Application of Data Mining in Islamic banking for modeling of Murabaha product Return Risk in a Macroeconomic Context

K. Chelhi, Faculty of Sciences Ben M'Sik, University Hassan II
M. El Hachloufi, Faculty of Law, Economics Ain Sebaâ,University HassanII,
M. Elfar , Faculty of Sciences, Dhar El Mahraz, University Sidi Mohammed Ben Abdellah,
A. Eddaoui , Faculty of Sciences Ben M'Sik, University Hassan II,
A. Marzak, Faculty of Sciences Ben M'Sik, University Hassan II

***Abstract*— Islamic banking is known as an ethical alternative of traditional financial activities available for those who wish to operate financially in line with sharia's principles. With the rising demand of Islamic products, investors are very attracted by this market which has a remarkable expansion recently.**

However, the investment based on Islamic financial products (PFI) may also present some risks related to different factors.

A significant number of risks are related to macroeconomic factors that may affect the performance of a PFI and should be taken into account.

The exclusion of macroeconomic indicators from the risk assessment model can result in distortions in the results.

In this study, we will be interested in the product Murabaha, which represents the most proposed PFI by Islamic financial institutions as it presents an income and a well-known and guaranteed margin plus the low costs generated.

In this research, we present an approach which is part of the continuity of the previous results on the preceding article "Estimation of Murabaha margin" allowing the Islamic bank to estimate the Murabaha margin outside of the index Labor related to the interest rate, using the performance history of an optimal portfolio of projects that remains as incomplete and dependent on market factors.

But this time this paper aims to go out with a more relevant model which takes into account the macroeconomic environment as well. This allows the Islamic bank to assess the risk incurred and the profitability of an investment project to their fair values taking into account macroeconomic factors through data mining tools especially neural networks.

Index Terms - : Data mining, neural networks, Islamic banks, Murabaha, Macroeconomic indicators, Risk assessment,

I. INTRODUCTION

With the arrival of globalization, markets have become interlinked and their economies more interdependent.

This context of opening up trade, has an influence on the performance of activities in different domains.

So Even more in a local market where all economic factors interact and depend on each other, macroeconomic factors has an impact on all the activities of a national economy and its traditional finance.

Hence, the need for framing that represents a part of the role of national financial institutions such as the central bank or the global bank and the IMF.

The field of Islamic finance does not escape this reality. Islamic financing is above all a method of financing, but which is framed by rules on Islamic religion which avoid the interest rate and wear (Riba in Arabic) prohibited by the Charia.

This regulatory framework imposes certain limitations on Islamic financial institutions to conform to the principles of the Charia. However, some studies have shown that IFIs can be exposed to a weakness in terms of liquidity, operational efficiency and risk.

In other words, the performance and performance of investments in Islamic financial products can be influenced by macroeconomic factors.

In order for an Islamic financing choice to be in line with the Charia, the investment must assume some of the risks related to either the assets financed or the activity.

However, the risk management of an investor in Islamic financial products is very important

Murabaha was chosen to represent here the other PFIs since it is the most used and more marketed in the Islamic financial institutions

In this research, we first study the possibility of correlation between the macroeconomic indicators and the return performance of the product Murabaha.

In the second part of this paper, we will be interested in risk management in the Murabaha investment, taking into account

macroeconomic factors in order to analyze their impact on profitability.

In this study, we will propose a model that could simulate the impact of macroeconomic factors on a given investment in the most favorable case of historical projects close to the project considered and bring the nature of the risk closer.

At the end of this research, we will go out with a model that will describe the performance behavior of the product Murabaha with characteristic benchmarks that inform the investor on the dimension of the risk in this case for assistance to the upstream decision based on a concrete simulation of the investment environment.

II. ISLAMIC FINANCIAL PRODUCTS

The demand for Islamic financing has changed recently and has begun to gain ground in the medium of financing.

