

An Optimal Prediction Model's Credit Risk: The Implementation of the Backward Elimination and Forward Regression Method

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Abstract—The purpose of this paper is to verify whether there is a relationship between credit risk, main threat to the banks, and the demographic, marital, cultural and socio-economic characteristics of a sample of 40 credit applicants, by using the optimal backward elimination model and the forward regression method. Following the statistical modeling, the final result allows us to know the variables that have a degree of significance lower than 5%, and therefore a significant relationship with the credit risk, namely the CSP (Socio-occupational category), the amount of credit requested, the repayment term and the type of credit. However, by implementing the second method, the place of residence variable was selected as an impacting variable for the chosen model. Overall, these features will help us better predict the risk of bank credit.

Keywords—Credit risk; prediction; optimal model; backward elimination; statistical modeling

I. INTRODUCTION

Generally in the banking environment, among a variety of risks to which a bank may be exposed, credit risk remains the biggest and most dangerous, its control and evaluation are essential steps to continually improve the performance of banks in the financial market [1]. This necessarily involves the implementation of instruments and devices to anticipate and predict this type of risk. In this sense, setting up credible mechanisms of banking risk management to ensure the stability of the international banking system, was the main goal behind the enactment of prudential rules, commonly referred to as the Basel Accords, which are generally applicable to all banks with significant international activity [2]. For the bank, the credit risk management is therefore a matter of survival. Moreover, logistic regression is the most widely used model in the development of credit scoring model [6].

In Morocco, the failure of banks' customers is increasing, since outstanding debts record the same upward trend every year, nevertheless no bank would resist at such conjunctures. Prior management of credit risk is fundamental since it takes into account the assessment and prevention of this risk.

In this article, we want to show the significant link between credit risk and the socio-economic, marital, cultural and demographic variables of the credit applicants. We would

like to point out that the central issue to which we are trying to provide empirical answers is the following: "How can the prediction of bank credit risk be improved?"

To answer the problematic of our research, we will review generalities about credit risk, overview of the inventory of outstanding debts in Morocco would also be necessary in our research, and we will of course discuss prudential and banking regulation as the international banking environment is governed by the Basel agreements, essentially the bank credit component. In the end, this paper will use a statistical model to predict the risk of bank credit.

II. LITERATURE REVIEW

A. Credit Risk : A General View

1) The conceptual framework: As soon as an economic agent gives credit to counterparty, a risk relationship is established between the creditor and his debtor, the latter can indeed, with good or bad faith, do not pay his debt on the agreed date. The risk of meeting a commitment to settle a debt is the credit risk [13]. Hence, the credit transaction might create the risk that a debtor cannot honor its commitments [15].

According to the Bank of International Settlements (2011) [5], the credit risk lies in the fact that the counterparty may not fulfill its obligations according to the agreed upon contractual conditions. A financial asset is considered unpaid when a counterparty has not made the payment due at the contractual maturity.

It can also manifest itself in counterparty defaults, failures in commitments or concentration of bad debts. In general, credit risk is a particular risk from a lending transaction, and the occurrence of a negative event affects the debt on which the debtor is engaged. It is one of the main causes of bank failure.

2) Credit risk assessment: To mitigate credit risk, it is highly recommended for banks to assess repayment capacity and guarantees, to select operations taking into account profitability and costs (financing, operational, cost of risk, return on equity), take into account the economic and legal

environment, and finally monitor bad debts and provisioning [11].

Banks have to set up a credit policy framed by a committee of commitments which sets the objectives (type of clientele, of credit, sectors and geographical areas), credit terms (rates, margins, guarantees) and delegations of power. The credit processing procedures go through the study of the demand (taking of information and evaluation of solvency), monitoring (detection of the risk of insolvency) and internal control of counterparty risk. The bank has real expertise in assessing the counterparty risk of individuals (consumer loans or mortgages) or companies (loans financing cash or investment) [14]. However, it is necessary to point out that it is common to use the term counterparty risk to refer exclusively to the credit risk while this is not the case.

B. Credit Risk and Basel Agreements

The bank is one of the most regulated economic sectors in the world. Otherwise, the State of the banking sector is indicative for the condition of the entire financial market and, by extension, of the entire economy [16]. To prevent the scale of banking crises, control devices have been introduced, mainly by Basel Committee. Their purpose is to help retail and investment banks control their credit or market risks through a prudential approach that combines risk measurement with a minimum equity allocation [14].

