

# DIGITALES ARCHIV

ZBW – Leibniz-Informationszentrum Wirtschaft  
*ZBW – Leibniz Information Centre for Economics*

## Periodical Part

### Les cahiers du CREAD ; Volume 36 (2020)

#### Provided in Cooperation with:

Research Center for Applied Economics for Development (CREAD), Bouzaréah Alger

*Reference:* Les cahiers du CREAD ; Volume 36 (2020) (2020).

This Version is available at:

<http://hdl.handle.net/11159/4682>

#### Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics  
Düsternbrooker Weg 120  
24105 Kiel (Germany)  
E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)  
<https://www.zbw.eu/econis-archiv/>

#### Standard-Nutzungsbedingungen:

Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte.  
<https://zbw.eu/econis-archiv/termsfuse>

#### Terms of use:

*This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence.*

# **TOWARDS A MODEL FOR PREDICTING THE FAILURE OF CORPORATES BORROWERS FROM COMMERCIAL BANKS WORKING IN CHLEF: CASE OF BNA, AGB , NATIXIS BANK**

Nacereddine **KARA ACHIRA\***  
Abderezak **HABBAR\*\***

**Received:** 22/01/2019 / **Accepted:** 31/12/2019 / **Published:** 09/07/2020

**Corresponding authors:** n.karaachira@univ-chlef.dz

## **ABSTRACT**

The purpose of this research is to build a model for predicting the failure of borrowing corporations from commercial banks working in Chlef. The data used in this study is 16 financial ratio obtained from the financial statements of the sample of 35 corporates during the period of 2006-2015. The sampling is based on 12 failed companies and 23 non failed companies, by using the Discriminant Analysis model, we have estimated a proposed model for predicting failure consists of 13 variables, this model has made a correct prediction rate amounts to 86,2 %.

**KEY WORDS :** Credit Risk Management, Credit Risk Modeling, Prediction Failure Models, Discriminant Analysis, Financial Ratios.

**JEL CLASSIFICATION :** G11, G21, G33, C61

---

\*Doctorant en science économiques à l'université de Chlef.

\*\*Maitre de conférences à l'université de Chlef, Email: a.habbar@univ-chlef.dz

## نحو نموذج للتنبؤ بفشل الشركات المقترضة من البنوك التجارية العاملة في ولاية الشلف: حالة البنك الوطني الجزائري، بنك الجزائر الحليح، بنك نتيكسيس

### ملخص

نهدف من خلال هذه الدراسة إلى بناء نموذج للتنبؤ بفشل الشركات المقترضة من البنوك التجارية العاملة في ولاية الشلف، اعتمدنا على 16 نسبة مالية مشتقة من القوائم المالية لعينة من 35 شركة مقترضة ( 23 منها سليمة و 12 فاشلة) خلال الفترة 2006-2015، وباستخدام نموذج التحليل التمييزي توصلنا إلى بناء نموذج يتكون من 13 متغير حقق نسبة تنبؤ صحيح بلغت 86,2%.

كلمات المفتاحية : إدارة مخاطر الائتمان، نمذجة خطر الائتمان، نماذج التنبؤ بالتعثر، تحليل تمييزي، نسب مالية.

تصنيف جال : G11, G21, G33, C61

# **UN MODÈLE DE PRÉVISION DE LA FAILLITE DES ENTREPRISES EMPRUNTEUSES DES BANQUES COMMERCIALES À CHLEF : CAS DE BNA, AGB, NATIXIS BANK**

## **RÉSUMÉ**

L'objectif de cette recherche est de construire un modèle pour prédire l'échec des entreprises emprunteuses auprès des banques commerciales exerçant à Chlef. Les données utilisées sont 16 ratios financiers obtenus à partir des états financiers de l'échantillon de 35 sociétés au cours de la période 2006-2015. L'échantillonnage est basé sur 12 entreprises défailtantes et 23 entreprises non défailtantes. En utilisant le modèle d'analyse discriminante, nous avons estimé un modèle proposé pour prédire l'échec qui se compose de 13 variables et qui a atteint un taux de prévision correcte de 86,2%.

**MOTS CLÉS:** Gestion du risque de crédit, Modélisation du risque de crédit, Modèles de prédiction d'échec, Analyse Discriminante, Ratios financiers.

**JEL CLASSIFICATION :** G11, G21, G33, C61

## INTRODUCTION

Since the beginning of the second half of the twentieth century, a new approach has emerged in the criteria on which banks rely on credit decision making. This approach promotes the use of mathematical and statistical models in the process of credit analysis. In addition to relying on financial analysis and financial ratios, banks also rely on more accurate models that permit to rationalize the credit granting decision. These models are called "Failure Prediction Models". Studies of W. Beaver (1966) and E. Altman (1968) were the first which found mathematical models to predict the failure of borrowing companies from banks, which led to many studies to find several models and using various statistical methods that aim to predict the failure of corporate borrowers from banks to rationalize the credit granting decision. In keeping with the innovations in the credit analysis process, commercial banks operating in Algeria must rely on such models to reduce the risk of credit default and increase returns. For this purpose, we will propose a model for predicting failure based on the data of borrowing companies. So the main question is :

**How accurate are of the failure prediction models to predict the failure of corporate borrowers from commercial banks operating in Chlef?**

In this study, we aim to build a model for predicting a feasible failure useable to rationalize the decision to grant credit in commercial banks operating in Algeria.

Commercial banks are constantly developing their methods of credit analysis to ensure that they have access to more accurate decisions to avoid credit defaults, for this purpose, the trend towards modeling of credit granting decision in line with the various changes

and rapid developments in the banking environment both at the level of borrowers and competitors domestically and internationally.

Mathematical models and quantitative methods helping to take a credit decision in commercial banks in Algeria have a limit use, in public banks, so it is important to address this issue because of its importance in reducing the risk of credit default.

In this study, we will rely on the deductive approach. We describe the literature review and the theoretical framework of the research and then analyze the available data from the financial statements of the companies to build the model of predicting failure.

## **1- LITERATURE REVIEW**

### **1.1- Credit Risk: Definition and types**

Credit risk includes credit default risk and credit spread risk. The former form of credit risk is the risk that an issuer of debt (obligor) is unable to meet its financial obligations resulting in an investor incurring a loss equal to the amount owed by the obligor less any recovery amount. Credit spread risk is the risk of financial loss or the underperformance of a portfolio resulting from changes in the level of credit spreads used in the marking-to-market of a product. Downgrade risk is a form of credit spread risk because the anticipating or actual downgrading of an issue or issuer will result in an increase in the credit spread (Frank J. Fabozzi et al, 2004).

### **1.2. Failure Definition**

Failure is defined as the inability of a firm to pay its financial obligations as they mature. Operationally, a firm is said to have failed when any of the following events have occurred: bankruptcy, bond default, an overdrawn bank account, or non-payment of a preferred stock dividend (W. Beaver, 1966). And according to E. Altman, failure, in an economic sense, means that the realized rate of return on

invested capital, with allowances for risk consideration, is significantly and continually lower than prevailing rates on similar investments. Somewhat different economic criteria have also been used, including insufficient revenues to cover costs and where the average return on investment is continually below the firm's cost of capital (E. Altman et al, 2019).

According to the Basel Committee on Banking Supervision, failure definition reflects many of these events: (Basel Committee on Banking Supervision, 2001)

- a) It is determined that the obliger is unlikely to pay its debt obligations (principal, interest, or fees) in full;
- b) A credit loss event associated with any obligation of the obligor, such as charge-off, specific provision, or distressed restructuring involving the forgiveness or postponement of principal, interest, or fees;
- c) The obligor is past due more than 90 days on any credit obligation;
- d) The obligor has filed for bankruptcy or similar from creditors.

### **1.3- The credit granting decision**

The credit granting decision is one of the most important decisions within the bank. As there must be controls and criteria to be taken in a way that contributes to the achievement of its objective, because this decision may result after its implementation to credit risks such as default risk, downgrade risk, credit spread risk (Anson et al, 2004). In the Oxford Dictionary, the word "risk" is defined as the possibility of something undesirable happening in the future (Sally Wehmeier, 2000). The risks inherent to bank credits are considered as the main challenge for the operation of measuring and managing the risks since the last 1990. The past few decades have seen the emergence of several quantitative methods that have been developed to decide on granting credits, including credit scoring models (Liang, 2003).

#### **1.4- Prior Research on Prediction Failure Models**

Research on business failure traces back to the late 1800s when the establishment of commercial banks greatly increased the flow and spread of financial information, this availability financial data was the genesis of business failure studies. Early studies primarily focused on financial and accounting measures and subsequently the topic spread into economics, information systems, general management, sociology and entrepreneurship. And in the 1930s the great depression formed the catalyst that led to the study of business failure to begin in earnest (Grace S. Walsh et al, 2016).

We will present the original studies, then the most important later studies that have made additions especially in the model building methods. We will take into account the diversity in the date of publication, the method used, and the case study.

The empirical literature on financial failure prediction is large and varied, in terms of explanatory variables and methodological techniques (Ashraf S, 2019). The earliest study of the prediction failure models might be dated back to the 1930s. The first study was published by Fitzpatrick entitled "A comparison of the ratios of successful industrial enterprises with those of failed companies". He compared the values of financial ratios between the failed and non-failed firms and found that the failed firms usually had poorer variables (Fitzpatrick, 1932). In 1966, Beaver published a study entitled "Financial ratios as predictors of failure". He examined the predictive power of 30 ratios when applied five years prior to failure, for a sample contained a pair of 79 failed and non-failed firms during the period from 1954 to 1964. And using unvaried discriminant analysis, he reached a model of three variables, this model achieved a correct prediction rate estimated at 78% five years prior to failure and 87% one year prior to failure (Beaver, 1966). In 1968 E. Altman



published a study entitled "Financial ratios, discriminant analysis and the prediction of corporate bankruptcy" which aims to predict the failure five years before its occurrence for a sample contained a pair of 33 failed and non-failed firms during the period from 1946 to 1965. Using the multiple discriminant analysis he reached a model of five ratios selected from 22 ratios called "Z-Score model", this model is extremely accurate in classifying 95 % of the total sample correct (E. Altman, 1968). In 1974, Blum published a study entitled "The failing company doctrine" which aims to identify the variables that can be used to predict failure. He built a model by using accounting data and financial market data during the period from 1954 to 1968 for a paired sample of 115 failed and non-failed firms. And using discriminant analysis method ,he reached a model of five variables that achieved a correct prediction rate estimated between 93% and 95% one year prior to failure, and 80% two years prior to failure and 70% three years prior to failure (Blum, Marc P, 1974). In 1977, E. Altman et al presented a study entitled " ZETATM analysis A new model to identify bankruptcy risk of corporations" which aims to make a comparison between the method of linear discriminant analysis and the quadratic discriminant analysis, and to identify the variables that permit to predict the failure five years before its occurrence, for a sample of firms consisting of 53 bankrupt firms and 58 non-bankrupt entities during 1969-1975. He used the linear discriminant analysis and developed its previous model "Z -score" into a new model of seven ratios known as the ZETA Score, this model achieved a correct prediction rate estimated at 93% one year prior to failure and 70% five years prior to failure (E. Altman et al, 1977). In 1980, Ohlson published a study entitled "Financial ratios and the probabilistic prediction of bankruptcy" which aims to predict failure, the study was conducted on a sample consisting of 105 failed firms and 2058 non-failed firms during 1970-1976. Using the conditional Logit model, Ohlson reached

a model of nine variables, this model achieved a correct prediction rate estimated at 96.12% a year prior to failure, 95.55% two year prior to failure. And he pointed out two points: First, the predictive power of any model depends upon when the information (financial report) is assumed to be available. Second, the predictive powers of linear transforms of a vector of ratios seem to be robust across (large sample) estimation procedures. Hence, more than anything else, significant improvement probably requires additional predictors (Ohlson, J. A, 1980). In 1994, Altman & all published a study entitled “Corporate distress diagnosis: Comparisons using linear discriminant analysis and neural networks (the Italian experience)” which aims to build a corporates distress prediction model and to analyze the comparison between traditional statistical methodologies for distress classification and prediction, i.e., linear discriminant or logic analyses, with an artificial intelligence algorithm known as neural networks. The study was conducted on a paired sample of 213 failed and non- failed firms during 1982-1992. Using linear discriminant analysis, the study achieved a correct prediction rate estimated at 86.4% for the failed firms and 90.3% for non- failed firms. And using neural networks, it achieved a correct predictive rate estimated at 97.7% for the non-failed firms and 97% for the failed firms (E. Altman et al, 1994). In 2008, Abdullah et al published a study entitled “Predicting corporate failure of Malaysia’s listed companies: Comparing multiple discriminant analysis, logistic regression and the hazard model” which aims to compares three methodologies for identifying financially distressed companies, multiple discriminant analysis, logistic regression and hazard model. In a paired sample of 52 distressed and non-distressed companies during 1990-2000, the predictions of the hazard model were accurate in 94.9% of the cases examined. This was a higher accuracy rate than generated by the other two methodologies. However, when the holdout sample is

included in the sample analyzed, MDA had the highest accuracy rate at 85% (Abdullah et al, 2008). In 2009 LIN, Tzong-Huei published a study entitled “A cross model study of corporate financial distress prediction in Taiwan: Multiple discriminant analysis, logit, probit and neural networks models” which aims to examine the predictive ability of the four most commonly used financial distress prediction models and thus constructed reliable failure prediction models for public industrial firms in Taiwan. Multiple discriminant analysis, logit, probit, and artificial neural networks methodology were employed to a dataset of matched sample of failed and non-failed Taiwan public industrial firms during 1998–2005. The results indicated that the probit, logit, and ANN models which were used in this study achieve higher prediction accuracy and possess the ability of generalization. The probit model possesses the best and stable performance. However, if the data does not satisfy the assumptions of the statistical approach, then the ANN approach would demonstrate its advantage and achieve higher prediction accuracy (LIN, Tzong-Huei, 2009). In 2010 Yazdipour, R. et al published a study entitled “Predicting firm failure: A behavioural finance perspective” which first argues that researchers in the area of financial distress and failure cannot ignore the human/managerial/decision-making side of the business and just focus on the business’ operations side, then it discussed how psychological phenomena and principles, known as heuristics or mental shortcuts, could be utilized in building more powerful failure prediction models especially for small and medium-sized enterprises (Yazdipour, R. et al, 2010). In 2012 Alhassan Bunyaminu et al published a study entitled “Predicting corporate failure of UK’s listed companies: Comparing multiple discriminant analysis and logistic regression” which aims to compares two corporate failure prediction models, namely; multiple discriminant analysis (MDA) and logistic regression in attempt to identify whether or not financial ratios can be

used as indicators of failure in the UK, to identify financial ratios that are most important for detecting potential insolvency of UK's public listed companies and also which model is better in predicting corporate failure. The study employed financial information for a paired sample of 50 distressed and non-distressed UK listed companies during the period 2000–2010. The initial sample of 100 companies was divided into a 70% estimation (training) sample and a 30% holdout (test) sample. The Logit model achieved the highest overall classification results for year 2 and 3 and also for the cumulative three years prior to insolvency, with average classification of 71% and 81.9% respectively. Although the MDA model achieved a lower percentage of overall correct classification (average of 68.9% all three years and 80% for cumulative three years), it resulted in slightly higher overall percentage in the first year prior to failure (Alhassan Bunyaminu et al, 2012). In 2017 Ibrahim OnurQz et al published a study entitled “A Theoretical Approach to Financial Distress Prediction Modeling” which aims to examine a theoretical base for the financial distress prediction modeling over eight countries for a sample of 2,500 publicly listed non-financial firms for the period from 2000 to 2014. Using panel logistic regression, the overall full sample prediction accuracy of the model is 87.16% at T-1 and 85.37% at T-2. And using neural networks, the overall prediction accuracy at T-1 for the full sample is 89.88% and 88.31% at T-2 (Ibrahim OnurQz et al, 2017). In 2019 Robert N. Lussier et al published a study entitled “Success versus Failure Prediction Model for Small Businesses in Ghana” aims to test the validity of Lussier model in predicting success or failure of small business in Ghana, the study uses Logistic Regression to analyze a sample of 101 failed and 107 non-failed small businesses. The study support the model validity in Ghana and three variables (capital, economic timing, and marketing skills) were significant in predicting small businesses success or failure. The

model achieved a correct predictive rate estimated at 86.5% (Robert N. Lussier et al, 2019)

## **2- METHODOLOGY RESEARCH**

### **2.1- Sample selection**

According to the data , we could get the current study targeted a sample of 35 firms that got a credit at least from commercial banks working in Algeria (BNA, AGB, Natixis bank) during period from 2006 to 2015, this sample consists of 23 non- failed firms and 12 failed firms.

### **2.2- Variables and Multiple Discriminant Analysis**

#### **2.2.1. Variables Selection**

Generally, there are five accounting ratio categories describing the main operating and financial aspects of a company's profile: liquidity, profitability, leverage, coverage and activity (Altman et al, 2018). All previous studies mentioned, regardless of the approach used, have one common impediment: they are not based on an economic theory in choosing the variables for distinguishing between failing and non failing firms. Instead, researchers selected financial ratios as predictor variables mainly because of their popularity and predictive success in previous research, and the choice of discriminating variables in the study was based on the major financial ratios that were found statistically significant in predicting failure in prior research (Evridiki Neophytou et al, 1999). These ratios are also examined in this study. In order to identify the statistically significant ratios.

The next step in the model building process is to identify a number of variables that could be helpful indicators of firm credit worthiness. Consistent with a large number of previous studies, we choose 16 accounting ratios extracted from the firms' financial statements according to their importance in assessing the credit worthiness, these ratios describe the main operating and financial aspects of a firm's profile; we present them in the following table:

**Table 1.** Original financial variables

Variables	Description
R1	Equity / Total debt
R2	Total debt / Total Assets
R3	Current assets / short term debt
R4	Working capital / Total Assets
R5	Net Income / Equity
R6	Short term debt / Total Assets
R7	(Current assets – inventory) / short term debt
R8	Non-current liabilities / Total Assets
R9	Cash / short term debt
R10	Sales / Total Assets
R11	Working capital / sales
R12	Current assets / sales
R13	Cash/ Sales
R14	Earnings before interest, tax, depreciation and amortization / Total Assets
R15	Total result before interest and taxes / Total Assets
R16	Inventory/sales

*Source: Realized by consulting the previous studies*

### 2.2.2. Multiple Discriminant Analysis (MDA)

R. A. Fisher published two studies in 1936 and 1938 respectively entitled "The use of multiple measurements in taxonomic problems" and "The statistical utilization of multiple measurements" (R. A. Fisher, 1938) which aims to develop the discriminant analysis model (R. A. Fisher, 1936), which can be used to determine the most significant ratios for firms' classification to failed or non- failed firm.

