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Explanatory Factors of Non-Performing Loans in Tunisian Banks: Evidence from panel ARDL/PMG Approach

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ABSTRACT

NPLs in Tunisia are increasing at an alarming rate every year. Therefore, the main objective of the present study is to investigate the specific factors explaining the increase of NPL levels in the banks. The current study used 10-years panel data (2010-2020) using a PMG-ARDL approach for a global panel consisting of 18 Tunisian banks to test the validity of banks specific hypotheses. The long-run PMG-ARDL estimation suggested that, in Tunisian banks, the cost inefficiency, the ROE and the size affected positively the non-performing loans. However, ROA and Credit growth had a negative effect on NPL. The short run dynamics show that the managerial inefficiency and credit growth are designed to increase the NPL but the ROA, the ROE and the size are considered to decrease the NPL. As a result, it's recommended that Tunisian banks should amend their policies regarding credit advancement to align them with the specific factors taken in this study. Besides, banks should improve credit monitoring to ensure the loaned-out funds are intended for the intended purpose. This would ensure economic sustainability.

ملخص

تسجل مستويات القروض المتعثرة في تونس زيادة مستمرة كل عام بمعدل ينذر بالخطر. لذلك، يتجلى الهدف الرئيسي من هذه الدراسة في استعراض أبرز العوامل التي تفسر زيادة مستويات القروض المتعثرة في البنوك. اعتمدت هذه الدراسة على مجموعة بيانات جدولية تغطي فترة 10 سنوات (2010–2020) باستخدام منهج PMG-ARDL لمجموعة تضم 18 بنكا تونسيا لاختبار صحة بعض فرضيات البنوك. ويشير تقدير PMG-ARDL بعيد المدى إلى أن عدم كفاءة التكلفة

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والعائد على حقوق الملكية وحجم القروض في البنوك التونسية أثر بشكل إيجابي على القروض المتعثرة. لكن كان للعائد على الأصول ونمو الائتمان تأثير سلبي على القروض المتعثرة. وتبرز الديناميكيات على المدى القصير أن عنصري عدم الكفاءة الإدارية ونمو الائتمان مصممان لزيادة القروض المتعثرة، لكن العائد على الأصول والعائد على حقوق الملكية والحجم من العوامل المسهمة في التقليص من القروض المتعثرة. لذلك من الجيد أن تنظر البنوك التونسية في مسألة تعديل سياساتها المتعلقة بالتقدم الائتماني لمواءمتها مع العوامل المحددة التي تم تناولها في هذه الدراسة. كما يتعين على البنوك تحسين عملية مراقبة الائتمان للتأكد من أن الأموال المقترضة مخصصة للغرض المقصود. وهذا من شأنه أن يضمن الاستدامة الاقتصادية.

ABSTRAITE

Les NPL en Tunisie augmentent à un rythme alarmant chaque année. Par conséquent, l'objectif principal de la présente étude est d'enquêter sur les facteurs spécifiques expliquant l'augmentation des niveaux de NPL dans les banques. L'étude actuelle a utilisé des données de panel sur 10 ans (2010-2020) en utilisant une approche PMG-ARDL pour un panel global composé de 18 banques tunisiennes afin de tester la validité des hypothèses spécifiques aux banques. L'estimation PMG-ARDL à long terme suggère que, dans les banques tunisiennes, l'inefficacité des coûts, le ROE et la taille affectent positivement les prêts non performants. Cependant, le ROA et la croissance du crédit ont un effet négatif sur les prêts non performants. La dynamique à court terme montre que l'inefficacité managériale et la croissance du crédit sont conçues pour augmenter les prêts non performants, tandis que le ROA, le ROE et la taille sont considérés comme diminuant les prêts non performants. En conséquence, il est recommandé que les banques tunisiennes modifient leurs politiques en matière d'avancement du crédit afin de les aligner sur les facteurs spécifiques pris en compte dans cette étude. En outre, les banques devraient améliorer le suivi du crédit afin de s'assurer que les fonds prêtés sont destinés à l'usage prévu. Cela permettrait d'assurer la durabilité économique.

Keywords: Non-performing loans, Bank specific determinants, Tunisian banks, Panel ARDL.

JEL Classification: C23, R41

1. Introduction

The banking system plays an important role in economic activities. This role stems from the money creation business carried out by banks through the credit facilities they provide, which contributes to the development of the national economy. With economic globalization, the role of banks has increased, especially in developing countries where the role of financial markets in the economic and financial sphere is minimal. This has led to an increasing reliance on banks to provide the necessary liquidity for available investment opportunities.

Bank credit is the most attractive investment for banks, through which most of the profits can be made, but this investment increases the risk of financial failure. This problem has received extensive attention from researchers, specialists and managers of the banking sector. The expansion of this phenomenon is due, on the one hand, to a number of economic, social and political variables that control the financial and monetary market and, on the other hand, to banks specifics variables.

