DETERMINANTS OF BAD LOANS IN ALBANIAN BANKING SECTOR USING DOE'S APPROACH

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ABSTRACT

The paper focused to explain which of the specific determinants are more influential on banking bad loans and which of them are considering not more influential. It applied DOE (Design of Experiment) approach to evaluate the determinants of bad loans and used to evaluate the impact of determinants and quality of them. DOE model required the practical construction of orthogonal matrix to obtain information by using the standard matrix L_2^8 Taguchi relying on the questionnaire. The questionnaire divided determinants into two groups respectively to slightest and largest impact to increase the bad loans and fulfilled by fifty loan's specialist of eight main second tier banks within sixteen banks of whole Albanian banking sector. It included the specific banking determinants related to the customer's reputation, ability to pay, loan conditions, quality of collateral, capital size, business' sectors and subjective assessment. Referring to DOE's approach confirmed the statistical significance and largest impact on the lending related to the "customer reputation", "ability to pay" and "loan conditions". Meanwhile we should be considered the influential interactions of factors related to the potential bad loans. The analysis of results using the Taguchi method through ANOVA's highlighted the significance and impact of the inclusive factors which affected lending. The results confirmed the significance of above determinants which they affected the quality of loans and should take into consideration due to their contribution into the progressive increase of non-performing loans in Albanian banking sector.

Keywords: Non-performing loans, DOE, Taguchi.

INTRODUCTION

The lending of banking sector remains the one of crucial determinants related to the economic development, particularly developing countries to catch up the required growth rates. Meanwhile the lending associated with certain risk due to the bad loans. That is one more reason why it should be guarantee the qualitative lending within its return into banking sector. Due to this reason there are some basic criteria into the loan's granting and they should be implemented into each second tier banks. Negera (2012) examined the causes of loan default and attributed to the poor loan assessment, failed loan monitoring, underdeveloped loan culture, lenient loan terms and conditions, aggressive lending, compromised integrity, weak institutional capacity, unfair competition among banks, willful default by borrowers and their knowledge limitation, fund diversion for unintended purpose, over/under financing by banks. Godquin (2004) emphasized that both age and size of loans reveal the inverse relationship to repayment performance. Also Hietalahti and Linden (2006) highlighted the too big loans induced the repayment problems, dissatisfaction and high dropouts. Bragg (2010) stressed that the short time frame reduced the risk of non-repayment to the bank, meanwhile the bank oriented to long-term variations in the interest rate. Mead and Liedholm (1998) demonstrated that enterprises in the service sector and manufacturing were less likely to close down compare to the wholesale and retail sector. Hwarire (2012) focused to the securing financing and loan repayments related to the small businesses like a significant challenge of them due to their consequences according to the economic development in South Africa, as well in other developing countries. She examined the loan repayment and credit management of SMMEs in a South African financial institution. She determined their relationship and impact on default related to factors like age, bank balance, relationships (personal, business and new customer), interest rate, loan size, loan term, product type, gender and race. Author estimated the results by the binary Logit model due to the dichotomous nature of the dependent variable (default) and demonstrated that 39 per cent of loan repayments were not fulfilled on time; meanwhile 28 per cent defaulted. Also race, gender and negative bank balance were statistically significant according to defaults in loan repayment and credit management.

The paper focused to determine the core criteria within lending of Albanian banking sector through the statistical technique of Design of Experiment (DOE). We applied DOE approach to evaluate the determinants of bad loans and to explain which of the specific determinants are more dominant on them.

The paper followed by this structure: First section included the introduction. Section 2 provided the empirical and theoretical background related to determinants of bank lending and bad loans. Section 3 demonstrated the empirical results of DOE in Albanian banking sector. The final section summarized the concluding remarks of paper.

LITERATURE REVIEW

The lending in banking sector has taken into considerations of theoretical and empirical analysis particularly in developing countries past the global financial crisis of 2008. The analysis will pursue the investigation of theoretical and empirical views related to lending due to the bad loans by borrower's default inducing the growth of non-performing loans.