Cieply (2018) [7] concluded that the purpose of prudential regulation is to reduce the probability of bankruptcy of banks. For this, in their normal business, banks are required to meet management standards. They aim is to contain each of the major risks to which banks are exposed, particularly the risk of illiquidity and insolvency.

So, each of the three Basel agreements entails regulatory constraints imposed on the banking institutions that they are expected to respect, in order to maintain their financial stability.

1) *Basel accord I*: The Basel accord I, created in 1988, sets up a system to better control the measurement of credit risks. A minimum ratio of 8% is then imposed between a capital of a bank and the risks it bears on the market or the credit risks it takes with its customers [9].

This regulatory constraint is in the form of a ratio called Cooke which, according to Cieply (2018) [7], require credit institutions to constantly comply with a ratio of at least 8% between their own funds and the commitments of credit weighted against their risk. The weighting was based in Basel I on the nature of the counterparty by following a purely institutional criterion.

2) *Basel accord II*: Dhafer and Cesbron (2012) [9] argue that in the face of a financial system that has become more complex, in particular because of the growing importance of globalization, the Basel Committee strengthened its regulation. The new device is based on three pillars: 1st pillar – the capital requirement with a ratio of 8%, 2nd pillar – the establishment of a more comprehensive prudential supervisor procedure with, *inter alia*, the introduction of an internal risk

management model, 3rd pillar – the need for better, transparent and uniform communication, which strengthens market discipline.

3) *According to dhafer (2012) [8], the purpose of pillar II is twofold*: On the one hand, to encourage banks to develop techniques for managing their risks and their level of capital and, on the other hand, to enable regulators to increase regulatory capital requirements if necessary. This need must be applied in two ways:

- Stress testing: Banks must prove during simulations of extreme situations, the validity of its own funds in case of economic crisis.
- Back testing: The banks must prove the validity of their statistical methods over quite long periods (5 to 7 years).

4) *Basel accord III reinforcement of the basel II system*: In 2010, the Basel Committee published the Basel Accord III in order to meet the Basel II limits and to prevent future crises [12].

In the same context, Dhafer and Cesbron [9] argue that following the 2008 crisis, the Basel Committee reacted and took a number of steps to strengthen the “resilience” of the banking sector. It is then a matter of consolidating the solvency of banks, to develop a greater liquidity monitoring, to improve the ability of banks to absorb shocks, resulting from financial and economic stress, and finally reduce and control the risks of overflow to the real economy.

These agreements focus on four points that are: the redefinition of own funds, the establishment of a precautionary capital or mattress and counter-cyclical measures, setting up ratios and covering certain risks [17].

C. Statement of Outstanding Debts of Banks in Morocco

In recent years, Moroccan banks have turned to the household segment to boost credit activity. However, the interest in this category is not without its repercussions: the aggravation and rapid evolution of the outstanding debts of individuals is one of the remarkable effects.

The monetary statistics provided by Bank Al-Maghrib under its report on financial stability (2018) [3] revealed as described in Fig. 1 that at the end of 2018 the outstanding debts recorded an increase of 3.7% against 2.3% a year earlier to reach 65.3 billion dirhams. This increase primarily concerns loans granted to households, which is more than 2.7 billion dirhams compared to 2017. On the other hand, the outstanding debts of companies fell by 1%. Moderately, the rate of outstanding debts posted is 7.3% against respectively 7.5% and 7.6% in 2017 and 2016.

According to the latest figures published by the BAM 2019 [4], at the end of June 2019, Table I shows that households are left with almost 27.5 billion DH of arrears at banks, given that the outstanding receivables total an amount of 67.7 billion dirhams and represent 7.5% of the total loans outstanding for the same period.