The literature determines two sets of factors to explain the evolution of NPLs over time. A number of researchers (Louzis et al., 2012, Warue (2013), Louangrath, 2015, Leka et al., 2019, Khan et al (2020), Pastory D. (2021)) focused on external events such as general macro-economic conditions, which are likely to affect borrowers' capacity to pay their loans. In effect, Louzis et al (2012)'s approach was using the dynamic panel data method to examine the determinants of NPLs. They found that macro-economic variables, specifically the real growth rate, the unemployment rate and the lending rates have a strong effect on the level of NPLs. In addition, they inferred that specific bank variables, such as performance and efficiency indicators, have additional explanatory power when added to the baseline model, thus supporting the "bad management" hypothesis linking these indicators to the quality of management. Leka et al., 2019 tested the impact of macro-economic factors on the level of NPL. They discovered that GDP decrease the level of NPL, but the monetary aggregate and the interest of loan increase the level of NPL.

The motivation behind this study is to investigate the explanatory power of banks' specific variables as determinants of NPLs, based on Berger and De Young's (1997) and Louzis et al (2012) studies. The Tunisian banking system plays an important role in the economy growth. It kept on moving due to changes that affect the environment through the reformulation of

capital markets, bank restructuring and portfolios sanitation of non-performing loans. In fact, after the Revolution of January 14, 2011, one of the weaknesses of the Tunisian banking sector was the increase in non-performing loans. According to statistics from the 2015's report of the Tunisian Central Bank, the outstanding balance of non-performing loans evolved from 6,618 MTD in 2014 to 7,392 MTD in 2015, thus registering an acceleration of its growth rate of 7.7% points. It represents the highest rate in the southern and eastern Mediterranean countries over the five years (from 2015 to 2020). In addition, the economic recession recorded in 2020 induced by the health crisis was accompanied by a slight increase in bank credit. In this regard, the gap of the "Credit/GDP" ratio compared to its long-term trend fell by 2.1% in 2020, reflecting an increase in credit and that of nominal GDP. Nevertheless, this increase in credit may constitute a risk that could affect the repayment capacity of the borrowers. Therefore, examining the factors that determine problem loans in Tunisian banking sector is an important question that interests banks, and mostly regulatory authorities concerned about financial stability.

Several researchers have studied the explanatory factors of non-performing loans in Tunisian banking sector (Zribi and Boujelbène (2011), Abid et al (2014) and Chaibi (2016).

The main contribution of our study is to investigate the dynamic causal links between banks specifics variables and non-performing loans. We take into consideration the pooled mean group/autoregressive distributed lag (PMG/ARDL) approach to investigate the short and the long-run association among the variables. It is worth mentioning that there had been no previous studies using the econometric approach in Tunisia, and thus, this is the first empirical study that is using it to examine the specific bank determinant of non-performing loans. The adoption of this type of econometric model seems to be very relevant since a sample of 18 Tunisian banks was investigated during the period between 2010–2020.

The paper is structured as follows: Section 2 covers the relevant literature on relationship between banks specifics variables and non-performing loans. Section 3 presents the explanatory factors and hypothesis development. Section 4 describes the data, the research design, and methodology. Section 5 discusses the empirical results. A brief conclusion follows with results implications and suggestions for future research.

2. Literature Review

In recent decades the theme of "non-performing loans" (NPL) has attracted more attention, and particularly the interest is attributed to understanding the determinants of NPL. The NPLs are among the main causes of the economic stagnation problems. Each impaired loan increases the possibility of leading a company to difficulty and unprofitability. Berger and De Young (1997) investigated causality between non-performing loans, cost efficiency and capitalization on a sample of US commercial banks using Granger causality tests. The study found evidence of skimping behavior among most efficient banks, moral hazard behavior among least capitalized banks, and the presence of the other two, bad management and bad luck behavior, in U.S. banks. Rossi et al (2009) extended Berger and De Young's (1997) technique to link banks' management behavior to loan portfolio diversification for Austrian commercial banks and found that diversification has a negative impact on banks' profitability, and reduces risk. On the other hand, it has a positive impact on banks' profit efficiency and capitalization.

In addition, Louzis et al (2012) examined the factors explaining non-performing loans (NPLs) in the Greek banking sector, for each type of loan (consumer, business and mortgage loans) in the period from 2003 to 2010. Their results stipulated that bank specific variables such as performance and efficiency indicators had additional explanatory power, which supported the "bad management" hypothesis that linked these indicators with the quality of management.

Khan et al (2020) conducted a study to assess the determinants of NPLs on the Pakistani banking sector over the period of 2005–2017. They considered the NPLs as a dependent variable, while income diversification, profitability, capital and operating efficiency as independent variables. Their results showed that the profitability and operating efficiency indicators have a significant negative relation with NPLs. However, income diversification and capital adequacy have insignificant results.