Due to the advent of the financial markets of ethical products that appear at first sight in conformity with morality and religion.

Islamic finance [2] is based on four main foundations framing with specific criteria that are:

- Lace of Riba or interest (wear)
- Lace of speculation and uncertainty or Ghrar and Maysir
- Lace of illicit (Haram) products prohibited by the sharia
- Profit and loss sharing obligations

As with conventional finance, Islamic finance presents a range of Islamic financial products based on contracts.

There are several types of products in Islamic finance, but the most well-known and common are the Islamic financial products in the following:

- L'Ijar:
It is a similar product to Leasing. The bank buys the property and rents it to the customer who becomes the owner of the property at the end of the refund of the sum paid in the amount of time payable in the form of similar deals to a rent.

- The Mucharaka:
It is a contribution of the bank and its customer in the capital of an investment project whose profits will be admissible proportionate to the initial contribution of each part of the partnership agreement.

- The Mudaraba:
This product may seem similar to the Mucharaka but it is different. It is also about the participation of the bank in an investment project by a capital injection.

But this time the project promoter participates with his work and his efforts with a possible low initial intake.

At the end there is a share of profits according to the proportions agreed at the beginning, but if there is a loss the majority of the deficit is borne by the bank as to the promoter it will have lost its time its efforts and its initial low input

- The Takaful:
It is an insurance based on mutual cooperation and assistance between the participants

- The Murabaha:
It is a contract of sale with profit: the bank buys the property from the supplier as a result of the order of a customer to sell it to him with a profit margin fixed before.

- Sukuk:
It is an investment in bonds that give the buyer access to a share of the assets or profits that he will receive in place of the interest

- The Salam:
It is a short-term contract by which the bank pays advance the amounts representing a future delivery of goods or goods an investment in bonds that give the buyer access to a share of the assets

- Istisna'a:
It is a contract between 2 parts the Moustasni'i that asks the Sani'i to produce it or make a product against a remuneration in advance, then split or end

III. MURABAHA PRODUCT

Murabaha [3] is the most popular Islamic Financial Product used and proposed by Islamic financial institutions. So in this study we will focus on this product for modeling the return risk.

Murabaha is an Islamic financial product defined by a sales contract with a known profit margin and communicated to the buyer in advance but also having a cost.

The profit margin is of great importance in the realization and development of this contract and is among the main elements defined for the product to be profitable commercially.

The profit margin in the Murabaha contract must be known in advance, as well as it is not enough to content oneself with the overall price.

In fact, benefit has to be determined at a definite value. The profit margin in the Murabaha contract may be estimated from the Libor indicator.

It is considered as a world reference for the rate of short-term interests) before elaborating the contract during the promise period (which is not considered as a sale).

The profit margin will not be fixed but variable depending on the time period and will be calculated at the end of the payment period of credit.

It follows that when the purchasing officer establishes the Murabaha contract, the profit margin cannot be based on the Libor indicator.

Otherwise, the contract will not be in accordance with Charia bearing in mind that a condition of the legitimacy of Murabaha is the fact that the profit margin is fixed and known in advance.

Banks need to use another indicator that measures and assesses the profit margin of Murabaha contract beyond the usual Libor indicator used by conventional banks.

This will clear any doubts about the conformity of the Murabaha contract to 'Charia'.

It can also establish a serene climate among users of these Islamic products.

Therefore, it helps to keep Islamic banks away from unbalanced competitiveness between them and conventional banks.

IV. RETURN PERFORMANCE RISKS RELATED TO THE (ECONOMY.

Any investment that is subject of a financial placement to generate a return is exposed to risks of different natures.

The higher the expected return is the greater the risk to be taken into account and any secure investment is subject to low profitability. The Return/Risk couple is inseparable and follows a proportional evolution.

On the other hand, given the economic change in the world today from globalization, and its influence on national financial instability.