Belaid (2014) examined the impact of banks' policies related to the banks-specific variables (cost efficiency, capitalization, activity diversification, credit growth and profitability), firm-specific aspects and macroeconomic circumstances on quality's loans according to Tunisian banking sector. He highlighted the significance of firm-specific features and macroeconomic circumstances related to the loan quality. Also he confirmed the banks-specific variables according to cost efficiency, capitalization, activity diversification that they have affected on the quality of loans portfolios.

Bonfim (2007) examined the determinants of loan default according to the relationship of credit risk and macroeconomic progress at the aggregate level. He confirmed the excessive risk-taking during economic growth due to the strong credit growth. Also he highlighted that the default probabilities affected by several firm-specific characteristics (like their financial structure), profitability and liquidity, their recent sales performance or their investment policy.

Moura Marins and Eiras das Neves (2013) analyzed the impact of business cycle on the credit default at microdata level in Brazilian market through the probability of default using the probit model. Their empirical results provided tough negative relationship among business cycle and credit default. They confirmed the largest effect on corporate defaults casing by GDP growth and inflation.

Jacobson et al. (2011) analyzed the relationship among the macroeconomic fluctuations and corporate defaults using a panel data set related to almost all incorporated Swedish businesses during 1990-2009. They found the tough proof in support of the substantial and stable impact from aggregate fluctuations on business defaults. Their analysis demonstrated that firm-specific factors were useful in ranking firms' relative riskiness, meanwhile the macroeconomic variables were required to realize the fluctuations in the absolute risk rank.

Podpiera and Weill (2007) examined the causality among the non-performing loans and cost efficiency referring to determinants of bank failures. Their findings supported the "bad management" hypothesis and reject the "bad luck" hypothesis using a panel of Czech banks during 1994 – 2005. Also they emphasized the enhancement of managerial performance through well education of bank managers.

Abid et al (2014) examined the determinants of households' non-performing loans in Tunisian banks during 2003 – 2012 using the dynamic panel data. They investigated the potential effect of both macroeconomic and bank-specific variables on the quality of loans. Their results highlighted that the households' non-performing loans could be explained by macroeconomic variables (GDP, inflation, interest rates) and the bad management quality.

Barth et al. (2008) examined the effects of both borrower and lender competition through the information sharing via credit bureaus/registries on corruption in bank lending. They found the significant results that the banking competition and information sharing reduced the lending corruption. Also their results demonstrated that the ownership structure of firms and banks, legal environment, and firm competition affected the lending corruption by large impacts.

Caporale et al. (2013) examined the macroeconomic and financial determinants of bad loans using SVAR approach to investigate the impact of excessive loans granting during the economic growth and loans' contribution into the increasing of non-performing loans through downturn. Their results confirmed the significance and continuity of bad loans to firms through the effects of a permanent shock to bad loans due to the excessive loans. Also these results did not reveal the bad loans to households or Cooperative Credit Banks due to the efficient lending policies.

Accornero et al. (2017) analyzed the impact of nonperforming loans (NPLs) on the supply of bank loan to nonfinancial firms in Italy during 2008 - 2015. They found that the banks' lending behavior did not affect by NPL ratios using time-varying firm fixed effects to control meant for demand shifts and changes related to the borrower characteristics. Their results demonstrated the negative correlation among NPL ratios and loan growth. Although the exogenous appearance of new NPLs and the linked enhance within provisions could reflect the negative adjustment in loan supply.