TABLE I. BREAKDOWN OF BANK CREDIT AND OUTSTANDING DEBTS

	Outstanding at the end of June 2019*	Monthly variation (in %)	Annual growth rate (in %)					
			June18	Sept.18	Dec.18	March19	May19	June19
Bank credit	900,4	3,5	1,8	2,9	3,2	5,1	4,4	5,1
Households credit	338,2	-0,2	3,7	4,9	5,3	5,7	5,8	5,4
Consumer credits	55	0,1	5,7	6,0	6,2	6,0	4,9	4,1
Real estate loans	219,1	-0,2	4,8	4,6	6,0	5,2	5,0	3,8
Housing loans	211,6	-0,1	4,3	4,6	5,7	5,6	5,7	4,9
Loans to real estate developers	6,8	-4,1	16,1	10,3	16,2	-2,3	-12,4	-19,8
Outstanding debts	67,7	0	2,9	3,4	2,5	5,5	3,7	5,7
Private non-financial corporations	39,5	1,9	3,9	3,2	2,5	0,7	0,1	2,8
Households	27,5	-1,9	1,2	3,9	2,7	13,7	11,3	11,3
Ratio of outstanding debts			7,5	7,7	7,5	7,7	7,8	7,5

*In billions of DH

Source: BAM, Août 2019, p.36



Source: BAM, 2018, p.75

Fig. 1. Evolution of Outstanding Debts of Banks.

The results recorded in relation to the situation of outstanding debts born by Moroccan banks, invite us to shed light on these findings, to think in a thorough way, and to further develop appropriate tools and mechanisms to assess this risk that could put banks in critical conditions.

III. MODELING OF CREDIT RISK

A. Work Methodology

Our empirical approach imposes the adoption of a methodology that is based on sampling, data analysis. These empirical results will be presented in statistical tables with their interpretations.

1) *Sampling*: To find the optimal model, we took a sample of 40 credit applicants using the simple random sampling method to estimate and predict credit risk through the backward elimination and forward regression method. The data is collected through the questionnaire method distributed to 40 respondents who are credit applicants. We choose these two statistical methods in order to search the optimal model in our scientific research.

Table II presents the composition of the sample of defaulting and non-defaulting customers.

TABLE II. BREAKDOWN OF DEFAULTING AND NON-DEFAULTING CUSTOMERS IN THE SAMPLE

	Sample	Percentage
Defaulting customer	13	32.5%
Non-defaulting customer	27	67.5%
Total	40	100%

2) *Characteristics of the sample*: The independent variables retained with their modalities for the analysis of the data are declined below:

- Age: The age of the customer [Under 30years, 30 to 39 years, 40 to 49years, 50 years and over].
- Gender: The gender of the client [Man, Woman].
- Etatmatri: The marital status of client [Single, Married, Divorced, Widower].
- Milieuderés: The place of residence of client [Urban, Rural].
- Zonegéo: The geographical area where the customer lives [Casablanca-Settat, Rabat-Salé-Kénitra, Fès-Meknès, Marrakech-Asfi, Tanger-Tétouan-Alhoceima, Oriental, others].
- CSP: The socio-occupational category of the client [Employee of a small company, employee of a large company, civil servant, tradesman and entrepreneur, liberal professions].
- Income (Revenu): The income received by the client [less than 4000dh, from 4000 to 6000dh, from 6000 to 10000dh, Greater than 10000dh].
- Nbredeoscréd: The number of credit files available to the client [0, 1, 2, 3].
- Montcrédsolli: The amount of credit requested [5000 to 10000dh, 10000 to 20000dh, 20000 to 50000dh, 50000 to 100000dh, 100000 and over].

- Duréerem: The repayment term of the credit [12months, 12-36months, 36-60months, more than 60months].
- Typecrédit: The type of credit desired [Consumer credit, Real estate credit].
- Degrérat: The difference between the amount requested and the amount awarded [=0, >0].

3) *Descriptive statistics:* First, we present the descriptive statistics relating to the explanatory variables in Table III as follow:

From the statistics above associated with the explanatory variables, we can observe a strong dispersion of the observations.

4) *Hypotheses to test:* Two hypotheses are to be tested by statistical modeling [10]:

H1: There is a significant relationship between the credit risk and the demographic, marital, cultural and socio-economic characteristics of credit applicants.

H2: Some variables may be important and impacting in predicting credit risk.

5) *The variables of the problem:* The variable to be explained and the explanatory variables adopted for the treatment of the problematic posed above is given as:

$$Y = b_0 + b_1X_1 + \dots + b_kX_k + \varepsilon, k = 12$$

Y = the variable to be explained (RISQCREDIT)

The explanatory variables:

X₁ = the age of the client (Age)

X₂ = the gender of the client (Sexe)

X₃ = the marital status of the client (Etatmatrimonial)

X₄ = the place of residence of the client (Milieuderés)

X₅ = the geographical area where the client lives (Zonegéo)

X₆ = the socio-occupational category of the client (CSP)

X₇ = the income received by the client (Revenu)

X₈ = the number of credit files available to the client (Nbredoscréd)

X₉ = the amount of credit requested (Moncrédsolli)

X₁₀ = the repayment term of the credit (Duréerem)

X₁₁ = the type of credit desired (Typecrédit)

X₁₂ = the difference between the amount requested and the amount awarded (Degrérat)

b_i = Coefficients representing the linear combination of the predictor and the constant

ε = The error

The dependent variable is credit risk. It is a dichotomous binary variable denoted "RISQCREDIT" such as:

RISQCREDIT = 0 if the client is solvent and repay his credits at maturity.