We are interested in the risks associated with the macroeconomic factors that have today taken a scale to be considered and taken into account in the performance calculations of an investment.

In this context, there will be two types of risk, market risk and macroeconomic risk:

A. Market Risk: Offering and Demand

We intend by the risk of the market the uncertainty based on the change in demand dynamics.

The volatility of prices and their fluctuations in the proposed offer on the market generates the risk to be taken into account. In this paper, we are interested in the risk of macroeconomic factors.

B. Macroeconomic risk

The financial turbulence due to globalization and the international political system on the national economy of a country and cause fluctuations in macroeconomic factors.

The macroeconomic factors [4] mean inflation, the trade deficit, the money supply, the GDP, the percentage of active population, etc.

The high-level uncertainty of the previous indicators represents an important risk that has an impact on the profitability of investment projects based on Islamic financial products.

V. MURABAHA PERFORMANCE RISK

In a Murabaha contract after the sale is concluded a debt cannot be changed or increased to keep the sales aspect compliant with the Charia because the interest rate is prohibited by the Islamic religion.

The Islamic bank and its client exposed it to the risk of performance dependent on macroeconomic factors. When investing in a Murabaha product, risk tolerance must be taken into account.

Generally, it is asymmetrical in other words; there is a lower tolerance for the risk of low yield than for the maximum yield risk according to the trend of macroeconomic factors.

VI. DATA MINING

A. Concept

Data mining [7] is based on the process of analyzing data using techniques of recognition and detection of correlation and trend of a mass of information to extract the most relevant information engulfed in the databases.

Data mining uses the statistics rules with mathematical algorithms to evaluate events and analyze the links between the data to conclude on the trend of the data and the correlation between the information.

Data mining uses different processes with analytical tools that allow the data to be searched to determine the associations, relationships and to take out the real information so that it can be built and developed models that can describe the behavior of an activity or predict future risks

B. Processes and techniques

Data mining uses different processes with analytical tools that allow the data to be searched.

It helps also to determine the associations, relationships and to take out the real information so that it can be built.

So it allows to develop models that can describe the behavior of an activity or predict future risks.

The exploitation of data to extract useful information goes through different phases.

The first stage is the collection of data on the activity to be evaluated that can be operational, transactional or macroeconomic data.»

The second stage is the centralization of these data in what we call the Datawarehouse, which is the basis for centralizing information from different sources.

The third stage is the preparation of the data. Since these data recovered and centralized so far are still raw and heterogeneous, sometimes they are redundant.

They must be filtered by removing the inconsistent values and duplicates, which is the purpose of this part.

The fourth stage is the segmentation that consists in discovering the data that appear similar according to a predefined algorithm for ulterior organization of them.

The fifth stage is the classification that is to put the data in order to put them in groups for the generation of class structures.

After the preliminary stages comes the step of exploration of data that is organized according to 4 varieties of functions namely:

- The association: the function that seeks the relationships and causalities between the data groups according to the predefined criteria. This allows you to discover the links between the data.

- The Clustering: It is the grouping of a series of data based on their characteristics to produce aggregates whose specifications have a high similarity.

- Prediction: This forecast phase allows future behavior to be predicted based on data history.

This is centered on dependent and independent variables, also called predictive analysis. Regression is often the technique used to find a data-modeling feature with a low error rate.

-Sequence Analysis: This is the data series locating phase in which an event informs about the arrival of another sequence of late event data.

C. *Datamining with Neural networks*

Neural networks [8] are one of the key tools used in data mining as a predictive technique for data classification and to model a variety of behaviors and activities.

