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INFORMATION TECHNOLOGY: AN OPPORTUNITY FOR THE FINANCIAL STABILITY OF TUNISIAN BANKS IN TIMES OF CRISIS

Syrine BEN ROMDHANE[1] & Khaoula KENZARI[2]

[1]University of Tunis, Higher Institute of Management of Tunis, BESTMOD-Lab, Tunisia
[2]University of Tunis El Manar, Faculty of Economics and Management of Tunis, LAPE-Lab, Tunisia

Abstract

As the financial industry becomes more and more reliant on Information Technology (IT), it is extremely policy-relevant to understand the consequences for financial stability of a more intense use of technology in lending decisions. This study examines the impact of IT investment, and its components, on Tunisian bank stability for the period 2008 to 2018 using the Generalized Method of Moments estimates in first difference and in system of the dynamic model, before, during and after Revolution crisis. The study findings reveal that IT investment has a significant positive relationship with bank stability and a negative relationship with non-performing loans (NPLs). The evidence presented in this paper suggests that investing in IT is likely to be beneficial to financial stability. Therefore, our results indicate that IT-adoption helps banks to select better borrowers and produce more resilient loans. Banks that adopted more IT before the crisis have a significantly lower share of NPLs post-crisis than banks with less IT adoption. Our study further demonstrates that Tunisian banks should devote the largest share of their resources to investing in software and services because by combining such investments with investments in hardware, banks will be less affected by a possible increase of NPLs during and after crisis, and then improve their financial stability.

Keywords

Dynamic Panel, Financial Stability, Information Technology, Non-Performing Loans.

JEL classification: D82, D83, E44, G14, G21, O3

Corresponding author: Syrine BEN ROMDHANE

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1. Introduction

There is no doubt that the world is witnessing massive changes in the field of information technology (IT). It is assumed that no other field is changing as rapidly as IT. The observed changes have created a greater dependence on IT facilities in almost all areas of life and business. This is probably since increased reliance on IT improves excellence, quality, efficiency, and effectiveness (Singh et al., 2015).

Banks' massive investments in IT have generated a debate on the financial stability impact of IT (Boot et al., 2021; Carletti et al., 2020). According to Di Maggio and Yao (2021), IT has been changing the way information is processed and the relative consequences for credit allocation and performance. However, a paramount question that remains largely unaddressed is whether IT adoption affects banks' resilience during periods of financial stress. High levels of non-performing loans (NPLs) weigh on banks' profitability and can, therefore, limit their lending, depressing real economic activity. According to Berg et al. (2020), technology boosts banks' performance by enhancing their monitoring and screening capabilities, improving their lending decisions, facilitating the selection of the best borrowers, thereby reducing the probability of loan default. For banks, disruption from IT poses a challenge (Truby et al. 2020). On the one hand, banks are being forced to lower their risk levels, increase capital adequacy, and improve the stability of their revenue pools due to the continued escalation in regulation (Buchak et al. 2018). On the other hand, banks are threatened by technological advancements as IT may reduce the banks' market share, leading banks to make riskier investments (Rupeika-Apoga & Wendt 2021). As a result, banks must adapt to a changing environment (Varma et al., 2022).

The level of NPLs has widely been considered an important indicator for banking sector distress (Demirgüç-Kunt & Detragiache, 2002) and a strong increase is associated with severe adverse macroeconomic consequences (Peek & Rosengren, 2000). While IT adoption improves banks' resilience, it can also protect their ability to extend credit to their customers during (and just after) financial turmoil. In doing so, we contribute to the organizational resilience literature

by studying how banks' pre-shock characteristics shape their subsequent ability to endure a shock (Buyl et al., 2019). For example, Pierri and Timmer (2020) show that firms that adopted IT experienced lower levels of NPLs and higher credit growth during the global financial crisis. However, the use of "hard information" provided by IT solutions may also lead to deteriorating borrowing terms for opaque clients (e.g., SMEs or start-ups) or excessive securitization associated with lower lending standards (Boot et al., 2021).

The impact of IT on bank stability has been widely studied (Boot et al., 2021; Carletti et al., 2020; Pierri & Timmer, 2020). However, whether -and to what extent- these IT impact bank financial stability is unexplored. Also, and to the best of our knowledge, these studies do not consider the impact of technological investments on banking financial stability. What is meant by technological investment here is an upgrade in trading systems through software, hardware and services. So, to fill this gap, and to understand the potential impact of IT investment, and its components, on financial stability, we study the NPLs on the balance sheet of Tunisian banks before, during and after the Revolution crisis. Therefore, this study aimed to address this research question: How have Tunisian banks that have adopted IT been able to contain the surge in NPLs during and after the crisis? The motivation for conducting this study came from three important sources. Firstly, to our knowledge, no systematic empirical study has been carried out on this subject in the Tunisian context. This study will attempt to fill this gap. Secondly, we believe that this topic is important and deserves to be examined empirically because the IT market is growing exponentially, and the banking sector is under market pressure to adopt advanced ITs in its day-to-day transactions and services. However, introducing these technologies simply to compete with new entrants at the cost of financial stability can put the entire banking sector at risk. Financial instability can occur if unhealthy competition and less goal-oriented IT services are added to the product base of banking services. Finally, our study adds to the literature and knowledge on the importance of IT investments for the financial stability of banks.

This study has important implications for regulators, policymakers, and bank managers. It provides important insights for regulators to adopt strategies to promote IT development to ensure the banking industry’s financial stability. Our research can guide policy makers to promulgate IT related policies and ensure good governance, as IT development promotes banking stability. This study’s findings may also guide bank managers to augment IT-based financial services.

The remainder of this paper is structured as follows. Section 1 summarizes the relevant theoretical and empirical literature and presents the hypotheses development. Section 2 provides information about the IT investments of Tunisian banks. Section 3 reports on the data and methodology used. Finally, section 4 illustrates empirical results and a discussion. This section will be followed by a conclusion and policy implications.