METHODOLOGICAL ASPECTS AND RESULTS

Methodological Aspects

Design of Experiments (DOE) is recognized as a statistical technique studied for the first time by R. A. Fisher in 1920s. Several statistical techniques studied the impact of factor on the dependent variable assuming the other factors remain unchanged, almost rather non-realistic assumption. Meanwhile, considering the simultaneous interaction of all factors generated various difficulties due to their numerous combinations. That's the core of DOE: assessment of relationship causality – consequence determining the minimum essential number of required experiments. DOE is the statistical method to assess the quality related to products and services. Among the most prominently used DOE techniques are Response Surface Methodology with Central Composite Design, Taguchi's method and Factorial Design. In DOE, synergy between mathematical and statistical techniques such as Regression, Analysis of Variance (ANOVA), Non-Linear Optimization and Desirability functions help to optimize the quality characteristics considered under a cost effective process. ANOVA helps to identify the effect of each factor versus the objective function (Wang et al. (2007)). According to Myers and Montgomery (2002), Full Factorial Design is a design in which all possible combinations of the factor levels are fulfilled. The result from the full factorial experiments would be more reliable, but conducting the full factorial experiments is costly and sometimes prohibitive.

Taguchi method (1986) is a broadly accepted method of DOE which has proven in producing high quality products at subsequently low cost. The original Taguchi method was designed to optimize a single performance characteristic. Although similar to DOE, the Taguchi design only conducts the balanced (orthogonal) experimental combinations, which makes the Taguchi design even more effective than a fractional factorial design. The steps included in the Taguchi parameter design are: selecting the proper Orthogonal Array (OA) according to the number of controllable factors (parameters); running experiments based on the OA; analyzing

data; identifying the optimum condition; and conducting confirmation runs with the optimal levels of all the parameters. ANOVA is the statistical treatment most commonly applied to the results of the experiments to determine the percentage contribution of each parameter against a stated level of confidence (Zhang *et al*., 2007). Taguchi suggests two different routes for carrying out the complete analysis. In the standard approach, the results of a single run or the average of repetitive runs are processed through the main effect and ANOVA (raw data analysis). The second approach, which Taguchi strongly recommends for multiple runs is to use the Signal to - Noise (S/N) ratio for the same steps in the analysis (Roy, 1990).

Referring to the number of factors and their levels, Taguchi put up the sample tables to assess precisely the measure of factors' impact. Taguchi standard table (orthogonal matrix) would be the L_2^8 (Table 1) due to taking into consideration the effect of seven factors by two levels (eg. 1 and 2 – correspond to "little" or "many") and the analysis of results would be sufficient to evaluate the accessible options in this table. We can realize the analysis of assessment according to the eight below options instead of evaluating options 128 (2^7).

Table 1: Combination of factors - Taguchi 7^2

	A	B	C	D	E	F	G
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

Source: Taguchi method

We determined the criteria/factors (Table 2) which were more considerable throughout the lending in banking sector:

- ✓ *Customer Reputation* (what was the customer's loan rating based on his historical behaviour with bank (or whole banking sector)
- ✓ *Ability to pay* (the ratio between the customer's revenue and its ongoing liabilities to liquidate the loan as well as other crucial expenditure of costumer)
- ✓ *Quality of collateral* (the possibility of its return to liquidities, the relevant sector, its size, etc.)
- ✓ *Loan conditions* (interest rate, macroeconomic circumstances, situation of the relevant sector, etc.)

- ✓ *The size of capital* (assume the contribution of costumer in relation to the received loan)
- ✓ *Business Sector* (assume the relevant sector where the economic activity worked up)
- ✓ *Subjective assessment* (assume the assessment of loan's lending relying on the personal recognition of the bank's specialist with customer)

Referring to the above orthogonal matrix demonstrated the whole relevant combinations within two level valuations: "1" considering relevant factors which did not take into consideration to affect the lending and loan's quality and "2" considering relevant factors which took into consideration to affect the lending and loan's quality.

