# A novel model to enhance the accuracy of the SMEs decision-making process and market analysis: Moroccan case study

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**ABSTRACT**: Previous literatures on small businesses around the world showed that SMEs fail to achieve their business goals; therefore, stagnation and disappearance occur to most of them. Many operate on the market with a severe lack of clear decision-making model and absence of any financial management strategy. In this paper, we introduce a simple solution allowing small companies managers to analyze their companies' future orientations and monitor their performances. The framework is mainly based on the financial data and includes both descriptive and predictive analysis, as well as the classification of companies' behavior. The solution predicts accounting management values over the coming years and explains SMEs financial accounting result. The main objective is to rethink their current decision-making model and innovates in the way they build a strategy from the predicted scenarios. The key success factors of this study consist on managers' ability to orient their companies through a practical and efficient action plan to reach superior future positions on the market.

**KEY WORDS**: Prediction, Making-decision model, Performance, Financial analysis, Information system, SMEs.

## I.INTRODUCTION

Small and Medium Enterprises (SMEs) are undoubtedly a real benefit to every economy, they potentially constitute the most dynamic firms in emerging countries [16]. Despite their value, they still have obstacles and challenges that prevent their efficient contribution. Their current situation is the result of a lack of managerial skills on how to establish a real strategy and to follow the company evolution on the market and evaluate its performance. Our previous researches have shown how managers are not able to expand and support their businesses growth, while at the same time; they lack skills to bolster their companies in decline moments. Literature conducted on the decision-making process or model, shares that strategic management can be grouped into two broad categories that are strategic content and strategic process [6], [14]. Studies that have focused on strategic content address strategic business-level questions, including product choices, markets, positioning, and so on. They use matrices such as the Ansoff matrix, BCG or Porter's models [9]. The second category of the strategic process concerns two main axes [7], namely strategic changes that can be implemented in companies, and strategic decision-making within an organization. The main objective of this paper is to propose a new decision-making framework based on statistical model [10].

To analyze SMEs data, we will use several methods especially the average annual growth rate, the prediction with the Panel data model, the description with the Hierarchical Ascending Classification (HAC), and the K-means clustering. As a reminder, the combination of these methods aim, from the real world of SMEs in Morocco, to allow a modelling of a system for generating artificial data, as shared by Andrew (see Figure 1) [15].
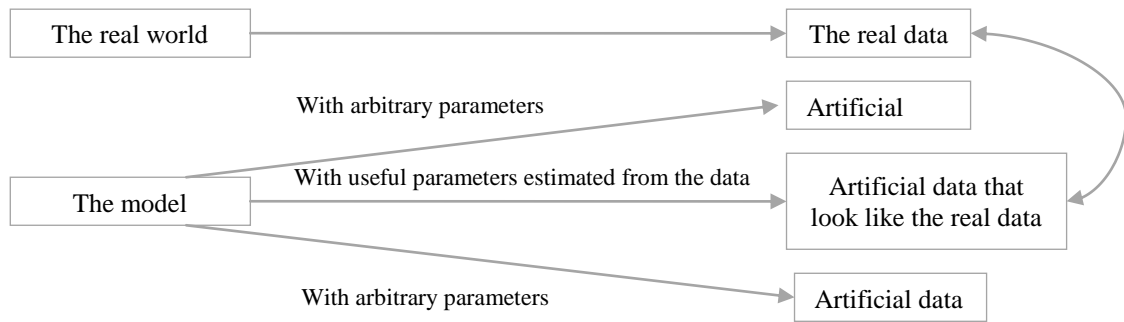
Fig1. A model is a system with equation generating artificial data

One of the critical components of the decision-making model is managers' knowledge and style that explain businesses orientations. In the Moroccan context, most managers' stylesare defenders and reactors [13]. These two styles explain how SMEs lack of having a comprehensible strategy and clear scenarios related to the future orientations and integrating risk. This absurd situation is calling into question the SMEs decision-making model that will only develop bad practices putting companies in more difficulties and crisis. This paper analysis is based on two principal information sources, it integers both the analysis from our survey conducted on 2013 [13], [12] and the financial analysis of a sample of Moroccan SMEs, that will be detailed on the next section.