2. Literature Review and Hypotheses Development

This section assesses the impact on financial stability of IT-induced changes in the banking sector. In recent years, IT has transformed the banking industry. Therefore, excessive reliance on IT solutions can lead to additional risk taking and even increase systemic risk in the banking system. Rajan et al. (2015) show that statistical models underestimated default risk before the global financial crisis in a systematic way, especially for borrowers for whom soft information

was more valuable. Concerns about systemic risk may stem from reliance on computer models that account for risk in the same way and, in the process, make the same errors. Evolving transaction-based banking operations, driven by IT developments, present an additional challenge to regulators. IT developments allow for rapid expansion that can lead to excessive risk-taking in the banking industry (Marinč & Vlahu, 2011). On the other hand, the non-relational nature of deposits has an impact on bank stability. Relationship-oriented core deposits appear to be more stable than market-based deposits. Shin (2009) showed that during the Northern Rock failure, internet, telephone, offshore, and postal accounts were depleted to a much greater extent than core branch deposits. In addition, the combination of the increasingly non-relational nature of bank lending and non-relational market-based deposits can increase bank fragility (Song & Thakor, 2007). In their study on the US commercial banks, Pierri and Timmer (2020) investigate the relationship between banks' IT adoption before the global financial crisis and their NPLs during and outside the crisis. Empirical evidence indicates a direct role of IT adoption in strengthening bank resilience; this includes instrumental variable estimates exploiting the historical location of technical schools. The authors present evidence pointing towards a causal impact of IT on banks' performance during the crisis. They evaluate different potential mechanisms for the impact of IT, including better screening of borrowers, better monitoring, differences in business models, and offload of risks to government-sponsored enterprises (GSEs).

The results of previous studies on the impact of IT investment on bank performance are contradictory, which arouses the interest of researchers who wish to clarify the nature of this relationship and its main determinants. While the works of Ben Romdhane (2013, 2021), Feronika and Kurniawati (2022), Nwakoby et al. (2020), Skvarciany et al. (2019), asserted that there is a positive impact of IT on bank performance, the results of Licht and Moch (1999), Prasad and Harker (1997) argued the opposite. Research conducted by the first group of authors proved that internet banking, mobile banking, and Automated Teller Machine (ATM) are considered to be able to improve the performance of commercial banks because they can increase banking efficiency, effectiveness, and productivity. Nevertheless, Research conducted by the second group of authors confirmed the "*Productivity Paradox*" of Robert Solow (Nobel Prize for economics in 1987) and attested that high IT investments are not associated with better performance.

The other issue of whether IT investment increases or reduces bank financial stability remains unexplored. We present, here, the most revealing works. Using a sample of 26 banks from an emerging market (Malaysia), over the period 2003-2018, Safiullah and Paramati (2022) found that IT investment increases bank financial stability. According to these authors, banks are forced to make risky investments, which will eventually lead to a reduction in their financial stability. Alternatively, due to the increasing presence of IT in the financial system, banks may be forced to adopt IT in their banking business, which may eventually help them operate efficiently and maintain their customer base and revenues, thereby maintaining their financial stability. Pierri and Timmer (2020) analyzed the implications of lenders' information technology adoption for financial stability. They estimated bank-level intensity of IT adoption before the global financial crisis using a novel dataset that provides information on hardware used in US commercial bank branches after mapping them to their parent bank. They found that higher

intensity of IT-adoption led to significantly lower NPLs when the crisis hit. These results suggested that technology adoption in lending can enhance financial stability through the production of more resilient loans.

As for the impact of hardware, software and services investments on bank performance, we present the results of the few research studies carried out by Beccalli (2007) and Ben Romdhane (2013). Beccalli (2007) found a positive relationship between total IT investment and performance in a study of the European banking sector (a sample of 737 banks) during the period 1994-2000. Using the Stochastic Frontier Analysis (SFA) to estimate the efficiencies of costs and benefits for European banks, the author showed that the impact of different types of IT on the performance of European banks was heterogeneous. While investment in services was positively related to bank profitability, acquisitions of hardware and software had a negative impact on performance. Likewise, the examination of the impact of different IT components (hardware, software and services) on the cost efficiency of Tunisian banks, conducted by Ben Romdhane (2013), provided an important conclusion: the "*productivity paradox"* does not affect the entire IT investment: opportunities associated with the acquisition of software are only effective in combination with hardware acquisitions and investments in services.
Accordingly, we propose the following competing research hypotheses:

H1*: Investment in information technology has a negative impact on bank NPLs.*

H1a*: Investment in hardware has a negative impact on bank NPLs.*

H1b*: Investment in software has a positive impact on bank NPLs.*

H1c*: Investment in services has a positive impact on bank NPLs.*

3. IT investments in Tunisian banks

According to Laudon and Laudon (2006), IT plays an essential role for four reasons: the weight of its investments, its contributions to the operation of banks, its productivity, and finally, its strategic advantages. In order to better measure the impact of IT on the firm's performance, it is necessary to assess the IT investment that goes beyond mere hardware expenditures. In fact, it is necessary to add expenses of various kinds such as computer hardware, networks and telecommunications, software and services. Therefore, these different components of IT should be defined: Computer hardware is the set of technological platforms. These include mainframes, local computers, laptops and desktops and peripheral parts used for the acquisition, storage, restitution and transmission of information; Software is a collection of information related to automate processing. Software includes Personal Digital Assistants (PDAs) and internal and/or external applications that can be accessed locally or remotely via an internet, extranet or intranet. Services allow transmission of the data, the consulting services, the implementation services, the operational services, the advice and education, and the training and maintenance. According to Ayadi (2014), the acquisition of information by the bank is carried out by two means corresponding to two technologies of information processing and credit granting. An external (hard information) mean which aim to quantify the risk of customers by statistical

methods (balance sheet data, rating, score balance...). The technologies used to grant credit are in this context score models. They produce hard information; and an internal (soft information) one which is interested in the banking relationship between the banker and his client. The banker's relationship with his client involves bank-borrower interactions. The bank thus collects private and non-financial information about the borrower's professional situation, reputation, management capacity and quality and its market positioning. This is soft information. Table 1 provides a detailed breakdown of Tunisian banks' IT investments in the three categories mentioned above: hardware (HA), software (SO) and services (SE), during the period 2008-2018.

Table 1 shows that IT investment in Tunisian banks is highly fluctuating. Also, Tunisian banks give more importance to tangible investments than to intangible and service-related investments over the whole studied period. In this context, it is interesting to note that, in 2018, Tunisian banks attached more importance to software than to hardware, since the share invested in software becomes almost equal to that invested in hardware. This result is explained by the fact that these banks are required to follow the technological evolution of the banking system. In fact, investing in software has today become a necessity rather than a choice. Indeed, these technologies are essential tools that banking institutions must manage and master to ensure their competitiveness. They have been integrated into the productive system of banks following the emergence of new equipment and the evolution of their needs.

Table 1. Investments in IT in Tunisian banks during the period (2008-2018).