Odunayo (2020) examined the determinant factors of NPLs from two perspectives, one from the firm-specific point of view and the other from the macro-economic point of view. In this study, 110 commercial banks from nine countries were analyzed using dynamic panel regression. Among the major factors affecting nonperforming loans in lower middle-

income countries' banks, the study found that lagged nonperforming loans, lending rates, capital adequacy, credit growth, and cost income ratio constituted the most significant factors. Therefore, regulations should be adopted by commercial banks to amend their policies regarding credit advances in accordance with the factors mentioned above. In order to ensure long-term economic sustainability, banks will need to ensure that loaned funds are dedicated to the envisioned purpose through improved credit -monitoring.

Pastory D. (2021) examined the determinants of non-performing loans in Tanzanian commercial banks. The study was inspired by the hypothesis that each the bank specific variables and macro-economic variables have an impact on NPLs. A statistically significant relationship was found between Non-Performing Loans rate, bank specific variables (insider lending, compromised integrity, poor credit appraisal, and inadequate market information), and macro-economic variables (unemployment rate, lending rate, effective tax rate, and inflation rate). However, poor credit policy and monitoring had a statistically insignificant relationship with NPLs.

The study of Singh et al (2021) was carried out to determine the effect of Non-Performing Loans (NPLs) on Nepalese conventional banks, with the data obtained from 2015 to2019. NPLs were used as a dependent variable, while Return on Asset (ROA), Bank Size, Capital Adequacy Ratio (CAR), Inflation and GDP growth were used as independent variables. As result, specifically, ROA, Bank Size, GDP, and Inflation all have a significant effect on NPL, whereas CAR does not. According to this study, GDP affects NPL negatively, while most studies show that GDP affects NPL positively. Hence, before taking decisions concerning NPLs, policymakers and bankers need to consider GDP growth carefully.

With annual data from 1988 to 2018, Kepli et al (2021) inspected the short- and long-run dynamics of a number of determinants using the Auto-Regressive Distribution Lag (ARDL) co-integration method. Despite mixed results in the empirical analysis, in the long run, exchange rates are significant and positively related to non-performing loans, while industrial production and money supply are significant and negatively related. Nevertheless, inflation does not significantly affect NPLs in Malaysia. The main findings can help macro and fiscal policy makers to develop macro-economic policies.

3. Explanatory Factors of Non-Performing Loans and Hypothesis Development

3.1. Managerial inefficiency

Several researchers have studied the relationship between NPLs and managerial efficiency in the banking industry (Berger and DeYoung, 1997; Podpiera and Weill, 2007; Reddy, 2011; Fiordelisi and al., 2010). They proved the existence of three relationships between managerial efficiency and volume of NPL by making three assumptions, which are "bad management" hypothesis, "skimping" hypothesis and "bad luck" hypothesis. "Bad management" hypothesis stipulates that management is considered to be bad when they lack the necessary skills, which allows a high amount of loans that have a negative net present value. Therefore, low managerial efficiency is a sign of poor management performance and should result in a higher volume of non-performing loans (Podpiera and Weill, 2007). According to "skimping" hypothesis, when bank executives track risky behavior based on performance as determined by the bank in previous years, a positive correlation can be established between non-performing loans and management efficiency. The "bad luck" hypothesis predicts that external events increase non-performing loans in banks. This hypothesis provides that the weakening of credit quality lead to bank managerial inefficiency.

Multiple studies (Louzis et al. (2012); Othmani (2021); Tinta and Sanou (2021)) argue that the inefficiency rate is positively associated with NPLs. In fact, an increase in the inefficiency rate is indicative of a deterioration in the bank's financial management. This leads to increase bank expenses and reduce the management efficiency of banks. Therefore, good bank management is a requirement for reducing bad debts. Consequently, we can formulate the following hypotheses:

H1: Managerial inefficiency is positively associated with the volume of non-performing loans.

3.2. Profitability

According to (Berger and DeYoung, 1997; Podpiera and Weill, 2007; Reddy, 2011; Fiordelisi and al., 2010), two opposite hypotheses can explain the relationship between profitability and non-performing loan: the Bad Management Hypothesis and the Procyclical Credit Policy Hypothesis. Under "Bad Management Hypothesis": low performance

increases future NPLs. This signifies a negative relationship between past earnings and problem loans. Under "Procyclical Credit Policy Hypothesis": good profitability can increase non-performing loan. According to Rajan (1994), the bank can try to convince the market about the profitability of its loans by adopting liberal credit policies and, therefore, inflate current earnings at the expense of future problem loans. A bank can also use loan loss provisions to increase its current earnings.

Studies conducted by Louzis et al (2012), Abid et al (2015) Harimurti et al (2022) confirmed the existence of a negative relationship between bank performance and NPLs. Thus, a weak performance can be considered as an index reflecting a lack of skills of the officials who grant credits. This leads to a failure in monitoring the operating costs and the loans quality, and therefore leads to a loss in capital. Consequently, we can formulate the following hypotheses:

H2: Profitability is negatively associated with the volume of non-performing loans.