## II. RESEARCH METHODOLOY

First of all, it is important to know that managing a company needs to follow a list of steps. These steps respect the three elements that guaranty a decision-making allowing performance regarding all areas of business activity [4]. Management is not restricted only to the organization, but also to its human component. We present the results of the managerial process in Figure below, inspired from Ivancevich and Donnelly works [8].
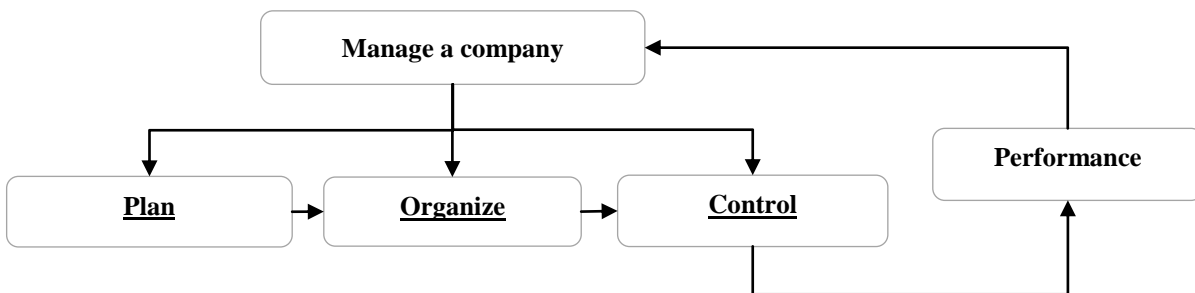


Fig2. Steps and objectives of the managerial process

Within the framework of this project, we limit the scope to the SMEs decision-making model improvement. This model allows performing, reviewing and controlling the company, as shown on Figure 2. To extend the first managerial process, we adopt the five steps of the strategic management framework from Atrill works, as illustrated in Figure 3[11]. This framework describes the process in more detail; the important consideration is that performance will be reached only by a clear definition of an actions plan.
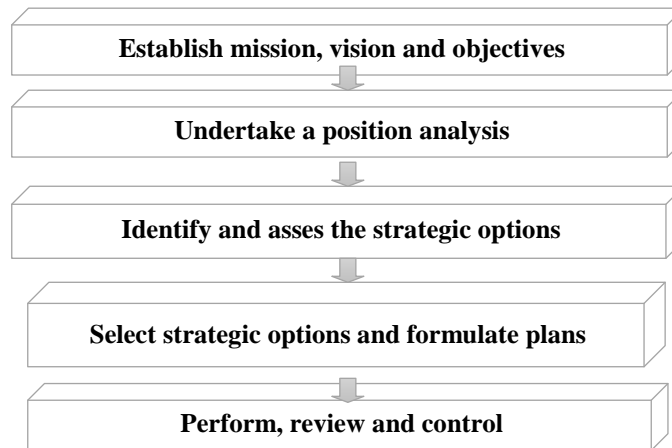
Fig3. The strategic management framework

The business should set out its mission, vision and objectives and develop plans in a systematic manner to achieve them [11].

## III. PREPARATION OF THE EXPERIMENTATION ENVIRONMENT

### A. Environment preparation

Before integrating the solution to a global information system, we test and validate the model using the R environment. We adopt this tool developed by Ross Ihaka and Robert Gentleman, because it is an open source solution designed to deal with statistical issues. This tool offers both a work environment and a computer language including commands executed with instructions with relatively simple syntaxes, and the results will take both text and graphics forms [1]. This step requires first, to download both R and StudioR available on the provider web side and easy to install. Subsequently, we imported a set of necessary libraries, as shown in Figure 4.



Fig4. RStudio environment

### B. Collecting and structuring SMEs financial data

We faced complexity to collect information from Moroccan SMEs, which is due mainly to two obstacles that are difficulty to find a company with more than five years of activity, and the second obstacles is to find a company that will accept sharing its financial data (even in an anonymous form). In spite of this situation, we succeed to have the collaboration agreement from a hundred of small companies. We collected financial data related to the three financial documents (or statements). The process adopted for data life cycle, was inspired from Artil works, as presented in Figure 5.
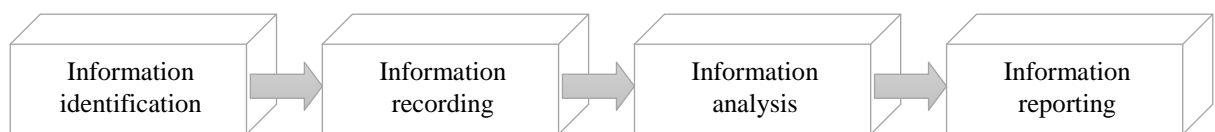


Fig5. Management accounting information system

Data collected cover the last ten years of each company's activity, and their classification respected the same criteria below:

- Same age,
- Same size (Micro, small, or medium),
- And, same geographical situation,