When neural networks are used as data mining algorithm, the output of the process is a trained model which can be used to process transactions and perform clustering:

The formal neuron is a model that is characterized by an internal state S, and variables of input signals n1...np and a function of the switch of state

$$s = f\left(\beta_0 + \sum_{J=1}^{P} \beta_J n^J\right) \qquad (1)$$

With β_0 matches the bias of the neuron

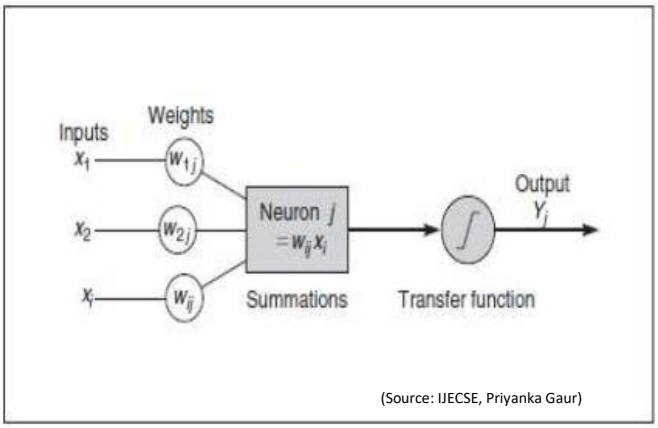

Fig 1: Neural Network Scheme

1) Methodology :

The steps in setting up a Neural Network for forecasting or ranking are:

- Identification of information or data entry and output
- Choice of a suitable topology for the project and the creation of the network
- Learning and testing of the network
- Model and application of the model generated by the learning

2) Learning Algorithm

The Neural networks use the principle of induction, in other words learning by experience.

It follows an integrated decision-making system based on the number of learning cases encountered.

The concept of learning deals with 2 realities of a consecutive way that are first, the memorization can assimilate several examples in broad form, then secondly the generalization able to treat separate examples not encountered thanks to those learned.

Learning algorithms are used to classify data and perform a model analysis.

Among the learning algorithms there is one older and more used on large volumes of data is the retro-propagation algorithm of the gradient, which starts on the principle of defining a notion

of error on an example and then calculating the contribution to this error of each of the synaptic weights.

D. Principle Component Analysis in datamining

Principles

We consider p to be quantitative variables, noted X1,...Xj; ..Xp, observed on n individuals,

rated 1; .. i; …to….n. Observing the Xj variable on the individual i, Xj(i), will be more simply

noted xij.

Method

We look for linear combinations of the original variables, called factors, or Main components, writing in the following form

$$C^1 = a_1^1 X^1 + a_1^2 X^2 + ... + a_1^p X^p \qquad (2)$$

$$C^2 = a_2^1 X^1 + a_2^2 X^2 + ... + a_2^p X^p \qquad (3)$$

...

With :

$$\sum_{j=1}^{p} \left(a_1^j\right)^2 = 1$$

$$\sum_{j=1}^{p} \left(a_2^j\right)^2 = 1$$

C1 and C2 are not correlated

VII. EXPLOITATION OF DATA MINING IN ISLAMIC FINANCE:

Over the last decade, the volume of data used in traditional banks has increased considerably and has begun to compel decision-making.

The same goes for Islamic banks, which now have a large number of customers and operations, which results in a huge mass of raw data that cannot be analyzed by the human being directly.

The use of data mining in Islamic finance can help reduce risk and help extract the performance data of several Murabaha

Projects to be able to analyze them and deduce them from high-risk behavior and elements.

Susceptive analysis can be used to make forecasts for future investment and to reach better conditions for the success of future Murabaha projects with a minimum of risk

VIII. THE EMPIRICAL STUDY

A. Modelise performance risk by Neural network

In a previous article [1], we were able to release a model: **R(T) = R(T-1) + 0,6Ɛ (T-1)** usable by the Islamic bank to define the range of forecasts between two values R_{min} and R_{max} of income R_T (Return during period T) that it can choose to check its margin and ensure the profitability of the investment of the product Murabaha .

So the model was based on ARMA [10] time series and allows to forecast the return R_T using historical values of this revenues ($R_1 \ldots R_k$) coming from optimal portfolio of previous projects that has performed.