3.3. Credit Growth

Keeton (1999) proposed a model in which he established a positive relationship between credit growth and credit loss. Such a relationship often stems from the relaxation of credit standards in favor of lower quality borrowers in order to increase the amount of loans. Similarly, Vithessonthi (2016) on a sample of 82 Japanese banks over the period 1993-2013 found a positive relationship between bank credit growth and non-performing loans before the financial crisis in 2007. However, Vithessonthi (2016), in the same study, found that this relationship was negative following a tightening of lending criteria by banks after the 2007 financial crisis. Keungne and MBA (2021) corroborated this result, according to which increased funding constraints on public consumption and investment spending are associated with worsening loan portfolio quality. Consequently, a decline in public order due to heightened fiscal strains leads to increased difficulties for local economic actors to repay loans, especially when external debt repayments take precedence over domestic debt repayments. Boudriga et al (2009), examining a sample of 10 major Tunisian banks report a negative relationship between credit growth ratio and NPL. They argue that the more the bank is concentrated in credit activities, the better it controls borrowers' solvency. This might indicate that focusing on lending activities allows banks to better assess

credit risk. Boudriga et al (2010) found the same result by analyzing the relationship between credit growth ratio and NPL ratio of banks in the MENA region. Consequently, we can formulate the following hypotheses:

H3: Credit growth is negatively associated with the volume of non-performing loans.

3.4. Bank Size

The bank's size can correlate with NPLs either positively or negatively. The findings of Misra and Dhal (2010) are similar to those of Das and Ghosh (2007). They identified a positive relation between size of the bank and NPLs. Their justification was that large banks are more likely to have relatively more NPLs. Nevertheless, Salas and Saurina (2002) found a negative effect of bank size on NPLs, and argued that a larger size allows for more diversification opportunities, and consequently to less loan problems. Hu et al (2006) studied the relation between government shareholding in Taiwan commercial banks and the ratio of NPLs over the period of 1996-1999. They claimed a negative relationship between the bank size and NPLs rate. They argued that large banks have more resources to evaluate and process loans. These can improve the quality of the loans and, therefore, effectively reduce the NPL rate. Similarly, the results of research papers directed by Eka et al (2018) Dewi et al. (2015) found that bank size negatively affects non-performing loans. Consequently, when the bank is able to increase its assets, non-performing loans may decrease. Tina and Sanou (2021) arrived at the same result. According to these authors, it seems that the larger the bank is, the less risk it takes. In addition, large banks have better risk management strategies and the necessary technology resources to regularly assess their credit situation and diversify their portfolio.Thus, we can formulate the following hypothesis:

H4: Bank size is negatively correlated with the volume of non-performing loans.

4. Data and Methodology

4.1. Data

The study sample consisted of 18 banks listed on the Tunisian Stock Exchange, from 2010 until 2020. We collected the annual data from the

banks' annual reports published by the Financial Market Council and The Tunisian Professional Association of Banks.

4.2. Model Specification

In this section, we examined the determinants of NPLs in the Tunisian banking sector, by referring to Jimenez and Saurina (2006), Louzis et al (2012). The baseline model is:

$$Y_{it} = f(\mathrm{INEF_{it}}, \mathrm{Prof_{it}}, \mathrm{GLoan}_{it}, \mathrm{Size_{it}}) \quad (1)$$

Where,Yit : Non-performing loans;

INEFit: Managerial inefficiency cost;

Profit: Bank Profitability measured by ROA and ROE;

GLoanit: Credit growth;Sizeit:

Bank Size;

i and t: the cross sectional and time dimension of the panel sample respectively.

The methodology used in this paper is based on the ARDL (The autoregressive distributed lag) approach proposed by Pesaran et al. (2001). There are various reasons for using this methodology. Firstly, the ARDL approach has the advantage that it does not require all variables to be I (1) as the Johansen (1991) framework, and it is still applicable if we have I(0) and I(1) variables Pesaran et al. (2001). Secondly, according to Haug (2002), the ARDL bounds testing model is more appropriate and provides better results for small sample size, and the short and long-term parameters are estimated simultaneously. Moreover, a dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation (Banerjee et al.1993). The ECM integrates the short-term dynamics with the long-run equilibrium without losing long-term information.

The PMG model supposes that the short-term coefficients are heterogeneous, while long-term coefficients tend to be identical and homogeneous for all panel individuals. The decision of such procedure is particularly supported when there is motivation to accept it over the long term. homogeneity can be obtained through various factors, like the role of the Tunisian Central Bank as a regulator of the Tunisian banking

system through monetary policy, financial Stability, policy and Bank governance regulations.