The economic sectors covered by our research include four main areas, the industrial sector, the construction sector, the services sector and finally the commerce sector. A breakdown based on the national survey conducted as part of the Moroccan National Economic census (2001-2002). We covered the four main sectors with equal repartition as shown in Figure 6.
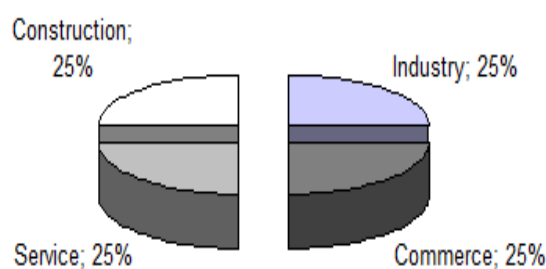


Fig6. SMEs sample distributions

We collected official data published by companies providing high quality. The data recorded between 2008 and 2017 are quantitative in nature, and were collected in three main ways: Word, PDF or Excel and are classified in a csv file that constitutes our data base analysis. In this study, only key variables of the income statement are part of the process and will be described and shared for three reasons[3]. Firstly, in order to simplify representation, secondly because only these variables permit to calculate the accounting result of an enterprise, and finally because variables allowing calculating the financial ratios are not part of this article scope. To simplify the processing, data have been extracted, treated and classified as shown below.

Table 1. Data structuring variable evolution / year

**9 variables**

**SMEs data for ten years**

| SME | Year | OpEx | FiEx | EXCo | ToCa | FiPro | OpRe | OpIn | ToRe | AR |
|---|---|---|---|---|---|---|---|---|---|---|
| SME1 | 2008 | 100130 | 67961 | 239581 | 407672 | 898277 | 81422 | 470725 | 1450424 | 1042752 |
| SME1 | 2009 | 355036 | 50209 | 310282 | 715527 | 341955 | 44565 | 623158 | 1009678 | 294151 |
| SME1 | 2010 | 301550 | 94968 | 292034 | 688552 | 62547 | 81831 | 291577 | 435955 | -252597 |
| SME1 | 2011 | 354929 | 54791 | 192536 | 602256 | 717704 | 1517 | 673388 | 1392609 | 790353 |
| SME1 | 2012 | 214670 | 62014 | 142414 | 419098 | 302429 | 19659 | 587066 | 909154 | 490056 |
| SME1 | 2013 | 119663 | 94551 | 781430 | 995644 | 244258 | 26192 | 741009 | 1011459 | 15815 |
| SME1 | 2014 | 409228 | 67225 | 439717 | 916170 | 160529 | 58704 | 323492 | 542725 | -373445 |
| SME1 | 2015 | 28335 | 66578 | 421487 | 516400 | 198871 | 20171 | 306822 | 525864 | 9464 |
| SME1 | 2016 | 399182 | 46943 | 385760 | 831885 | 306471 | 86736 | 137612 | 530819 | -301066 |
| SME1 | 2017 | 299474 | 24132 | 488654 | 812260 | 701816 | 20416 | 761753 | 1483985 | 671725 |
| SME2 | 2008 | 207538 | 52978 | 381074 | 641590 | 864503 | 67781 | 518757 | 1451041 | 809451 |
| SME2 | 2009 | 21929 | 97236 | 97897 | 217062 | 446809 | 32224 | 606119 | 1085152 | 868090 |
| SME2 | 2010 | 88416 | 35043 | 627784 | 751243 | 23774 | 70744 | 67200 | 161718 | -589525 |
| SME2 | 2011 | 39602 | 21775 | 704407 | 765784 | 307417 | 86440 | 365612 | 759469 | -6315 |
| SME2 | 2012 | 447356 | 19077 | 290688 | 757121 | 727460 | 37176 | 174503 | 939139 | 182018 |
| SME2 | 2013 | 51196 | 24223 | 262916 | 338335 | 796775 | 13254 | 576750 | 1386779 | 1048444 |
| SME2 | 2014 | 411519 | 47345 | 487289 | 946153 | 836308 | 40674 | 442876 | 1319858 | 373705 |
| SME99 | 2014 | 213524 | 18373 | 150338 | 382235 | 75822 | 33535 | 706291 | 815648 | 433413 |
| SME99 | 2015 | 37490 | 61814 | 381753 | 481057 | 999977 | 95023 | 199589 | 1294589 | 813532 |
| SME99 | 2016 | 268030 | 86347 | 279243 | 633620 | 322685 | 86122 | 29778 | 438585 | -195035 |
| SME99 | 2017 | 461025 | 14803 | 292740 | 768568 | 757676 | 44768 | 598071 | 1400515 | 631947 |
| SME100 | 2008 | 188010 | 27049 | 463067 | 678126 | 786671 | 74768 | 8307 | 869746 | 191620 |
| SME100 | 2009 | 317801 | 92415 | 501793 | 912009 | 228849 | 49426 | 262670 | 540945 | -371064 |
| SME100 | 2010 | 486854 | 49494 | 670946 | 1207294 | 601282 | 78644 | 750079 | 1430005 | 222711 |
| SME100 | 2011 | 134773 | 88913 | 706837 | 930523 | 542933 | 61128 | 64649 | 668710 | -261813 |
| SME100 | 2012 | 471338 | 12256 | 17032 | 500626 | 75757 | 29906 | 444071 | 549734 | 49108 |
| SME100 | 2013 | 269459 | 39408 | 320230 | 629097 | 877364 | 67307 | 739596 | 1684267 | 1055170 |
| SME100 | 2014 | 96137 | 42355 | 345782 | 484274 | 826101 | 29663 | 438605 | 1294369 | 810095 |
| SME100 | 2015 | 11461 | 99785 | 211388 | 322634 | 731169 | 71590 | 342470 | 1145229 | 822595 |
| SME100 | 2016 | 307490 | 61155 | 308138 | 676783 | 168475 | 92309 | 175051 | 435835 | -240948 |
| SME100 | 2017 | 13223 | 29155 | 152426 | 194804 | 223140 | 59820 | 23505 | 306465 | 111661 |