RISQCREDIT = 1 if the client is insolvent and will not repay his credits at maturity.

This makes it possible to highlight the degree of significance of the independent variables with respect to the dependent variable.

TABLE. III. EXPLANATORY VARIABLES

Explanatory variables	Mean	Median	Max	Min	Std. dev	Skewness	Kurtosis	Jarque-Bera	probability
Age	1.325	1.000	3.000	0.000	1.071484	0.210487	1.819931	2.616306	0.270319
Gender	0.450	0.000	1.000	0.000	0.503831	0.201008	1.040404	6.669387	0.035625
Marital Status	0.950	1.000	3.000	0.000	0.845804	0.866483	3.474737	5.380910	0.067850
Place of residence	0.250	0.000	1.000	0.000	0.438529	1.154701	2.333333	9.629630	0.008109
Geographical area	1.225	1.000	5.000	0.000	1.310461	1.238532	3.851849	11.43583	0.003287
Socio-occupational Category	1.775	2.000	4.000	0.000	1.270726	0.202029	2.179973	1.392843	0.498365
Income	1.750	2.000	3.000	0.000	1.031553	-0.195169	1.858760	2.424654	0.297504
Number of Credit files	0.575	0.000	3.000	0.000	0.747217	1.234518	4.202353	12.56966	0.001864
Amount of credit requested	2.625	3.000	4.000	0.000	1.314368	-0.790170	2.605819	4.421424	0.109623
Repayment term of credit	2.325	3.000	3.000	0.000	0.828576	-0.934844	2.912953	5.838853	0.053965
The type of credit	0.250	0.000	1.000	0.000	0.438529	1.154701	2.333333	9.629630	0.008109
The degree of rationing	0.325	0.000	1.000	0.000	0.474342	0.747265	1.558405	7.186359	0.027511

Source: These statistics were prepared using EViews

B. Empirical Results

1) *The selection of the optimal model:* Now, we proceed to the tests of the choice of the most significant explanatory variables in relation to the variable to be explained, and we will do this through the method of elimination of non-significant variables at the threshold of 5% one by one in order to make a successive correction of the proposed model. In this context, we use the backward elimination method and the forward regression.

- The Backward Elimination method

The initial model adopted using the different variables that is supposed to be explanatory is given as follows in Table IV:

- Income variable is the least significant. We eliminate it and we continue to re-estimate the equation. The new model then takes the new form (Annex 1).
- The variable to be eliminated this time is the marital status variable. Then the new model is obtained in Annex 2.
- Then, we eliminate the variable AGE. Hence the new model is in Annex 3.

- The variable to be eliminated now is the number of credit files available to the client (NBREDOSCRED). And the re-estimated model obtained in Annex 4.
- Then, the variable associated to the place of residence (MILIEUDERES) is eliminated. The new model takes the new form in Annex 5.
- And this time, the variable to eliminate is Gender. The new model (Annex 6) takes the new form.
- Then, we eliminate the variable associated with the degree of rationing (DEGRERAT) which means the difference between the amount requested and the amount awarded. And the re-estimated model becomes as indicated in Annex 7.
- And then the variable associated with the geographical area (ZONEGEO) is eliminated. Hence, the following and the last model adopted is given in Table V:

In this new final model, the remaining variables, CSP, MONTCREDSOLLI, DUREEREM, and TYPECREDIT are significant at the threshold of $\alpha=5\%$. This is the optimal model obtained by the backward regression method.