Years	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Variation of total IT investment (%)	-	11,80	-5,78	-1,15	1,52	6,75	11,55	-0,07	-1,44	19,88	15,70
Variation of investment in HA (%)	-	17,91	-10,52	3,57	-2,72	8,37	3,34	16,46	-5,48	16,94	23,52
Variation of investment in SO (%)	-	0,38	13,24	-3,30	12,46	6,40	13,30	-14,81	4,20	29,79	1,35
Variation of investment in SE (%)	-	13,78	-19,73	-11,65	-7,14	1,47	40,41	-16,68	2,57	7,99	23,35
Investment in HA / Total IT investment (%)	50,84	53,62	50,92	53,36	51,13	51,91	48,09	56,04	53,74	52,42	55,97
Investment in SO / Total IT investment (%)	30,45	27,34	32,86	32,14	35,61	35,49	36,05	30,73	32,49	35,17	50,66

Investment in SE / Total IT investment (%)	18,71	19,04	16,22	14,50	13,26	12,61	15,87	13,23	13,77	12,40	21,74

4. Methodology and Data

In this section, we investigate the relationship between banks' IT adoption and their NPLs in period of crisis. This section describes our variables, data sources and methodology. For this research, we considered a database made up of variables whose choice was guided by recent studies on banks' financial stability (Chen et al. 2021; Hu et al. 2022; Safiullah & Paramati, 2022; Sheng, 2021). The literature review exposed above enabled us to identify a set of variables supposed to explain variations in NPLs' levels among banks. We have selected those which seem to better characterize the Tunisian banking system and whose data are available throughout the study period (2008-2018).

4.1 Sample Presentation

To determine the impact of IT investment on banks' financial stability, we use a sample of 12 Tunisian banks. The database that we have built for this analysis depends on the availability of data in Tunisia. However, the only publicly available individual banking data are those published in banks' activity reports and by databases of the Tunisian Professional Association of Banks and Financial Institutions (TPABFI), the latter themselves taken from balance sheets and accounts of results published by banks. The data are collected over 11 years from 2008 to 2018, that's to say 132 observations.

4.2 Definition of Variables

In the model that we will adopt, NPLs will be regressed on the use of IT (variable of interest) and other appropriate variables (control variables). To analyze the factors explaining the volatility of non-performing bank loans, we introduce the NPLs variable measuring the cost of credit risk. This is the litigation rate calculated by the ratio of overdue debts to total loans (Ben Romdhane & Kenzari, 2020). This article mainly selects the NPL rate as an indicator to reflect the bank's credit risk management level, because in Tunisia, the NPL rate is an important indicator reflecting the quality of the bank's operation and directly related to the bank's credit level. A high NPL ratio denotes bank instability due to high default risk (Chinoda & Kapingura, 2023). The variable of interest is the total investment in IT. According to Beccalli (2007), we use the IT/Equity ratio (IT share of bank equity) for measuring IT investment. This study uses firm size (SIZE), capitalization (CAP), profitability (ROA), average staff salaries (ASS), share of wholesale funding over assets (FUND) and debt capacity (DEBT), as control variables. Firm size is measured by the natural logarithm of total assets (Almulla & Aljughaiman, 2021). In previous research on NPLs, the results focused on the relationship between firm size and NPLs are mixed. For example, while Agoraki et al. (2011) found a negative relationship between these two variables, Ben Romdhane and Kenzari (2020), Louzis et al. (2012) rather found a

positive relationship, supporting that large banks that manage their resources more efficiently are accepting risky projects. Also, to control the differences, in terms of credit risk, relating to the capital structure of the bank, we take into account the capitalization variable which is equal to the ratio of shareholders' equity to the total assets of the bank (Pathan, 2009). The bank's capital can influence its management risk. High capital induces large losses for shareholders in case of bank failure (Repullo, 2004), and such high level of capital is to limit the likelihood the bank will act in a less careful way when granting loans (Dell'Ariccia et al., 2013). Bank profitability is measured by the ROA, return on assets. The study of profitability in terms of flow ensures that the sustainability of benefits and severity of risks incurred are taken into account (Ben Romdhane & Kenzari, 2020). Higher profitability often contributes to lower NPLs, as better managed banks are believed to have higher quality assets (Love & Ariss, 2013). Makri et al. (2014) have emphasized the relationship between the "DEBT" variable, measured by the ratio of loans to total deposits, and NPLs. This ratio indicates bank liquidity by measuring the funds banks use to lend from collected deposits (Saiful & Ayu, 2019). Banks that are less dependent on deposits are more oriented towards external sources of funding, and therefore, the transfer of risk from the internal capital market would be more visible (Ben Romdhane & Kenzari, 2020). The share of wholesale funding over assets (FUND) variable, measured by the ratio of funding to total assets, is used as evidence of partners' trust in a framework of ex-ante informational asymmetries. Indeed, the higher this ratio is, the lower the risk of asset substitution, since the partners would be the first to be robbed in the event of an excessively risky investment (Ayadi, 2014). Finally, average staff salaries (ASS) variable is measured by the natural logarithm of average salaries. When reviewing the literature, this article found that scholars have different conclusions on the relationship between average staff salaries and risk-taking. Some authors have found a significant negative correlation between ASS and NPLs of banks (Meng & Yang, 2021), others have found a positive relationship between these variables (Wang, 2020), and even a non-linear correlation (Li et al., 2016). **Table 2** defines the different variables retained in our study and presents the corresponding sources.

Table 2. Definition of variables and data sources.

Variables	Definition	Sources
The dependent variable		
Non-performing loans (NPLs)	This is the litigation rate calculated by the ratio of overdue debts to total credits.	CBT and TPABFI
The independent variables		
Variable of Interest: Total Investment in IT (IT)	Tangible (Hardware: HA), intangible (Software: SO) and services (SE) investments related to the bank's equity.	Questionnaire*

Control Variables		
Size (SIZE)	Natural logarithm of total assets (in TD)	ARB
Capitalization: shareholder equity ratio or equity ratio (CAP)	Capital / Total Assets (in %)	ARB
Profitability (ROA)	ROA: Net income / Total assets (in %)	ARB
Average staff salaries (ASS)	Natural logarithm of average salaries	ARB
Share of wholesale funding over assets (FUND)	Funding/Total Assets	ARB
Debt capacity: measure of liquidity (DEBT)	Loans/Total Deposits	ARB
Revolution crisis (REV)	Dummy variable	

ARB: Annual reports of banking activities. TPABFI: Tunisian Professional Association of Banks and Financial Institutions. CBT: Central Bank of Tunisia.

* To collect data relating to IT investments from Tunisian banks, we opted for a questionnaire to be sent to Management Control Directors or Information System Directors of these banks. This questionnaire aims to find out the amounts invested in IT during the period 2008-2018 (in thousands of Dinars, TD).