Where:

Expenses:
*ExcEx: Exceptional Expenses*
*FEx: Financial Expenses*
*OpEx: Operating Expenses*
*ToEx: Total Expenses*
Products:
*ExcPro: Exceptional Products*
*FiPro: Financial Products*
*OpPro: Operating Products*
*ToPro:Total Products*

*AR: Accounting Result*

SMEs financial analysis projection is a complex system than the simplistic representation giving in Table 1. Regarding the information analysis phase, we identify nine key variables of the income statement that constitute the process. These variables allow calculating the accounting result of each company; they were manipulated and integrated in different ways. Numbers in Table 1 are expressed in DH, the Moroccan current currency.

## III. Process steps

It is important to clarify once again the steps taken to reach our objectives. For that, it should be noted that companies usually use the financial ratios (see Figure 7) in order to evaluate their current situation [3].
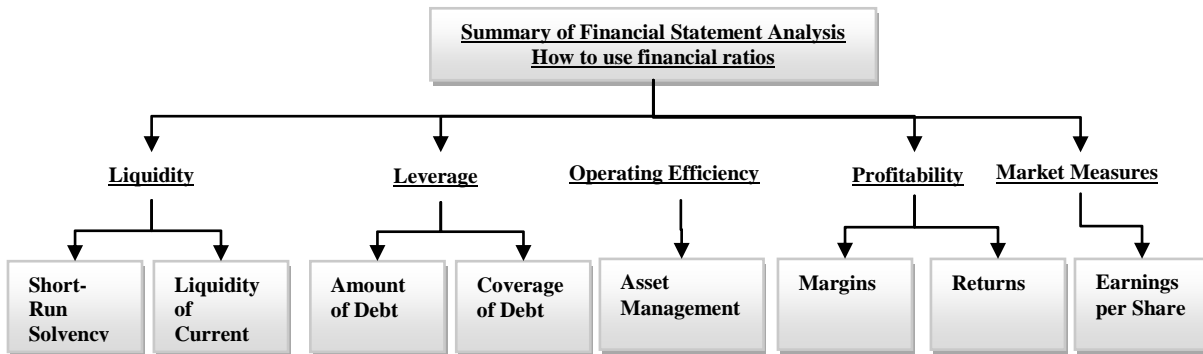


Fig7. Summary of financial ratios

The expectation from this project is to be able to evaluate the performance of an enterprise in the future. This objective can be reached through two stages, stage 1 predicting or estimating future financial values and estimating each company in order to know whether it is performing or not and establishing a strategy to support or address its situation.