TABLE. IV. THE INITIAL MODEL ADOPTED

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 07/29/19 Time: 21:01				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGE	0.018147	0.092667	0.195827	0.8462
SEXE	0.114491	0.160077	0.715222	0.4804
ETATMATRIMONIAL	0.014819	0.107447	0.137916	0.8913
MILIEUDERES	0.112921	0.206375	0.547163	0.5886
ZONEGEO	0.063002	0.060039	1.049345	0.3030
CSP	0.088344	0.065254	1.353843	0.1866
REVENU	0.011269	0.143172	0.078711	0.9378
NBREDOSCRED	-0.046702	0.137017	-0.340850	0.7358
MONTCREDSOLLI	-0.281958	0.153218	-1.840240	0.0764
DUREEREM	0.215460	0.145782	1.477959	0.1506
TYPECREDIT	0.410711	0.249898	1.643511	0.1115
DEGRERAT	0.213677	0.208225	1.026186	0.3136
R-squared	0.324790	Mean dependent var		0.325000
Adjusted R-squared	0.059529	S.D. dependent var		0.474342
S.E. of regression	0.460007	Akaike info criterion		1.528173
Sumsquaredresid	5.924969	Schwarz criterion		2.034837
Log likelihood	-18.56346	Hannan-Quinn criter.		1.711367
Durbin-Watson stat	1.881081			

Source: These estimates were prepared using Eviews

TABLE. V. THE LAST MODEL ADOPTED

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 07/29/19 Time: 21:47				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CSP	0.131344	0.050025	2.625593	0.0126
MONTCREDSSLILLI	-0.364113	0.092067	-3.954881	0.0003
DUREEREM	0.374530	0.098955	3.784852	0.0006
TYPECREDIT	0.462116	0.206267	2.240377	0.0313
R-squared	0.216425	Mean dependent var		0.325000
Adjusted R-squared	0.151127	S.D. dependent var		0.474342
S.E. of regression	0.437031	Akaike info criterion		1.277016
Sumsquaredresid	6.875868	Schwarz criterion		1.445903
Log likelihood	-21.54031	Hannan-Quinn criter.		1.338080
Durbin-Watson stat	1.836085			

Source: These estimates were prepared using EViews

TABLE. VI. FORWARD REGRESSION METHOD

	RISQCREDIT
RISQCREDIT	1.000000
AGE	-0.213150
SEXE	0.230673
ETATMATRIMONIAL	-0.086280
MILIEUDERES	0.338983
ZONEGEO	0.085593
CSP	-0.003190
REVENU	-0.615730
NBREDOSCRED	-0.251392
MONTCREDSSLILLI	-0.539792
DUREEREM	-0.340877
TYPECREDIT	-0.030817
DEGRERAT	0.202279

Source: These estimates were prepared using EViews

- Forward Regression method

The forward regression consists in selecting one by one the explanatory variables according to the highest correlation coefficient recorded with the variable to be explained.

Table VI presents the correlation coefficients connecting the dependent variable to the independent variables. The used method prompts us to use the highest correlation coefficient recorded with the credit risk (Y).

The highest coefficient correlation we have selected is the variable place of residence (MILIEUDERES); we then check the meaning of the correlation coefficient:

$$\hat{t} = \frac{0.338983}{\sqrt{\frac{1-0.338983}{40}}} = 16.677$$

Table VII gives us a new model with the variable selected.

Regarding the forward regression, the place of residence variable (MILIEUDERES), even if it was eliminated by the backward elimination method, since it is not significant at the 5% level, it was selected by forward regression since it scored the highest correlation with the variable to be explained. This occurred just after we assumed that the addition of this variable is significant, which means that it is significantly correlated with credit risk.

TABLE. VII. THE NEW MODEL WITH THE EXPLANATORY VARIABLE SELECTED

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 07/30/19 Time: 20:50				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.233333	0.082540	2.826909	0.0075
MILIEUDERES	0.366667	0.165080	2.221143	0.0324
R-squared	0.114910	Me andependent var		0.325000
Adjusted R-squared	0.091618	S.D. dependent var		0.474342
S.E. of regression	0.452091	Akaike info criterion		1.298839
Sumsquaredresid	7.766667	Schwarz criterion		1.383283
Log likelihood	-23.97677	Hannan-Quinn criter.		1.329371
F-statistic	4.933476	Durbin-Watson stat		1.770529
Prob(F-statistic)	0.032376			

Source: These estimates were prepared using Eviews

are used to perform this modeling on a sample of 40 borrowers of bank credits.