However, this choice remains random according to the variation of the market, which also remains under the influence of macroeconomic factors.

In a continuity of what has preceded, this research will focus on managing the risk of return for a good assessment of an investment project and better decision-making.

The current context of this study is the development of a predictive model of the performance risk of a Murabaha product investment related to fluctuations in macroeconomic factors using Neural Networks.

This modeling represents a decision-making aid to invest or not based on macroeconomic factors.

That said, to keep among (one can only remember) those with a strong influence on the risk of return of a Murabaha investment was used the method Principal component analysis (PCA) [11].

1) Identification of data in input and output

a) Principle Component Analysis

The PCA is a descriptive technique used for dimension reduction: it allows studying the relationship of dependence between continuous variables or multi-variable observations in

Order to obtain a dense representation for a better projection of data on different axes.

The PCA is a classic method used for dimension reduction and that allows extracting the important directions of the data from a multidimensional point cloud.

In addition, this method reduces the number of variables called the main components.

This allows the cloud of individuals projected on the new main plans to be the least distorted possible to make the maximum inertia of the projected cloud.

This gives a representation of the variables in the main plans, whose coordinates are the correlation values of the initial variables with the main components.

b) Study of the correlation between macroeconomic factors and the return on investment

To this end, an empirical study was carried out on a data base, of 331 observations of a financial institution of alternative products for various investments during the period 3_2012 to 2-2015. And macroeconomic data as inflation, GDP, monetary mass… related to Morocco from the global bank.

The objective is to assess the relationship between macroeconomic factors and the return on investment. The representation below describes this relationship:

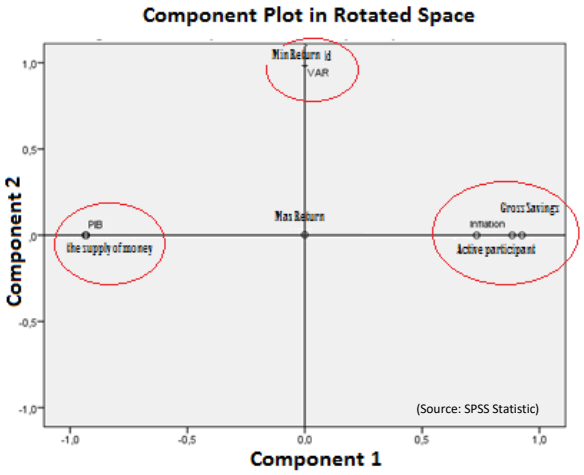

Fig2: Component Plot in rotated space

Interpretation of the results:

The results of this method showed the different correlations between the different macroeconomic factors.

The main part of the information is explained by the first 2 factorial axes.

These two axes taken into account to describe the correlations between the spatial structure variables alone hold 73.88% of total information, respectively 48.94 % for the axis 1 and 24.92 % for the axis 2.

The analysis of the results shows that the first factorial axes explain the important part of the information.

The factorial card also allowed us to describe the structure by 2 main components of the investment:

- A component 1, expressed to its positive pole by the risk and the investment Rend_Min explaining an investment, which displays less volatility, will

  Have a potential of gain and loss lower than an investment showing a higher volatility.

- A component 2 expressed by the macroeconomic factors impacting the investment by positively influencing it is the case of GDP and the monetary mass, or inversely for inflation and the others.

2) Presentation of the input vectors & the propagation of these to the network output layer

Significant and representative variables of the PCA will serve as input variables for our Neural network The base structure used is a three-tier (PMC) multilayer network: entry, hidden, and exit. The neurons of these three layers include:

- Six neurons of entry: It is the representative variables of the PCA that will influence the result of the yield, which corresponds to the function variables (Investment, inflation, GDP, money supply, gross savings and Asset participation)
- An exit neuron representing the output of the network that allows to predict the success of the investment. In other words, which shows whether macroeconomic factors have an impact on performance or not.