The validation of the model respects and follows the diagram below.
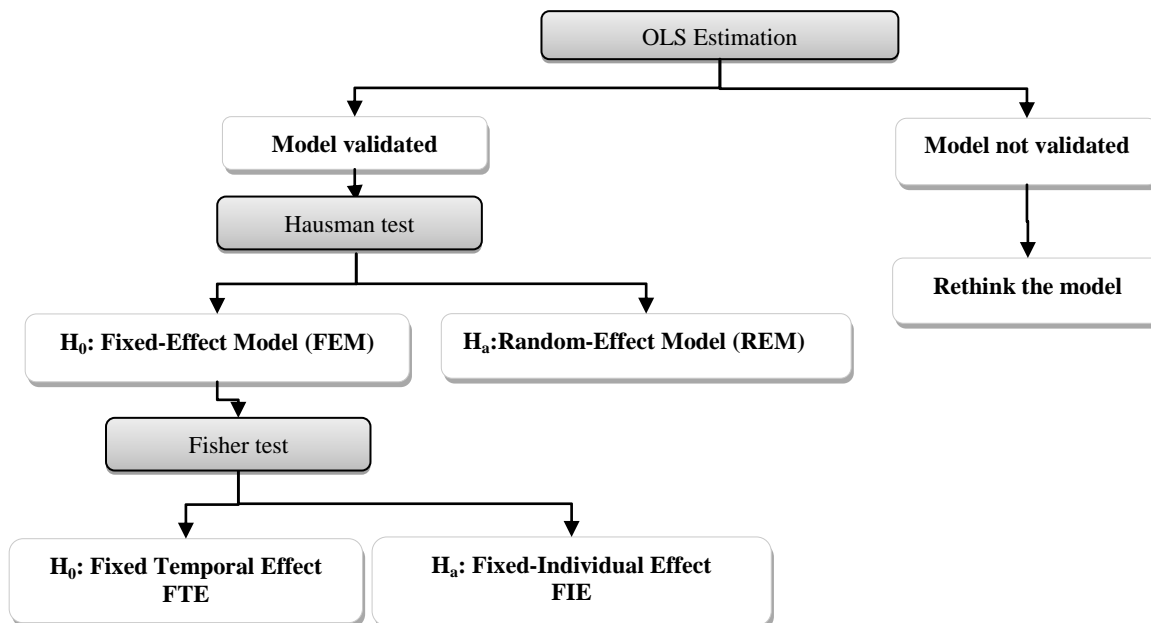


Fig8. Adopted estimation methodology

We apply the Panel model to all data on the time axis between 2008 and 2017, to estimate and explain the variable accounting result for the years 2018, 2019, and 2020. In order to validate the model that can be adopted, we use the

Fisher Test and the Hausman test methods [5].The first step of the estimation consists on doing the OLS test, as presented below.

$$R_{it} = \beta_{0it} + \beta_1 ExcEX_{it} + \beta_2 FEx_{it} + \beta_3 OpEx_{it} + \beta_4 ExcPro_{it} + \beta_5 FiPro_{it} + \beta_5 OpPro_{it} + \varepsilon_{it}$$

Where variables are:

> Expenses:
> ExcEx($it$)Exceptional Expenses of the company $i$ at the date $t$
> FEx($it$)                Financial Expenses of the company $i$ at the date $t$
> OpEx($it$)Operating Expenses of the company $i$ at the date $t$
> Products:
> ExcPro($it$)Exceptional Products of the company $i$ at the date $t$
> FiPro ($it$)            Financial Products of the company $i$ at the date $t$
> OpPro($it$)Operating Products of the company $i$ at the date $t$
>
> R($it$)                Accounting Result
> $\varepsilon_{it}$ White noise

The second step permits to make the choice between the fixed effect model and the random effect model, using the Hausman test. The statistical test is based on the following two assumptions.

> H0: We accept to adopt the random effect model
> Ha: We accept to adopt the fixed effect model

This third and last step allows choosing between the individual or temporal fixed effect models, the Fisher test is performed.

$$H_0: \alpha_1 = \alpha_2 = \cdots = \alpha_n = 0 \; et \; \gamma_t \neq 0$$
$$H_a: \gamma_1 = \gamma_2 = \cdots = \gamma_T = 0 \; et \; \alpha_i \neq 0$$

If the hypothesis $H_0$ is accepted, then the temporal-effect model will be adopted. Otherwise, the alternative hypothesis is accepted, namely the individual effect model.

### A. OLS Application model

The first stage in adopting a sample of panel data, consists in verifying and testing the equality of the coefficients of the model studied in the individual dimension (homogeneity or heterogeneity). These tests permit to determine if the studied theoretical model having the same values for all the companies, otherwise, to confirm existence of heterogeneity regarding SMEs repartition. These specification tests confirm as shown on Figure 8, the heterogeneities of the results from year-to-year. The formula used to visualize data is shared below.

```
plotmeans(R ~ year, main="Heterogeneity from one year another", data=data_panel)
```
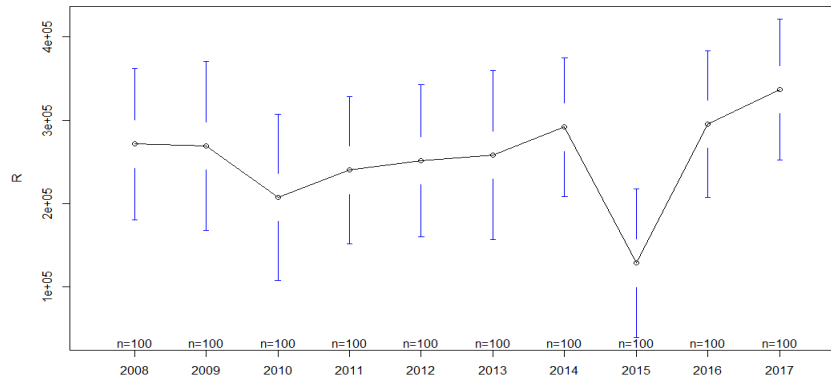
Fig9. Heterogeneity from one year to another