MDA is used for modelling the value of a categorical dependent variable based on its relationship to more than one independent variable. In its most common form MDA tries to derive a linear combination of characteristics of these variables that best discriminates between the categories, based on the statistical decision rule of maximizing the between category variance while minimizing the within category variance among these variables. One advantage of

MDA is the reduction of the analysis space dimensionality, i.e. from the number of independent variables to  $k-1$  dimension(s), where  $k$  equals the number of original a priori categories. Since the financial distress prediction is concerned with only two categories of failed group and non-failed group, the analysis is transformed into its simplest one dimension and the discriminant function transforms the values of variables to a single discriminant score of  $Z$ , which is then used to classify and predict the financial performance of the original firms or/and out-of-the-sample ones. MDA can be described mathematically as follow:(Liang Qi, 2003)

Consider  $n$  firms in the model sample, and a set of  $p$  independent variables (financial ratios),  $X_1, X_2, \dots, X_p$ , and a binary category variable  $Z$  referring to firm financial performance. The predicted categorical measure  $Z_u$  (discriminant score) for firm  $u$  may be represented as:

$$Z_u = b_0 + \sum_{i=1}^p b_i X_{iu} , \quad i = 1, 2, \dots, p, u = 1, 2, \dots, n$$

Where  $b_i$  is the discriminant coefficient and  $b_0$  is the constant. MDA assigns firm  $u$  to the failed category of  $g$  if the posterior probability of membership of firm  $u$  in category  $g$  is greater than that in the non-failed category of  $g'$ . That is

$$P(g/X_u) > P(g' / X_u) , \quad g \neq g'$$

Posterior probability is a likelihood of category membership conditioned on knowing  $X_u$ . Assuming that the independent variables follow multivariate normal distribution and the two category covariance matrices are equal, then the posterior probability of membership of firm  $u$  in category  $g$  is given as

$$P(g / X_u) = \frac{q_g \cdot \exp \left( -\frac{1}{2} D_{ug}^2 \right)}{\sum_{g'=1}^k q_{g'} \cdot \exp \left( -\frac{1}{2} D_{ug'}^2 \right)}$$

Where  $q_g$  and  $q_{g'}$  denote respectively the prior probabilities of membership in category  $g$  and  $g'$ , "prior" in the sense that is a probability of category membership before  $X_u$  is known.  $D_{ug}$  and  $D_{ug'}$  are distance between the observation vector of firm  $u$  and the centroid of category  $g$  and  $g'$ .

### 3- RESULTS AND DISCUSSIONS

Through the SPSS<sup>23</sup> software; we have conceived the failure prediction model using the MDA as a method to identify the discriminatory variables that could be helpful indicators of firm credit worthiness. We get the following variables (see appendix 01):

**Table2:** The discriminatory variables of the model and its coefficients

Variables	Coefficients	Variables	Coefficients
R1	-0.006	R10	-0.227
R2	-0.097	R11	-0.366
R4	0.153	R12	0.090
R5	5.462	R13	-0.715
R6	0.989	R14	-4.847
R8	4.380	R15	-0.142
R9	0.141	Cst	-1.446

Source: SPSS output (see appendix 01)

We note from table 1 that among 16 financial ratios, the MDA produced 13 of the most significant financial ratios for predicting the risk of failure. And three variables were considered to be unable of discrimination are : current assets / short term debt, (current assets – inventory) / short term debt, Inventory/sales (see appendix 02).

Through the previous table, we have the model's equation as follows:

$$Z = -0.006 R1 - 0.097 R2 + 0.153 R4 + 5.462 R5 + 0.989 R6 + 4.380 R8 + 0.141 R9 - 0.227 R10 - 0.366 R11 + 0.090 R12 - 0.715 R13 - 4.847 R14 - 0.142 R15 - 1.446$$



What can be seen from the proposed model is that the financial ratio that has the highest ability of discrimination is R5 (Net Income / Equity) which has the largest coefficient (in absolute terms), the positive sign of its coefficient reflects the positive relationship between it and the firm's distinctive point. The distinctive point value rises as R4 increases. Thus, the likelihood of this firm belonging to the non-failed firms group rises. And we can observe that R1 (Equity / Total debt) has the least ability of discrimination, the negative sign of its coefficient indicates an inverse relationship between it and the firm's distinctive point. The distinctive point value declines as R1 increases. Thus, the likelihood of this firm belonging to the failed firms group rises.

After formulation of the proposed prediction model, we can calculate the cut point  $Z^*$  on which to classify the borrowing firms in the future. We can calculate  $Z^*$  according to the following equation :

$$Z^* = \frac{N_1 Z_1 + N_2 Z_2}{N_1 + N_2}$$

Where  $N_1$  and  $N_2$  are the sample size of failed and non-failed firms respectively,  $Z_1$  and  $Z_2$  are average discriminatory values for failed and non-failed firms respectively. If the distinctive point of the new borrowing firm is greater than or equal to the cut point, it is classified as a non-failed firm, if less, it is classified as a failed firm.

We found the cut point value equal to :  $Z^* = 0.000344828$ .

The following table shows the sample prediction results of prediction failure model:

**Table 3:** Results of prediction failure model

	The classification's results		Total
	1	0	
Number of failed firms	2	8	10
Number of no failed firms	17	2	19
Rate of failed firms	20%	80 %	100%
Rate of no failed firms	89.5%	10.5%	100%

*Source: Prepared according to the outcomes of SPSS23 software (see appendix 04)*

We note that MDN eliminated six firms in building the model because of their missing values. Through the results shown in table2, we notice that among 10 really failed firms, the proposed model found that there are only 02 failed firms and 08 non-failed firms, that means the model achieved a correct prediction rate of the failed firms estimated at 80%. And among 19 non-failed firms, the model found a 17non-failed firms and only 02 failed firms, that means the model achieved a correct prediction rate for the non-failed firms estimated at 89.5%. Therefore, the overall correct prediction rate of the proposed model is 86.2%.

The accuracy of the prediction failure model is also evaluated on the basis of Type I and Type II errors. The Type I error measures the percentage of failed firms that are classified as non-failed and Type II error measures those firms classified as failed but which didn't fail. The results in table3 shows that the Type I error of discriminant analysis model proves to be 20% while the Type II error is better at 10.5%. The average of the two types is lower than the assumed rate at the beginning of this study, and this is a good indicator of the quality of the proposed model.

## CONCLUSION

Our main question in this study was: **How accurate are the failure prediction models to predict the failure of corporate borrowers from**

**commercial banks operating in Algeria?** We hypothesized that the proposed prediction failure model achieves an acceptable level of accuracy in prediction estimated at more than 80%.

Through this study, we have built a predicting failure model of 13 variables, chosen from 16 variables according to their importance in assessing the credit worthiness. These variables represent financial ratios extracted from the firms' financial statements of a sample of 35 firms that borrowed from commercial banks (BNA - AGB - NATEXIS) during the period from 2006 to 2015. And by using the MDA, we found that the model achieved a total correct predicting rate of 86.2% which is an acceptable rate.

Varying results were achieved in terms of the predictive power of the models that have been built, therefore it is changing by changing time and place, and still hasn't been reached a model that could generalized, and in this study we have reached a corresponding results compared to the previous studies results which used MDA.

At the level of the banking sector, relying on failure prediction models helps to avoid bank failures problems and achieves bank security by reducing the risk of credit portfolios of lender banks and stabilizing their revenues, thus contributing to improving their performance.

In the future, we will use new models such as Logit&Probit, Hazard model, and neural networks, to compare its results with the current study result, and we will as we will try to apply to a larger sample of the current sample. And we recommend future studies to rely on new variables such as corporate governance principles and behavioral variables

### Bibliographic References

**Fabozzi F. J., Mann S. V., & Choudhry M., (2003).** *Measuring and controlling interest rate and credit risk* (Vol. 104). John Wiley & Sons, pp. 6-7.

**Basel Committee on Banking Supervision (2001c).** *The Internal Ratings Based Approach*, January, p Available at <https://www.bis.org/publ/bcbsca05.pdf>

**Altman E. I., & Hotchkiss E. & Wang W. (2019).** *Corporate Financial Distress, Restructuring, and Bankruptcy: Analyze Leveraged Finance, Distressed Debt, and Bankruptcy*. Wiley, p 07.

**Anson M. J., Fabozzi F. J., Choudhry M., & Chen R. R. (2004).** *Credit derivatives: Instruments, applications, and pricing* (Vol. 133). John Wiley & Sons, p. 5.

**Sally W., (2005).** *Oxford Advanced Learner's Dictionary*, Oxford University Press, p. 1105.

**Liang, Qi., (2003).** *Corporate financial distress diagnosis in China: empirical analysis using credit scoring models*. Hitotsubashi journal of commerce and management, p. 13.

**Charitou A., Neophytou E., & Charalambous C., (2004).** *Predicting corporate failure: empirical evidence for the UK*. European Accounting Review, 13(3), p 8.

**Altman Edward I., Maurizio Esentato & Sabato G., (2018)** "Assessing the creditworthiness of Italian SMEs and mini-bond issuers" Global Finance Journal, September, p11.

**Walsh G. S., & Cunningham J. A., (2016).** *Business failure and entrepreneurship: Emergence, evolution and future research*. Foundations and Trends in Entrepreneurship, 12(3), p 178.

**Ashraf S., GS Félix E., & Serrasqueiro Z., (2019).** *Do Traditional Financial Distress Prediction Models Predict the Early Warning Signs of Financial Distress?* Journal of Risk and Financial Management, 12(2), p3.

**Fitz P., & Joseph P., (1932).** *A comparison of the ratios of successful industrial enterprises with those of failed companies.*

**Beaver W. H., (1966).** *Financial ratios as predictors of failure.* Journal of accounting research, (04), 71-111.

**Altman E. I., (1968).** *Financial ratios, discriminant analysis and the prediction of corporate bankruptcy.* The journal of finance, 23(4), 589-609.

**Blum M., (1974).** *Failing company discriminant analysis.* Journal of accounting research, 16(1), 1-25.

**Altman E. I., Haldeman R. G., & Narayanan P., (1977).** *ZETATM analysis A new model to identify bankruptcy risk of corporations.* Journal of banking & finance, 1(1), 29-54.

**Ohlson J. A., (1980).** *Financial ratios and the probabilistic prediction of bankruptcy.* Journal of accounting research, 18(1).109-131.

**Altman E. I., Marco, G., & Varetto F., (1994).** *Corporate distress diagnosis: Comparisons using linear discriminant analysis and neural networks (the Italian experience).* Journal of banking and finance, 18(3), 505-529.

**Abdullah N. A. H., Halim, A., Ahmad H., & Rus R. M., (2008).** *Predicting corporate failure of Malaysia's listed companies: Comparing multiple discriminant analysis, logistic regression and the hazard model.* International Research Journal of Finance and Economics, 15, 201-217.

**Bunyaminu A., & Issah M., (2012).** *Predicting corporate failure of UK's listed companies: Comparing multiple discriminant analysis and logistic regression.* International Research Journal of Finance and Economics, 94, 6-22.

**Lin, T. H., (2009).** *A cross model study of corporate financial distress prediction in Taiwan: Multiple discriminant analysis, logit, probit and neural networks models.* Neurocomputing, 72(16-18), 3507-3516.

**Yazdipour, R., & Constand R., (2010).***Predicting firm failure: A behavioral finance perspective.* The Journal of Entrepreneurial Finance, 14(3), 90-104.

**Oz I. O., & Yelkenci T., (2017).** *A theoretical approach to financial distress prediction modeling.* Managerial Finance, 43(2), 212-230.

**Robert N., Lussier P. G., & Kingsley O. Appiah. (2019).***Success versus Failure Prediction Model for Small Businesses in Ghana.* Journal of African Business, 1-20.

**Fisher R. A., (1936).** *The use of multiple measurements in taxonomic problems.* Annals of eugenics, 7(2), 179-188.

**Fisher R. A., (1938).***The statistical utilization of multiple measurements.* Annals of eugenics, 8(4), 376-386.

## APPENDIX

### Appendix 01 : Discriminant Function Coefficients

	Function 1
Equity / Total debt	-,006
Total debt / Total Assets	-,097
Working capital / Total Assets	,153
Net Income / Equity	5,462
Short term debt / Total Assets	,989
Non-current liabilities / Total Assets	4,380
Cash / short term debt	,141
Sales / Total Assets	-,227
Working capital / sales	-,366
Current assets / sales	,090
Cash/ Sales	-,715
Earnings before interest, tax, depreciation and amortization / Total Assets	-4,847
Inventory/sales	-,142
(Constant)	-1,446

### Appendix 02 : Variables Failing Tolerance Test<sup>a</sup>

Within-Groups Variance	Tolerance	Minimum Tolerance
---------------------------	-----------	----------------------

Current assets / short term debt	1623103,368	,000	,000
(Current assets – inventory) / short term debt	1349280,825	,000	,000
Inventory/sales	368,378	,000	,000

All variables passing the tolerance criteria are entered simultaneously.

a. Minimum tolerance level is ,001.

### **Appendix 03 : Classification Results<sup>a</sup>**

		Etatd'entreprise	Predicted Group Membership		Total
			Failed	Non failed	
Original	Count	Failed	8	2	10
		Non failed	2	17	19
	%	failed	80,0	20,0	100,0
		Non failed	10,5	89,5	100,0

a. 86,2% of original grouped cases correctly classified.

## **THE ASYMMETRIC IMPACT OF OIL PRICE SHOCKS ON THE EVOLUTION OF THE UNEMPLOYMENT RATE IN ALGERIA: NEW EVIDENCE USING NARDL ANALYSIS**

Mohamed Dahmani **DRIOUCHE\***  
Abdelatif **HAMRIT \*\***

**Received:** 23/06/2019 / **Accepted:** 15/05/2020 / **Published:** 09/07/2020

**Corresponding authors:** dah9moh@yahoo.fr

### **ABSTRACT**

This research aims to study and analyze the asymmetric effects of oil price shocks and the evolution of certain macroeconomic variables on unemployment rates in Algeria during the period 1990-2017 and the use of the nonlinear NARDL model. In the long term, the results showed that there is an asymmetric cointegration which means that there are long-term relationships between the variables of our econometric study and asymmetric effects as well. This is due to the negative shocks of oil prices that have a greater impact on unemployment rates than positive shocks. Also, the effects of oil prices in the short term were asymmetric as diagnostic tests showed the advantage of the first estimated model. The results also showed that economic growth rates have a significant impact on unemployment rates compared to the investment expenditures, as well as the size of loans provided to the private sector. Moreover, the results indicate that the non-hydrocarbon GDP growth is distorted and may not reflect the contribution of this sector in reducing unemployment, as its rise is caused by the previous booms in the oil sector.

**KEYWORDS:** Positive and negative oil price shocks; unemployment; asymmetric effects, NARDL.

---

\* Conférence master (lecturer), University of Djillali Lyabès, Sidi Bel Abbas,

\*\* Phd Student, University of Djillali Lyabès, Sidi Bel Abbas, hamritabdelatif@gmail.com ,  
Algeria



JEL CLASSIFICATION : Q430, J640, J680

## التأثير غير المتماثل لصدمات أسعار النفط على اتجاه معدلات البطالة في الجزائر: أدلة تجريبية باستخدام نماذج NARDL غير الخطية

ملخص

الهدف من هذه الورقة البحثية هو تحليل الآثار الغير متماثلة لصدمات أسعار النفط وتطور بعض المتغيرات الاقتصادية الكلية على اتجاه معدلات البطالة في الجزائر خلال الفترة 1990-2017 باستخدام نموذج الـ NARDL غير خطي. في المدى الطويل أظهرت النتائج وجود تكامل مشترك غير متناظر، أي وجود علاقات طويلة الأمد بين متغيرات الدراسة وأن هناك تأثيرات غير متماثلة، حيث أن الصدمات السلبية لأسعار النفط لها تأثير أكبر على معدلات البطالة من الصدمات الموجبة. أيضا تأثيرات أسعار النفط في المدى القصير جاءت غير متماثلة حيث أن الاختبارات التشخيصية بينت أفضلية النموذج الأول المقدر. كما بينت النتائج أن معدلات النمو الاقتصادي لها تأثير كبير على معدلات البطالة مقارنة بالنفقات الاستثمارية وكذا حجم القروض المقدمة للقطاع الخاص. بينت النتائج أيضا أن الناتج المحلي خارج قطاع المحروقات مشوه ولا يعكس مساهمة هذا القطاع في التخفيض من حدة البطالة، حيث أن ارتفاعه هو نتيجة للطفرات السابقة في قطاع النفط.

كلمات مفتاحية:

صدمات أسعار النفط الموجبة والسالبة؛ البطالة؛ الآثار غير المتماثلة؛ نماذج الانحدار الذاتي للنفجوات الزمنية المتباطئة الموزعة غير الخطية.

تصنيف جال: Q430، J640، J680

# **L'IMPACT ASYMÉTRIQUE DES CHOCES DES PRIX DU PÉTROLE SUR L'EVOLUTION DU TAUX DE CHÔMAGE EN ALGÉRIE : UNE PREUVE EMPIRIQUE PAR LE MODÈLE NARDL**

## **RÉSUMÉ**

L'objectif de cet article est d'étudier et d'analyser les effets asymétriques des chocs des prix du pétrole et l'évolution de certaines variables macroéconomiques sur les taux de chômage en Algérie au cours de la période 1990-2017 à l'aide du modèle non linéaire NARDL. À long terme, les tests de cointégration asymétrique ont montré qu'il existe des relations à long terme entre les variables et qu'il existe des effets asymétriques, ou les chocs négatifs des prix du pétrole ont un impact sur les taux de chômage plus important que les chocs positifs. De plus, les effets des prix du pétrole à court terme semblaient asymétriques, car les tests de diagnostic ont montré l'avantage du premier modèle estimé. Les résultats ont également montré que les taux de croissance économique ont un impact significatif sur les taux de chômage par rapport aux dépenses d'investissement, ainsi que les crédits fournis au secteur privé. En revanche, les résultats ont montré que le taux de croissance du PIB hors hydrocarbures est déformé et ne reflète pas la contribution de ce secteur à la réduction du chômage, car sa hausse est le résultat des booms précédents du secteur pétrolier.

## **MOTS CLÉS :**

Chocs pétroliers positifs et négatifs ; chômage ; effets asymétriques, NARDL.

**JEL CLASSIFICATION :** Q430, J640, J680

## INTRODUCTION

Unemployment is one of the most important macroeconomic issues faced by all governments because of the social and economic impacts it has on their economies. Therefore, governments endeavor to adopt appropriate and effective policies that promote employment rates. As it stands, policymakers examine various factors and phenomena that may have an impact on unemployment rates, such as the potential effect of oil-price shocks on economic activity through various channels to eventually suggest new policies for improving the employment rate.

Since the first oil crisis of the 1970's, the relationship between oil-price shocks and macroeconomic activities has considerably received the attention of economists. The economist Hamilton (1983) revealed that the increase in oil prices affected negatively real gross domestic product (RGDP henceforth) in the United States of America. Economic Theory, through the works of Hamilton (1983; 1988) and Carruth et al (1998) shows that oil-price shocks can affect unemployment in the short term, and most commonly, in the long term. We will focus more on the impact of oil-price shocks on unemployment rather than on GDP as Changes in GDP do not always interact with unemployment (Okun, 1962). We will attempt to answer the central question of the study stated as:

Do oil-price shocks have symmetric or asymmetric effects on unemployment rates in Algeria?

Through the present research, we would study and determine both the asymmetric effects of oil-price shocks and the evolution of some macroeconomic variables on Algeria's unemployment rates. This is feasible by using relatively recent and non-linear standard methods that were developed by Shin et al. (2014) (NARDL Model) and through the use of some annual data covering the period of 1990-2017. In this paper, we would distinguish between positive and negative oil-price shocks and their impacts on unemployment rates in the short- and long-term. It is very important to distinguish between positive and

negative movements of oil price changes as this allows us to measure whether unemployment will react differently when oil price falls, compared to how it occurs when the price of oil rises.