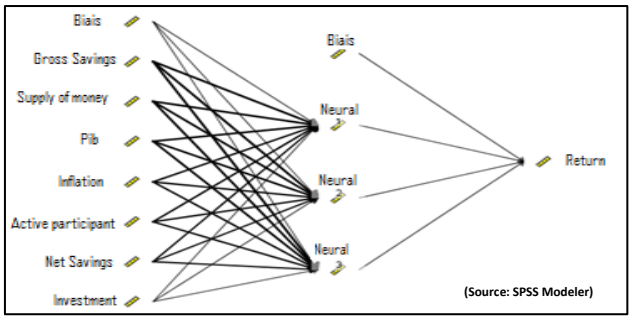

Fig 3: General structure of the neural network used

For this, I have carried out a number of analysis that will help in a first time to change data and create a base of studies, in a

second time to build a predictive model, so as to identify the macroeconomic factors that influence the investment of the bank. And this using the neuron network algorithm under SPSS Modeler.

In the next interface which represents a workspace where a workflow build from different phases has been achieved:
1) Loading and preparation phase of the data"
2) Research phase of a predictive model based on my historical base

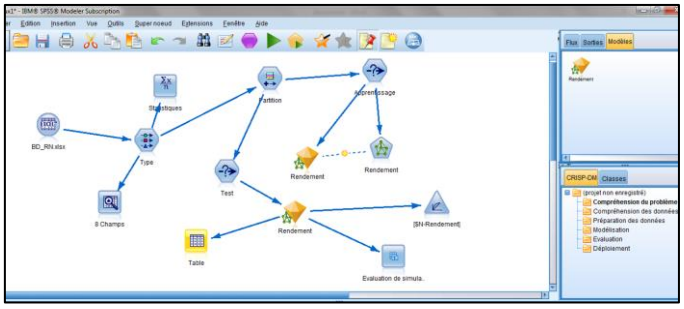

Fig. 5 : Flux interface-Source SPSS Modeler

The last phase will consist of scoring our model and we will have as result additional information that will be added in my data to be compared with the theoretical decision

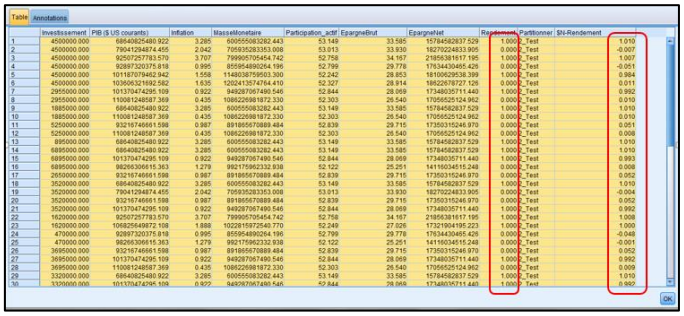

Fig 6: Result table - Source SPSS modeler

3) The results of Neural network modeling

In this paragraph, one proceeds to model the risk of return of an investment for prediction.

To do this several experiments were conducted on the Neural Network and which led to the summarized results below.

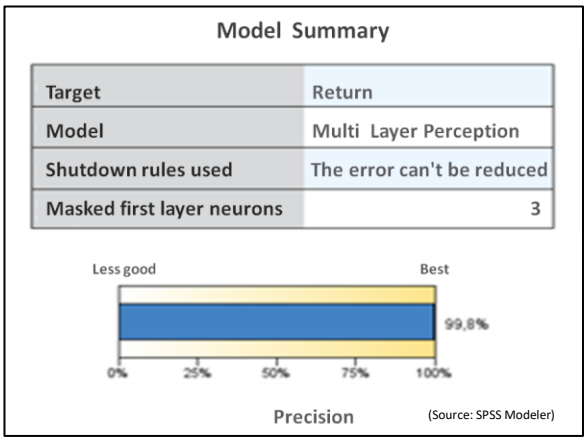

Fig4: Neural network Ranking Performances

The model is represented and described by the graph above, which reflects a good overall significance of the order of 99.8% so the model is good.