Table 2: Combination of lending factors - Taguchi 7^2

Variants	Customer Reputation	Ability to pay	Quality of collateral	Loan conditions	The size of capital	Business Sector	Subjective assessment
	A	B	C	D	E	F	G
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

Source: Authors' estimations

The questionnaire was work up according to orthogonal matrix and fulfilled by fifty specialists of banking sector within eight second-tier banks from sixteen banks of the whole Albanian banking sector. Each specialist has evaluated each of eight combinations ranking evaluation from "1" to "6", where "1" considered into the case occurring in very few cases, meanwhile "6" considered into the case occurring always and so on the progressive evaluation to other occurrence from "2" to "5". Table 3 demonstrated the percentage of ranking from "1" to "6".

Table 3: Results of evaluation ranking related to questionnaire

1	0%
2	20%
3	40%
4	60%
5	80%
6	100%

Source: Authors estimations

Results

Results of variations to the average ranking in percentage are presented in Table 4. Referring to these results we confirmed that the seventh variant has occurred more than the others (70.4%) where the criteria on customer's reputation (A), the ability to pay (B), the size of capital (E) and the sector of business (F), have been taken into consideration; meanwhile other criteria, such as collateral quality (C), credit conditions (D), and subjectivism (G), have been considered to slight evaluation. After this variant were ranked the fourth variant (59.2%) and eighth variant (57.6%). Meanwhile it confirmed the first occurring very rarely compare to others respectively 11.2%, where all criteria have been rated "1" according to the loan portfolio.

Table 4: The average rating (%) according to factor's combinations

Variants	Customer Reputation	Ability to pay	Quality of collateral	Loan condition	Size of capital	Business' Sector	Subjective assessment	Estimation of experts (1 to 6) average	%
	A	B	C	D	E	F	G		
1	1	1	1	1	1	1	1	1.56	11.2
2	1	1	1	2	2	2	2	2.60	32.0
3	1	2	2	1	1	2	2	3.48	49.6
4	1	2	2	2	2	1	1	3.96	59.2
5	2	1	2	1	2	1	2	3.28	45.6
6	2	1	2	2	1	2	1	3.20	44.0
7	2	2	1	1	2	2	1	4.52	70.4
8	2	2	1	2	1	1	2	3.88	57.6

Source: Authors' estimations

Descriptive analysis

The first step of analysis related to the average evaluation of factors by their level ("1" or "2"). Data processing with MINITAB demonstrated the following results (Table 5 and Figure 1). The average assessment of level "1" (considering "slight") related to "customer reputation" represented 38.00% from 0 – 100% according to "little" ranking, meanwhile the level "2" (considering "large") showed 54.00% for this factor. The difference among two levels of each factor represents by "Delta" and ranks from 1 to 7 each factors related to it. The large "Delta" means the large impact of factor to lending and the ranking demonstrates the most influential factor according to "ability to pay", "customer reputation" and "size of capital". These results demonstrated by Figure 1.

Table 5: Results of Taguchi analysis related to means of factors

Taguchi Analysis: C8 versus Customer Rep, Ability to p, Quality of c, ...