This paper's main objective lies in the attempt to enrich the existing body of literature, particularly on the asymmetric impact of oil-price shocks on Algeria's unemployment rates. In specific, we would analyze supply shocks caused by real oil prices.

The structure of the paper is as follows: The first section presents a series of relatively recent models and applied studies that attempted to determine the impact of oil-price changes on the unemployment rate in a number of economies. The second section is devoted to exposing the developments of oil prices vis-à-vis growth and unemployment rates in Algeria. The third section elaborates on the study approach and presents data analysis. Then, it displays the results of the standard study that may support the research hypothesis on the existence of asymmetric effects of oil prices. This section ends with some concluding observations.

## **1- LITERATURE REVIEW**

Many researchers have conducted multiple studies using different models on the same topic. However, they have come to different results depending on the nature of the economic structure in each country. Amongst these investigations, the study of Alkhateeb, Tarek Tawfik Yousef, et al (2017) entitled as "Oil price and employment nexus in Saudi Arabia" during the period of 1980-2015". Whereby, the most important indicator of economic growth in Saudi Arabia is attributed to high oil prices, because of the country's heavy dependence on oil revenues. Out of this, employment rates are closely related to oil-price change. Thus, this paper sets forth to examine this problem using Linear and Nonlinear Autoregressive Distributed Lag Models (ARDL and NARDL models) together with the study data and variables. Results from the ARDL model revealed positive effects of economic growth and oil price on employment levels in the short and long term. While in the NARDL model, the results proved that changes in oil price promote employment rates, these effects are asymmetric though as the positive movement of oil prices has a greater

impact on the level of employment in the long term. In parallel, the negative movement of oil prices has a negative impact on the level of employment, but these effects are small because of the government support for the economy during the period of the oil-price decline crisis. Whereas, Saudi economic growth has a positive impact on employment in the short and long term in both models. Therefore, higher oil revenues should be afforded in the period of high prices and prosperity, in order to boost employment and reduce unemployment during the period of oil crises.

The second study was conducted by Elsiddig Rahma, Noel Perera and Kian Tan (2016). It attempted to determine the impact of real oil-price shocks on two key macroeconomic indicators in Sudan during 2000-2014, because the Sudanese economy has become heavily dependent on oil exports in the late 1990s. This paper uses Vector Autoregression Models (VAR models), and Granger Causality test to identify the reciprocal effects of fluctuations in oil prices, GDP growth, and unemployment rates in the Sudanese economy. The results indicate symmetric effects between oil prices and GDP growth, as well as the existence of a reverse causality between oil prices and unemployment, as positive oil prices increase output growth and reduce unemployment by creating new job opportunities. In the same vein, negative oil-price shock slows down GDP growth, and it has a crucial negative impact on unemployment, despite the existence of positive factors such as government employment policy and massive migration to the Gulf Arab states and other countries. Yet, similar studies conducted in developed countries continue to dominate the academic field, both in terms of data accuracy and the use of advanced methodologies, as well as the adoption of relatively different and modern models. These works will last as a fundamental reference for many researchers and experts.

Some relatively recent studies include that of Juna Carlos Cuestas and Javier Ordóñez (2018). The researchers analyzed oil-price movements vis-à-vis the augmentation of unemployment rates in the United Kingdom, using Bayesian Structural Vector Autoregression (Bayesian

SVAR) methodology and relying on quarterly data covering the period of 2000-2014. This latter was to define the nature of the relationship between oil prices and unemployment rates before and after the UK's economy global crisis of 2008, and to determine the nature of the effects existing between them. The study results indicated that there are asymmetric effects between the study variables, and that the nature of the relationship between unemployment and oil prices varies before and after the crisis period. Despite positive pre-crisis oil-price movements that had a negative impact on employment (inverse relationship) and caused relatively high unemployment rates, lower oil prices after the crisis maintained unemployment rates at relatively low levels. This is because the distinction between positive and negative oil-price shocks paves the way to the development and implementation of economic plans that can stand against the challenges facing the UK economy during crises.

Another worth noting academic study entitled "The Causal Nexus between Oil Prices, Interest Rates, and Unemployment in Norway: Using Wavelet Methods" conducted by Hynjoo Kim Karlsson, Yushu Li and Ghazi Shukur (2018). It endeavors to apply the Wavelet analysis technique and the VAR model in addition to Granger Causality test and Toda-Yamamoto method, using monthly data for 1997-2015, in order to determine the nature of the relationship between the three variables investigated in the Norwegian economy. As Norway is an oil exporter, the rise and/or fall in oil prices reduces and/or rises unemployment rates. This means that there is a one-way inverse causal relationship between them. In simple words, unemployment rates in Norway respond negatively to oil-price shocks two years later, so the effects of oil-price changes on the labor market is not immediately noticed, and therefore this oil price-labor market mechanism should be a concern of decision-making in the short-term. The study of Johanna Bocklet and Jungho Baek (2017) is also important to mention. It aims to find out whether oil-price changes have symmetric or asymmetric effects on the Alaska unemployment rates; using a quarterly data series during 1987-2014, since labor markets are seem to have different reactions to higher oil prices than to lower oil prices. Therefore, this paper intends to help reveal whether the effect

of oil-price change on unemployment is symmetric or asymmetric in Alaska. In this study, the NARDL methodology is implemented and empirical results showed that changes in crude oil-prices have asymmetric effects on the short-term unemployment rate, i.e., an inverse relationship exists, so that the Alaska unemployment rate is more sensitive and responsive to higher oil prices than to lower prices. Yet, the short-term asymmetric effects proved unable to last for long terms.

Irina Kurnysheva and Dmitry Burakov (2017), at the same time, tried to probe how oil-price shocks affect competition in the Russian labor market, the article intended to reveal what the relationship between oil prices, labor, and the overall level of real wages in the Russian economy was between 1990-2016. This was accomplished using Vector Error Correction Model (VECM henceforth) to test the hypothesis that oil-price shocks have an impact on competition in the labor markets of oil-exporting countries. The results demonstrated that there is a long-term relationship between the study variables since the rise of oil prices increases the overall wage level and the employment rates, and the opposite occurs when there is a negative oil shock. In the short term, the oil-price shock has a direct impact on oil revenues and, above all, on expenditure plans. This latter can either decline or rise employment rates. In addition, employment shocks lead to overall real wage growth, because the increasing demand for labor by employers raises competitive pressure in the labor market and leads to augmented employee needs, which can only be covered by more supply of wages.

Nyakundi Michieka and Richard Gearhart (2015) conducted another study entitled "Oil Price Fluctuations and Employment in Kern County: A Vector Error Correction approach". The paper analyzes the short- and long-term effects of oil-price fluctuations on labor and unemployment in this province: California's largest oil producer in 1990-2015. This is achieved by using VECM to know the extent to which oil price correlates with employment, whether in the short or long term. The results revealed a one-way causality between the rise

of oil prices and the increase of employment rates (low unemployment) in the long term, since oil prices have symmetric effects on employment (direct relationship). While no causality was found between the variables studied in the short term, Kern Province had accordingly to formulate appropriate economic policies that consider the fact that changes in oil prices have long but not short-term effects on employment and unemployment, such as to consider expanding the industrial base to protect employment from oil-price shocks.

Moreover, it is worth mentioning the study of Bulent Altay, Mert Topcu and Ebrun Erdogan (2013) about assessing the relationship among oil prices, real output growth and employment in Turkey over the period of 2000-2012 by using vector error correction methodology (VECM). Findings indicated a long-run relationship among the variables. In addition, short-term Granger Causality results based on VECM revealed a strong evidence of bi-directional causality link between oil prices and output to employment. Thus, oil-price shocks have noticeable effects on the short-term unemployment rate in the Turkish economy. In the long-term, however, oil and production prices had no obvious impact on employment.

## **2- OIL PRICES VOLATILITY AND THE TRENDS IN UNEMPLOYMENT RATES IN ALGERIA**

Most recent applied studies revolving around labor market have shown that Algeria's unemployment rates are closely related to the economy structure. These rates need long-term policies, which depend on restructuring the economy in general. Among the most important of these studies, we mention that of Davide Furceri <sup>1</sup> (2012) on "Unemployment and Labor Market Issues in Algeria" and that of Kangni Kpodar (2007) on "Why Has Unemployment in Algeria Been Higher than in MENA and Transition Countries?" <sup>2</sup> Given the significant role played by oil prices in determining the state's public

---

<sup>1</sup> Davide Furceri (2012), Unemployment and Labor Market Issues in Algeria, IMF Working Paper, Middle East and Central Asia Department, WP/12/99.

<sup>2</sup> Kangni Kpodar (2007), Why Has Unemployment in Algeria Been Higher than in MENA and Transition Countries? IMF Working Paper, African Department, WP/07/210.



revenues, we framed them as an explanatory variable to unemployment rates.

Oil prices were marked by sharp and large fluctuations between the early 1970s to the present time. This had a major impact on Algeria's dynamic of economic activity. From **Figure 1**, it is clear that as a result of the 1973 war, crude oil prices rose four times, from \$3 per barrel in 1972 to \$12 per barrel by the end of 1974. This increase was the result of the Arab oil embargo, which later helped to rise the financial returns of the fuel sector, as increasing revenues were the best solution for financing heavy-industry-based economic development projects. All of this has foregrounded the sector to originate a development strategy to create job opportunities in Algeria. A decrease in unemployment rates accompanied the rise in oil prices from 24.83% in 1972 to 16.33% in 1979. The 1979 Iranian revolution and the 1980 Iran-Iraq war also helped maintain high oil prices during 1979-1985. Although they declined from \$35.41 to \$26.48 per barrel in 1981, unemployment rates continued to fall to 13.29% in 1984 and stabilized at 13.59% until 1985. At the end of 1986, oil prices collapsed from \$27 to under \$10. Algeria witnessed difficult economic events during 1989-1986, including mainly the oil shock that had a negative impact on macroeconomic variables, especially on unemployment rates that rose from 16.14% in 1986 to 20.04% in 1990. Despite the slight improvement of oil prices after the Second Gulf War in 1990, unemployment stabilized at 22.25% as an average during 1990-1995. However, by the end of this year, the rates rose to a maximum level of 29.50% in 2000. This rise coincided with an oil-price collapse; it reached its lowest level estimated as 12.16 dollars in 1998.

Oil prices then began to recover at the end of 1999, as OPEC reduced the production three times during 1998 and 1999. While the world economy was growing, Oil prices continued to rise in 2000 and surpassed the highest levels rates 1981. They rose to \$28.1 in 2003,

jumped in 2007 and kept ascending to the level of \$147.27 in 2008<sup>3</sup>. Nevertheless, they quickly declined since the global demand was uncertain because of the global economic recession caused by the mortgage crisis in October 2008. Prices then reached \$60 per barrel as the lowest level by the end of 2008, and oil lost about 32% of its value. Meanwhile, during 2001-2011 (oil boom era), Algeria had a significant decline of unemployment rates estimated at a 9.8% low in 2011. After that, oil prices improved again in 2010. They progressed from an average of \$ 80\$ to reach 105\$ at the end of 2013. This rise was accompanied by a stabilization of unemployment rates, which remained in the range of 10%. It was also a period of stable and modest economic-growth rates (3% as an average). World markets' oil prices were steadily falling in June 2014. The Algerian oil was in the range of 110\$ per barrel, on average, and it declined to 53\$ in the early days of January 2015 because of several factors. Such as, the US shale-oil boom, the change in OPEC strategic behavior, the decline in world oil demand, especially from some major economies like China, and other factors like the increase in Iranian oil exports and the restoration of their market-share after the West embargo was lifted. Crude oil prices continued to fall in 2016 and reached an annual average of 39\$; however, this latter rose in 2017 to 55\$ per barrel.

### 3. THE EMPIRICAL STUDY

#### 3.1. Data and Research Methodology

The objective of this research is to study and identify oil price shocks asymmetric effects and to develop some key economic variables about the direction of Algeria's unemployment rates, using relatively recent standard approaches (non-linear models), and drawing on annual data from 1990-2017. The major macroeconomic variables were selected from a number of studies in this area. These variables are:

- **Unemployment (unem):** in terms of the Annual Unemployment Rate.

---

<sup>3</sup> Noura bint Abdul-Rahman Al-Yousef, the rise and fall in oil prices from 1970 to 2008, Work Papers, College of Business Administration, King Saud University, Saudi Arabia, June 2008.

- **Oil Prices (roil):** in terms of Real Oil Prices Annual Average (crude oil blends)
- **The growth rate of Real Gross Domestic Product (rgdp):** the RGDP was measured in constant prices for 2000 (using the GDP deflator) which is the most important measure to determine a country's development level of economic activity.
- **Inflation Rate (inf):** measured by consumer prices (%); an indicator that can demonstrate a country's economic stability because most recent applied studies suggest that high and volatile inflationary directions always tend to increase uncertainty levels, large fluctuations in inflation rates affect unemployment rates accordingly.
- **Domestic credit to the private sector (priva):** The ratio of domestic credit granted for the private sector to GDP (% GDP). This variable was used in many recent applied studies to detect the private sector's facilities. It may reflect an important proportion of the investment in this sector. Kar and Pentecost (2000) have shown that private sector loans generated large investments, in many countries, and doubled this latter's productivity, which in turn influenced employment rates.
- **Non-Oil Real GDP Growth (hgdp):** An indicator that measures annual real GDP growth at Constant prices for all sectors except for that of oil. Non-hydrocarbon GDP growth is one of the essential macroeconomic indicators reflecting the national economy's general state over successive years.
- **Government Capital Expenditures (equi):** measured in the ratio of equipment expenditures to GDP. These expenditures of an investment nature (also known as investment expenditures) are generated when GNP increases.

The data were obtained from national statistical agencies and international organizations (ONS, CNES, OPEC, WB, and the Sherbrook University database). To analyze and measure the relationship between these variables, we converted all data series into the logarithmic formula to standardize the measure units (because the

units of the variables are in percentages and prices in dollars) as follows:

$$\text{Lunem}_t = f(\text{lroil}_t, \text{lv}_t, \text{lz}_t) \quad (1)$$

That is:  $(v_t, z_t)$  are the independent macroeconomic variables to be included in addition to oil prices.

### 3.2. Nonlinear Autoregressive Distributed Lag Model

To examine the asymmetric effects of oil prices on Algeria's unemployment rates, the NARDL model, Shin et al. (2014), is used. It helps separate long and short-term asymmetric effects. It is also an asymmetric extension of the linear ARDL model; it is formulated as follows:

$$\text{Lunem}_t = f(\text{lroil}_t^+, \text{lroil}_t^-, \text{lv}_t, \text{lz}_t) \quad (2)$$

The NARDL model adopts a comprehensive analysis to avoid errors as well as to obtain the correct dynamic multiples by eliminating the non-significant variables. Based on our discussion of Algeria's non-linear response to external shocks, we presume that oil price has an asymmetric effect on unemployment rates. The starting point is, therefore, to illustrate the asymmetric long-run regression model as follows:

$$\text{Lunem}_t = \alpha_0 + \alpha_1 \text{lroil}_t^+ + \alpha_2 \text{lroil}_t^- + \alpha_3 \text{lv}_t + \alpha_4 \text{lz}_t + \varepsilon_t \quad (3)$$

$$Y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t \quad (4)$$

That is:  $\beta^+$  and  $\beta^-$  are the long-term associated parameters, and  $x_t^+$  ( $\text{lroil}_t^+$ ) as well as  $x_t^-$  ( $\text{lroil}_t^-$ ) are partial sum processes of positive and negative changes of the variable  $x_t$ . And  $x_t$  represents detailed vector regression demonstrated as:

$$\text{lroil}_t = \text{lroil}_0 + \text{lroil}_t^+ + \text{lroil}_t^- \quad (5)$$

$$\text{lroil}_t^+ = \sum_{j=1}^t \Delta \text{lroil}_j^+ = \sum_{j=1}^t \max(\Delta \text{lroil}_j, 0) \quad (6)$$

$$\text{lroil}_t^- = \sum_{j=1}^t \Delta \text{lroil}_j^- = \sum_{j=1}^t \min(\Delta \text{lroil}_j, 0) \quad (7)$$

Shin et al. (2014), linked correlated equation (3) with the linear ARDL model of Pesaran et al. (2001) to attain the non-linear ARDL (NARDL) relationship as follows:

$$\begin{aligned}
 \Delta lunem_t = & \alpha_0 + \phi lunem_{t-1} + \theta^+ lroil_{t-1}^+ + \theta^- lroil_{t-1}^- + \lambda lv_{t-1} + \delta lz_{t-1} \\
 & + \sum_{j=1}^p \gamma_j \Delta lunem_{t-j} + \sum_{j=1}^q \gamma_j \Delta lv_{t-j} + \sum_{j=1}^q \delta_j \Delta lz_{t-j} \\
 & + \sum_{j=0}^q (\pi_j^+ \Delta roil_{t-j}^+ + \pi_j^- \Delta roil_{t-j}^-) + e_t, \quad (8) \\
 & j = 1, \dots, q-1, \quad \beta^+ = -\theta^+/\rho \text{ and } \beta^- = -\theta^-/\rho
 \end{aligned}$$

The first step of the econometric analysis is to estimate the NARDL (p,q) model (equation 8) using ordinary least squares (OLS) method. The second step is to conduct the asymmetric tests (nonlinear relationship) to measure the cointegration among the variables  $lunem_t, lroil_t^+, lroil_t^-$ .

In particular, the null hypothesis that there is no cointegrating relationship i.e.  $\rho = \theta^+ = \theta^- = 0$ .

It is tested by using the ARDL bounds testing approach to cointegration as proposed by Pesaran et al. (2011) and Shin et al. (2014), which is based on corrected F test ( $F_{PSS}$ ). This test uses two critical values; lower and upper-bound critical values. If the empirical value of the  $F_{PSS}$  statistic exceeds the upper bound, then there is evidence of a long-run equilibrium relationship. If it lies below the lower critical bound, the null hypothesis of non-cointegration cannot be rejected; and if it lies between the critical bounds, the test is inconclusive.

Finally, in the third step, we test long and short symmetry by using the Wald test, we examine the null hypothesis to test is  $H_0: \beta^+ = \beta^-$  i.e.  $-\theta^+/\rho = -\theta^-/\rho$ . In the short-run symmetry can take one of the following forms:  $H_0: \sum_{j=0}^{q-1} \varphi_j^+ = \sum_{j=0}^{q-1} \varphi_j^-$ ;

In specific, this method is more advantageous compared to other methods in the literature. First, it divides the most important variable (oil price) into two components partial (a positive and a negative one). Second, it allows the use of these variables in different

integration order, unlike other methods, which require the integration and analysis of all the variables in the same ranks.

Finally, the NARDL method is the most appropriate to serves this research purposes as it permits not only to measure the short- and long-term asymmetries, but also to measures long-run cointegration relationship. This method also allows investigating the adjustment in the long term of the positive and negative shocks across the cumulative dynamic multipliers (Zouhair Mrabet et al, 2019).