4.3 Model

In our study, the sharp increase in the ratio of overdue debts to total credits occurred after the revolution, in the years from 2011-2014. Therefore, we define these years as the crisis period (Pierri & Timmer, 2020). To examine the impact of IT adoption on NPLs, we collect data on 12 Tunisian banks. In a first step, to investigate whether banks with different levels of IT adoption experienced different levels of NPLs before, during and after this period, we follow Albuquerque et al. (2020) and Ding et al. (2021), and we start by estimating the following static panel equation (**Model 1**):

$$NPL_{b,t} = \alpha_b + \delta_t + \beta IT_b . REV_t + (X_b \times REV_t)\,\Upsilon + \varepsilon_{b,t} \qquad (1)$$

Where $NPL_{b,t}$ is the value of the NPLs of bank b in year t. IT_b is our measure of bank-level IT adoption before the crisis, REV is the Revolution crisis, $\alpha_b + \delta_t$ are bank and year fixed effects, respectively. X_b is a vector of bank level variables that may be associated with NPLs during the crisis. The vector contains several bank characteristics: the loan-to-deposits ratio, size as measured by the log of total assets, the share of capital to assets, the share of wholesale funding to assets, ROA, and the log of average wages. Second, we estimate different version of equation 1 via OLS, together with standard error double-clustered at the bank and year level.

Whereas NPLs are a dynamic phenomenon, and recent research findings on NPLs confirm that their past value has an impact on their current value (Radivojevic et al., 2019; Skrabic Peric et al., 2018). Thus, in the second step of our investigation, it would be obvious to use dynamic

panel data estimators. Our model will then be estimated with the lags of the endogenous variable (**Model 2**). Thus, the estimated dynamic equations take the following form:

$$NPL_{b,t} = \Sigma \varphi_m NPL_{b,t-1} + \beta IT_{b,t} + \delta X_{b,t} + \mu_b + \rho_{b,t} \quad (2)$$

$IT_{b,t}$ is the information technologies' investment of bank b in year t. $X_{b,t}$ is the vector of the control variables. $NPL_{b,t-1}$ is the lagged endogenous variable. We also assume that the absolute value of the sum of the parameters φ_m is lower than the unit and that $\rho_{b,t}$ is the zero expectation error term with $E(\rho_{b,t}^2) = \sigma_\rho^2$ variance. Moreover, these stochastic disturbances are independent of the specific effects (μ_b) and are not correlated when taken in pairs. However, the presence of a lagged variable makes the usual estimation techniques on panel data inappropriate. This is due to the correlation between the endogenous variable and the residuals from the regression. To overcome this problem, the method of instrumental variables applied to the first difference model (to eliminate individual fixed effects) allows endogeneity to be taken into account by the use of lagged explanatory variables as instruments. We distinguish two approaches to estimate the empirical model: The first difference GMM estimator (DGMM) of Arellano and Bond (1991) and the system GMM estimator (SGMM) of Blundell and Bond (1998). Thus, in our study, we use both DGMM and SGMM estimators for empirical verification of the proposed model. Between the first difference GMM method and the second difference GMM method, the first difference GMM estimator is chosen because it tends to be less biased when the sample size is small.

In the third step of our research, to investigate whether banks with different levels of hardware, software and services adoption experienced different levels of NPLs before, during and after crisis period, we consider the following regression model (**Model 3**):

$$NPL_{b,t} = \Sigma \varphi_m NPL_{b,t-1} + \beta HA_{b,t} + \beta SO_{b,t} + \beta SE_{b,t} + \delta X_{b,t} + \mu_b + \rho_{b,t} \quad (3)$$

$HA_{b,t}$, $SO_{b,t}$ and $SE_{b,t}$ are respectively the investment in hardware, software and services of bank b in year t. $X_{b,t}$ is the vector of the control variables. $NPL_{b,t-1}$ is the lagged endogenous variable.

5. Results and discussion

5.1. Descriptive Statistics

Before outlining our econometric estimates, a descriptive analysis of our data that aggregates the observations of different individuals seems to be crucial. **Table 3** shows that the average NPL ratio for the sample for the study period 2008 to 2018 is approximately 13.75%. The minimum value of the variation in the ratio of ant NPLs recorded in Tunisia is of the order of 5%, while the maximum is 36%. It is therefore noticeable that the Tunisian banking sector is

characterized by a high level of NPLs, given that unpaid credits relating to the household sectors have increased, especially over the period 2011-2016. Also, as this table shows, the correlation coefficients between the different explanatory variables are low. Thus, no variable will be excluded from the model. It can be seen from this table that the correlation coefficient between NPLs and IT is (-0.063), and NPL and IT are negatively correlated at a significance level of 0.05, which is basically consistent with hypothesis ***H1***.

Table 3. Descriptive statistics and correlation matrix for Tunisian banks.

Variable	NPL	IT	SIZE	ROA	CAP	ASS	FUND	DEBT
Obs	132	132	132	132	132	129	132	132
Mean	13.751	43.964	14.992	0.837	9.209	11.122	9.269	87.377
Std. Dev.	6.467	193.019	1.000	0.984	5.742	1.854	44.201	92.247
Min	5	-9.045	11.01	-4.48	-1.622	6.782	0.082	0.063
Max	36	1126.178	16.29	2.74	34.157	18.380	316.805	694.027
NPL	1.0000							
IT	-0.063*	1.0000						
SIZE	-0.0750*	0.0100*	1.0000					
ROA	-0.5175*	0.0456*	0.2291*	1.0000				
CAP	-0.3058	-0.3629*	-0.4392*	0.2799*	1.0000			
ASS	-0.0836	0.1021	0.4710*	-0.0010*	-0.3555*	1.000		
FUND	0.1780	-0.0351*	-0.2710	-0.1477*	-0.0618*	-0.1694*	1.000	
DEBT	-0.1480*	0.6425*	-0.1867	0.0986	-0.2495*	0.0762	0.0062*	1.000

Note: * indicate statistical significance at 5%.

5.2 Empirical Results

Table 4 presents the results of the panel regressions in normal times and in period of crisis. The base effect of technology adoption on NPLs is negative but not statistically significant. We do not find that IT adoption significantly affects NPLs during normal times. However, the interaction between the crisis dummies and IT adoption is negative and statistically significant. In times of the crisis banks that adopted more IT before the crisis had a significantly lower share of NPLs than banks with less IT adoption, which is consistent with hypothesis ***H1***. This result is robust to the inclusion of bank and year fixed effects and various controls. In addition, the coefficient is stable across specifications, suggesting a low correlation between the controls included and the measure of IT adoption. Table 5 presents the results of the estimates of the GMM method in first difference and GMM in system of the dynamic model before and after Revolution crisis (**Model 2**). Additionally, we assess both the contemporaneous and lagged

effects of IT investment on NPLs (Safiullah & Paramati, 2022). The use of the lagged values of the independent variables serves two purposes: First, it addresses the reverse causality concern, and second, it allows some time for the independent variables to impact the dependent variable. This is important for our study, as IT investment firms' impact on bank stability may not be observed immediately. The use of lagged values of IT variable resolves this impact in relation to the period. Sargan's test for GMM estimates shows that all the selected instruments are validated. The first and second order tests of the AR(1) and AR(2) serial correlation confirm the expected diagnoses. Thus, the AR(1) test rejects the null hypothesis of a first-order serial non-correlation. The results of the estimation of our model according to two dynamic approaches: DGMM and SGMM show that the lagged dependent variable of NPLs is statistically significant at the 1% threshold and positive, confirming the results of recent studies (Radivojević et al. 2019). There is then a positive and significant relationship between the NPLs lagged variable and the current NPLs rate.