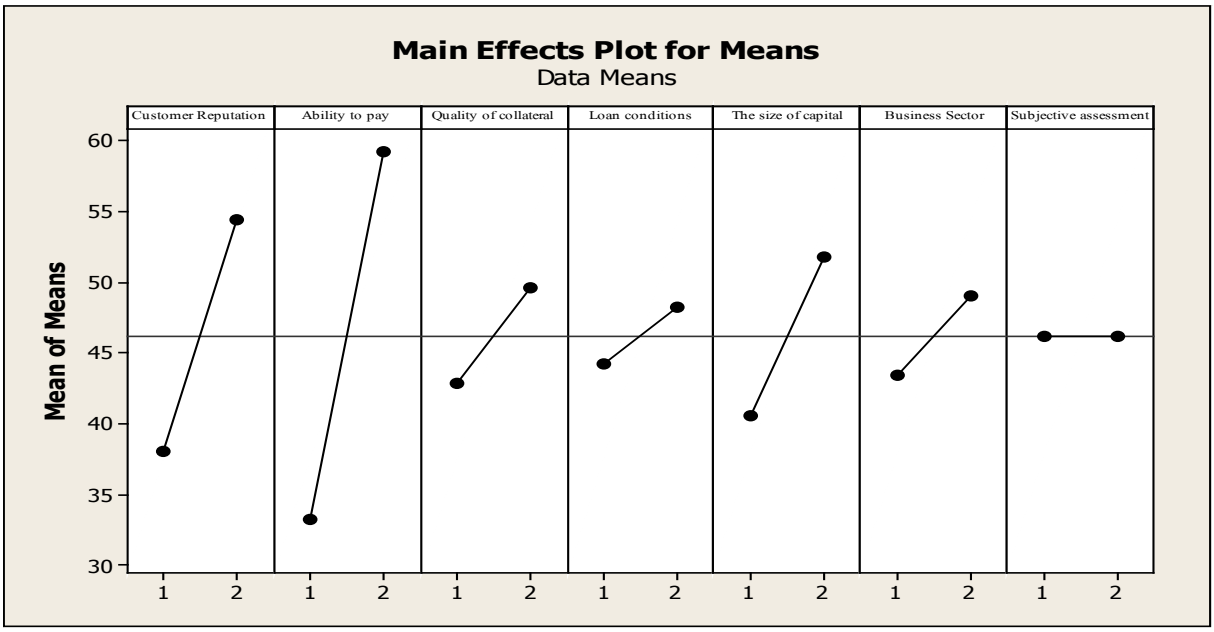
Response Table for Means

Level	Customer Reputation	Ability to pay	Quality of collateral	Loan conditions	The size of capital	Business Sector
1	38.00	33.20	42.80	44.20	40.60	43.40
2	54.40	59.20	49.60	48.20	51.80	49.00
Delta	16.40	26.00	6.80	4.00	11.20	5.60
Rank	2	1	4	6	3	5

Level	Subjective assessment
1	46.20
2	46.20
Delta	0.00
Rank	7

Source: Authors' estimations

Figure 1: Effects of means



Source: Authors' estimations

Theoretically DOE model considered as "signal" the involved factors affecting the relevant output. However this output could affect by other considerable factors on output's impact but they were not considered into the analysis due to they cannot be controlled and influenced by us. Such factors are considered as "noise" in the DOE. Referring to this aspect DOE required the calculation of another index, known as the S/N ratio which characterizes the relation between signal factors (S) and those noises (N). This indicator intended to receive as great value as in the experiment (Larger is better). Table 5 and Figure 2 demonstrated the estimation of S/N by MINITAB, as well as the ranking of influential factors by this index. Also the "ability to pay", "customer reputation" and "size of capital" were most influential to lending converging to results of factors' means.

Table 6: Results of Taguchi analysis related to Signal to Noise ratios of factors

Taguchi Analysis: C8 versus Customer Rep, Ability to p, Quality of c, ...