### 3.3. Econometric Results

#### 3.3.1 Unit Roots Tests

The first step is to examine the stationarity of all variables to test the cointegration between these variables.

we conducted the augmented Dickey–Fuller test ADF (1979) test and Phillips–Perron test PP (1988) to examine the unit root and verify the null hypothesis stipulating that there is a unit root, i.e. the series is non-stationary. The test results are displayed in **Table 1** below:

**Table 1.** PP and ADF Unit Root Tests Results

Variables	ADF			PP			Integration level
	I	II	III	I	II	III	
lunem <sub>t</sub>	-0.80	-1.46	-2.89	-0.77	-0.71	-1.90	<b>I(1)</b>
dlunem <sub>t</sub>	**	** -2.98	-2.90	*	***	-2.85	
	-2.93			-2.87	-2.92		
lroil <sup>+</sup> <sub>t</sub>	4.15	0.07	-2.13	3.67	-0.002	-2.13	<b>I(1)</b>
dlroil <sup>+</sup> <sub>t</sub>	**	* -4.05	** -3.95	** -2.54	**	*** -3.58	
	-2.50				-3.66		
lroil <sup>-</sup> <sub>t</sub>	2.95	0.21	-1.64	4.28	0.52	-1.64	<b>I(1)</b>
dlroil <sup>-</sup> <sub>t</sub>	*	* -4.72	* 4.77	* -3.81	*	* -4.91	
	-3.81				-4.73		
lrgdp <sub>t</sub>	7.31	1.18	***	5.24	0.83	***	<b>I(0) or I(1)</b>
			-3.42			-3.23	
dlrgdp <sub>t</sub>	-0.85	* -3.71	***	-1.36	**	***	
			-3.52		-3.69	-3.48	
linf <sub>t</sub>	-1.37	-2.31	2.36	-1.27	-2.31	-2.18	<b>I(1)</b>
dlinf <sub>t</sub>	*	* -7.83	* -7.84	* -7.92	*	* -8.18	
	-7.92				-7.83		

$lpriva_t$	-0.98	-2.51	** -4.18	-0.96	-2.59	* -6.12	<b>I(0) or I(1)</b>
$dlpriva_t$	* -4.26	* -4.18	* -4.78	* -4.26	* -4.18	* -4.78	
$lhgdp_t$	* -1.75	** -3.18	* -3.30	-1.51	** -3.14	* -3.30	<b>I(0)</b>
$ldhgdp_t$	* -7.40	* -7.27	** -3.72	* -7.86	* -7.70	* -7.52	
$lequi_t$	0.34	-1.24	-2.67	0.61	-1.12	-2.78	<b>I(1)</b>
$ldequi_t$	* -5.44	* -5.50	* -5.37	* -5.46	* -5.63	* -5.48	

**Note:** \*, \*\* et \*\*\* indicate significance at 1%, 5% et 10% levels, respectively.

$\Delta$  the difference I: the first model without constant and trend, II: the second model with constant, III: the third with constant and trend  
The results indicated that time series of the variables  $lunem_t$ ,  $lroil^+_t$ ,  $lroil^-_t$ ,  $linf_t$ ,  $lequi_t$  contain a unit root, and then these variables are stationary in first difference i.e., integrated of the first order  $I(1)$ . However, as to the series of the variables  $lrgdp_t$  and  $lpriva_t$ , the results showed that the series are stationaries at the level  $I(0)$ , but the result is inconclusive. Other traditional unit roots such as PP and ADF often lead to spurious results as by ignoring the structural break in the series, (Rahman, Z. U., & Ahmad 2019), (Muhammad Shahbaz & all 2015).

Therefore, we conducted other relatively recent tests such as the unit-root test with a structural break (Zivot-Andrews). In the Zivot-Andrews tests, the null hypothesis is that the series has a unit root with the structural break, and if the t statistic exceeds in absolute value the critical values tabulated in Zivot and Andrews the null hypothesis of unit root can be rejected (1%, 5%, and 10%). **Table 2** illustrates the test results below:

**Table 2.** Zivot and Andrews test for unit roots with one structural break

Variables	Level		First Difference		Integration level
	I	II	I	II	
lunem <sub>t</sub> TB	-3.05 (3) <b>2013</b>	-5.04 ** (3) <b>2004</b>	-5.42 ** (1) <b>2004</b>	-2.92 (1) <b>2001</b>	<b>I(0)</b>
lroil <sub>t</sub> <sup>+</sup> TB	-3.52 (1) <b>2012</b>	-3.48 (1) <b>2004</b>	-5.67 * (1) <b>2005</b>	-5.70 * (1) <b>2012</b>	<b>I(1)</b>
lroil <sub>t</sub> <sup>-</sup> TB	-3.46 (0) <b>2012</b>	-2.46 (0) <b>2003</b>	-5.03 *** (0) <b>2002</b>	-5.16 ** (0) <b>2009</b>	<b>I(1)</b>
lrgdp <sub>t</sub> TB	-3.51 (0) <b>2010</b>	-5.53 * (0) <b>2002</b>	-6.28 * (0) <b>2006</b>	-5.64 * (0) <b>1995</b>	<b>I(0)</b>
linf <sub>t</sub> TB	-4.12 (1) <b>2000</b>	-3.89 (1) <b>1997</b>	-12.06 * (0) <b>2001</b>	-9.90 * (0) <b>2001</b>	<b>I(1)</b>
lpriva <sub>t</sub> TB	-2.83 (2) <b>2001</b>	-3.96 (2) <b>2001</b>	-2.65 * (2) <b>2001</b>	-2.75 * (2) <b>2001</b>	<b>I(1)</b>
lhgdp <sub>t</sub> TB	-10.03 * (0) <b>1998</b>	-4.81 *** (0) <b>1998</b>	-9.23 * (0) <b>1998</b>	-9.46(0)* <b>1998</b>	<b>I(0)</b>
lequi <sub>t</sub> TB	-3.92 (0) <b>2007</b>	-3.60 (0) <b>2005</b>	-5.95 * (0) <b>2010</b>	-6.07(0)* <b>2010</b>	<b>I(1)</b>

**TB:** is the time of the break.

I: Model without constant and trend the critical values are -5.75 (1%), -5.08 (5%), -4.82 (10%), II: the model with constant the critical values are -5.34 (1%), -4.93 (5%), -4.58 (10%). (K): The number of lag order is shown in parentheses and determined by AIC to remove the serial



correlation in the series of residuals. \* \*\* and \*\*\* mean the unit root is rejected by the null hypothesis at the levels 1, 5 and 10% respectively. ZIVOT and Andrews (1992) results confirmed that most findings of the ADF and PP tests, except for the Lunem series, which is stationary at level, and contain structural break (2004) as well as for the Lrgdp and Lhgdg series, approved the first test results.

### 3.3.2. Multicollinearity Diagnostics

Before estimating the necessary econometrics models it is required to consider calculating the correlation coefficient between independent variables or calculating the Variance Inflation Factor (VIF) to avoid multicollinearity problem between independent variables, and to make sure the model is not spurious, and it does not reflects the true relationship between the variables. To confirm this, the VIF was calculated. If the VIF value is  $VIF > 5$ , this means that there is a problem of multicollinearity between the independent variables. **Table 3** below illustrates VIF values from the Eviews.10 output for the models before and after removing the variables:

**Table 3.** Variance Inflation Factor (VIF)

Indep variable	VIF before removal	VIF after <i>lrgdp</i> removal	VIF after <i>lequi</i> removal
<i>lrgdp</i>	5.47	---	3.95
<i>lpriva</i>	1.42	1.41	1.41
<i>lhgdg</i>	1.28	1.27	1.27
<i>lequi</i>	4.77	3.44	---
<i>lroil</i>	4.59	3.52	4.08

**Source:** EViews 10 software package outputs

**Table 3** indicates a multicollinearity problem between independent variables particularly between *lrgdp* and *lequi*. In the first model, VIF value for *lrgdp* is greater than 5 and it is almost 5 for *lequi*. To eliminate this problem, the variables were removed separately while estimating the different models. After that, the VIF was calculated for

several times, and all values proved below the 5 accordingly, as shown in the previous table. These results entail the ability to generate and estimate different models using the NARDL method.

### 3.3.3. Estimation of the NARDL Models

After testing for stationarity of all-time series variables, and after determining the dynamic correlation between the independent variables using the VIF, it is possible to identify and estimate the number of different models to explore the asymmetric effects of oil-price shocks and some major macroeconomic variables on Algeria’s unemployment rates, depending on many recent macro-econometric studies, (see Cuestas, J. C., & Gil-Alana, L. A 2018, Nusair, S. A 2016, Nusair, S. A 2016). These models are as follows:

- I                 $Lunem_t = f ( lroil^+_t, lroil^-_t, lrgdp_t, linf_t )$     (9)
- II                $Lunem_t = f ( lroil^+_t, lroil^-_t, lpriva_t, linf_t )$     (10)
- III               $Lunem_t = f ( lroil^+_t, lroil^-_t, lhgdp_t, linf_t )$     (11)
- IV               $Lunem_t = f ( lroil^+_t, lroil^-_t, lequi_t, rgdp_t )$     (12)

After this, the NARDL models can be estimated according to some relatively recent studies (see Ibrahim M, 2015; Shin et al, 2014; Bahmani-Oskooee & Mohammadian, 2016; Saeed A. Meo 2018). **Table 4** below demonstrates nonlinear cointegration test results for the four models as follows:

**Table 4.** Asymmetric Cointegration based on Nonlinear Bounds Testing Approach

NARDL	F	Lower bounds	Upper bounds	Decision
I	*** 3.32	2.20	3.09	yes
II	3.54 **	2.56	3.49	yes
III	2.35	2.56	3.49	no
IV	* 5.57	3.29	4.37	yes

**Notes:** The statistics F (F<sub>PS</sub>) Nonlinear denote the F-statistic proposed by Pesaran, Shin, and Smith (2001).

\*, \*\* et \*\*\* indicate significance at 1%, 5% et 10% levels, respectively.

the null hypothesis for Asymmetric Cointegration is:  $\rho = \theta^+ = \theta^- = 0$

This table indicates that Wald test ( $F_{-PSS}$ ) value exceeded the upper bounds at 1% for model IV and at 5% and 10% for model II and model I respectively. This proves thus the asymmetric cointegration relationship, i.e. the existence of a long-term relationship between the variables in the non-linear models IV, II and I respectively. Whereas, the null hypothesis was accepted in model III i.e. the absence of a cointegration relationship because Wald test ( $F_{-PSS}$ ) value is below the lower bounds at 1%.

### Long-run and Short-run Asymmetry Test

In the second step, the experimental results of the nonlinear models' estimations are displayed in **Table 5**. Besides, the Wald tests of asymmetric in long-run and short-run are shown in **Table 6**.

For the model I, in the long and short-term, the values of Wald test are significant at 5% and 1% respectively, and therefore the null hypothesis is rejected and the alternative is accepted, i.e. oil-price shocks have asymmetric effects on unemployment rates. However, in model II, the effect of positive and negative oil shocks on unemployment rates is symmetric in both the long and short run, but the results are insignificant. Finally, in model IV, Wald statistic is significant only in the long-term at 1%, that is, the alternative hypothesis of asymmetric effect is accepted for this model.

**Table 5.** Estimation results of the NARDL model (short-run)

Dependent Variable: $\Delta Unem$		The Three Different Models		
Variables	I	II	IV	
C	---	---	---	
$dlunem_t(-1)$	* 1.17	---	* 0.38	
$dlunem_t(-2)$	** 0.57	---	---	
$dlroil^+_t$	** - 0.40	---	---	
$dlroil^+_t(-1)$	- 0.15	---	---	
$dlroil^+_t(-2)$	---	---	---	
$dlroil^+_t(-3)$	---	---	---	
$dlroil^-_t$	* - 0.43	- 0.03	- 0.10	
$dlroil^-_t(-1)$	* 1.61	** 0.21	---	

$dlroil_t^-(-2)$	* 1.1	---	---
$dlroil_t^-(-3)$	---	---	---
$dlinf_t$	* 0.15	---	---
$dlinf_t(-1)$	* 0.08	---	---
$dlinf_t(-2)$	** 0.03	---	---
$dlrgdp_t$	- 0.43	---	* 1.72
$dlrgdp_t(-1)$	* 6.52	---	** 1.39
$dlrgdp_t(-2)$	1.35	---	---
$dlpriva_t$	---	- 0.01	---
$dlpriva_t(-1)$	---	0.01	---
$dlequi_t$	---	---	* 0.15
$dlequi_t(-1)$	---	---	* 0.19
$ECM(-1)$	* - 3.24	* - 0.63	* - 0.76
$R^2$	0.93	0.60	0.81
$\bar{R}^2$	0.85	0.52	0.75

Notes: « + » and « - » demonstrate the positive and negative partial processes, respectively

F<sub>PSS</sub> statistic is used to test the null hypothesis:  $\rho = \theta^+ = \theta^- = 0$

\*, \*\* and \*\*\* indicate the significant at 10%, 5% and 1% level of significance, respectively.

$ECT_{t-1}$  is the error correction term, which measures the speed of adjustment to long-run equilibrium.

**Table 6.** Long-run non-linear ARDL model results and asymmetric tests

Variables	I	II	IV
$lroil_t^+ (\theta^+)$	* - 0.29	* - 0.48	0.04
$lroil_t^- (\theta^-)$	* - 0.66	* - 0.63	* - 0.60
$Lrgdp_t$	* - 1.63	---	* - 2.59
$Linf_t$	* - 0.11	* - 0.02	---
$Lpriv_t$	---	* - 0.37	---
$Lequi_t$	---	---	** - 0.34
$c$	* 50.13	* 3.85	* 77.92
<b>Long-run Asymmetry</b>			
	I	II	IV
$W_{LR}$	** 8.52	1.10	* 13.19
<b>Short-run Asymmetry</b>			
	I	II	IV
$W_{SR}$	* 18.86	1.41	1.02

**Notes:** \*, \*\* and \*\*\* indicate the significant at 10%, 5% and 1% level of significance, respectively.

$W_{LR}$  denotes the Wald test for the null of long-term symmetry defined by:  $H_0: -\theta^+/\rho = -\theta^-/\rho$

$W_{SR}$  refers to Wald test for null hypothesis of short-term symmetry defined by:  $\sum_{j=1}^{p^*} \pi_j^+ = \sum_{j=1}^{p^*} \pi_j^-$ .

### Result Analysis of the Nonlinear Models in the Long-run

Findings of the three models indicate that long-term oil-price negative shocks ( $lroil^-_t$ ) have a greater impact, than positive shocks ( $lroil^+_t$ ) have, on unemployment rates at the level of significance 1%. The results the model I showed that the positive shock in oil prices by 1% leads to a decrease in the unemployment rate by 0.29%. Whereas, if a negative shock at 1% happens, unemployment rates will increase by 0.66%. Models II and III revealed nearly the same results. Therefore, it is concluded that long-run negative shocks have a greater impact than positive shocks on Algeria's unemployment rates.

The asymmetric consequences of the positive and negative oil-price shocks on long-run unemployment rates entail the urgent need to diversify the country's economic structures. The transition towards a diversified economy may raise the value-added out of the non-hydrocarbon sectors and therefore create permanent and productive job opportunities. This diversification may strengthen Algeria to face the world oil-market fluctuations and uncertainty. The findings indicated that, as the public sector can offer a limited number of job opportunities, the private sector might create more new opportunities. As the results of model II showed that the increase in the rate of loans provided to the private sector by 1% will push unemployment rates down by 0.37%.

The results also indicated that economic growth rate  $Lrgdp_t$  increased, in the long term, by 1% in model I and model IV, and this, in turn, will help decline unemployment rates by 1.63% and 2.95% respectively. This result is consistent with Okun's law; where that reducing unemployment rate requires to raising real GDP. However,

the domestic product out of the non-hydrocarbon sectors ( $Lhgd p_t$ ) proved distorted and unreflective of the sector's progress, and its rise is the result of previous hydrocarbon-sector booms, where the results showed the absence of cointegration relationship in the model III. While, the inflation rates  $Lin f_t$  had very little impact on the direction of unemployment rates (a decline of 0.11% and 0.02% in model I and II respectively). The results proved all significant at 1% in the long-run. Model IV results confirmed model I results regarding the economic growth rate. It was also shown in the results that an increase of 1% in the government capital expenditures will reduce unemployment rates by 0.34%.

### **Result Analysis of the Nonlinear Models in the Short-run**

Model I result indicate that the effects of oil-price shocks in Algeria proved asymmetric in the short run, and these results are consistent with many recent studies; negative shocks have a greater impact than positive shocks. According to **Table 5**, a negative oil shock  $d0^-_t$ <sup>4</sup> causes an increase of 0.43% in unemployment rates; this result is significant at 1%. While negative shocks at late intervals  $d0^-(-1)$ ,  $d0^-(-2)$ , decrease unemployment rates by 1.61% and 1.1% respectively.

While, any positive oil-price shock  $d0^+$  reduces unemployment rates, but at lower rates, ie 0.40%, and at a significant level at 5%. Nonetheless, the effects of these positive and negative oil shocks, in model II and model IV, proved very weak (see **Table 5**).

#### **3.3.4 Cumulative Effects of Negative and Positive Oil Shocks on Unemployment Rates**

To illustrate further the result analysis, we can be completed by examining the asymmetry model obtained from the dynamic multipliers. These multipliers emphasize the adjustment process before the shock to the new equilibrium (after the shock) (Charfeddine, L., & Barkat, K, 2020). It also gives us time to adjust to the new balance. The positive and negative dynamic multipliers correlated with the changes of  $Lroil^+_t$  and  $Lroil^-_t$  are put as:

---

<sup>4</sup>  $d0$  is the abbreviation of  $dloil$

$$m_h^+ = \sum_{i=0}^h \frac{\partial Lunem_{t+i}}{\partial lroil^+_t}, m_h^- = \sum_{i=0}^h \frac{\partial Lunem_{t+i}}{\partial lroil^-_t}$$

**Figure 3** illustrates the dynamic multiples for 15 years. The thick dotted red line indicates the difference between a 1% positive shock and a 1% negative shock, and the thin dotted red lines symbolize the confidence interval for the different effects of both shocks (positive and negative). Whereas, the continuous black line indicates a positive oil shock and the dotted black one indicates a negative shock. Models I and IV results showed a strong reaction to oil-price negative changes; convergence towards long-run coefficients takes place gradually, but the response to positive changes is slow. It is worth noting that in both models the multiples take about nine years to converge towards the values of long-term multiples.

3.3.5 Examination of residuals for models estimated

**Table 7. Results of Examination of Residuals for these Models**

Diagnostic Tests of the Models			
Test Type	Model I	Model II	Model III
LM (F) test (P-value) -2-	1.80 (0.30)	0.15 (0.85)	1.71 (0.22)
ARCH (F) test (P-value) -2-	0.06 (0.93)	0.80 (0.32)	0.25 (0.62)
Normality test (JB) (P-value)	0.77 (0.67)	1.32 (0.51)	0.61 (0.73)
RESET (F) test (P-value)	0.04 (0.84)	2.81 (0.01)	2.5 (0.02)
CUSUM	stability	stability	stability
CUSUMSQ	stability	stability	stability

According to the stability and the diagnostic tests, the three estimated models are highly reasonable and compatible (the results of LM test indicates the absence of serial correlation in the residuals, the ARCH test shows that the variance of the errors is constant over time, the Jarque-Bera test confirm the approximate normality of the residuals). The diagnostic test was conducted using Ramsey Test, and its results for the model I reject the null hypothesis "existence of model misspecification", hence, the model takes the appropriate functional and it is correctly specified. however, model II and model IV results are insignificant.