Table 4. The results of the panel regressions.

In normal times (without crisis): 2008-2010			**In period of crisis: 2011-2014**		
Dependent Variable: NPLs before Revolution crisis			**Dependent Variable:** NPLs during Revolution crisis		
	Linear Regres-sion (**Model 1**)	Cross-Sectional Regression (GLS) (**Model 1**)		Linear Re-gression (**Model 1**)	Cross-Sectional Regression (GLS) (**Model 1**)
IT	-0.006	-0.006	**IT × REV**	-0.006**	-0.006***
	(-2.62)	(-2.04)		(-2.08)	(-1.15)
SIZE	-0.731	-0.731	**SIZE × REV**	0.689***	0.689
	(-0.81)	(-0.93)		(2.65)	(1.83)*
ROA	-2.487**	-2.487***	**ROA × REV**	-2.713***	-2.713***
	(-2.48)	(-4.37)		(-2.94)	(-4.91)
CAP	-0.339**	-0.339***	**CAP × REV**	-0.304**	-.304**
	(-2.23)	(-2.78)		(-2.30)	(-2.16)
ASS	-0.440***	-0.440	**ASS × REV**	-0.318	-0.318
	(-2.98)	(-1.52)		(-1.34)	(-0.67)
FUND	0.021	0.021	**FUND × REV**	0.039**	0.039
	(1.40)	(0.84)		(2.15)	(1.55)
DEBT	-0.022***	-0.022***	**DEBT × REV**	-0.017***	-0.017**
	(-3.94)	(-3.15)		(-3.91)	(-2.53)
_CONS	36.378**	36.378***	**_CONS**	12.796***	12.796***
	(2.57)	(3.07)		(10.87)	(13.28)

(Within) R-squared	0.3755	0.2447	(Within) R-squared	0.2896	0.5177
Number of obs.	36	36	Number of obs.	48	48

Results of estimating the following equation: $NPL_{b,t} = \alpha_b + \delta_t + \beta IT_b . REV_t + (X_b \times REV_t)\Upsilon + \varepsilon_{b,t}$

Where *b* is a bank, *t* one year between 2008 and 2018. *REV* a dummy variable indicating years 2011 to 2014. α_b are bank fixed effects, and δ_t are year fixed effects. The dependent variable $NPL_{b,t}$ is the ratio of overdue debts to total credits in *b*'s regulatory filing for year *t*. IT_b is the pre-crisis IT-adoption of bank *b*. The bank-level set of controls X_b includes pre-crisis (2008-2010) and during crisis (2011-2014) average of: the loans to deposits ratio (DEBT), the capital to assets ratio (CAP), the wholesale funding ratio (FUND), ROA, the (log of) average wages in thousands of Dinars (ASS), and the (log of) assets size in thousands of Dinars (SIZE).

(.) t of Student

**** Significance at 1%, ** 5%, * 10%*

Since NPLs have a high degree of persistence, this expected result indicates that the NPLs shock is likely to have a lasting effect on the banking system. In pre-crisis period, the effect of IT adoption on NPLs is negative but not statistically significant. However, this interaction becomes statistically significant at the 5% threshold post-crisis, based on the estimation results of the DGMM and SGMM models (**Table 5**). Also, results show that lagged effect (one year) of IT investment on the NPLs of Tunisian banks is significant and negative across alternative models. Notably, the lagged impact of IT on financial stability is greater, and this evidence is consistent across alternative models. This result confirms the one found in the estimation of **Model 1**. Once again, banks that adopted more IT before the crisis had a significantly lower share of NPLs post-crisis than banks with less IT adoption. This result is again consistent with hypothesis ***H1***. Overall, these results suggest that the lagged impact of IT is greater on banks' financial stability than the contemporaneous effect. These findings indicate that the banks begin responding and taking appropriate actions to improve their financial stability when they begin to experience the competition from the IT in the market. The estimates demonstrate a significant relationship between bank size and NPLs in the two periods: pre and post-Revolution crisis. The sign obtained is positive. This indicates that large Tunisian banks that manage their resources more efficiently are accepting risky projects. Indeed, these banks will be protected by the State in case of bankruptcy. Consistent with Louzis et al. (2012), larger banks had a stronger increase in NPLs than smaller banks. The bank's capital shows a negative and significant relationship at the 10% threshold pre-crisis and at the 5% threshold post-crisis with the banks' NPLs. This shows that banks with large capital have fewer NPLs. It appears that Tunisian banks with a high level of capital act prudently when granting loans. Again, these banks avoid riskier customers because of the large potential losses to shareholders in the event of bank failure. This result confirms that found by Ben Romdhane and Kenzari (2020). Based

on dynamic panel estimation methods, pre- and post-crisis wholesale funding and the ROA ratio did not have a significant impact on NPLs. However, the share of loans relative to deposits shows a positive and significant relationship at the 5% threshold pre-crisis and at the 1% threshold post-crisis with the banks' NPLs. Banks that had more loans as a share of deposits had a stronger increase in NPLs. Also, the results find that there is a negative correlation between the excess average staff salaries (ASS) and corporate risk-taking in both periods, consistent with Meng and Yang (2021).

Table 5. The results of the GMM estimates of a dynamic panel data model before and after Revolution crisis.