2) *Analysis of results:* Overall and according to tests done on Eviews, the obtained results showed that the explanatory variables, among the twelve variables are significant at the 5% level, namely the CSP (socio-occupational category), the MONTCREDSOLLI (amount of credit requested), the DUREEREM (repayment period), and the TYPECREDIT (type of credit). This is based on the optimal model and the Backward Elimination, which consists of eliminating each non-significant explanatory variable. This means that the remaining variables, which are socio-economic characteristics related to the profile of each applicant for credit, have an influence on credit risk. More explicitly, these variables predict the default of credit applicants at maturity and can prove their impact on the probability of repaying debts or not. While the Forward Regression method gave us a new result, which is the variable "place of residence". We can therefore conclude that there is a significant relationship between credit risk and the socio-economic, marital, cultural and demographic characteristics of credit applicants, and that some independent variables can be impacting and predictive of credit risk, therefore, we confirm the two hypotheses (H1) and (H2) that have been tested and verified through modeling.

IV. CONCLUSION

Credit risk is a particular risk that can be one of the main causes of bank failure in the event of actual occurrence. Thus, this article concludes that the two methods of statistical modeling (Backward Elimination and Forward Regression), carried out on Eviews, could lead to different results, and proposed new models.

The purpose of this research was to select the explanatory variables that predict the likelihood of credit risk for banks among credit applicants. To do this, two statistical methods

The above results lead us to assume that it is difficult to bypass the credit risk in Morocco which represents the variable to explain in our case. However, it is important to note that the explanatory variables selected by the models, such as the type of credit, the repayment period, the socio-occupational category, the amount of credit requested and finally the place of residence, represent an influence tools on the probability of repayment of credits.

REFERENCES

- [1] Ahmed, A., Seyoum, A., Kedir, H., & Kedir, S. (2015). Credit Risk Management Of Mfis Found In Ethiopia. European Scientific Journal, 11(31).
- [2] Angima, C.B., Mwangi, M., Kaijage, E., & Ogutu, M. (2017). Actuarial Risk Management Practices, Underwriting Risk and Performance of P & C Insurance Firms in East Africa. European Scientific Journal. 13(22). doi: 10.19044/esj.2017.v13n22p207.
- [3] Bank Al-Maghrib (2018). Rapport sur la stabilité financière, Number 6.
- [4] BAM (2019). Revue mensuelle de la conjoncture économique, monétaire et financière. August.
- [5] Bank of International Settlements (2011). « Réforme de la réglementation financière : Réalisations, risques et perspectives », 81e Annual Report, Bâle Suisse, June, 228p.
- [6] Chen, H., & Xiang, Y. (2017). The study of credit scoring model based on group lasso. Procedia computer science, 122, pp.677-684.
- [7] Cieply, S. (2018). Quel avenir pour la relation banque-entreprise ?, Caen, EMS editions, 99p.
- [8] Dhafer, S. (2012). L'impact de la réglementation de bale III sur les métiers des salariés des banques, étude thématique, Université Lille Nord de France, Septembre, 50p.
- [9] Dhafer, S., & Cesbron, C. (2012). L'impact de la réglementation de bale III sur les métiers des salariés des banques, thematicstudy, University Lille Nord de France et SKEMA et cabinet MEDIATION Observatoire des métiers, des qualifications et de l'égalité professionnelle entre les femmes et les hommes dans la banque, pp.20-23.
- [10] Ghassan, H., & Raiss, N., & El-Moudden, A. (2008). Testing the Effect of the Land Tax on Tourism Investment.Munich Personal RePEc

- Archive (MPRA), n°56384, pp.1-11. June. (Online at <http://mpra.ub.uni-muenchen.de/56384/>).
- [11] Greuning, H., & BrajovicBratanovic, S. (2004). Analyse et gestion du risque bancaire : Un cadre de référence pour l'évaluation de la gouvernance d'entreprise et du risque financier, 1ère édition, Paris, Editions ESKA.
- [12] Hologne, A.-L. (2014). Le stress financier impacte-t-il les banques ? Cas de Belfius et d'Axa Bank Europe, Mémoire de recherche, Université catholique de Louvain, Louvain School of management, 126p.
- [13] Kharoubi, C., & Thomas, P. (2016). Analyse du risque de crédit : Banque & Marchés, 2ème édition, Paris, RB édition, 164p.
- [14] Pierandrei, L. (2015). Risk Management, Gestion des risques en entreprise, banque et assurance, Paris, Dunod, 320p. 2015.
- [15] Siqani, S. H., & Sekiraca, E. (2016). The Impact of the Internal Audit in Reducing Credit Risk in Commercial Banks in Kosovo. European Scientific Journal, 12(4). doi: 10.19044/esj.2016.v12n4p268.
- [16] Sumna, P. (2013). Credit risk dynamics in Czech Republic. European Scientific Journal, 9(16).
- [17] Yota, R. (2016). Le test de l'effet médiateur de la prise de risque et des effets modérateurs de la réglementation prudentielle et de la taille de la banque, Doctoral Thesis in Management Sciences, supported on 12 Decembre 2016, University of Artois, 253p.