Both tests of CUSUM and CUSUM of the squares for the three models illustrate that the parameter line is within the boundaries of critical lines at 5 % probability level area indicating complete stability in the three models. That is, CUSUM and CUSUM of the squares tests point out that the estimated coefficients were stable. At last, it is concluded that diagnostic tests demonstrate that Model I is the best and that it overcame all econometric problems.

## CONCLUSIONS

This paper's contribution, from a new perspective, lies in the fact that it tracks the asymmetric effects of oil-price shocks as well as the evolution of the direction in economic growth rates and some macroeconomic variables on Algeria's unemployment rates during 1990-2017. It was validated and confirmed, using the NARDL model, that oil-price shocks have asymmetric effects. Moreover, cointegration tests (Shin et al, 2014) revealed a long-term relationship between the study variables in the three different models. However, long and short-term asymmetry tests proved significant only in the first model (I), and the diagnosis tests confirmed that this model is the best and that it jumped over all standard problems. The results also showed the existence of long-term asymmetric effects and short-term symmetric effects in model IV, but asymmetry tests in model II were insignificant. Overall, the results demonstrated that negative oil-price shocks have a greater impact than positive shocks, especially in the long term, on unemployment rates. They also demonstrated that economic growth rates have a greater impact on unemployment rates than investment expenditures and private sector loans. However, the domestic product without the fuel sector, revealed distorted and unreflective of this sector's development, rather its increase is the result of previous fuel-sector mutations.

The asymmetric consequences of the positive and negative oil-price shocks on long-run unemployment rates call for diversifying the country's economic structures. Therefore, understanding the direction of oil-price shocks is critical for policymakers, particularly in oil-exporting countries. Long-term results proved that, in consistency



with many recent studies, negative shocks have a greater impact than positive shocks.

Economic diversification strategy has now become an urgent concern for Algeria. Diversification policies comprise structural reforms that promote and develop the non-fuel sector, such as improving the public sector effectiveness, promoting private sector development, improving the financial sector, changing the workers' structure of motives and encouraging private sector employment. Also, volatile and depleted oil revenues should be transformed into more stable financial investments, which can help develop the country's economy by establishing engines for long-term sustainable economic growth. The cyclic government expenditure should also end by using appropriately the revenues adjustment fund by setting clear rules of the deposit and the withdrawal processes. Algeria can also benefit from Norway's experience as a preventive solution to strengthen the country's economy. To expand the study of this topic, more in depth-studies, on the current economic structure and on the channels through which oil price changes, are needed. At last, it would be useful to analyze the effects of oil-price shocks on the budget deficit, the current account, the profit prices and the real exchange rates.

### Bibliographic references

أحمد السيد النجار (2006)، "الطفرة النفطية العربية الثالثة، دراسة للملامح والأسباب وآليات التوظيف"، مركز الدراسات السياسية والاستراتيجية، دراسات استراتيجية، السنة السادسة عشرة- العدد رقم (165).

دحماني محمد ادريوش، عطوشي منال (2008)، "أثر صدمات أسعار النفط على ديناميكية النشاط الاقتصادي ومعدلات البطالة: أدلة تجريبية من الجزائر باستخدام نماذج الانحدار الذاتي الهيكلي"، مجلة رؤى اقتصادية، العدد 08، ص 49-64، الجزائر.

دحماني محمد ادريوش (2013)، "النمو الاقتصادي والبطالة في الجزائر: دراسة قياسية"، مجلة جامعة النجاح للأبحاث، المجلد 27 (6)، نابلس، فلسطين، ص 1293-1322.

دحماني محمد ادريوش (2012)، "النمو الاقتصادي واتجاه الإنفاق الحكومي في الجزائر: بعض الأدلة التجريبية لقانون فانغر باستعمال منهج الحدود"، مجلة الاقتصاد والمناجمت، جامعة أبوبكر بلقايد، تلمسان، العدد 11، نوفمبر.

نورة بنت عبد الرحمن اليوسف (2008)، "ارتفاع وانخفاض أسعار النفط من عام 1970 إلى 2008"، أوراق عمل، كلية إدارة الأعمال، جامعة الملك سعود، المملكة العربية السعودية، جوان.

**Charfeddine, L., & Barkat, K. (2020, February).** "Short-and long-run asymmetric effect of oil prices and oil and gas revenues on the real GDP and economic diversification in oil-dependent economy". *Energy Economics*, 86, 104680.

**Cherifa.B & Hussein A. Al-Zeaud. (2012).** Oil Price Distortion and Their Impact on Algerian Macroeconomic, *International Journal of Business and Management*; Vol. 7, No. 18., PP 102-103.

**Cuestas, J. C., & Gil-Alana, L. A. (2018).** "Oil price shocks and unemployment in Central and Eastern Europe". *Economic Systems*, 42(1), 164–173.

**Dahmani, Mohamed Driouche and Rekrak, Mounia (2015):** Revisiting the Relationship between Unemployment Rate and Economic Growth in Algeria, 1970-2014: Co-Integration Approach using ARDL model. Munich Personal RePEc Archive. Retrieved from <https://mpra.ub.uni-muenchen.de/92110/>

**Davide Furceri (2012),** "Unemployment and Labor Market Issues in Algeria", IMF Working Paper, Middle East and Central Asia Department, WP/12/99.

**Elsiddig R, Noel P, Kian T. (2016).** "Oil price shocks and their consequences on Sudan's GDP growth and unemployment rates", the 21st international academic conference, 9-21 February, Miami, Florida, United states.

- Hyunjoo K, Yushu L, Ghazi S, (2018),** "The Causal Nexus between Oil Prices, Interest Rates, and Unemployment in Norway Using Wavelet Methods", *sustainability Journal*, 10 (8).
- Irina K, Dmitry B, (2017),** "Do Oil Price Shocks Matter for Competition :A Vector Error Correction Approach to Russian Labor Market", *International Journal of Energy and Policy*, 7(4), 68-75.
- Johanna B, Jungho B, (2017),** "Do oil price changes have symmetric or asymmetric effects on the unemployment rate: Empirical evidence from Alaska", *Energy Sources, Part B: Economics, Planning, and Policy*, 12(4), 1-6.
- Juan C, Javier O, (2018),** "Oil price and unemployment in the UK before and after the crisis: A Bayesian VAR approach", *Physica A: Statistical Mechanics and its Applications*, vol 510, 200-217.
- Kangni Kpodar (2007),** "Why Has Unemployment in Algeria Been Higher than in MENA and Transition Countries?" IMF Working Paper, African Department, WP/07/210.
- M. Hakan Berument, Nildag Basak Ceylan and Nukhet Dogan (2010).** "The Impact of Oil Price Shocks on the Economic Growth of Selected MENA Countries". *The Energy Journal*, Vol. 31, No. 1, pp. 149-176.
- Mohamed Driouche, D, MANEL, A. (2019).** "Assessing the fluctuations of macroeconomic aggregates: Evidence from Algeria". *Journal of Empirical Economics and Social Sciences*, 1 (1), 17-28. Retrieved from: <http://dergipark.gov.tr/jeess/issue/43816/505279>
- Mrabet, Z., Alsamara, M., Salem S. A. Al-Marri, S., & Ali Al-khayat, Z. (2019).** "Modelling the asymmetric responses of price level to oil price changes in Qatar". *The Journal of International Trade & Economic Development*, 1-13.
- Nusair, S. A. (2016).** "The effects of oil price shocks on the economies of the Gulf Co-operation Council countries: Nonlinear analysis". *Energy Policy*, 91, 256-267.
- Nusair, S. A. (2020).** "The asymmetric effects of oil price changes on unemployment: Evidence from Canada and the US". *The Journal of Economic Asymmetries*, 21, e00153.

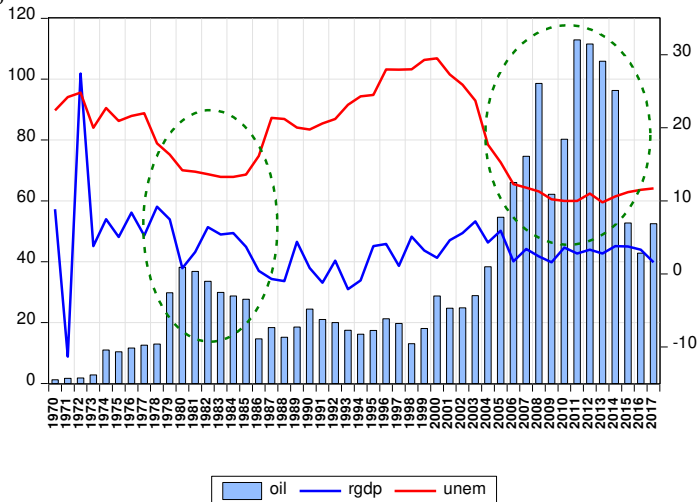
**Nyakundi M., Richard G., (2015), "Oil price fluctuations and employment in Kern Country: A Vector Error Correction approach", *Energy Policy*, 87, 584-590.**

**Satrovic, E. (2017). "Fnancial development and capital in Turkey: ARDL approach". *Kapadokya Akademik Bakış - Cappadocia Academic Review*, 1 (2), 1-15. Retrieved from <http://dergipark.gov.tr/car/issue/33536/352504>.**

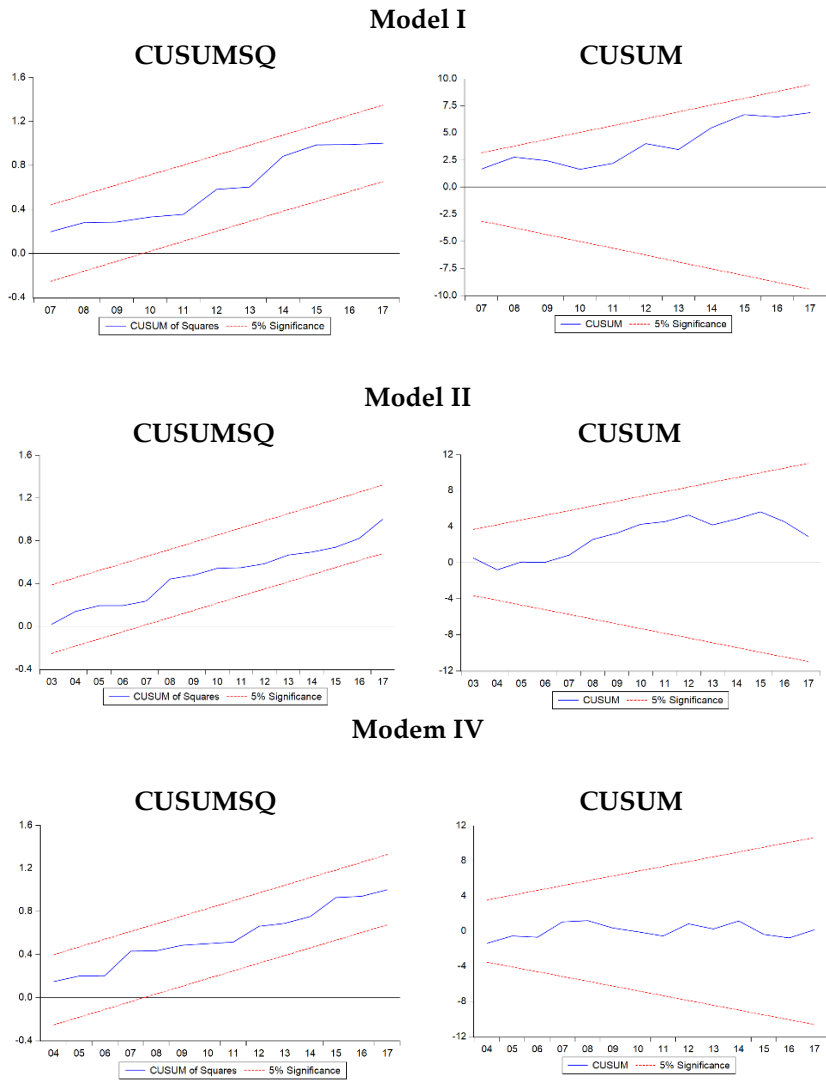
**Tarek T., Haider Zafar A., and Nawaz A., (2017), "Oil Price and Employment Nexus in Saudi Arabia", *International Journal of Energy and Policy*, 7(3), 277-281.**

## Appendices

**Figure 1:** Oil-prices development, growth rates and unemployment direction in Algeria



**Figure 2 :** Cumulative sum of recursive residuals and cumulative sum of squares of recursive



**Figure 3:** Cumulative Effects of Negative and Positive Oil Shocks on Unemployment Rates

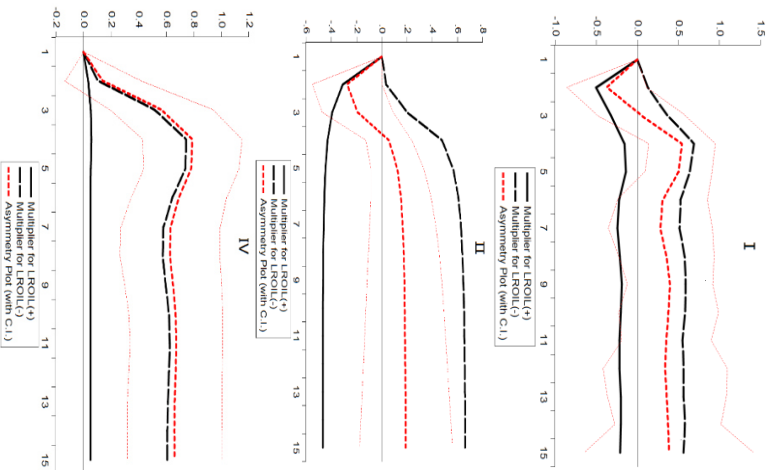
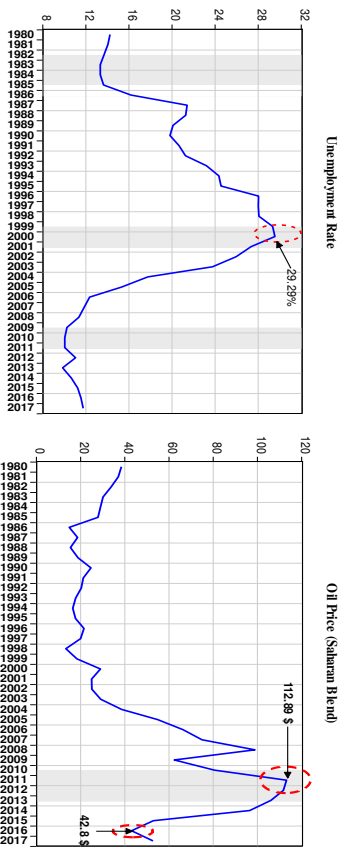
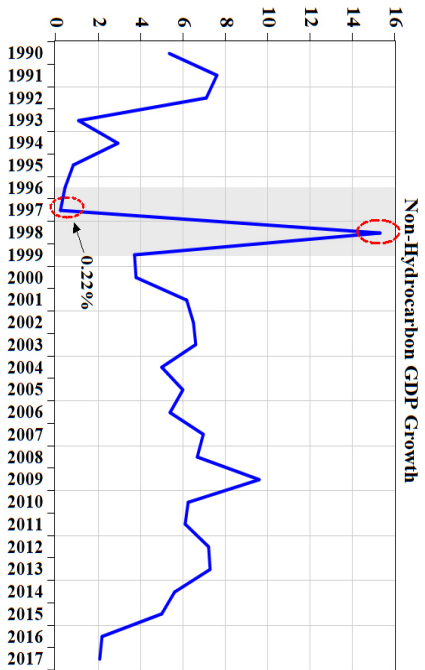
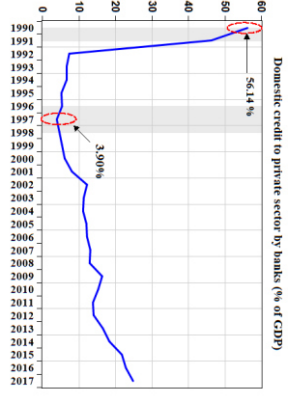
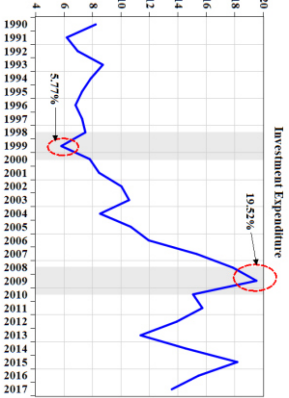
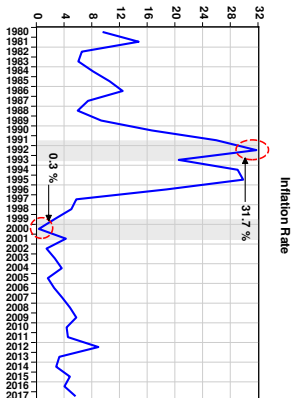
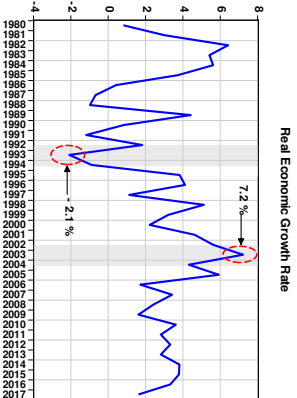


Figure 4: Direction of the study variables during 1980-2017





## **PERFORMANCE ASSESSMENT OF THE "ALGERIAN TAX SYSTEM" ECONOMIC STUDY OF ORDINARY TAXATION BETWEEN 2000-2016**

Samir MAHTOUT\*  
Kamal OUKACI\*\*

Received: 02/02/2019 / Accepted: 22/05/2020 / Published: 09/07/2020

Corresponding authors: mahtout\_samir@yahoo.com

### **ABSTRACT**

The Algerian tax system is essentially declarative; it provides two tax structures. The first concerns the taxation of revenues and income earned by physical and legal persons (ordinary taxation), while the second concerns the operations carried out by oil companies (petroleum taxation). This article aims to assess the performance of ordinary Algeria tax system. Thus, we have studied the different taxes in terms of yields and tax burden. The results show that tax revenues come mainly from the taxation of wages and expenses. In conclusion, this taxation cannot contribute to financing the economic development, owing to the scant mobilization of the tax performance.

### **KEY WORDS:**

Ordinary taxation, tax revenues, tax burden.

**JEL CLASSIFICATION:** H20, H24, H25, H27, H30.

---

\* Doctorant à la faculté des sciences économiques, commerciales et des sciences de gestion. Université de Bejaia. mahtout\_samir@yahoo.com, Algérie.

\*\* Professeur à la faculté des sciences économiques, commerciales et des sciences de gestion. Université de Bejaia. oukaci.kamal@gmail.com, Algérie.