	GMM in first difference	**First-order SGMM**	**GMM in first difference**	**First-order SGMM**
	Dependent Variable: NPLs before Revolution crisis		**Dependent Variable**: NPLs after Revolution crisis	
NPL (-1)	0.404***	0.428***	0.435***	0.412***
	(3.53)	(3.46)	(2.28)	(3.11)
IT	-0.014	-0.014	-0.221**	-0.220**
	(-2.22)	(-2.21)	(-1.65)	(-1.64)
IT (-1)	-1.345**	-2.546**	-0.154***	-0.422***
	(-2.54)	(-3.87)	(-5.35)	(-8.55)
SIZE	21.581**	21.174**	18.35***	17.54***
	(2.22)	(2.16)	(4.32)	(4.00)
ROA	3.892	3.820	2.657	2.546
	(1.34)	(1.30)	(0.03)	(0.12)
CAP	-1.370*	-1.433*	-0.453**	-0.411**
	(-1.88)	(-1.90)	(-0.65)	(-0.70)
ASS	-21.376**	-20.812**	-18.765*	-16.873*
	(-2.20)	(-2.13)	(-1.76)	(-1.65)
FUND	0.004	0.004	0.065	0.065
	(0.81)	(0.83)	(2.64)	(2.87)
DEBT	0.075**	0.073**	0.198***	0.180***

	(2.31)	(2.22)	(3.51)	(3.56)
Number of obs.	36	36	48	48
AR(1) Test. p-value	0.534	0.341	0.365	0.276
AR(2) Test. p-value	0.298	0.236	0.113	0.159
Number of instruments	61	62	54	55
Sargan test (p-value)	0.167	0.128	0.121	0.254

Results of estimating the following equation: $NPL_{b,t} = \Sigma \varphi_m NPL_{b,t-1} + \beta IT_{b,t} + \delta X_{b,t} + \mu_b + \rho_{b,t}$

Where b is a bank, t one year between 2008 and 2018 (before Revolution crisis: 2008-2010, and after Revolution crisis: 2015-2018). The dependent variable $NPL_{b,t}$ is the ratio of overdue debts to total credits in b's regulatory filing for year t. $NPL_{b,t-1}$ is the lagged endogenous variable. IT_b *is* IT-adoption of bank b. $IT_b(-1)$ is the lagged investment of IT variable. The bank-level set of controls X_b includes the pre and the post-crisis average of: the loans to deposits ratio (DEBT), the capital to assets ratio (CAP), the wholesale funding ratio (FUND), ROA, the (log of) average wages in thousands of Dinars (ASS), and the (log of) assets size in thousands of Dinars (SIZE).

(.) t of Student

**** Significance at 1%, ** 5%, * 10%.*

AR(1) et AR(2) are tests of serial correlation of first and second order of Arellano and Bond.

For further analysis, we investigate whether banks with different levels of hardware, software and services adoption experienced different levels of NPLs before, during and after crisis period. The estimation results of **Model 3**, presented in **Table 6**, show a negative correlation between each component of IT investment and NPLs of Tunisian banks, for all models and all periods. We then confirm the hypothesis ***H1a*** and reject the hypotheses ***H1b*** and ***H1c***. It is interesting to note that, before Revolution crisis, investment in hardware has a significant effect on banks NPLs, unlike the other IT components. This seems logical since investment in hardware reduces the cost of granting credit and increases the speed of decision making by increasing the volume of loans granted, as well as the risk-adjusted pricing, thus reducing credit rationing (Ayadi, 2014). However, the interaction between software investment and NPLs becomes statistically significant at the 5% threshold (SGMM) during and after Revolution crisis, and the one between services investment and NPLs becomes statistically significant at the 5% threshold (DGMM and SGMM) in the same periods. Therefore, we can conclude that Tunisian banks should devote the largest share of their resources to investing in software and services because by combining such investments with investments in hardware, banks will be less affected by a possible increase of NPLs during and after crisis, and then improve their financial stability.

Table 6. Components of IT investment and NPLs before, during and after crisis.

	Cross-Sectional Regression (GLS)	**GMM in first difference**	**First-order SGMM**	**GMM in first difference**	**First-order SGMM**	**GMM in first difference**	**First-order SGMM**
	Dependent Variable: NPLs entire period	**Dependent Variable**: NPLs before Revolution crisis		**Dependent Variable**: NPLs during Revolution crisis		**Dependent Variable**: NPLs after Revolution crisis	
NPL (-1)		0.241***	0.778***	0.826***	0.254***	0.590***	0.528***
		(2.56)	(0.95)	(2.54)	(2.00)	(2.84)	(2.61)
HA	-0.009***	-0.121**	-0.009***	-0.025**	-0.311***	-0.018**	-0.009***
	(-0.072)	(-2.57)	(-1.01)	(-2.87)	(-1.76)	(-2.12)	(-0.84)
SO	-0.001**	-0.125	-0.047	-0.154*	-0.023**	-0.038*	-0.029**
	(-0.07)	(-1.26)	(-1.95)	(-1.11)	(-1.27)	(-1.89)	(-1.54)
SE	-0.007**	-0.812	-0.046	-0.215**	-0.646**	-0.020**	-0.004**
	(-0.28)	(-0.58)	(-1.67)	(-0.32)	(-0.03)	(-0.85)	(-0.53)
SIZE	-0.733	13.768**	-1.702	9.546	11.545	11.267	14.010
	(-0.94)	(0.37)	(-0.39)	(0.54)	(1.98)	(0.79)	(1.01)
ROA	-2.484***	0.864*	-3.347	0.555	2.435*	0.990	2.173*
	(-4.36)	(0.46)	(-1.26)	(0.05)	(0.21)	(0.25)	(0.66)
CAP	-0.339***	-1.765**	-1.067*	-1.883*	-1.736**	-1.691*	-1.714**
	(-2.78)	(-2.64)	(-1.03)	(-2.54)	(-2.65)	(-2.17)	(-2.18)
ASS	-0.439	-6.152	7.465*	-6.844	-8.655	-6.909	-12.270
	(-1.51)	(-0.28)	(1.67)	(-0.52)	(-0.99)	(-0.44)	(-0.85)
FUND	0.021	0.175	0.086	0.865	0.822	0.003	0.002
	(0.84)	(0.11)	(0.43)	(0.12)	(0.95)	(0.56)	(0.47)
DEBT	-0.021***	0.184	-0.007	0.155	0.167	0.037	0.046
	(-2.57)	(0.89)	(-0.38)	(0.32)	(0.76)	(0.77)	(0.98)
Number of obs.	132	36	36	48	48	48	48
AR(1) Test. p-value		0.144	0.165	0.365	0.276	0.546	0.686
AR(2) Test. p-value		0.311	0.432	0.113	0.159	0.133	0.187
Number of instruments		64	62	64	64	63	63
Sargan test (p-value)		0.255	0.287	0.121	0.254	0.243	0.265

Results of estimating the following equation: $NPL_{b,t} = \Sigma \varphi_m NPL_{b,t-1} + \beta HA_{b,t} + \beta SO_{b,t} + \beta SE_{b,t} + \delta X_{b,t} + \mu_b + \rho_{b,t}$

Where *b* is a bank, *t* one year between 2008 and 2018 (before Revolution crisis: 2008-2010, during Revolution crisis: 2011-2014, and after Revolution crisis: 2015-2018). The dependent variable $NPL_{b,t}$ is the ratio of overdue debts to total credits in *b*'s regulatory filing for year *t*. $NPL_{b,t-1}$ is the lagged endogenous variable. $HA_{b,t}$, $SO_{b,t}$ and $SE_{b,t}$ are respectively the investment in hardware, software and services of bank *b* in time *t*. The bank-level set of controls X_b includes pre, during and post-crisis average of: the loans to deposits ratio (DEBT), the capital to assets ratio (CAP), the wholesale funding ratio (FUND), ROA, the (log of) average wages in thousands of Dinars (ASS), and the (log of) assets size in thousands of Dinars (SIZE).

