0.02		0.01		0.06		0.09	
AIC	57 879.9		41 806.3		37 884.5		36 468.8	

We add in model 7, macroeconomic information with the bank-specific variables. The results regarding the impact of bank-specific variables remain robust. In model 8, we add firm-specific variables to the previous specification. The results regarding the impact of bank-specific factors remain also robust.

The Akaike information criteria (AIC) suggests that model 4 using probit method and taking into account, simultaneously, bank-specific variables, firm-specific characteristics and macroeconomic factors, is the one which provides the more accurate results regarding the explanation of the impact of banks' policies in terms of cost efficiency, capitalization, activity diversification, liquidity, credit growth and performance on loan problems. Table 8 summarizes the results found and their implication on the hypotheses tested in this paper.

TABLE 8
SUMMARY RESULTS OF TESTED HYPOTHESES

Variables	Hypotheses tested	Expected signs	Results found		Hypotheses
			Probit	Ordered probit	
Liquidity	''Debt rollover '' Hypothesis	(-)	(-)	(-)	C
Cost Inefficiency	''Bad Management I'' Hypothesis	(+)	(+)	(+)	C
Capitalization	''Moral hazard'' Hypothesis	(-)	(-)	(-)	C
Diversification	''Diversification'' Hypothesis	(-)	(+)	(+)	NC
Size	''Too Big To Fail'' Hypothesis	(+)	(-)	(-)	NC
Profitability	''Bad management II'' Hypothesis	(-)	(+)	(-)	NC

Note: C. and NC denote hypothesis confirmed and non-confirmed, respectively.

V. CONCLUSION

In this paper we examine the determinants of the loan quality in the Tunisian banking sector. The results provide clear evidence that loan quality in the Tunisian banking sector is positively impacted by bank's cost efficiency. In other words, the positive relation between cost inefficiency and problem loans relies on the fact that cost inefficient banks are managed by bad managers who do not control and monitor their operating expenses in a sufficient way, which leads to high measured cost inefficiency almost immediately. Also, bad managers have poor skills in monitoring borrowers, credit scoring and assessment of pledged collateral. These poor practices in terms of credit risk management will be reflected in an increase of the problem loans (in other words a decrease in the loan quality), but only after some time passes (after one year). The results provide also clear evidence that loan quality in the Tunisian banking sector is positively impacted by banks' capitalization suggesting that managers of under-capitalized banks may respond to moral hazard incentives by increasing their credits by extending loans to lower quality of borrowers at the expenses of increases in future problem loans.

The results obtained with probit and ordered probit models provide clear evidence that loan quality in the Tunisian banking sector is negatively impacted by bank liquidity risk. In other words, when banks are illiquid their debtors encounter losses due to debt rollover at higher costs. In such case, firms' shareholders may respond to agency problem incentives by choosing to default earlier on their commitments rather than supporting the whole losses while bankers are paid in full. The results found for the relation between bank's activity diversification and problem loans suggest that there is no evidence in the Tunisian banking sector for the "diversification" hypothesis. The positive relation found between activity diversification and problem loan may be explained by the fact that banks that rely on other types of banking activities may have poor skills in terms of credit risk management as they have other core business (investments, financial engineering, etc). These banks may also do not devote enough resources to improve such skills at the expenses of decreases of loan portfolios quality.

Our findings argue that loan quality is positively affected by bank's size. We can explain our result by the fact that large banks may have sufficient resources allowing them to improve their credit risk management unlike small banks which leads to a positive relation between bank's size and loan quality. The results do not seem to offer an important contribution in explaining the relation between bank's performance and loan quality.

When macroeconomic factors and firm-specific characteristics are taken into account, the results regarding the impact of bank-specific variables on loan quality improve considerably. These findings allow us to argue that macroeconomic and microeconomic conditions have an additional contribution in explaining the determinants of loan quality which should be examined from a financial stability perspective.

Our results have several policy implications. First, there is an evidence that bank's cost efficiency may serve as leading indicator for future problem loans suggesting that supervisory authorities should focus on bank's managerial performance in order to detect banks with potential problem loans increases. Second, regulators should place emphasis on under-capitalized banks having severe credit risk exposures in order to prevent future financial instability. Finally, policy makers should consider macro prudential regulation and supervision instead of relying only on the micro prudential perspective, when analyzing the loan quality of banks (for loan losses provisioning, stress tests, banks capitalization requirements, etc). One possible consideration, from the macro prudential regulation perspective, is to make banks' capital requirements countercyclical since credit risk may vary with overall macroeconomic conditions. One objective of such regulation would be to act as countervailing force to the natural decline in measured credit risk in a boom and the subsequent rise in measured credit risk during the collapse.

The study can be extended in different ways. Firstly, future studies of the loan quality determinants may focus on different types of loans (business, mortgage, consumer) rather than considering an aggregate level. Secondly, other statistical techniques may be used, such as duration models, to examine the intertemporal relations between loan quality and bank-specific variables since we have found that some relations materialize only after some time passes. Thirdly, future lines of research may examine firms' access to credit after default rather than only analyzing the determinants of the credit default event.

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