The second vision is to study the heterogeneity between firms, as shown in the figure below.
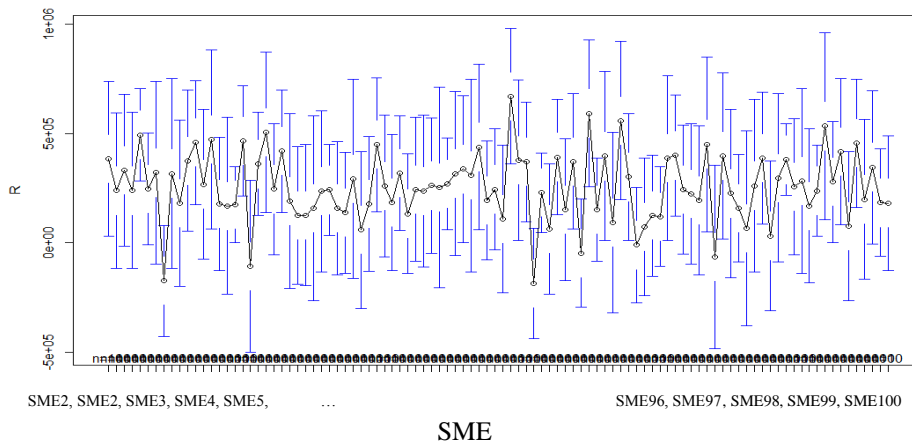


Fig10. Heterogeneity from one SME to another

A first estimation gives the result below.