(.) t of Student

**** Significance at 1%, ** 5%, * 10%* and AR(1) et AR(2) are tests of serial correlation of first and second order of Arellano and Bond.

Conclusion

This study examines the impact of IT investment, and its components (hardware, software and services), on Tunisian non-performing loans for the period 2008 to 2018 using the Generalized Method of Moments estimates in first difference and in system of the dynamic model, before, during and after Revolution crisis. The study findings reveal that IT investment has a significant positive relationship with bank stability and a negative relationship with NPLs. Therefore, our results indicate that IT-adoption helped banks to select better borrowers and produce more resilient loans. Banks that adopted more IT before the crisis have a significantly lower share of NPLs post-crisis than banks with less IT adoption. Our study further demonstrates that Tunisian banks should devote the largest share of their resources to investing in software and services because by combining such investments with investments in hardware, banks will be less affected by a possible increase of NPLs during and after crisis, and then improve their financial stability. The evidence presented in this paper suggests that investing in IT is likely to be beneficial to financial stability.

The findings have several implications for financial regulation and policy. Financial regulators should place emphasis on strong credit risk controls as banks seek to collaborate with IT lenders to increase lending to different sectors. Also, bank supervisors should consider the disruptive capacity of IT lenders in their stress-test scenarios as well as the effect of such disruption on the activities and performance of traditional banks in their stress-test scenarios. This will help bank supervisors to gain a more robust picture of how financial innovation affects the level of NPLs in the banking sector.

However, our study has certain limitations. First, the study did not include more recent data in the analysis due to the lack of availability of recent IT data at bank level. Second, the study did not examine the indirect mediating effect of IT investment on banks' NPLs. Third, the set of explanatory variables used in the study is limited.

Finally, we suggest some areas for future research. Future studies can expand the dataset to more recent years when the data becomes available. Two, future research can examine the behavior of NPLs in the FinTech era. Three, future studies can conduct a mediation analysis to examine the extent to which investing in IT affects the overall amount of loans which in turn affect the level of NPLs. Four, future studies can re-assess NPLs and consider a wide range of explanatory variables which might affect the size of NPLs.

At the end, we stress that it would also be interesting to consider many of the institutional features associated with ITs that could be important for financial stability, such as the link with the shadow banking system and the possibility of regulatory arbitrage. This idea could enrich the debate on IT and financial stability in banking.

References

[1] Agoraki, E. K., Delis, M. D., Pasiouras, F. (2011). Regulations, competition and bank risk-taking in transition countries. Journal of Financial Stability. 7: 38-48.

[2] Albuquerque, R., Koskinen, Y., Yang, S., Zhang, C. (2020). Resiliency of Environmental and Social Stocks: An Analysis of the Exogenous COVID-19 Market

Crash. The Review of Corporate Finance Studies, 9(3), November: 593-621, https://doi.org/10.1093/rcfs/cfaa011

[3] Almulla, D., Aljughaiman, A. A. (2021). Does financial technology matter? Evidence from an alternative banking system. Cogent Economics and Finance, 9(1). https://doi.org/10.1080/23322039.2021.1934978

[4] Arellano, M., Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The Review of Economic Studies. 58(2): 277-297.

[5] Ayadi, F. (2014). The impact of credit risk and information asymmetry on the banking decision. Management Science Journal, 3(267-268): 115-122.

[6] Beccalli, E. (2007). Does IT investment improve bank performance? Evidence from Europe. Journal of Banking and Finance. 31 (7): 2205-2230.

[7] Ben Romdhane, S. (2021). Impact of Information Technologies' Investments on the Profitability of Tunisian Banks: Panel Data Analysis. Indian Journal of Finance and Banking, 5(2): 44-61.

[8] Ben Romdhane, S. (2013). Impact of Information Technology on the Performance of Tunisian Banks: A Stochastic Frontier Analysis with Panel Data. Asian Academy of Management Journal of Accounting and Finance, 2, 2013.

[9] Ben Romdhane, S., Kenzari, K. (2020). The Determinants of the Volatility of Non-Performing Loans of Tunisian Banks: Revolution versus COVID-19. Review of Economics and Finance, 18: 92-111.

[10] Berg, T., Burg, V., Gombovic, A., Puri, M. (2020). On the Rise of FinTechs: Credit Scoring Using Digital Footprints. The Review of Financial Studies, 33(7), July: 2845-2897, https://doi.org/10.1093/rfs/hhz099

[11] Bhattacharyya, A., Wright, S., Rahman, M. L. (2021). Is better banking performance associated with financial inclusion and mandated CSR expenditure in a developing country? Accounting and Finance, 61(1); 125-161. https://doi.org/10.1111/acfi.12560

[12] Blundell, R., Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics. 87 (1): 115-143.

[13] Boot, A., Hoffmann, P., Laeven, L., Ratnovski, L. (2021). Fintech: what's old, what's new? Journal of Financial Stability, 53, 100836.

[14] Buchak, G., Matvos, G., Piskorski, T., Seru, A. (2018). Fintech, regulatory arbitrage, and the rise of shadow banks. Journal of Financial Economics, 130: 453-483.

[15] Buyl, T., Boone, C., Wade, J. B. (2019). CEO Narcissism, Risk-Taking, and Resilience: An Empirical Analysis in U.S. Commercial Banks. Journal of Management, 45(4), https://doi.org/10.1177/014920631769952

[16] Carletti, E., Oliviero, T., Pagano, M., Pelizzon, L., Subrahmanyam, M. G. (2020). The Covid-19 Shock and Equity Shortfall: Firm-level Evidence from Italy. CSEF Working Paper, 566, Center for Studies in Economics and Finance (CSEF), University of Naples, Italy.

[17] Chen, X., Hu, X., Ben, S. (2021). How do reputation, structure design and FinTech ecosystem affect the net cash inflow of P2P lending platforms? Evidence from China. Electronic Commerce Research, 21: 1055-1082.

[18] Chinoda, T., Kapingura, F. M. (2023). The Impact of Digital Financial Inclusion and Bank Competition on Bank Stability in Sub-Saharan Africa. Economies, 11: 15.

[19] Dell'Ariccia, G., Laeven, L., Suarez, G. (2013). Bank leverage and monetary policies risk-taking channel; evidence from the United States. International Monetary Fund. IMF Working Paper No. 13/143.