According to Pesaran, Shin and Smith (1999, 2001), an ARDL (p, q,) representation of equation (1) is formulated as follows:

$$\Delta NPL_{it} = \alpha_0 + \alpha_{1i} NPL_{it-1} + \alpha_{2i} Ineff_{it-1} + \alpha_{3i} Prof_{it-1} + \alpha_{4i} Gloan_{it-1} + \alpha_{5i} Size_{it-1} + \sum_{j=1}^{p-1} \beta_{1ij} \Delta NPL_{it-j} + \sum_{j=0}^{q-1} \beta_{2ij} \Delta Ineff_{it-j} + \sum_{j=0}^{q-1} \beta_{3ij} \Delta Prof_{it-j} + \sum_{j=0}^{q-1} \beta_{4ij} \Delta GLoan_{it-j} + \sum_{j=0}^{q-1} \beta_{5ij} \Delta Size_{it-j} + \varepsilon_{it} \quad (2)$$

Where

α_0: The drift component;

Δ: The first difference operator;

εit: White noise error term.

To investigate the presence of long-run relationships among non-performing loans, managerial efficiency cost; bank profitability, credit growth and size, the bound testing procedure proposed by Pesaran, et al. (2001) is used. This procedure is based on the F-test that verifies the hypothesis of co-integration absence or existence among the variables, denoted as:

$$H_0: \alpha_{1i} = \alpha_{2i} = \alpha_{3i} = \alpha_{4i} = \alpha_{5i} = 0 \text{ (no co} - \text{integration)}$$
$$H_1: \alpha_{1i} \neq \alpha_{2i} \neq \alpha_{3i} \neq \alpha_{4i} \neq \alpha_{5i} \neq 0 \text{ (presence of co} - \text{integration)}$$

Pesaran et al. (2001) presented the acceptable bounds of critical values with which to compare the calculated F-statistics. For some level of significance, α, If the calculated F statistic is higher (lower) than the upper limit (lower) critical value, then the null hypothesis of non-co-integration is rejected (accepted). If the calculated F-statistic falls outside the critical limit, a conclusive inference can be made regarding co-integration without the need of knowing the order of integration of the series. If the calculated F-statistic falls outside the critical limit, conclusive inferences are often made regarding co-integration without the necessity to identify the series integration order. After affirmation of the presence of a long-term relationship between the variables within the model, the long run and

short run models can be determined. If the co-integration relationships are established, the equation of the long term can be estimated.

The last step is to study the dynamic relationship in the short-term, by estimating an error correction model (ECM). The error correction model (ECM) is defined as:

$$\Delta NPL_{it} = \alpha_0 + \sum_{j=1}^{p-1} \beta_{1ij} \Delta NPL_{it-i} + \sum_{j=0}^{q-1} \beta_{2ij} \Delta Ineff_{it-i} + \sum_{j=0}^{q-1} \beta_{3ij} \Delta Prof_{it-i} + \sum_{j=0}^{q-1} \beta_{4ij} \Delta GLoan_{it-i} + \sum_{j=0}^{q-1} \beta_{5ij} \Delta Size_{it-i} + \delta_i ECT1_{t-1} + \varepsilon_{it} \quad (3)$$

Where the residual ε_{it} is independent and normally distributed with zero mean and constant variance, and ECT_{it-1} is the error correction term defined from the long-run relationship. The parameter δ_i indicates the speed of adjustment to the equilibrium level.

4.3. Definitions and Measures of Variables

In this study, the variable to be discussed is Non-performing loans, which are calculated by dividing them by total gross loans.

On the other hand explicative variables are:

- Managerial inefficiency cost: measured by dividing operating expenses by operating incomes.
- Bank Profitability: measured by ROA and ROE.
- Credit growth: Measured by the difference between the current year's loan amount and the previous year's loan amount divided by the previous year's loan amount.
- Bank Size: measured by the logarithm of total Assets.

Based on Louzis et al (2012) study, Table 1 presents the bank specific variables and their corresponding specific hypothesis.

Table 1: Definitions and Measure of Variables

Variables	Definition	Hypothesis tested	expected sign
NPL	Aggregate non-performing loans to total gross loans		
Inefficiency	$\text{INEF}_{\text{it}} = \frac{\text{Operating Expenses}_{it}}{\text{Operating Income}_{it}} * 100$	Hypothesis 1	(+)
Profitability	$\text{ROA}_{it} = \frac{\text{Profits}_{\text{it}}}{\text{Total Assets}_{\text{it}}} * 100$	Hypothesis 2	(-)
	$\text{ROE}_{it} = \frac{\text{Profits}_{\text{it}}}{\text{Total Equity}_{\text{it}}} * 100$		
Credit growth	$\text{GLoans}_{it} = \frac{Loan_{it} - Loan_{it-1}}{Loan_{it-1}} * 100$	Hypothesis 3	(-)
Size	$\text{Size}_{\text{it}} = \log \text{Total Assets}_{\text{it}}$	Hypothesis 4	(-)

Source: author's compilation

4.4. Analysis of descriptive statistics

Table 2: Descriptive statistics of the variables

	NPL	**INEFF**	**GLOANS**	**ROA**	**ROE**	**SIZE**
Mean	16.82	35.86	5.55	0.40	4.37	6.14
Maximum	60.56	71.43	16.85	9.18	101.43	6.99
Minimum	0	0.671	0.0053	-12.22	-176.47	4.21
Std. Dev	11.33	12.62	4.99	2.16	20.98	0.59

Source: author's compilation and values obtained from Eviews

The descriptive statistics provided in Table 2, reveal that the average non-performing loans ratio, classified by the study, is 16.82%. The maximum value of NPL is 60.56%. We notice, therefore, that the Tunisian banking sector is characterized by a high level of non-performing loans, and we notice an upward trend in this rate in the18 Tunisian banks for the period 2010 to 2020.