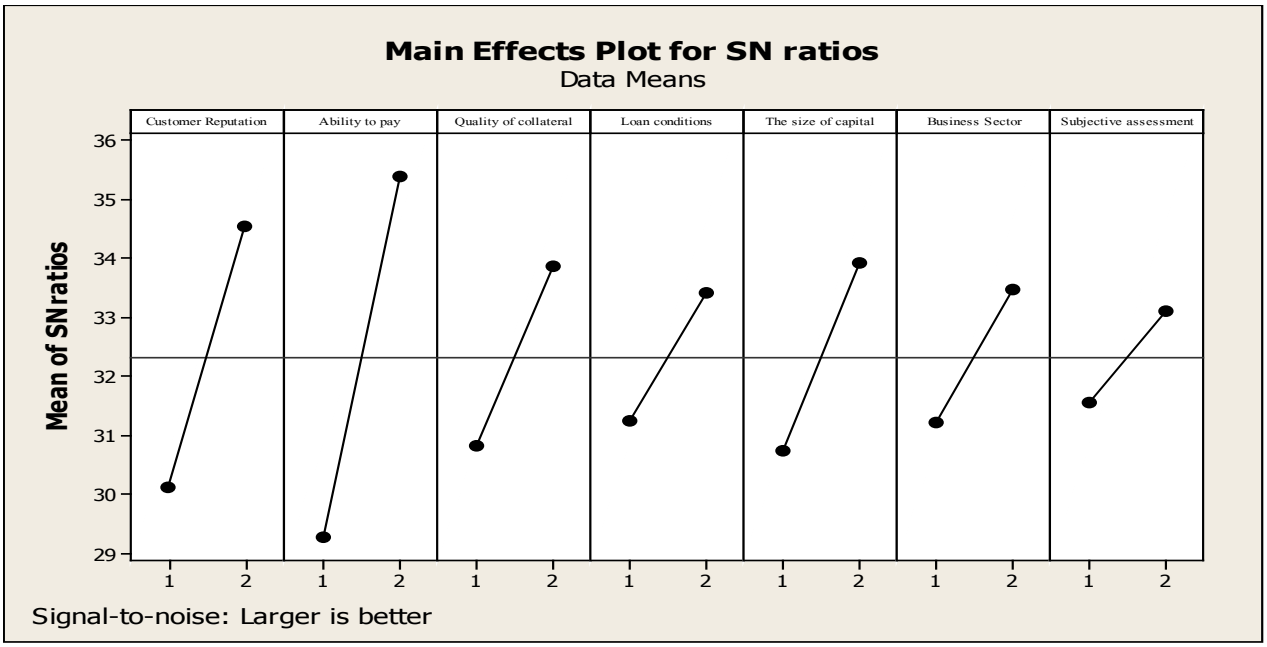
Response Table for Signal to Noise Ratios
Larger is better

Level	Customer Reputation	Ability to pay	Quality of collateral	Loan conditions	The size of capital	Busines Secto
1	30.11	29.28	30.81	31.26	30.74	31.2
2	34.55	35.38	33.85	33.41	33.92	33.4
Delta	4.44	6.10	3.04	2.15	3.18	2.2
Rank	2	1	4	6	3	

Level	Subjective assessment
1	31.56
2	33.10
Delta	1.54
Rank	7

Source: Authors' estimations

Figure 2: Effects of SN ratios



Source: Authors' estimations

The standard deviation is another indicator which it used to assess the variation in Taguchi model. This indicator provides to assess the variation of the factor in output due to the noise factors. Results of standard deviation confirmed the most influential factors to lending like the "ability to pay", "customer reputation" and "size of capital" ranking in the three last positions and demonstrating in Table 7 and Figure 3.

Table 7: Results of Taguchi analysis related to standard deviations of factors

Taguchi Analysis: C9, C10, ... versus Customer Rep, Ability to p, ...