By taking the following profit graph out, we notice that the result is very satisfactory.

This confirms the first result found in the previous graph that is to say that the model is correct

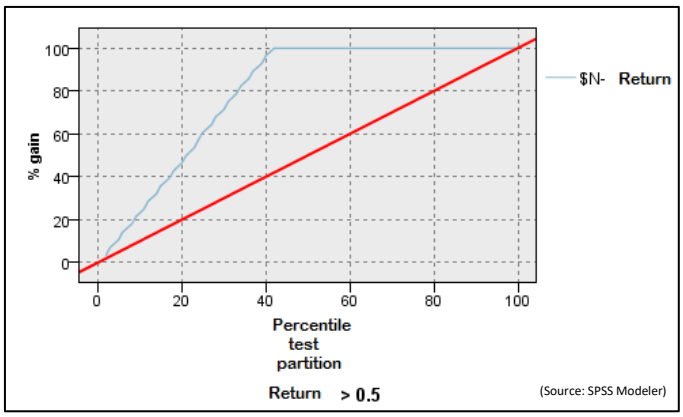

Fig 7: Rock graphic

These results allow us to conclude that our model is meaningful and correct, so the bank can rely on it to predict the investment or not.
In other words, during an investment request, it will introduce the amount of the project and the macroeconomic factors cited above for this model and therefore see if they will impact negatively or not to predict the acceptance of the demand of the product Murabaha or not.

IX. RELATED WORK

This work has made it possible to verify that the return of a Murabaha investment can possibly be influenced by macroeconomic factors; confirmed by the presence of a relationship between the performance risk of the Murabaha product and the macroeconomic factors of the empirical study.

We have shown through this approach that the bank may already have, prior to signing the contract a visibility on the position of its performance according to the macroeconomic factors, which will reduce the risk of the margin Murabaha, linked to the national economy.

Our research was crowned by modeling through Neural' networks using the Data mining tool.

The model illustrates that the Islamic bank can define the interval of yield forecasts, to reach a maximum yield and to place it according to the values of macroeconomic indicators to check its margin and to ensure the profitability of the investment of the product Murabaha.

This study is part of a continuation of a previous article that dealt with the estimation of Murabaha Margin [1].

This research confirmed some aspects of the Murabaha performance but also addressed the risk factor associated with the macroeconomic environment.

This by giving more visibility as to the evolution performance and its behavior given external factors related to the national economy for a good risk assessment of a Murabaha investment project and better decision making.

In the end, the previous results represent an impulsive approach to a modeled performance approach for an estimate of the risk.

X. CONCLUSION

In summary this study has shown that the return of a Murabaha investment is actually influenced by Macroeconomic factors.
Confirmed by the presence of a relationship between the performance risk of the Murabaha product and the macroeconomic factors of the empirical study.

Islamic banks may have prior to signing the contract a global view through the model.
The model is meaningful and correct, so the bank can rely on it to predict the investment. It allows to evaluate the project financed by the Islamic bank and have visibility on the position of its performance according to the macroeconomic factors.
This reduces the risk of the Murabaha return related to the economy;

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K. Chelhiis based in Casablanca, and PhD student in Business Intelligence in Faculty of Sciences Ben M'Sik, University Hassan II in Casablanca Morocco.

She has an European Master degree in Information Technologies from Henry Poincare University of Nancy I (France) in 2001. She is Information System engineer

She is a Professor of Information Systems since 2008 teaching Information Technologies and Systems to Engineer studentsof ESITH (High School of Engineers in Casablanca).

She published an article entitled "Estimation of Murabaha Margin" in the Journal of Applied Finance & Banking/Scienpress.