5. Estimation Results

5.1. Unit root test

As a beginning, it is important to hold the unit root test to make sure that all the variables satisfy the underlying assumption of the ARDL model. The results of the unit root tests for the series with individual intercept or with individual intercept and trend, from Table 3 and 4 show that the NPL, managerial inefficiency (Ineff), credit growth (Gloans), and size are stationary in first differences. The different tests illustrate that they are not stationary in level. So, we can conclude that NPL, inefficiency, Gloans and size are integrated for order 1, I (1). However, most tests confirm the stationary of the variables ROA and ROE in level, so integrated for order zero (I (0)).

Table 3: Panel unit root results: series in level

		LLC	IPS	ADF	PP
NPL	Intercept	-9.9133 (0.0000)	-2.3454 (0.2985)	66.7449 (0.1452)	44.0354 (0.1681)
	Trend	-9.9140 (0.0000)	-0.0992 (0.4605)	40.1034 (0.2931)	40.9658 (0.2617)
Ineff	Intercept	-2.9207 (0.0017)	0.5225 (0.6963)	31.0526 (0.7028)	30.0239 (0.7478)
	Trend	-14.1079 (0.0000)	0.04743 (0.5189)	35.8268 (0.4768)	35.1817 (0.5073)
ROA	Intercept	-19.6348 (0.0000)	-4.1425 (0.0000)	61.6966 (0.0049)	60.4597 (0.0065)
	Trend	-12.5593 (0.0000)	-2.5232 (0.0058)	71.8177 (0.0004)	73.0864 (0.0003)
ROE	Intercept	-32.1545 (0.0000)	-6.2949 (0.0000)	66.8613 (0.0013)	74.5966 (0.0002)
	Trend	-23.1813 (0.0000)	-3.0118 (0.0013)	69.8726 (0.0006)	86.6968 (0.0000)
Gloans	Intercept	-2.8328 (0.0023)	0.6395 (0.7388)	35.9745 (0.4698)	43.7683 (0.1751)
	Trend	-9.3621 (0.0000)	-1.01128 (0.1559)	52.2230 (0.1393)	71.1026 (0.1123)
Size	Intercept	-8.9279 (0.0000)	-1.6754 (0.1469)	51.8888 (0.2420)	75.9099 (0.2101)
	Trend	-2.5828 (0.0049)	0.9720 (0.8345)	33.3529 (0.7752)	29.3646 (0.7752)

Notes: Table 3 shows the statistics of the panel unit root tests. The values in brackets are the corresponding p values.
Source: author's compilation and values obtained from Eviews

Table 4: Panel unit root test results: series in first difference

		LLC	IPS	ADF	PP
ΔNPL	Intercept	-5.1473 (0.0000)	-1.3824 (0.0834)	46.1641 (0.0195)	88.3325 (0.0000)
	Trend	-4.5550 (0.0000)	-0.1075 (0.0572)	39.6267 (0.0114)	91.2302 (0.0000)
ΔIneff	Intercept	-7.9138 (0.0000)	-2.9451 (0.0016)	67.8436 (0.0010)	115.992 (0.0000)
	Trend	-6.3217 (0.0000)	-0.7256 (0.0198)	52.2162 (0.0394)	135.843 (0.0000)
ΔROA	Intercept	-8.02683 (0.0000)	-6.1544 (0.0000)	110.839 (0.0000)	155.192 (0.0000)
	Trend	-8.7336 (0.0000)	-2.6069 (0.0046)	90.4991 (0.0000)	134.742 (0.0000)
ΔROE	Intercept	-12.8671 (0.0000)	-6.5466 (0.0000)	111.932 (0.0000)	163.110 (0.0000)
	Trend	-7.8621 (0.0000)	-3.0260 (0.0012)	99.4312 (0.0000)	147.526 (0.0000)
ΔGloans	Intercept	-9.9247 (0.0000)	-3.7448 (0.0001)	78.8309 (0.0000)	123.027 (0.0000)
	Trend	-10.0004 (0.0000)	-0.9121 (0.0808)	58.5583 (0.0101)	112.9 (0.0000)
ΔSize	Intercept	-2.8888 (0.0019)	-1.3190 (0.0936)	53.1539 (0.0326)	92.2332 (0.0000)
	Trend	-5.3441 (0.0000)	-0.4037 (0.0343)	46.7844 (0.0076)	113.614 (0.0000)

Notes: Table 4 shows the statistics of the panel unit root tests. The values in brackets are the corresponding p values.
Source: author's compilation and values obtained from Eviews

5.2. Co-integration bounds test

After performing the stationarity test, we must examine the long-run relationship among all the variables by applying the bounds test approach for the three models

The calculated F-statistics for the "bounds" tests are presented in Table 5. According to the table of Pesaran, (2001), the two sets of critical values are 2.88 and 3.99 and for 1% level. At 5% level the two sets are 2.27 and 3.28. At 10% level the two sets are 1.99 and 2.94.