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 142800 on 994 degrees of freedom
Multiple R-squared:  0.9063,  Adjusted R-squared:  0.9058
F-statistic:  1922 on 5 and 994 DF,  p-value: < 2.2e-16
```

R square is close to 1, the OLS model cannot be adopted. Then, it is necessary to do a test of comparison between the two models OLS and fixed effects, for that we adopt the Fisher test. This section assumes that individual effects are deterministic parameters. We will then be asked to present the construction and properties of the within estimator of the model.  For the fixed-effect model, there are two cases:

➢   Individual fixed effect model: a specific effect for each individual or SME.
➢   Temporal fixed effect model: a specific effect for each year.

The Fisher test permits to choose between the two models.

**B. Comparison between fixed effect model and OLS**

We compare here the fixed effect model with the OLS model. We share the result of the comparison below.

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:   1.9178e+14 Residual Sum of Squares: 1.8288e+13  R-Squared: 0.90464

Adj. **R-Squared: 0.89356**

F-statistic: 1698.12 on 5 and 895 DF, p-value: $< 2.22e-16$

To test the two models, we use the Fisher test as shown below.

F test for individual effects

F = 0.97363, df1 = 99, df2 = 895,  **p-value = 0.5547**

alternative hypothesis: significant effect

The P value permits to validate the acceptation or not of the hypothesis. In this test p-value >5%: H0 is accepted (the fixed effect model is preferable to the OLS model). We conclude that the OLS model is not applicable to SMEs data.

**C. Comparison between fixed and individual fixed effects models**

This step consists in comparing the two individual and temporal fixed effect models in order to know which one we can retain.

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:   1.9178e+14 Residual Sum of Squares: 1.8127e+13 R-Squared:    0.90548

Adj. **R-Squared: 0.89343**

F-statistic: 606.278 on 14 and 886 DF, p-value: $< 2.22e-16$

H0 is accepted (the temporal fixed effect model is preferable to the OLS model): OLS is not applicable.
The test applied to test between the two models is Fisher test as shown below.

F = 0.87585, df1 = 9, df2 = 886, **p-value = 0.5464**

alternative hypothesis: significant effects

Now, two cases will have to be distinguished: the case where the parameters $\alpha_i$ are deterministic constants (fixed effects model), and the case where the parameters $\alpha_i$ are realizations of a random variable, expectancy and finite variance (model random effects). It is assumed in this section that individual effects are no longer parameters, but random variables with a common distribution for all individuals. We will begin by studying the residue structure of this mixed variance model. We will then study the different estimators of the coefficients of the random effects model and more particularly the Generalized Least Squares estimator.
The Hausman test is used to choose between the two specifications (random and fixed). The results of this test are shared below.

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    2.1568e+14
Residual Sum of Squares: 2.0221e+13
R-Squared:    0.90625
Adj. **R-Squared: 0.90577**
F-statistic: 1921.64 on 5 and 994 DF, p-value: < 2.22e-16

The Hausman test, described below:

Hausman Test
chisq = 0.80416, df = 5, **p-value = 0.9768**
alternative hypothesis: one model is inconsistent

We accept H0: The random effect model is chosen.

### D. Application of the Average Annual Growth Rate (AAGR)

Given the complexity of studying SMEs Moroccan market (lack of information,…etc.), we used the AAGR. The AAGR is an economic indicator that measures economic growth. Despite the simplicity of this indicator, it is widely used in economic applications to evaluate the growth of business sectors such as the United Nations World Economic Situation and Prospects (eg: report realized in 2018). It remains a widely used basis for statistical organizations, and very popular in the media and consumer consumption, or in the analysis of various social or economic phenomena [2]. Given the financial data nature and in order to offset the low frequency of their production (annual frequency), we applied estimation to find future variables. The calculation of AAGR respected two phases, at the level of the SME (1), and at the level of a sector (2). We illustrate this calculation below with an application to the industry sector (the first twenty-five SMEs).

# Annual growth for each SME's financial variables
Ag (SME1) = (Fv – Iv)^(1/9) =
Ag (SME2) = (Fv – Iv)^(1/9) =
Ag (SME3) = (Fv – Iv)^(1/9) =
…
Ag (SME25) = (Fv – Iv)^(1/9) =

Where Ag: is the Annual Growth, Fv: is the Final value and Iv: is the Initial value.

The second phase consists of calculating the growth rate by sector, which allows estimating the income statement variables.

# Annual growth for each Sector
Ag (Industry sector) = [Ag (SME1) + Ag (SME2) + Ag (SME3) + … + Ag (SME25)]/25

**We then finish by calculating the coefficients of the prediction equation as illustrated below.**

$$R_{it} = \beta_{0it} + \beta_1 ExcEX_{it} + \beta_2 FEx_{it} + \beta_3 OpEx_{it} + \beta_4 ExcPro_{it} + \beta_5 FiPro_{it} + \beta_5 OpPro_{it} + \varepsilon_{it}$$

data_pred1$R = -2.6555e+05 + -8.1327e-01 * data_pred1$ExcEx -1.0217e+00 * data_pred1$FEx +1.0165e+00 * data_pred1$OpEx + 9.6192e-01 * data_pred1$ExcPro + 1.0155e+00 *data_pred1$FiPro + 2.1135e+00 *data_pred1$OpPro

Where data_pred1$R is companies accounting result which is calculated based on financial variables.

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The representation of all variables is more complex, hence the choice of the significant economic variable in the life of a company. This variable is described by the set of explanatory variables presented in the equation.

### E. Classification of SMEs behaviors

The final step of the processin studying SMEs financial data is the classification of companies' behaviors. This classification makes it possible to clarify and validate the management style on the Moroccan business scene. The two methods used for the classification are:

- The CAH method

```
>rect.hclust(cah.ward,k=4)
>groupes.cah<- cutree(cah.ward,k=4)
> print(sort(groupes.cah))
 [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
[42] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3
[83] 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4!
```

- The K-means method

```
> print(groupes.kmeans)
K-means clustering with 4 clusters of sizes 34, 14, 20, 31
Cluster means:
 data_ana2018
1  -0.3842061
2   1.5770553
3  -1.3908828
4   0.6065126
Clustering vector:
 [1] 4 1 4 1 2 4 3 3 3 1 2 1 3 1 4 3 1 4 4 4 1 1 1 1 1 1 2 1 4 3 4 1 2 3 1 4 1 4 4 1 4
[42] 1 4 4 3 2 4 2 3 1 2 4 4 1 2 4 1 4 4 2 1 4 4 4 1 4 4 1 2 3 1 4 1 2 3 4 3 4 2 1 3 1
[83] 2 3 3 1 1 4 1 3 3 3 1 1 1 3 2 3 4
```

- Comparison of the two methods