## تقييم أداء النظام الجبائي الجزائري: دراسة اقتصادية للجباية العادية خلال الفترة 2016-2000

### ملخص:

النظام الضريبي الجزائري هو بشكل أساسي تصريحي، فهو ينص على هيكلين ضريبيين. الهيكل الأول يتعلق بفرض الضرائب على الإيرادات والأرباح التي يحققها الأشخاص الطبيعيون والمعنويون (الضرائب العادية)، بينما يتعلق الثاني بالعمليات التي تقوم بها شركات النفط (الضرائب على البترول). تهدف هذه المقالة إلى تقييم أداء الضرائب العادية في الجزائر. للقيام بذلك، درسنا مختلف الضرائب من حيث أداء التحصيل والعبء الضريبي. تظهر النتائج أن الإيرادات الضريبية تأتي أساساً من فرض الضرائب على الأجور والنفقات. في الختام، لا يمكن لهذا الهيكل الضريبي أن يساهم في تمويل التنمية الاقتصادية، بسبب عدم كفاية أدائه في التحصيل الضريبي.

### كلمات مفتاحية:

الضرائب العادية، تحصيل الضرائب، العبء الضريبي.

تصنيف جال: H30، H27، H25، H24، H20

## **EVALUATION DES PERFORMANCES DU SYSTEME FISCAL ALGÉRIEN : ÉTUDE ÉCONOMIQUE DE LA FISCALITE ORDINAIRE DURANT LA PÉRIODE 2000-2016**

### **RÉSUMÉ**

Le système fiscal algérien est essentiellement déclaratif. Il prévoit fondamentalement deux structures d'imposition. La première concerne l'imposition des recettes et les profits réalisés par les personnes physiques et morales du droit commun (fiscalité ordinaire), tandis que la deuxième vise les opérations réalisées par les entreprises relevant du secteur des hydrocarbures (fiscalité pétrolière). Cet article a pour objectif d'évaluer les performances de la fiscalité ordinaire en Algérie. Pour ce faire, nous avons étudié les différents impôts et taxes en termes de rendement et de pression fiscale. Les résultats montrent que les recettes fiscales proviennent essentiellement de la taxation des salaires et de la dépense. En conclusion, cette fiscalité ne peut contribuer au financement du développement économique, en raison d'une mobilisation insuffisante du rendement de l'impôt.

**Mots clés :** Fiscalité ordinaire, recettes fiscales, pression fiscale.

**CODES JEL :** H20, H24, H25, H27, H30.

### **INTRODUCTION**

Taxation is considered an important tool in the hands of every government since it helps to achieve several goals, namely economic, budgetary and social ones. Throughout the centuries, taxes have been at the heart of public policy because of the significant impact they have on the economy. The normal running of any society obviously entails the covering of public charges which can only be insured by taxes (Allais, 1990) In addition, taxes have always been considered among the principal organs in forming the power and independence of nations. They represent as well a fundamental tool of the existence of the State (Neurrisse, 1978). Furthermore, state economic and social interventionism has long been the matter of intense debate in the history of economic thought.

In fact, classics believe that taxes are economically neutral, hence they are assimilated as the price paid by the taxpayer for the security and the services brought to him by the State. According to the classics, taxes are dissipative levies (Smith, 1776). Tax contributions have, however, a harmful role on economic activity and they only create difficult choices (Ricardo, 1817). The classics have defined four fundamental tax maxims, including the rule of justice, certainty, convenience and the rule of economy (Smith, 1776).

However, the interventionist tax theory derived from the Keynesian theory considers that the tax is not neutral. Indeed, it is a powerful instrument used by public authorities for fiscal policy purposes, in particular to stimulate overall demand or improve economic growth. The recovery of the economies, particularly those of the developing countries, depends on the implementation of economic policies, especially in fiscal policies that guide long-term actions and to act in line with priorities, the development of an efficient and diversified productive economy. Thus, in the current socioeconomic context, the public authorities are constantly asking the adoption of tax measures that could design tax structures that would further improve the business environment, and generate as much financial return to finance economic development. To this end, public policy-makers must give well-deserved attention to tax policy in view of its major role in the foundations of contemporary societies and also sine qua non of their existence (Neurrisse, 1978). On the other hand, the intense use of the public authorities to tax the economic activity in order to finance the State's budget requires well-studied and scrupulously defined reflections to reduce harmful effects of taxation on economic growth (Barro, 1990), (Lucas, 1990), (Easterly et al, 1993b), (Engen et al, 1996), (Milesi-Ferretti et al, 1998), (Arnold et al, 2011), (Arseneau et al, 2011)...etc.

Nowadays, the financing of the State budget became more and more a challenge for governments which are looking for appropriate tax measures that can generate budgetary revenues and ensure a permanent income for the State. In Algeria, the tax system is essentially declarative subject to the right of control and verification. It

consists of two distinct large parts. The first part deals with ordinary taxation, it is broken down into direct and indirect taxation, which applies to all the activities of natural and legal persons, goods and services. The second part deals with the oil tax and on specific activities relating to hydrocarbons sector. During the period 2000-2016, ordinary tax revenues contribute 36.8% to total tax revenues (ordinary and oil taxes and 22.51% of Gross Domestic Product Non-Hydrocarbon and Non-Agricultural (GDPNH-NA), despite the efforts to modernize the tax administration on the one hand and increase revenues from ordinary taxation on the other hand.

This study aims to assess the performance of Algerian tax system, in particular ordinary tax system, by examining the evolution of the tax structure and analyzing the performance of the various tax categories. The evaluation focuses on two periods (2000 to 2014) and (2015 to 2016). This purpose makes it possible to measure the impact of the changes observed on the international energy market (the fall in oil prices begun in 2014) on the performance of ordinary taxation in Algeria. This work is based on three sections. The first is to review the theoretical and empirical literature on taxation and its effects on the economy. In the second section, we will present the main stages of Algerian taxation, in particular after the major reforms of 1992, as well as the main taxes constituting the current tax system. The third section will be devoted to evaluate the ordinary tax system through an economic analysis of the various taxes in terms of financial performance and tax burden.

#### **1- THEORETICAL AND EMPIRICAL LITERATURE REVIEW:**

The tax represented by the tax is a benefit of the monetary values required of individuals, due by individuals, according to fixed rules and by means of authority, for the purpose of covering expenditure of general interest<sup>1</sup>. Fiscal policy was always, in particular for developing countries in order to achieve many economical, budgetary

---

<sup>1</sup> Jeze G, quoted by BOUVIER M, (2016). «Introduction au droit fiscal général et à la théorie de l'impôt». LGDJ, 10th edition, P 24.

and social goals<sup>2</sup>. First, the tax is used to mobilize budgetary resources to finance public spending. Governments also use this instrument to direct economic activity towards targeted sectors to promote economic well-being and growth. Finally, it intervenes to ensure equity in income redistribution and to correct externalities (Azizul, 2001). Furthermore, the expected role of the tax system, according to several studies, is particularly the collection of tax revenues to cover government costs (Burgess et al, 1992). The aim of designing a sound fiscal policy is not only to reduce the distortions it creates for economic activity but also to generate absolutely sufficient financial revenues for the proper functioning of the State services (Mackenzie et al, 1997). However, the implementation of simple, fair and efficient tax system is a major challenge, especially for developing countries. Indeed, the tax structures of these economies are suffering from a crisis of mobilization of tax revenues; they must increase in urgency twice the current financial performance to integrate them successfully into world economy (Tanzi et al, 2001). Economic crises frequently as noted recently in these countries have made it possible to give a crucial importance to taxation as a suitable solution to development policy.

However, the failure of these governments to achieve this goal has caused many economic imbalances (Attila et al, 2009) and the inability of public finances to develop growth-generating sectors (education, health, infrastructure), hence the low level of development in these States (Chambas, 2005a).

In order to fix these shortcomings, the success of the tax transitions is the optimal solution, through the improvement of the efficiency of the value added tax and the widening of its tax base (Chambas, 2005b; Brun et al, 2007). The financing public budgets problem through the proceeds of ordinary taxation, in particular for those of most developing economies, is mainly due to a poor conception of a tax

---

<sup>2</sup> Jean-Marc D, (2008). «Richard Musgrave et les fonctions économiques de l'Etat». La revue du Trésor n° 1, P 61.

structure which conforms to socio-economic characteristics of each country, owing to the importance of recoveries made by the taxation of natural resources. The obstacle of corporate taxation in generating sufficient financial resources to these economies, at the time of prolonged external shock, to deplorable economic, social and political crises (Bouilef, 2014). Moreover, the inefficiency of ordinary taxation, both for countries rich in natural resources and for those without natural resources, results in excessive use of optimization behaviour in aggressive taxation, in particular tax evasion and fraud, attractiveness, tax dumping, etc. (Bensahli, 2015).

The debate on tax measures which conducts the economic growth is increasingly intense, given the impact of taxation on economic activity, in particular business environment and economic growth. Arnold et al. (2011) conclude that real estate and consumption taxations are the least detrimental to economic growth. While, taxation of personal income and corporations' profits is more damaging. In addition, Arseneau et al. (2011) suggest that consumption taxation has a more positive impact on economic growth than income taxation.

Lee et al. (2004) conclude that a 10% increase in corporate income tax leads to a 0.82% decline in the economic growth rate. Padovano et al. (2001) show a negative relationship between the marginal tax rate and the average GDP growth rate. Wildmalm (2001) shows that the progressivity of personal income tax is the most damaging factor to economic growth. Furthermore, several other approaches have shown that the component of tax structure, in particular progressive taxation (taxation of personal income) strongly influences entrepreneurial activity (Gentry et al, 2000; Gordon, 1998) It also distorts employment and wages (Arulampalam et al, 2010; Hasset et al, 2006; Felix, 2006). Also, the tax structure, especially corporate taxation, has a significant and negative effect on investment, including foreign direct investment (Hartman, 1984; Boskin et al, 1987; Young, 1988).

## **2- PRESENTATION OF ALGERIAN TAX SYSTEM:**

The Algerian tax system is mainly a declarative system subject to the right of control and verification, it was a historical legacy of the French tax system. Economic reforms undertaken in the late 1980s aiming to liberalize the national economy and to initiate a transition to economy's market required an upgrade of Algerian fiscal policy. Thus, a break was initiated in 1992 with the genesis of new tax structure comparable to that noticed in most countries in transition, particularly those in Latin America and Southeast Asia's region. The main measures introduced were the introduction of three new taxes, in particular value added tax (VAT), instead of turnover taxes, particularly the Unique Global Tax on Production and the Unique Global Tax on Services, the introduction of Corporate Income Tax (CIT) and the creation of Global Income Tax (GIT). Furthermore, reforms also aimed to reduce the tax burden and simplifying the tax structure through the abolition and replacement of archaic taxes international practices in order to improve the financial position of ordinary taxation, in particular reducing disastrous effects of an external shock on hydrocarbon prices, other reforms were implemented in the early 2000s. Several goals have been pursued by these reforms, as the simplification and harmonization of the tax system, the broadening of the tax base for various taxes, the fight against tax evasion and evasion... etc. The main measures to be taken under this consolidation are, in particular the rescheduling of the tax debt of companies facing financial difficulties to increase the level of recovery, and to improve economic entity's tax environment and voluntary tax compliance program<sup>3</sup>. These reforms also aim at the introduction of a preferential tax regime for corporate groups, the reduction of the tax burden through the abolition of the flat-rate payment (FV), the reduction rates of Taxes on Professional Activity

---

<sup>3</sup> The main target of Voluntary Tax Compliance Program is banking the resources and regularization of tax situation. It is part of the government's will to mobilize tax resources in order to finance productive investments and to encourage the business climate and economic agents to integrate formal sphere'.

(TAP) and VAT<sup>4</sup>. A process of modernization of tax administration has been established to carry out these reforms. This process involves equipping the tax administration with an organization and procedures based on international best practices and more suitable means of services (new infrastructure, equipment and staff training). Moreover, the tax system is mainly based on two major principles, in particular the principle of reporting and the principle of withholding tax. As an economic investment incentive, it grants several tax advantages in the form of exemptions, tax withholding, etc. Finally, Ordinary tax system has adopted mainly the Global Income Tax (GIT), which is a single annual tax, applies to the taxpayer's total net income, is declarative and is calculated annually according to a progressive scale.

It also has the Corporate Income Tax (CIT), which is an annual tax on all profits or income earned by companies, the CIT's rate is set according to the nature of the activity. There is also the Tax on Professional Activity (TAP) which is payable by any private or legal person who carries out a professional activity in Algeria. This tax applies on turnover at tax rates determined according to the nature of the activity. Furthermore, VAT is an indirect consumption tax, declared and paid to the State by the corporations (legal providers), ultimately borne by the final consumer, There is also the Single Lump sum Tax (SLT) which is payable by all private and legal persons in industrial, commercial, craft or liberal activity whose annual turnover does not exceed 30,000,000 DA, the tax rate is set at 5% for production activities and sale of goods and a rate of 12% for the other activities.

Finally, the Registration and Stamp duties (RSD) represent a formality to which agreements and deeds under private or authentic signature are subject, relating to many transactions such as transfers (sales, donations, exchanges), leases, mortgages, etc., the applied rates change according to the nature of the act.

---

<sup>4</sup> Articles 23 and 27 of Financial Law 2017.



### **3- PERFORMANCE ASSESSMENT OF ORDINARY TAX SYSTEM DURING THE PERIOD 2000-2016:**

The assessment of the performance of ordinary tax revenues in Algeria, during the period 2000-2016, will be presented through the assessment of direct and indirect taxes' yield, the analysis of the evolution of the ordinary tax burden, in relation to GDPNH-NA and then, by the assessment of tax effort of the main taxes constituting the taxation. Taxes with this study are Global Income Tax (GIT/NS, IRG/TS)<sup>5</sup>, Corporate Profit Tax (CPT), Value Added Tax (VAT), Customs Duties (CD), Registration and Stamp Duties (RSD) and Indirect Taxes (ID).

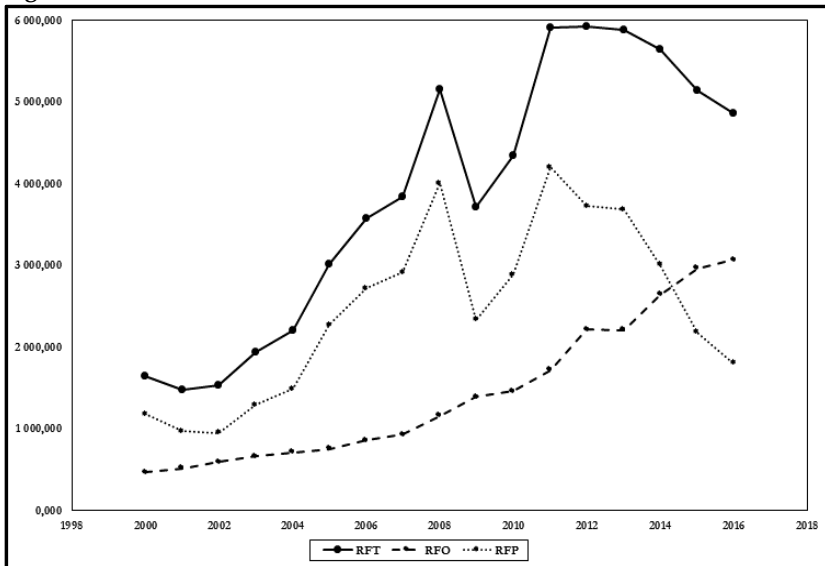
#### **3.1- The structure of Total Tax Revenue (TTR):**

Ordinary Tax Revenues (OTR) increased from 460.9 billion DZD in 2000 to 3,064.8 billion DZD in 2016, with a nominal annual average growth rate of 12.8%. At the same time, Oil Tax Revenues (OTR) also showed a positive trend. Increasing from 1,173 billion DZD in 2000 to 1,801.1 billion DZD in 2016, with a nominal annual average growth rate of 7.6%. We note a particular specificity in tax revenues' trend in Algeria. Indeed, this development is distinct by two major periods, the period between 2000-2014, characterized by the oil tax yield preponderance, while the second period between 2015-2016, is a stage where ordinary tax collection has regained a dominant position, marking a larger contribution in tax revenues' mobilization. The improvement in performance of ordinary taxation performance can be explained by the increase in the collection of all taxes categories. However, the decline in oil tax revenues can be explained by the drop in oil prices that began in 2014, and worsened during 2015 and 2016 (oil prices fell by about 10%, 90% and 21% in 2014, 2015 and 2016 respectively).

---

<sup>5</sup> GIT/NS: means Global Income Tax for non-salaried persons, GIT/TS: means GIT for Treatments and salaries.

**Figure 1:** Evolution of Total Tax Revenues



Source: Users' calculations based on General Directorate of Taxes (GDT) data.

TTR: means Total Tax Revenues (RFT).

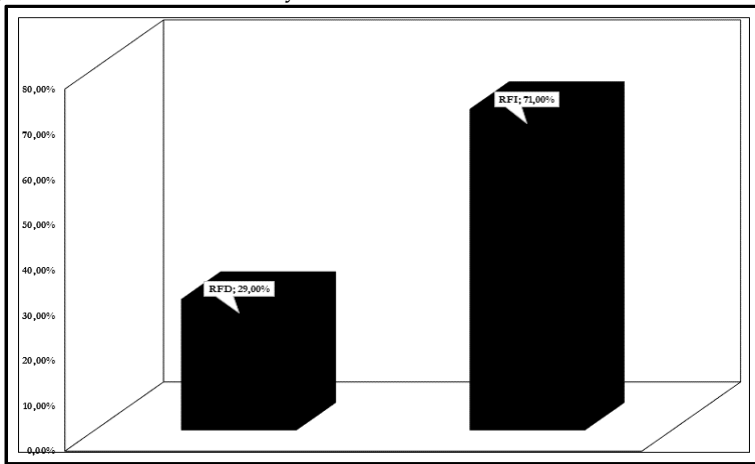
OTR: means Ordinary Tax Revenues (RFO).

OTR: means Oil Tax Revenues (RFP).

### 3.2- Analysis of ordinary taxation's financial performance.

The financial performance of various taxes represents approximately 36.8% of total tax revenues between 2000-2016. This yield will be analyzed in Direct Tax Revenues (DTR) and Indirect Tax Revenue (ITR). Furthermore, this decomposition makes it possible to reflect an image of tax system's structure in Algeria, which means the determination of taxation type from the ordinary financial yield (see Figure 2).

**Figure 2:** Structure of Ordinary Tax Revenues.



*Source: Users' calculations based on General Directorate of Taxes (GDT) data.*

DTR: means Direct Tax Revenues (RFD).

ITR: means Indirect Tax Revenues (RFI).

Indirect taxation represented an average of 71% of total tax revenues during the period of study, this result feed through to the increase of products' consumption subject to such taxation, in particular products subject to domestic VAT as well as on imports. The in-depth analysis of the indirect financial yield shows the preponderance of revenue from Turnover Taxes (TT) over other tax categories<sup>6</sup>. However, direct contributions are represented mainly by income, including wages and salaries and non-salaried persons (IRG/TS-IRG/NS), as well as Corporate Income Tax (CIT). Furthermore, these charges account for approximately 28.27% of ordinary tax revenue.