The calculated F-statistic is higher than the critical value at 1%, 5% and 10% levels, respectively. This signifies that the null hypothesis of no co-integration can be rejected, and that there is a long-term relationship between non-performing loans and their key determinants, as managerial efficiency cost, bank profitability, credit growth and size.

Table 5: Co-integration bounds test

Dep. var	F-Statistic	Probability	Result
NPL	4.95	0.0001***	co-integration

*Note: ***at 1%.*
Source: author's compilation and values obtained from Eviews

5.3. Long run relationship estimation

Table 6: PMG/ARDL Long-run estimation

Bank Specific Variables	**Long Run Equation**	
	Coef.	**P>|z|**
Inefficiency	0.05	0.0392
Credit Growth	-1.68	0.0000
ROA	-3.52	0.0000
ROE	0.07	0.0011
Size	9.18	0.0000

Source: author's compilation and values obtained from Eviews

Long run results in table 6 show that all bank specific variables have a significant effect on non-performing loans.

The coefficient of the cost inefficiency variable is positive and statistically significant at 5%. This implies that the increase in banks management inefficiency leads to higher levels of non-performing loans' portfolios, so the first hypothesis is confirmed. This finding shows that Tunisian banks support the "bad management" and the "skimping" hypothesis. This result is in line with the finding of Berger and DeYoung (1997), Louzis et al. (2012), Ekanayake and Azeez (2015). More recently, Abid et al (2015) and Chaibi (2016) found a positive relation between inefficiency and NPL in Tunisian banks. This proves that Tunisian banks give credits without using sophisticated evaluation methods to detect, in advance, the insolvent creditors. Bad management increases the nonperforming loans because it is related to a weak borrower control, a bad credit scoring evaluation, and a weak warranties evaluation. To cope with this situation, the Tunisian Central Bank published, in May 2011, a new circular 2011-06, related to the reinforcement of good governance rules in lending institutions. It proposed important legal regulations for the management and the control of Tunisian banks, and contained nationally and

internationally recognized standards for responsible governance. Now the separation of control and of the tasks execution is recommended, risk management is prioritized and prudential management is required.

For the two profitability measurements, the results estimation are contradictory. In effect, for the first measure, we identify negative and statistically significant correlation between the ROA and NPL at 1% level, so the second hypothesis is confirmed. This negative correlation also coincides with the view that bad management can lead to risky activities and weak performance. Indeed, profitable banks have less incentive to generate revenue, so they are less constrained to engage in risky activities such as issuing risky loans. This result is reached by Boudriga et al (2009), Louzis et al (2012), Messai and Jouini (2013), and Peyavali (2015). However, in long run relation, the ROE has a positive and statistically significant correlation between the ROE and NPL at 1% level. This finding infirm the second hypotheses. Banks may adopt liberal credit policies to convince the market of the profitability of their loans, thereby inflating current earnings at the expense of future problem loans (Rajan (1994)). In fact, inefficient banks are obliged to issue credits deemed to be risky and subsequently obtain high-value impaired loans.

Credit growth has a negative and significant effect on the non-performing loans at the 1% level. This result confirm the third hypothesis in long run relation for Tunisian banks system. This result is in line with the findings of (Boudriga et al (2009), and Ekanayake and Azeez (2015), it reflects the conservative lending stance adopted by commercial Tunisian banks. It shows that credit exposure is not driven by aggressive commercial strategies. Banks that focus on credit activities are more likely to effectively assess the true credit quality of borrowers (Boudriga et al (2009)). Consistent with previous research, this study shows that as banks become more efficient, non-performing loans also decrease. Bank size is inversely proportional to non-performing loans.

Concerning the relationship between the bank size and non-performing loans, it is positive and significant at the 1% level in Tunisian banking sector. This result infirm the fourth hypotheses. This finding is in line with the studies of Stern and Feldman (2004), Jia (2009), Louzis et al. (2012) and Zhang et al (2016). It can be explained by the fact that most large Tunisian banks are the state banks. Indeed the public banks have a credit management less effective than that of the private banks. Stern and Feldman (2004) believe that large banks are more inclined to take risks

by issuing loans to low-quality borrowers. In fact, it is well known that the government protects large financial institutions and their creditors from bankruptcy. As a result, large banks may increase their leverage ratio to provide loans to lower-quality borrowers. According to Jia (2009), the Chinese banking industry is protected by the government, and its lending activities often have clear political motives. Their loans are more likely to flow to all inefficient industries in the country, and these industries are also likely to default, resulting in a high level of non-performing loans. Louzis et al. (2012), expect a positive correlation between the size of banks and the level of NPLs, based on the 'too big to fail' hypothesis.