```
> print(table(groupes.cah,groupes.kmeans$cluster))
groupes.cah    1   2   3   4
          1    0   5   0  30
          2   31   0   0   1
          3    3   0  20   0
          4    0   9   0   0
```

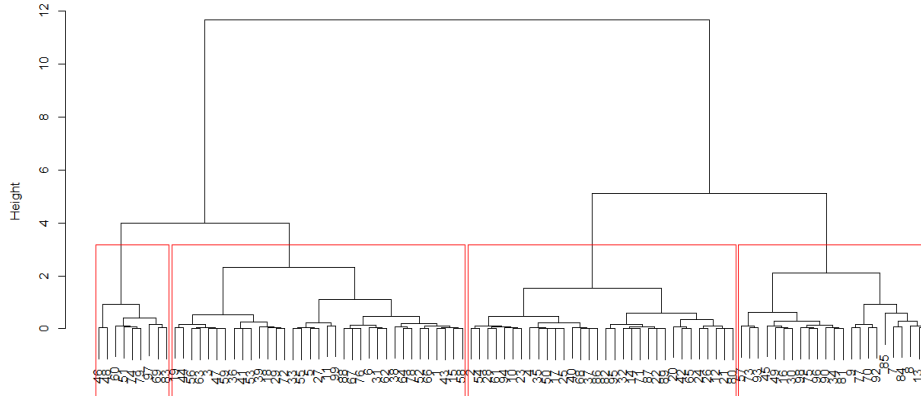The graphical representation shows us the distribution by four classes.
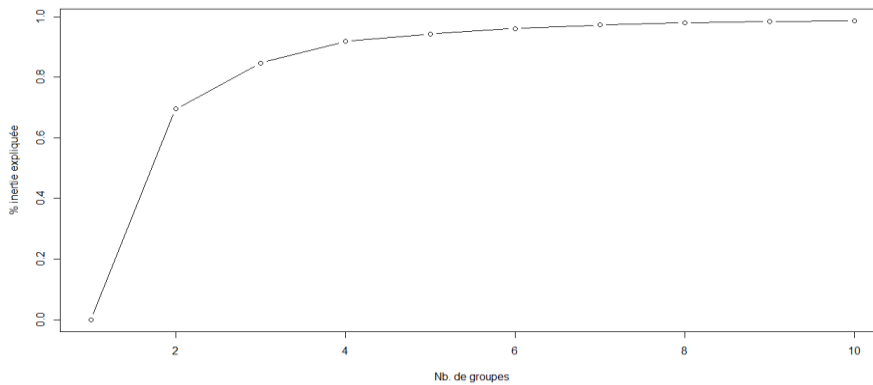
Fig11. Classification of Moroccan SMEs



Fig12. Repartition of SMEs classification

The figure 11 shows that 86% of the SMEs analyzed represent the four behaviors of the Moroccan Market. The new classification of Moroccan SMEs respects four classes (Figure 11, and 12), with a distribution different compared to the activity sectors distribution.
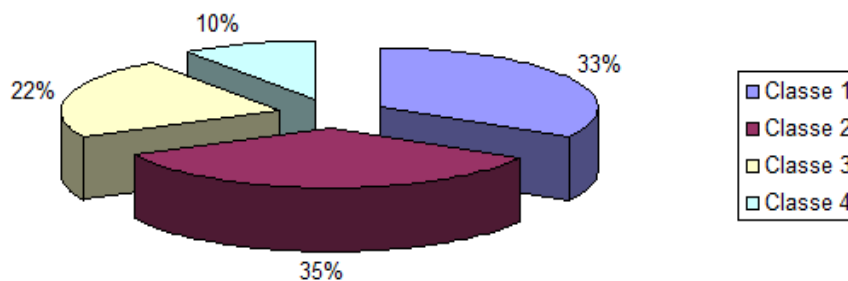


Fig13. Real classification of Moroccan SMEs

It is important to note that the real classification of SMEs behaviors is completely different from the economic distribution based only on the activity sectors (Figure 6). The new classification represents the real positioning of SMEs on the Moroccan market, a positioning that reflects the decision-making style (with a large presence of reactors and defenders) and how they perform.

## IV. CONCLUSION AND FUTURE PRESPECTIVES

This paper presents a novel model we developed to enhance the accuracy of the SMEs decision-making process. It also provides a support to visualize the future orientations of a business. This will allow managers to build the company's strategical plan in advance and determine the values of the next accounting years. Managers will therefore be able to adapt to changes in the market for each business sector.

This work aims to provide managers a vision about the future orientations of their companies and permits them to build an action plan in line with future evolution. Our next step will be on exploring statistical models to build automatically an action plan based on future predicted financial values.

### Acknowledgment

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