ANNEXURES

ANNEX. I. ELIMINATION OF THE VARIABLE INCOME AND THE RE-ESTIMATION OF THE EQUATION

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 29/07/19 Time: 21:10				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGE	0.018242	0.091057	0.200337	0.8426
SEXE	0.116106	0.156013	0.744207	0.4627
ETATMATRIMONIAL	0.016870	0.102438	0.164682	0.8703
MILIEUDERES	0.111442	0.201966	0.551787	0.5853
ZONEGEO	0.062670	0.058856	1.064805	0.2957
CSP	0.089524	0.062408	1.434497	0.1621
NBREDOSCRED	-0.040635	0.111317	-0.365034	0.7177
MONTCREDSOLLI	-0.274525	0.118566	-2.315371	0.0279
DUREEREM	0.213862	0.141866	1.507494	0.1425
TYPECREDIT	0.404838	0.234376	1.727297	0.0948
DEGRERAT	0.205480	0.177195	1.159626	0.2557
R-squared	0.324640	Meandependent var		0.325000
Adjusted R-squared	0.091758	S.D. dependent var		0.474342
S.E. of regression	0.452056	Akaike info criterion		1.478394
Sumsquaredresid	5.926280	Schwarz criterion		1.942836
Log likelihood	-18.56789	Hannan-Quinn criter.		1.646322
Durbin-Watson stat	1.879857			

ANNEX. II. ELIMINATION OF THE VARIABLE MARITAL STATUS AND THE RE-ESTIMATION OF THE EQUATION

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 07/29/19 Time: 21:16				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGE	0.024276	0.081999	0.296049	0.7692
SEXE	0.116249	0.153460	0.757520	0.4546
MILIEUDERES	0.111904	0.198645	0.563335	0.5774
ZONEGEO	0.060792	0.056797	1.070345	0.2930
CSP	0.091816	0.059843	1.534282	0.1354
NBREDOSCRED	-0.039854	0.109398	-0.364304	0.7182
MONTCREDSOLLI	-0.275347	0.116524	-2.362996	0.0248
DUREEREM	0.216841	0.138408	1.566677	0.1277
TYPECREDIT	0.405861	0.230464	1.761064	0.0884
DEGRERAT	0.208043	0.173625	1.198231	0.2402
R-squared	0.324009	Meandependent var		0.325000
Adjusted R-squared	0.121212	S.D. dependent var		0.474342
S.E. of regression	0.444666	Akaike info criterion		1.429329
Sumsquaredresid	5.931822	Schwarz criterion		1.851549
Log likelihood	-18.58658	Hannan-Quinn criter.		1.581990
Durbin-Watson stat	1.860989			

ANNEX. III. ELIMINATION OF THE VARIABLE AGE AND THE RE-ESTIMATION OF THE EQUATION

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 29/07/19 Time: 21:20				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SEXE	0.122524	0.149736	0.818267	0.4195
MILIEUDERES	0.103856	0.193859	0.535730	0.5960
ZONEGEO	0.066633	0.052470	1.269930	0.2136
CSP	0.096744	0.056629	1.708374	0.0976
NBREDOSCRED	-0.030639	0.103322	-0.296544	0.7688
MONTCREDSOLLI	-0.273460	0.114625	-2.385691	0.0233
DUREEREM	0.222274	0.135152	1.644624	0.1102
TYPECREDIT	0.395921	0.224624	1.762591	0.0878
DEGRERAT	0.190603	0.160905	1.184570	0.2452
R-squared	0.322034	Meandependent var		0.325000
Adjusted R-squared	0.147075	S.D. dependent var		0.474342
S.E. of regression	0.438073	Akaike info criterion		1.382246
Sumsquaredresid	5.949152	Schwarz criterion		1.762244
Log likelihood	-18.64493	Hannan-Quinn criter.		1.519642
Durbin-Watson stat	1.861077			