[20] Demirgüç-Kunt, A., Detragiache, E. (2002). Does deposit insurance increase banking system stability? An empirical investigation. Journal of Monetary Economics, 49 (7): 1373-1406.

[21] Di Maggio, M., Yao, V. (2021). Fintech Borrowers: Lax Screening or Cream-Skimming ? Review of Financial Studies, 34(10), October: 4565–4618.

[22] Ding, W., Levine, R., Lin, C., Xie, W. (2021). Corporate immunity to the COVID-19 pandemic. Journal of Financial Economics, 141(2) : 802–830. https://doi.org/ 10.1016/j.jfineco.2021.03.005

[23] Feronika, Kurniawati, H. (2022). Information Technology and Profitability: Empirical Evidence in Indonesia, Jurnal Pendidikan Tambusai, 6(2):8829-8838.

[24] Hu, D., Zhao, S., Yang, F. (2022). Will Fintech development increase commercial banks risk-taking? Evidence from China. Electronic Commerce Research.

[25] Laudon, K.C., Laudon, J.P. (2006). Management of Information System. 9th edition, Eric Fimbel, Pearson Education, France, 638 pages.

[26] Li, X., Cao, J., Liu, J. (2016). An empirical study on the impact of executive compensation on bank risk-taking and performance: Based on the data of listed banks in China. Yuejiang Journal, 8 (01): 39-52, 144-145.

[27] Licht, G., Moch, D. (1999). Innovation and information technology in services. Canadian Journal of Economics, 32(2): 48-61.

[28] Louzis, D. P., Vouldis, A. T., Metaxas, V.L. (2012). Macroeconomic and bank-specific determinants of non-performing loans in Greece: A comparative study of mortgage, business and consumer loan portfolios. Journal of Banking and Finance. 1012-1027.

[29] Love, I., Ariss, R. T. (2013). Macro-Financial Linkages in Egypt: A Panel Analysis of Economic Shocks and Loan Portfolio Quality. IMF Working Paper: 01-40.

[30] Makri, V., Tsagkanos, A., Bellas, A. (2014). Determinants of non-performing loans: The case of Euro zone. Pano economicus. 61: 193-206.

[31] Marinč, M., Vlahu, R. (2011). The Economics of Bank Bankruptcy Law, Springer.

[32] Meng, Q., Yang, D. 2021. Does executive excess compensation affect enterprise risk-taking. Friends of accounting, 4: 44-52.

[33] Nwakoby, N. P., Okoye, J. N., Ezejiofor, R. A., Anukwu, C. C., Ihediwa, A. (2020). Electronic Banking and Profitability: Empirical Evidence from Selected Banks in Nigeria. Journal of Economics and Business, 3(2). https://doi.org/10.31014/aior.1992.03.02.227

[34] Pathan, S. (2009). Strong Boards, CEO Power and Bank Risk-Taking. Journal of Banking and Finance. 33: 1340-1350.

[35] Peek, J., Rosengren, E. S. (2000). Collateral damage: Effects of the Japanese bank crisis on real activity in the United States. American Economic Review, 90 (1): 30-45.

[36] Pierri, N., Timmer, Y., (2020). Tech in fin before Fintech: Blessing or curse for financial stability? IMF Working Paper, 20 (14).

[37] Prasad, B., Harker, P.T. (1997). Examining the contribution of information technology toward productivity in US retail banking. Working Paper, Wharton School, University of Pennsylvania.

[38] Radivojević, N., Cvijanović, D., Sekulic, D., Pavlovic, D., Jovic, S., Maksimović, G. (2019). Econometric model of non-performing loans determinants. Physica A 520: 481-488.

[39] Rajan, U., Seru, A., Vig, V. (2015). The failure of models that predict failure: Distance, incentives, and defaults. Journal of Financial Economics, 115 (2): 237-260.

[40] Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking. Journal of Financial Intermediation. 13(2): 156-182.

[41] Rupeika-Apoga, R., Wendt, S. (2021). FinTech in Latvia: Status Quo, Current Developments, and Challenges Ahead. Risks, 9: 181.

[42] Safiullah, M., Paramati, S. R. (2022). The impact of FinTech firms on bank financial stability. Electronic Commerce Research.

[43] Saiful, S., Ayu, D. P. (2019). Risks Management and Bank Performance: the Empirical Evidences from Indonesian Conventional and Islamic Banks. International Journal of Economics and Financial Issues, 9(4): 90-94. https://doi.org/10.32479/ijefi.8078

[44] Sheng, T. (2021). The effect of Fintech on banks' credit provision to SMEs: Evidence from China. Finance Research Letters, 39, 101558.

[45] Shin, H. S. (2009). Securitisation and Financial Stability. The Economic Journal, 119(536), February: 309-332. https://doi.org/10.1111/j.1468-0297.2008.02239.

[46] Singh, V., Sankhwar, S., Pandey, D. (2015). The role of information communication technology (ICT) in agriculture. Global Journal of Multidisciplinary Studies, 3(4), March, ISSN: - 2348-0459 225.

[47] Skrabic Peric, B., Smiljanic, A. R., Aljinovic, Z. (2018). Credit risk of subsidiaries of foreign banks in CEE countries: Impacts of the parent bank and home country economic environment. North American Journal of Economics and finance. doi.org/10.1016/j.najef.2018.03.009

[48] Skvarciany, V., Jureviciene, D., Morkunas, M. (2019). Determinants of bank profitability: empirical research on Lithuanian market. International Journal of Economic Policy in Emerging Economies, 12(5), January, doi: 10.1504/IJEPEE.2019.104637

[49] Solow, R. (1987). We'd better watch out. New York Times Book Review: 36.

[50] Song, F., Thakor, A. (2007). Relationship Banking, Fragility, and the Asset-Liability Matching Problem. Review of Financial Studies, 20(6): 2129-2177.

[51] Temkin, K., Kormendi, R. (2003). An Exploration of a Secondary Market for Small Business Loans. Washington, DC: SBA Office of Advocacy.

[52] Truby, J., Dean Brown, R., Dahdal, A. M. (2020). Banking on AI: Mandating a Proactive Approach to AI Regulation in the Financial Sector. Law and Financial Markets Review, 14(2), doi: 10.1080/17521440.2020.1760454

[53] Varma, P., Nejjer, S., Sood, K., Grima, S., Rupeika-Apoga, R. (2022). Thematic Analysis of Financial Technology (Fintech) Influence on the Banking Industry. Risks, 10: 186. https://doi.org/10.3390/risks 10100186 Academic Editor: Mogen.

[54] Wang, B. (2020). Executive pay gap and risk-taking: Based on the empirical evidence of Chinese Listed Banks. Financial development review, 11: 80-94.

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