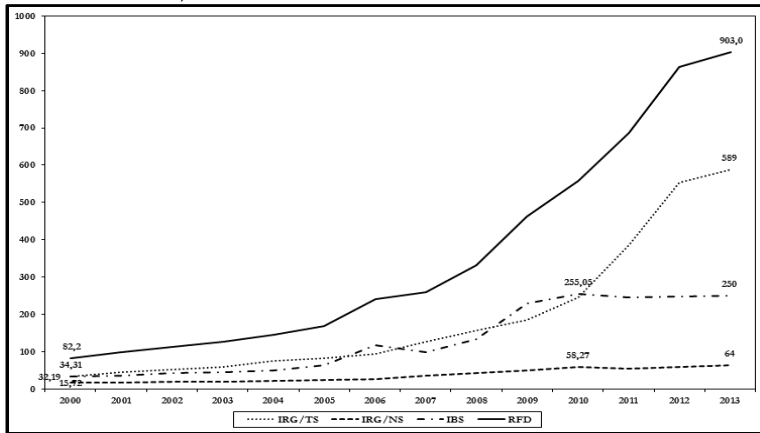
The in-depth auditing of tax yield structure in this tax category shows the preponderance of the GIT/TS with an average contribution of 48.96% to direct tax revenues, compared to only 12.77% for the GIT/NS and 38.26% for the IBS.

<sup>6</sup> An in-depth analysis of the financial performance of indirect taxation shows that the TT yield rise up to 20.66% compared to 22.23% on excise duties.

### 3.2.1. Analysis of direct tax revenues:

This section provides a comprehensive analysis of the evolution of direct tax revenues during the period 2000-2013. The choice of this period is subject to the availability of statistical data on tax recovery. There has been an upward trend in direct tax revenues since 2000, from 82.34 billion DZD to 903 billion DZD in 2013. This result is mainly reflected in the substantial recovery under the GIT/TS following the implementation of several indemnity schemes for the payment of salaries of civil employees under various public institutions. Additionally, the analysis of direct contribution revenues shows that GIT/TS remains predominant (see Figure 3). It represented 65.23% of direct tax revenues and 26.72% of regular tax revenues in 2013, an average of 48.96% and 14.19% between 2000 and 2013 respectively. On the other hand, direct taxation part paid by taxpayers subject to GIT/NS is clearly low and is evolving slowly. In fact, this tax category generates a financial return of 12.77% of direct tax revenues and 3.31% of ordinary tax revenues. This result can be explained by the repetitive deficits of the enterprises, the amount is more and more important remains to be recovered, the various fraudulent practices to evade taxes (tax evasion and tax evasion), as well as the many tax expenditures (exemptions and abatements) to improve the business climate and support domestic and international investment. In addition, the study also shows that the IBS is a component which has undergone a growing trend in terms of ordinary receipts, from 32.19 billion DZD in 2000 to 250.164 billion DZD. This upward trend in revenues can be explained by an increase in the number of taxpayers in this tax category, as well as a downward adjustment of tax rates to reduce the tax burden and broaden the tax base.

**Figure 3:** Evolution of the components of direct taxation (% of direct tax revenues)



Source: Users' calculations based on General Directorate of Taxes (GDT) data.

GIT/TS: mean Global Income tax on treatment and salaries (IRG/TS).

GIT/NS: means total income tax of Non-Salaried persons (IRG/NS).

CIT: means Corporate Income Tax (IBS).

TRC: Tax Revenue per Capita (RFD).

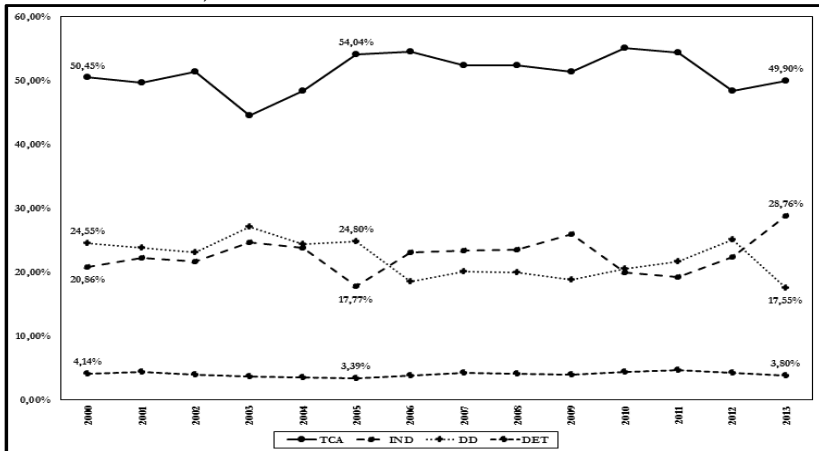
This financial performance's exhaustive analysis of direct taxation shows that the bulk of direct tax revenue comes from labour taxation (salaries tax) and corporate profits.

### 3.2.2. Analysis of Indirect Tax Revenues:

In this section, we will analyze the evolution of indirect tax revenues, in particular the products generated by VAT (VAT/INT), VAT on imports (VAT/IMP) and VAT on petroleum products (VAT/PP), as well as Domestic Consumption Tax (DCT) products and customs revenue. Revenues from indirect taxation was 1,301.1 billion DZD in 2013 compared to 1,345.8 billion DZD the year before, showing a decrease of 3.27%. This result is due to the fall in customs revenues of (-32.34%). Revenues from indirect taxation showed an upward trend throughout the period under review, where they increased by 31.34% compared to 2011. Revenues increased by 350% during 2000-2013 period. Figure 4 shows that this trend in indirect taxation is reflected in the significant increase in VAT, customs duties and indirect taxes, including DCT, miscellaneous budget products, domain products and

other revenues. We noticed also that revenues from Registration and Stamps Duties (RST) are almost stable and marginal, with a financial mobilization of 4.01% of indirect revenues and 2.86% of the total ordinary taxation. However, it is noticeable that the importance of Turnover Taxes (TT) especially VATS remains predominant as they contributed to 52% of total indirect revenues and 36.68% of ordinary tax revenues. Furthermore, customs revenues and indirect contribution revenues (DCT and other revenues) are an important source of Indirect Taxes (ID), representing respectively an average of 16.01% and 16.2% of indirect tax revenues.

**Figure 4:** Evolution of the components of indirect taxation (% of indirect tax revenue)



Source: Users' calculations based on General Directorate of Taxes (GDT) data.

TT: means Turnover Tax (TCA)

ID: means Indirect Tax (IND)

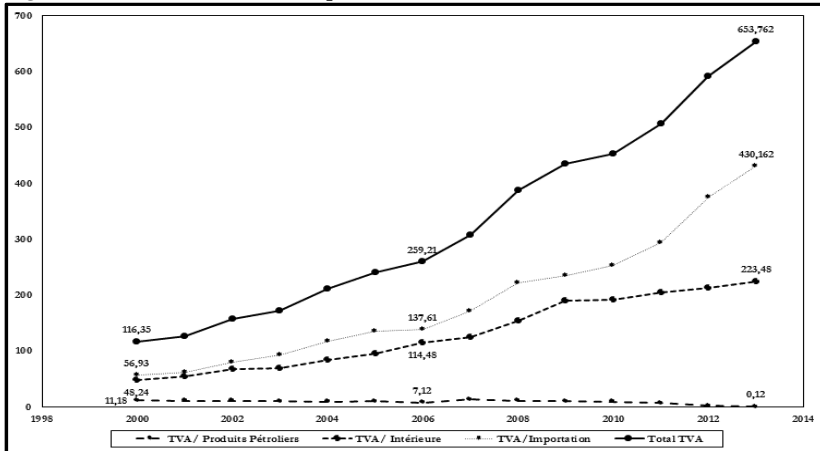
CD: means Customs Duties (DD)

RSD: means Registration and Stamp Duties (DET)

The previous analysis showed the dominant position of turnover taxes in the structure of indirect taxation. We will try in the following section to analyze components of VAT and then determine the place of each of them in terms of yield. The examination of Figure 5 shows that the share of the (VAT/IMP) remains important over the whole period. It rose from 56.93 billion DZD in 2000 to 430.162 billion DZD in 2013. This result is explained by the dramatic increase in imports

during this period. We also noticed that the (VAT/MSA) varies considerably despite the tax expenditures granted in the context of tax benefits. For example, it rose from 48.24 billion DZD in 2000 to 223.48 billion DZD in 2013. This result is mainly reflected in the increase of taxpayers' number subject to VAT, the high rate of VAT and the efforts of the tax administration in terms of controls. Consequently, the analysis of indirect tax revenues showed that the share of VAT (domestic and import) remains dominant during the period 2000-2013.

**Figure 5:** Evolution of the components of value added tax (In % total VAT)



Source: Users' calculations based on General Directorate of Taxes (GDT) data.

VAT/PP: means VAT/Petroleum Products (TVA/Produits Pétroliers).

VAT/Dom: means AT/Domestic (TVA/Intérieure).

VAT/Imp: means VAT/Import (TVA/Importation).

T/VAT: means Total VAT (Total TVA).

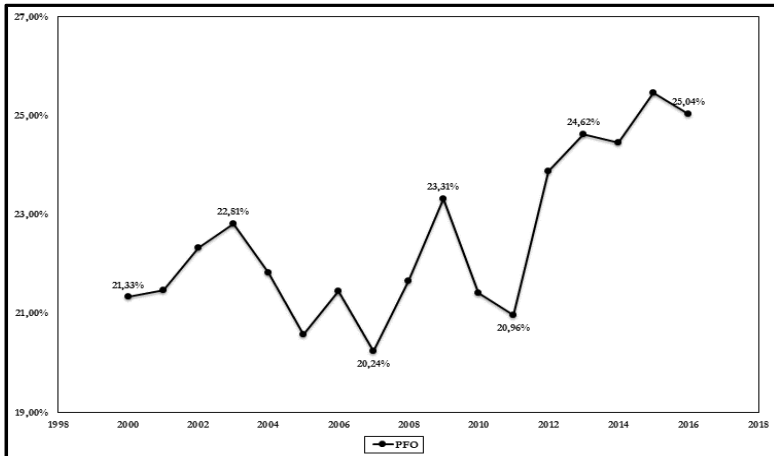
### 3.2.3. Analysis of Ordinary Tax Pressure (OTP):

An examination of Figure 6 shows that the OTR<sup>7</sup> showed a positive trend. However, it is increasing slowly (21.33% in 2000 to 25.04% in 2016). This positive development is explained by the tax reforms implemented in recent years in order to broaden the tax base and improve the tax yield. Furthermore, the downward trend noticed in 2003, 2006 and 2009 indicates that tax revenues are moving indicates

<sup>7</sup> OTR= (Ordinary Tax Recovery/ GDP Non-Hydrocarbons and Non-Agricultural).

that tax revenues are moving slower than GDPNH-NA. In general terms, tax burden recorded an average of (22.51%), indicating a major obstacle to mobilize sufficient tax revenues for financing State budget and developing a productive and diversified economy.

**Figure 6:** Evolution of ordinary tax burden (In % of GDPNH-NA)



Source: Users' calculations based on General Directorate of Taxes (GDT) data.

By way of comparison, the revealed average rate of tax burden (22.51%) is absolutely low compared to those noticed on the international scale (see table1). In 2015, the rate of tax burden in Tunisia was 30.3%, 26.1% in Morocco, an average of 22.8% in Latin American and Caribbean States (GRULAC) and an average of 34.3% in the member states of OECD<sup>8</sup>.

**Table n°1:** Tax burden in certain countries in % of GDP (2015)

Country	Total Tax Revenue % GDP
---------	-------------------------

<sup>8</sup> Calculs des auteurs à partir des données statistiques de l'OCDE.



---

Mexico	17.4
Chilli	20.6
Bolivia	24.7
Jamaica	25.6
Venezuela	20.6
Brazil	32
Argentina	32.1
Costa Rica	23.1
Paraguay	17.9
LAC States	22.8
Morocco	26.1
Tunisia	30.3
Cameroon	16.4
Kenya	18.4
Niger	17
Uganda	12.5
African countries	19.1
OECD countries	34.3

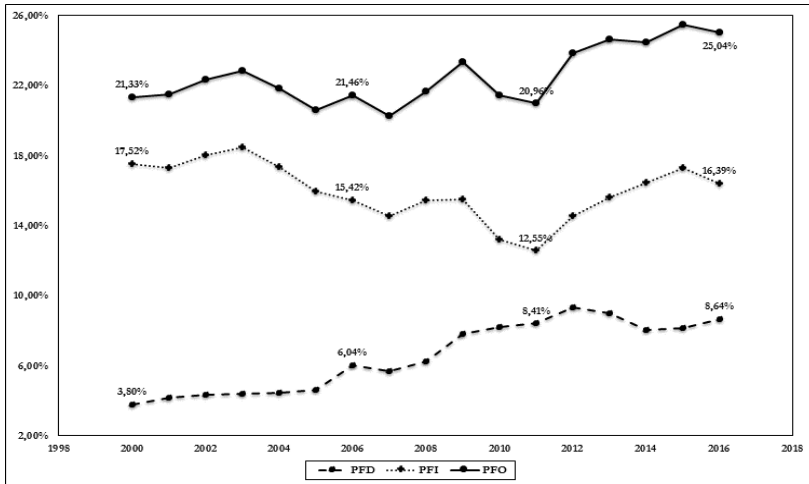
---

*Source: Users calculations based on OECD data.*

### **3.3- Differential analysis of direct and indirect tax burden:**

The ordinary tax burden is a quantitative tool that can conceal contradictory tendencies, and therefore cannot provide information on the detailed structure of tax burden. In this regard, the analysis of the differential tax burden proves pertinent, and it is carried out on two levels. Firstly, in relation to direct tax burden (DTB) and secondly, in relation to indirect tax burden (ITB). Figure 7 show that the direct tax revenues gained nearly five (5) points in percentage of GDP. The direct tax revenues increased from 3.8% in 2000 to 8.64% in 2016. This upward tendency can be explained by the augmentation of levies and taxes that constitute this tax system, particularly withholding taxes on the salaries of public service. On the other hand, the ratio of indirect tax revenue compared to the HH-HA GDP has recorded a recession in the same period, as it has decreased from 17.52% to 12.55% in 2015, then increased to 16.39% in 2016. This situation of the differential tax burden instability is resulted by the irregularities of indirect taxes due to the definition of the taxable matter which is determined by the riskiness of the economic conjuncture and the multiple changes in rates and scales of various levies and taxes. Moreover, the structure of the tax burden is characterised by the modest role of direct taxes, particularly during the period (2000-2007), which represents on average only 6.31% of GDP and 32.66% of the ordinary tax revenue. Whereas, the indirect taxes represent on average 15.85% of GDP and 67.34% of ordinary tax revenue.

**Figure n°7:** Evolution of direct and indirect tax burden (in % HH-HA GDP).



Source: Users calculations based on the General Directorate of Taxes data.

PFD: Direct Tax Burden.

PFI: Indirect Tax Burden.

PFO: Ordinary Tax Burden.

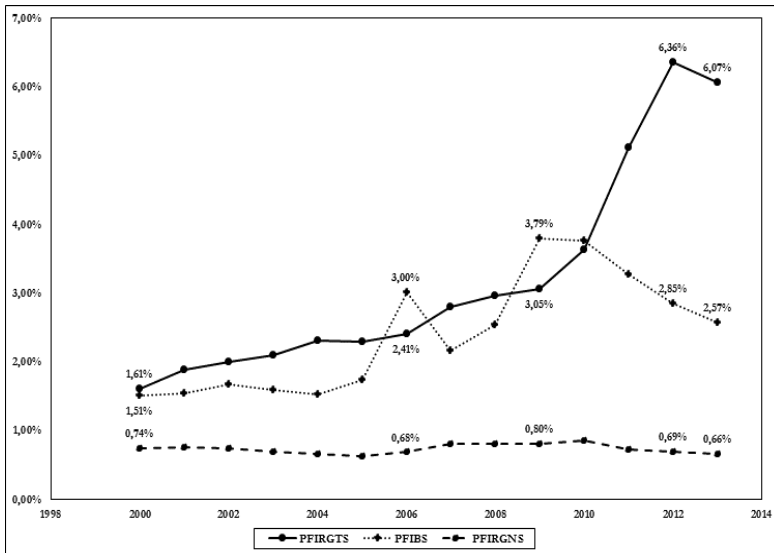
Finally, the upward tendency of direct taxation, as well as the importance of the direct taxation impact, has motivated us to trace more precisely the part of each of the contributions in relation to HH-HA GDP in order to identify tax burden in Algeria.

### 3.3.1. Differential analysis of direct tax burden:

Analysis of figure 8 shows that DTB is unevenly distributed among the various taxes that constitute the tax system. It seems that the current tax system does not fairly tax the revenues of the different income sources. In fact, the average total rate of compulsory deductions of direct taxation during the period from 2000 to 2013 is estimated at 6.5% of (HH-HA GDP). The average tax burden IRG/TS (PFIRGTS) alone represents 3.18% (6.07% in 2013). Hence, the tax burden on direct taxes is due to this category of taxes. Secondly, the part of tax burden on IBS (PFIBS) has an average rate of 2.39% (2.57% in 2013) and lastly, the tax burden on IRG/NS (PFIRGNS) with an average contribution estimated at 0.73% (0.66% IN 2013). To sum up, this analysis shows that direct taxation focuses fundamentally on

working income. In fact, the formal sector employees, specifically civil service employees are those who actually carry the burden of direct taxes.

**Figure 8:** Evolution of tax burden on direct taxes and (in% HH-HHA GDP)



Source: Users calculations based on General Directorate of Taxes data.

PFIRGTS: Tax burden on total income tax of wages and salaries

PFIBS: Tax burden on corporation taxes

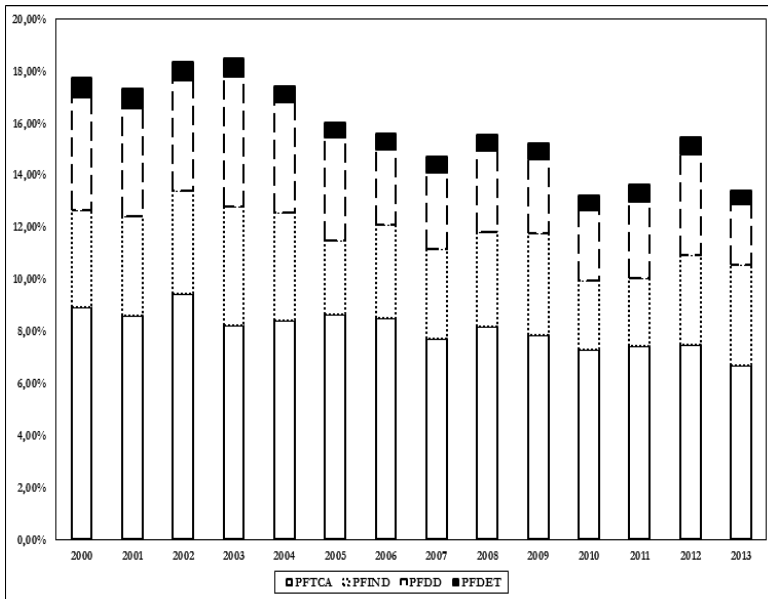
PFIRGNS: Tax burden on total income tax of non-salary

### 3.3.2- Detailed analysis on indirect tax burden:

Figure 9 shows the tax burden of each type of levies and indirect taxes, particularly tax burden on turnover taxes, tax burden on customs duty (TBCD), tax burden on registration and stamp duty and finally tax burden on indirect taxes (TBIT). Thus, we notice that the predominant tax in indirect taxation is the category of turnover taxes, VAT in particular. On an overall rate of 15.8% of compulsory deductions, VAT generates an average yield of 6.46%. On the other hand, the share of customs duty has dropped from 4.35% in 2000 to 2.35% of HH-HA GDP in 2013, i.e. a drop of 2%. This result is mainly due to the process of foreign trading liberalisation begun in the

80's. This analysis shows that the indirect taxation focuses more on consumption. In fact, the households are the one to actually bear the burden of indirect tax, VAT in particular.