ANNEX. IV. ELIMINATION OF THE VARIABLE NUMBER OF CREDIT FILES AND THERE-ESTIMATION OF THE EQUATION

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 07/29/19 Time: 21:27				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SEXE	0.126886	0.146873	0.863918	0.3941
MILIEUDERES	0.116494	0.186402	0.624960	0.5364
ZONEGEO	0.067668	0.051603	1.311329	0.1991
CSP	0.094739	0.055417	1.709561	0.0970
MONTCREDSSLILLI	-0.274303	0.112945	-2.428643	0.0210
DUREEREM	0.214715	0.130821	1.641287	0.1105
TYPECREDIT	0.415985	0.211118	1.970389	0.0575
DEGRERAT	0.1177909	0.152880	1.163717	0.2531
R-squared	0.320111	Meandependent var		0.325000
Adjusted R-squared	0.171385	S.D. dependent var		0.474342
S.E. of regression	0.431785	Akaike info criterion		1.335079
Sumsquaredresid	5.966028	Schwarz criterion		1.672855
Log likelihood	-18.70158	Hannan-Quinn criter.		1.457208
Durbin-Watson stat	1.846679			

ANNEX. V. ELIMINATION OF THE VARIABLE PLACE OF RESIDENCE AND THE RE-ESTIMATION OF THE EQUATION

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 29/07/19 Time: 21:34				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SEXE	0.134660	0.144987	0.928771	0.3598
ZONEGEO	0.069575	0.051034	1.363297	0.1820
CSP	0.107824	0.050834	2.121104	0.0415
MONTCREDSSLILLI	-0.308620	0.097783	-3.156157	0.0034
DUREEREM	0.248393	0.118100	2.103230	0.0432
TYPECREDIT	0.438383	0.206123	2.126799	0.0410
DEGRERAT	0.184605	0.151089	1.221827	0.2304
R-squared	0.311812	Meandependent var		0.325000
Adjusted R-squared	0.186687	S.D. dependent var		0.474342
S.E. of regression	0.427780	Akaike info criterion		1.297211
Sumsquaredresid	6.038847	Schwarz criterion		1.592765
Log likelihood	-18.94421	Hannan-Quinn criter.		1.404074
Durbin-Watson stat	1.899551			

ANNEX. VI. ELIMINATION OF THE VARIABLE GENDER AND THE RE-ESTIMATION OF THE EQUATION

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 07/29/19 Time: 21:38				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ZONEGEO	0.073479	0.050758	1.447632	0.1569
CSP	0.116151	0.049936	2.326006	0.0261
MONTCREDSOLLI	-0.337580	0.092491	-3.649873	0.0009
DUREEREM	0.294141	0.107121	2.745872	0.0096
TYPECREDIT	0.467207	0.203362	2.297416	0.0279
DEGRERAT	0.190543	0.150649	1.264817	0.2145
R-squared	0.293823	Mea dependent var		0.325000
Adjusted R-squared	0.189974	S.D. dependent var		0.474342
S.E. of regression	0.426914	Akaike info criterion		1.273015
Sumsquaredresid	6.196701	Schwarz criterion		1.526347
Log likelihood	-19.46029	Hannan-Quinn criter.		1.364612
Durbin-Watson stat	1.773236			

ANNEX. VII. ELIMINATION OF THE VARIABLE DEGREE OF RATIONING AND THE RE-ESTIMATION OF THE EQUATION

Dependent Variable: RISQCREDIT				
Method: Least Squares				
Date: 07/29/19 Time: 21:42				
Sample: 1 40				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ZONEGEO	0.074019	0.051189	1.445979	0.1571
CSP	0.116358	0.050361	2.310457	0.0269
MONTCREDSOLLI	-0.364881	0.090704	-4.022743	0.0003
DUREEREM	0.347684	0.099241	3.503426	0.0013
TYPECREDIT	0.491187	0.204203	2.405380	0.0216
R-squared	0.260596	Mea dependent var		0.325000
Adjusted R-squared	0.176093	S.D. dependent var		0.474342
S.E. of regression	0.430557	Akaike info criterion		1.268993
Sumsquaredresid	6.488267	Schwarz criterion		1.480103
Log likelihood	-20.37986	Hannan-Quinn criter.		1.345324
Durbin-Watson stat	1.779325			