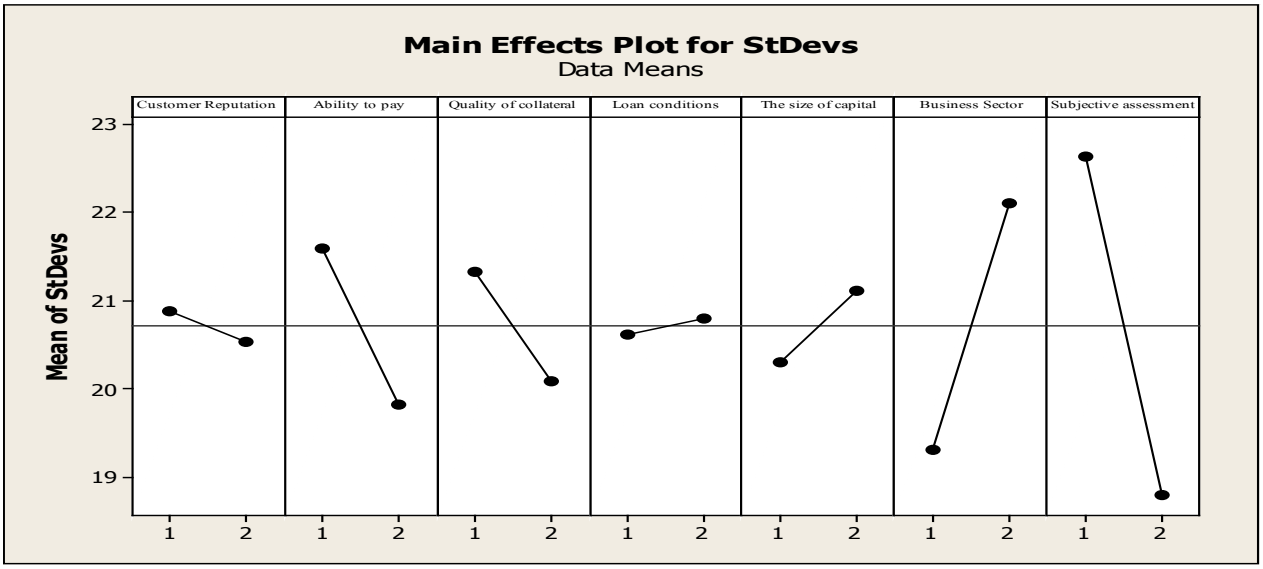
Response Table for Standard Deviations

Level	Customer Reputation	Ability to pay	Quality of collateral	Loan conditions	The size of capital	Business Sector
1	20.89	21.60	21.33	20.62	20.31	19.32
2	20.54	19.83	20.10	20.80	21.11	22.11
Delta	0.35	1.77	1.24	0.18	0.80	2.78
Rank	6	3	4	7	5	2

Level	Subjective assessment
1	22.63
2	18.80
Delta	3.83
Rank	1

Source: Authors' estimations

Figure 3: Effects of standard deviations



Source: Authors' estimations

ANOVA Analysis

Variation analysis related to ANOVA demonstrated the relevant procedure associated with the calculation of several indicators illustrating in Table 8.

Relevant coefficients in above table presented:

- ✓ *f – degrees of freedom (DOF)*
- ✓ *S – sum of square*
- ✓ *V – variance – mean of square*
- ✓ *P –factor's contribution (%)*
- ✓ *F – factor ratio (significances of factor)*

"P" represents the percentage of impact related to the relevant factor to lending. The results confirmed the most influential factors to lending and ranking like the "ability to pay" (58%), "customer reputation" (23%) and the "size of capital" (11%). The evaluation of variation related to S, V, and F. These indicators related to the assumed error in model and the statistical significance of each factor. We controlled the results if they were equal or proximately to zero, it recommended no further evaluation to statistical significance. We eliminated the "subjective assessment", "loan conditions" as well the "business' sector" due to the slight percentage of impact on output. After this elimination we recalculated the coefficients of "S", "V" and "F" different from zero demonstrating in Table 9.

Table 8: ANOVA

Factors		f	S	V	F	P
1. Customer Reputation	A	1	537.9	537.9		23.1%
2. Ability to pay	B	1	1352.0	1352.0		58.1%
3. Quality of collateral	C	1	92.5	92.5		4.0%
4. Loan conditions	D	1	32.0	32.0		1.4%
5. The size of capital	E	1	250.9	250.9		10.8%
6. Business' Sector	F	1	62.7	62.7		2.7%
7. Subjective assessment	G	1	0.0	0.0		0.0%
Other / Error	E	0	0	0		
Total		7	2328.0			100.00%

Source: Authors' estimations

Table 9: ANOVA

Factors		**f**	**S**	**V**	**F**	**P**
1. **Customer Reputation**	A	1	506.3	537.9	17.0	21.75%
2. **Ability to pay**	B	1	1320.4	1352.0	42.8	56.72%
3. **Quality of collateral**	C	1	60.9	92.5	2.9	2.62%
4. **The size of capital**	E	1	219.3	250.9	7.9	9.42%
Other / Error	E	2	0	31.6		9.49%
Total		6	2328.0			100.00%