5.4. Short-run Dynamics Estimation

Table 7: PMG/ARDL ECM estimation

Bank Specific Variables	ECM model	
	Coef.	**P>|z|**
C	-8.88	0.0001
D(Ineff)	0.20	0.0001
D(Credit Growth)	0.74	0.0066
D(ROA)	-1.36	0.0000
D(ROE)	-0.0048	0.0397
D(Size)	-6.08	0.0540
ECM(-1)	-0.32	0.0000

Source: author's compilation and values obtained from Eviews

The fact that the variables in our model are co- integrated gives support for using error correction model mechanism (ECM) representation to study short-term dynamics. In table 7, we find the same results of long run equation, for the managerial inefficiency and ROA. Consequently, we confirm the first and second hypothesis.

For the two profitability measurements, the estimation results strongly confirm the second hypothesis. Indeed, in this model ROE and ROA has a negative and significant effect on NPL at 5% level. This result is reached by Makri et al (2014) in Eurozone's banking systems. This means that poor performance will increase future NPLs, which is similar to bad management assumptions, because the lower cost inefficiency is due to poor manager performance.

Credit growth has a positive and significant effect on the non-performing loans at the 1% level. This result infirm the third hypothesis in short run relation for Tunisian banks system. The result of current study is consistent with the existing studies (Festic et al (2011), Fawad and Taqadus (2013), and zhang et al (2016)). Festic et al. (2011) recommended that procyclicality and high economic growth have increased the country's credit, but due to the inability of borrowers to repay loans, the decline in economic growth has led to an increase in NPLs.

According to the relationship between the bank size and non-performing loans in short run equation, it is negative and significant at the 10% level in Tunisian banking sector. The same result is reached by Salas and Saurina (2002), Hu et al. (2006), and Ekanayake and Azeez (2015), who have showed that large banks have a lot of resources to evaluate their loans, thereby improving the quality of loans. They reported an inverse relationship between the two variables. Salas and Saurina (2002) declared that large banks have more diversification opportunities, so they can reduce the level of non-performing loans. Hu et al (2006) stated that bank size is negatively related to the rate of NPLs, large banks have more resources to estimate and treat loans. These can improve the quality of loans, thereby effectively reducing the rate of non-performing loans. The size hypothesis shows that with the increase in size, banks should diversify their loan portfolio in order to reduce credit risk and increase the circle of operation to the other sectors (Fawad and Taqadus, 2013).

6. Conclusion

This paper examined the dynamic causal relationships between bank-specific variables and non-performing loans of the Tunisian banking sector over the period 2010-2020. The study presented some new empirical evidence on long-term and short-term dynamic causal relations based on the PMG/ARDL approach.

Firstly, the empirical results of bounds co-integration test and the entire error correction model revealed the existence of long-run association between these variables.

Secondly, the long-run estimation suggested that in Tunisian banks, the cost inefficiency, the ROE and the size affected positively the non-

performing loans. However, ROA and Credit growth had a negative effect on NPL.

Thirdly, the error correction model mechanism (ECM), which investigated the short run dynamics, show that the managerial inefficiency and credit growth are designed to increase the NPL but the ROA, the ROE and the size are considered to decrease the NPL.
The results obtained indicate that Tunisian banks should pay much more attention to several factors by granting loans, to decrease the NPL level. It can be assumed that prevention is the best way to deal with NPLs. This is achieved by developing a reasonable plan to collect the loan from the customer based on firm and objective rules and making rational decisions to guarantee that loans will not become non-performing loans. In effect, Banks should allocate sufficient effort to studying loan grant files and processing them properly, and allocate the necessary resources to follow up and monitor loans and evaluate collaterals. They should improve credit monitoring to ensure the loaned-out funds are intended for the intended purpose.

Banks should increase the amount of financial provisions for doubtful debts in case of expanding lending in order to reduce liquidity risks.

It is necessary to carry out programs for the restructuring of the banking sector, especially in terms of governance, implement a set of measures that aim at consolidating banks' capital, and strengthening prudential rules.

Tunisian banks must also consider the real economy performance when granting loans, as non-performing loans can reach high levels in times of recession.

There were a number of limitations to the study that should be addressed and possible extensions to these limitations could be explored in more depth. The first limitation is the relatively small size of our sample as only 18 of 21 Tunisian banks were included. The second is that the moral hazard problem has not been addressed in this paper, so we can include the impact of solvency ratio and loans to deposit ratio on NPLs. In this context, future studies might be conducted using more recent data to determine whether and to what degree this study’s recorded findings are confirmed.

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