She published an article entitled "Use of Data mining for the Assessment of the Mudaraba Performance Risk" in the Journal of Global Journal of Economics and Business (GJEB).

Mrs Chelhi contributes in different conferences and communications as “Business Intelligence applied to Islamic Financial Risks effective management “in the 5th edition of the International Conference on ITMC’ in 2015.

She participates with“ Contribution of the Business Intelligence and Econometric models in the management of Risk in Islamic Banks “in the 2nd edition of the International Conference on JSSA’16 held in Casablanca .

And contributes inthe 2nd edition of the International Conference of CITISI 2018 held in Turkey contributing with a communication under the title “ Application of data mining in the determination of Murabaha performance linked to Economic factors “

M. El Hachloufi received a Phd in Economic Sciences and management, Specialization in Finance from the Faculty of Science FSJES in Rabat.

He had also a Phd in Applied Mathematics, Specialization in Finance Mathematics &Statistics from the Faculty of Sciencein Rabat, and has a Phd in Computing obtained at the Faculty of Science in Marrackech.

He is a Professor at the Faculty of Economics and Laws Science in Ain Sebaa-Casablanca.

He is also Coordinator of the branch Master of Islamic Finance & Risks Management at the faculty of Science FSJES in Casablanca and he’s responsible of the Training for the obtention of the Master degree in Islamic Finance at the University FSJES.

Mr El Hachloufi has a large experience as University professor teaching various programs like Econometric Modelization for the Master in Islamic Finance at the Polydisciplinary University of Tetouan, as Statistics Applied to Insurance at the Faculty of Sciences & Technics in Tangier.

He teached also Portfolio management for the Master of Mathematics & Statistics at the Faculty of Sciences in Rabat.

He has published 30 articles and has 40 communications in Economy, Finance, Financial Mathematics, Statistics & computing.

M. EL FAR has a Phd in computing in 2011 from the Faculty of Sciences & Technics, of the University Hassan 1st of Settat. His Research was entitled Application of Data mining tools for Indexing 3D databases.

He received a Postgraduate diploma in Operational research &Application in data mining. He has also different certifications of Microsoft, Oracle and VMware. And he is Microsoft Certified Trainer.

Mr El FAR is a member (M) of IEEE and he is an Expert and consultant in business intelligence, big data, Databases and has worked on different projects.

He has animated various trainings for large companies, banks, in Morocco and at Africa Level. He accomplished different audit missions for large companies and banks like Central Bank of Gabon

A. MARZAK is a Professor in Computing at the Faculty of Sciences Ben M'sik Casablanca since 1994, a coordinator of the Branch Master in Information Science & Engineering at the same Faculty since 2014

From 2011-2015 he is responsible of The Team 3 at the Laboratory of Information technology and Modelization.

He is member of the Board of the Faculty of Sciences Ben M'sik, Casablanca at the University Hassan II Mohammedia.

He is member of the Partnership and Cooperation commission of the board of the faculty, member of the scientific Commission of the Board of the Faculty of Sciences Ben M’sik Casablanca.

Mr Marzak has participated at different Science productions and articles about generation of models, Business Intelligence, computing and data processing.

A. EDDAOUI is a moroccan professor working as an Associate Professor in Computer Science teaching information security and supervising research workat the College of Computer Science & IT - Shaqra UniversityKingdom of Saudi Arabia, since Oct 2017 to Present.

He has a PhD in Computer Sciences at Faculty of techniques and Sciences from Hassan II University Casablanca.

He has a Master degree at Faculty of Sciences Rabat from Mohamed V University in Computer Sciences & Telecommunication and Multimedia.

He has worked as Associate Professor in Computer Science – in Department of math and Computer sciences, at Faculty of sciences Ben M’Sik, Hassan II University Morocco from May 2016 – October 2017.

Mr EDDAOUI has teached Audit and security, Information System governance and Networking Administration. He has published more than 30 articles in computer science Modelization, cloud computing and approaches for security management.