Source: Authors' estimations

The evaluation of factor's significance is the most essential after these calculations. We realize it according to Taguchi method by comparing the F value (ratio factor) of each factor with the estimated values in standard tables related to the certain level of confidence. The statistically significant factor will be considered if the value of F factor in the experiment will

be greater than the tabular value[1]. Referring to the significance level in our case 97.5%, factor's DOF =1 and error's DOF = 3, the estimated value of F is 17.443. Table 10 confirmed only the "ability to pay" (42.8) to exceed according to this significance level. According to significance level 95%, the estimated value of F is 10.128 meaning significant statistically like the "ability to pay" (42.8%) and "customer reputation" (17.0%). Meanwhile the other two factors according to this significance level are considered not significant statistically, so they should be eliminated and recalculated. The last column of Table 10 shows the impact of particular factors on the lending. It demonstrates that the larger impact provides by the "ability to pay" (56.7%) and "customer reputation" (21.6%). The calculations with MINITAB related to ANOVA provide the results of Table 10. The influence of two above factors in lending can be considered statistically significant (P <0.05). Also R-Sq is high (90.51%) confirming that these factors explain over 90% of lending.

Table 10: General linear model

General Linear Model: % versus Customer Reputation, Ability to pay,

Factor	Type	Levels	Values
Customer Reputation	fixed	2	1, 2
Ability to pay	fixed	2	1, 2
Quality of collateral	fixed	2	1, 2
The size of capital	fixed	2	1, 2

Analysis of Variance for %, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Customer Reputation	1	537.92	537.92	537.92	17.04	0.026
Ability to pay	1	1352.00	1352.00	1352.00	42.82	0.007
Quality of collateral	1	92.48	92.48	92.48	2.93	0.186
The size of capital	1	250.88	250.88	250.88	7.95	0.067
Error	3	94.72	94.72	31.57		
Total	7	2328.00				

S = 5.61902 R-Sq = 95.93% R-Sq(adj) = 90.51%

Term	Coef	SE Coef	T	P
Constant	46.200	1.987	23.26	0.000
Customer Reputation	-8.200	1.987	-4.13	0.026
Ability to pay	-13.000	1.987	-6.54	0.007
Quality of collateral	-3.400	1.987	-1.71	0.186
The size of capital	-5.600	1.987	-2.82	0.067

Source: Authors' estimations

ANOVA shows their value to the level "1" according to coefficients. Since each factor is taken into consideration by two levels "1" and "2, the dependence of output (Y) (the lending) related to the factors may be presented by the following equation:

$$Y = 46{,}200 + (-8.200 + 8.200)A + (-13.000 + 13.000)B + (-5.600 + 5.600\ )E$$

[1] The tabular values are determined by the level of confidence, as well as the DOF factor and the DOF of the error term.

The equation demonstrates the largest impact on the lending referring to the "ability to pay" (A) and "customer reputation" (B) converging above results.

CONCLUDING REMARKS

The lending in banking sector associated with certain risk due to the bad loans. We focused to examine the determinants of lending by DOE's approach in order to guarantee the qualitative lending within banking sector. Due to this reason it should be implemented some basic criteria into each second level's banks in order to investigate the borrower's default and to avoid the bad loans. Results of DOE's approach confirmed the statistical significance and largest impact on the lending related to "ability to pay", "customer reputation" and "size of capital". Also ANOVA's results highlighted the significance and impact of the inclusive lending's factors converging to DOE's results. The results confirmed the significance of above determinants affecting the quality of loans and should be considered the probable factors inducing the bad loans. Banking bad loans in Albania should be monitor in future by second level bank due to the growth of non-performing loans. Restrictive lending policy applied by second level's banks recently relying on these determinants and loan's managers should be investigate in details and realize no a priori implementation.

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