**Figure n°9:** Evolution of tax burden of indirect taxes (in% HH-HA GDP).



Source: Users calculations based on General Directorate of Taxes data.

PFTCA: tax burden on turnover taxes.

PFDD: tax burden on custom duty. .

PFDET: tax burden on registration and stamp duty

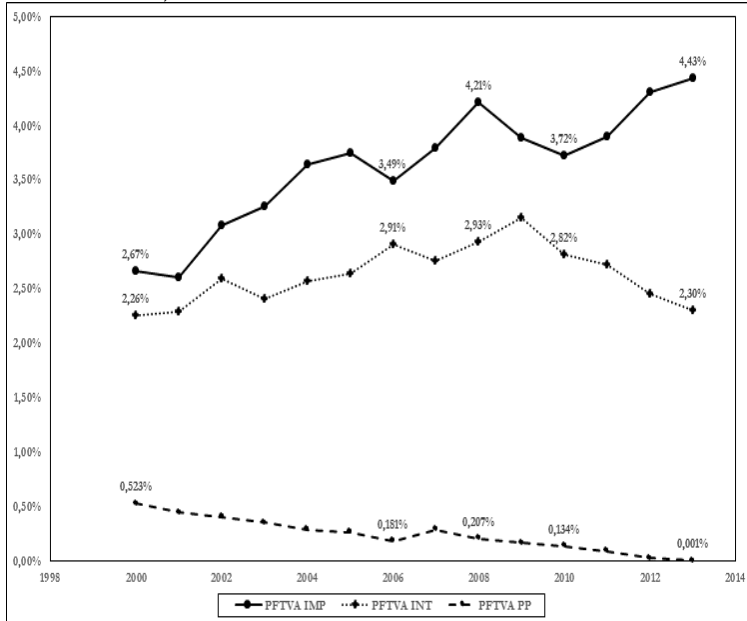
PFIND: tax burden on indirect taxes.

### 3.3.3- Differential analysis of tax burden on Added Value Taxes:

Analysis of figure 10 shows clearly the tax burden of each VAT. In fact, it seems that the tax burden on IMP/VAT holds a dominant part over the whole study period. Furthermore, on an overall rate of compulsory taxes of (6.49%) IMP/VAT generates a yield of 3.62%. Secondly, the importance of tax burden on TVA/INT (Added Value Taxes on domestic services) appears as well with a financial mobilisation of 6.62%. As for the importance of PP/VAT (TB VATPP), it remains quite low with a percentage of 0.24%. At the end of this analysis, it appears that the share of VAT on importation and

domestic VAT remains dominant among indirect taxes. (Indirect tax burden is mainly due to these two types of taxes).

**Figure n°10:** Evolution of tax burden of the elements of value added taxes and (In% HH-HA GDP)



Source: Users' calculations based on the General Directorate of Taxes data.

PFTVA IMP: tax burden of VAT on importation.

PFTVA INT: tax burden of domestic VAT

PFTVA PP: tax burden of VAT on petroleum products.

## CONCLUSION:

This study describes an economic evaluation of the performance of the taxation system in Algeria, particularly the system of ordinary taxation. First of all, we have noticed that the state's tax revenues have significantly increased. This growth is the result of the important recovery of levy and tax system, except for the customs revenues due to the liberalisation of foreign market policy. We have noticed as well a remarkable change in the structure of total taxation revenues since 2014. In fact, the financial revenue of ordinary taxation is becoming more efficient than the financial revenue of oil taxation. The analysis

by the differential tax burden approach shows that the TTR/TS and importation VAT are respectively the main financial sources of direct and indirect taxes, mobilising respectively tax revenues of 3.18% and 6.49% of HH-HA GDP. Although the government has accelerated the reform process since 2000, today's ordinary tax system has not yet achieved its all objectives, in particular, efficiency and equity. This evaluation has also allowed recognizing the great weakness of the system in terms of mobilisation and collection of tax revenues to cover total budget expenditures or at least the current expenditures. The last changes that were noticed on the energy market (oil price dropping, the use of cleaner energy) hastily require reconsideration of the Algerian tax policy to be compatible with these changes. Finally, many international organisations specifically International Monetary Fund (IMF) and the Organisation of Economic Cooperation and Development (OECD) recommend the enhancement of tax system efficiency, especially for the developing countries in order to achieve their development goals. In our case, the challenge of the tax policy consists in finding balance between a tax system that is favourable towards business climate and a taxation level that generates enough revenue to fund the state budget. To this end, the government is called to widen the tax base in order to increase the tax revenue, fight against informal aggressive tax planning and work on improving business climate.

#### **Bibliographic references**

- Arnold J, Brys B., Heady C., Johansson A., Schweltnus C., and Varita L., (2009).** «Tax policy for economic recovery and growth». *The Economic Journal*, 121 (February), F59-F80.
- Arulampalam W., and Devereux M.P., Maffini G., (2010).** «The direct incidence of corporate income tax on wages». *IZA DP N° 5293*.
- Alinson Felix R., (2007).** «*Passing the burden: Corporate tax incidence in open economies*». *University of Michigan*.
- Allais M., (1990).** «*Pour la réforme de la fiscalité*». Clément Juglar.
- Arseneau M., Ha Dao N., Godbout L., (2012).** «Le dosage des impôts et la croissance économique : des leçons pour le Québec». *Chaire de*

*recherche en fiscalité et en finances publiques, document de travail 2012/01, Université de Sherbrooke.*

**Attila G., Chambas G., Combes J.L., (2009).** «Corruption et mobilisation des recettes publiques, Une analyse économétrique». *Recherches Economiques de Louvain* 2009/2, vol 75, 229-268.

**Azizul I., (2001).** «Issues in tax reforms». *Asia-Pacific Development Journal*, Vol 8, n° 1.

**Barro R.J., (1990).** «Government spending in a simple model of endogenous growth». *The Journal of Political Economy*, vol 98, S103-S125.

**Bensahli M., (2015).** «L'optimisation en fiscalité : Équation - Enjeux et Défis». OPU. Alger.

**Boskin M., and Gale W., (1987).** «New results on the effects of tax policy on the international location of investment». In M, Feldstein Ed, *The effects of taxation on capital accumulation*, 201-222.

**Bouilef H., (2014).** «La mobilisation des ressources publiques par la fiscalité ordinaire. ENAG. Alger.

**Bouvier M., (2016).** «Introduction au droit fiscal général et à la théorie de l'impôt». LGDJ 10<sup>ème</sup> édition.

**Brun J.F., Chambas G., Laurent M., (2007).** «Economie politique de la réforme de transition fiscale, Le cas du Maroc». *Afrique Contemporaine*, 2007/3, n° 223-224, 309-324.

**Burgess R., and Stern N., (1992).** «Taxation and development». *Journal of Economic Literature*, Vol 31, n° 2, 762-830.

**Chambas G., (2005a).** «Afrique au sud du Sahara, Quelle stratégie de transition fiscale? Afrique Contemporaine». 2005/1, n° 213, 133-163.

**Chambas G., (2005b).** «TVA et transition fiscale en Afrique, Les nouveaux enjeux, Afrique Contemporaine». 2005/3, n° 215, 181-194.

**Commission Européenne, (2011).** «Politique fiscale propices à la croissance dans les Etats membres et amélioration de la coordination fiscale». *Communication de la commission au parlement Européen et au conseil, au comité économique et social européen et au comité des régions, Examen annuel de la croissance* 2012.

**Daniel J.M., (2008).** «Richard Musgrave et les fonctions économiques de l'Etat». *La revue du trésor* n° 1.

**Easterly W., Rebelo S., (1993B).** «Marginal Income Tax Rates and Economic Growth in Developing Countries». *European Economic Review*, Vol 37, N° 3, 409-417.

**Engen EM., and Skinner J., (1996).** «Taxation and economic growth». *National Tax Journal*, Vol 49, n° 4, 617-642.

**Gentry WM., and Hubbard RG., (2000).** «Tax policy and entrepreneurial entry». *Graduate School Business, Columbia University*, 1-47.

**Gordon R., (1998).** «Can high personnel tax rate encourage entrepreneurial activity? ». *IMF Staff Papers*, Vol 45, n° 1, 49-80.

**Hartman DG., (1984).** «Tax policy and foreign direct investment in the United States». *National Tax Journal*, Vol 37, n° 4, 475-88.

**Hasset KA., and Mathur A., (2006).** «Taxes and wages». *American Enterprise Institute for Public Policy Research, Working Paper* n° 128.

**Lee Y., Gordon RH., (2005).** «Tax structure and economic growth». *Journal of Public Economic*, Vol 89, 1027-1043.

**Lucas R.E., (1990).** «Supply-Side Economics: An Analytical Review». *Oxford Economic Papers*, vol 42, n° 2, 293-316.

**Mackenzie GA., Orsmond D., Gerson P., (1997).** «The composition of the fiscal adjustment and growth». *International Monetary Fund, Washington, DC*, n° 149.

**MFA, (2018).** Code des taxes sur le chiffre d'affaire. DGI.

**MFA, (2018).** Code d'enregistrement. DGI.

**MFA, (2018).** Code du timbre. DGI.

**MFA, (2018).** Code des impôts indirects. DGI.

31-MFA, (2000-2016). Lois de finances.

31-MFA, (2000-2016). Lois de finances.

**Milesi-Ferretti G., Roubini N., (1998).** «Growth effects of income and consumption taxes». *Journal of Money*, vol. 30, n°4, 721-744.

**Ministère des Finances Algérie (MFA), (2018).** Code des impôts directs et des taxes assimilées. DGI.

**Neurrisse A., (1978).** «Histoire de l'impôt. Que sais-je? ». *Presse Universitaire de France*.

**Padovano F., Galli E., (2001).** «Tax rates and economic growth in the OECD Countries (1950-1990) ». *Economic inquiry*, vol 39, 44-57.



**Pfister M., (2009).** «Une fiscalité orientée vers l'investissement et le développement : Aperçu de quelques enjeux de politique fiscale en Afrique». *Réunion ministérielle et table ronde d'expert de l'initiative NEPAD-OCDE*.

**Ricardo D., (1817).** «*On the principles of political economy and taxation*». Batoche Books, Kitchener 2001.

**Smith A., (1776).** «*An inquiry into the nature and causes of the wealth of nations*». The Electric Book Company Ltd.

**Tanzi V., & Zee H., (2001).** «Une politique fiscale pour les pays en développement». *Fond Monétaire International*.

**Widmalm F., (2001).** «Tax structure and growth: Are some taxes better than others? ». *Public Choice, Vol 107, 199-219*.

**Young K., (1988).** «The Effects of Taxes and Rates of Return on Foreign Direct Investment into the United States». *National Tax Journal, Vol 41, 109-121*.

## TARIFICATION ET USAGE DOMESTIQUE DES SERVICES D'EAU ALGÉRIENS : APPROCHE MICRO ÉCONOMETRIQUE\*

Ali ZEGGAGH\*\*

Received: 09/12/2019 / Accepted: 22/05/2020 / Published: 09/07/2020

Corresponding authors: ali.zeggagh@univ-bejaia.dz

### RÉSUMÉ

Cet article présente les résultats d'une étude sur la tarification des services d'eau potable en Algérie, avec comme objectif l'amélioration de son efficacité économique. Il s'agit en effet d'atteindre à l'aide de cette tarification l'optimum social de « second-rang », au sens de Ramsey-Boiteux, permettant aux opérateurs de couvrir par les recettes, le financement des activités liées à la production et à la distribution de cette ressource rare. La mise en œuvre de cette tarification nécessitant la connaissance des fonctions de demande et d'offre, cette étude intègre deux analyses micro-économétriques. La première analyse se focalise sur la fonction de demande et s'attache à estimer l'élasticité-prix et l'élasticité-revenu, qui sont ensuite utilisées dans la simulation de la politique tarifaire qui tient compte de la fréquence de distribution pour l'Alimentation en Eau Potable. La seconde se concentre quant à elle, sur la structure des coûts d'alimentation en eau potable. Nous estimons le coût marginal de production ainsi que divers paramètres de mesure de rendement, telles que les économies de densité, d'échelle et d'envergure afin d'évaluer la performance relative des réseaux de production et de

---

\* Cet article s'appuie la Partie 3 de ma thèse soutenue en 2012 à l'Université d'Alger 3 sous la codirection de M.Y. Ferfera et A. Thomas envers qui j'exprime ma profonde gratitude. Une version antérieure de cet article a été présentée au Colloque *Modélisation et analyse statistique et économique*, Tunis, décembre 2019. Je remercie les participants à ce colloque pour leurs commentaires. Enfin, je remercie F. Gasmi et deux évaluateurs anonymes de cette revue pour leurs suggestions qui m'ont permis d'améliorer considérablement cet article. Toutes les erreurs qui subsistent sont cependant les miennes.

\*\* Maître de Conférences à l'Université de Bejaia, HDR en sciences économiques. Université Abderrahmane Mira-Béjaïa

distribution d'eau potable en Algérie. Ces analyses empiriques de la demande et de la structure des coûts nous permettent d'obtenir des informations quantitatives sur deux paramètres complémentaires et cruciaux pour la fixation des prix, à savoir, la disposition à payer des usagers et le coût économique de production et de distribution de la ressource en eau. Ces paramètres fournissent en effet des signaux pertinents pour une utilisation optimale des ressources rares.

**Mots clefs :** Ressources en eau potable, données de panel, coût marginal de production, élasticité-prix de la demande, tarification des services d'AEP, fréquence et plages horaires de distribution.

**JEL classification:** B21 C33 L95 L98

## **PRICING AND DOMESTIC USAGE OF ALGERIAN WATER SERVICES: A MICRO-ECONOMETRIC APPROACH**

### **ABSTRACT**

This article reports on a study about water services pricing in Algeria. The goal is to improve its efficiency, in particular, to make the revenues from these services fulfill the financing needs of the activities related to the production and distribution of this resource. The implementation of the tariffs requiring the knowledge of demand and supply functions, this study integrates two micro-econometric analyses. The first analysis focuses on demand seeking to estimate price-elasticity and income-elasticity that are then used in the simulation of the pricing that takes into account the frequency of drinking water provision. The second, is concerned with the cost structure of drinking water supply. We estimate the marginal cost of production as well as other parameters that characterize the efficiency of production such as economies of density, scale, and scope in order to evaluate the relative performance of the drinking water production and distribution networks in Algeria. These empirical analyses of demand and cost structure allow us to recover quantitative information on two parameters that are both complementary and crucial for price fixing, namely, users' willingness to pay and economic production and distribution cost of the water resource.

These parameters provide indeed pertinent signals for an optimal use of scarce resources.

**Key words:** Drinking water resources, panel data, marginal cost of production, price-elasticity of demand, pricing of drinking water provision, frequency and distribution time slots.

**JEL classification:** B21 C33 L95 L98.

### تسعيرة خدمات المياه الشروب في الجزائر: مقارنة الاقتصادية الجزئي القياسي

#### الملخص

تعرضنا في هذا المقال إلى نتائج دراسة حول تسعيرة خدمات مياه الشروب في الجزائر، والتي تهدف إلى تحسين كفاءتها، و لاسيما العمل على أن تكون الإيرادات الناجمة عن تلبية الاحتياجات التمويلية للخدمات المتعلقة بالإنتاج والتوزيع لهذه المادة الحيوية. تعرضنا في هذا المقال إلى نتائج دراسة حول تسعيرة خدمات مياه الشروب في الجزائر، والتي تهدف إلى تحسين كفاءتها، و لاسيما العمل على أن تكون الإيرادات الناجمة عن تلبية الاحتياجات التمويلية للخدمات المتعلقة بالإنتاج والتوزيع لهذه المادة الحيوية. قصد تنفيذ هذه التسعيرة يستلزم دراية شاملة لقاعدة العرض والطلب، وتتضمن هذه الدراسة تحليلين للاقتصاد الجزئي القياسي:

يركز التحليل الأول على دلالة الطلب والتي ترتبط بقياس مرونة الأسعار ومرونة الدخل التي تستعمل بعد ذلك في محاكاة سياسة التسعيرة التي تأخذ بعين الاعتبار مواقيت التردد في توزيع المياه.

أما التحليل الثاني فيركز على هيكلية تكاليف التوريد بالمياه الصالحة للشرب، حيث نقوم في هذا المجال بتقدير التكلفة الحدية للإنتاج، وكذلك التعرف على التدابير المتعلقة بمعالم قياس المردودية، اقتصاد السلم، اقتصاد الحجم... الخ، من أجل تقييم مؤشرات عن حالة شبكات الإنتاج وتوزيع المياه الصالحة للشرب في الجزائر. يتيح لنا التحليل التجريبي المزدوج للسوق الحصول على معلومات كمية حول استعداد المستهلك لهذه المادة الحيوية

بدفع مستحقات الخدمة والتكلفة الاقتصادية لإنتاج وتوزيع الموارد المائية، وهما عاملان متكاملان وحاسمين في تحديد السعر. توفر هذه الأخيرة مؤشرات صحيحة للاستخدام الأمثل للموارد النادرة. الكلمات المفتاحية: الموارد المائية الصالحة للشرب، بيانات البانال، التكلفة الحدية للإنتاج، مرونة سعر الطلب، التسعيرة، مواقيت التردد في التوزيع.

تصنيف جال: B21 C33 L95 L98

## 1 – INTRODUCTION

En Algérie, la rareté de l'eau demeure une donnée admise du fait que  $\frac{3}{4}$  de la surface du pays se situe en zone semi-aride, voire plus. Par conséquent, « la disponibilité de la ressource renouvelable par habitant est relativement rare. Nous ne disposons que de 470  $m^3$  par habitant et par an »<sup>1</sup>, alors que la Banque mondiale considère qu'il y a "rareté" sous le seuil de 1000  $m^3$  par habitant et par an, et définit une situation comme "problématique" dès lors que la ressource tombe sous le seuil de 1700  $m^3$  par personne et par an. L'eau est devenue en somme une denrée rare dans ce pays. Et qui dit rareté dit souvent élévation de la valeur. Assigner un prix à l'eau, ce serait un moyen d'en limiter le gaspillage. C'est ainsi que le rapport de la Banque mondiale sur le développement durable, affirme que le moyen le plus efficace d'encourager l'utilisation rationnelle de l'eau est de faire asseoir une tarification économiquement efficace et socialement juste. Cet article participe à cette recherche en proposant de faire asseoir une tarification à usage domestique via l'estimation des fonctions de demande et du coût pour le service d'alimentation en eau potable (AEP). Notre choix s'est porté sur l'usage domestique pour plusieurs raisons : premièrement, la fourniture à l'ensemble de la population d'eau potable de qualité réglementaire, en quantité suffisante, doit être garantie. Cet usage est, à ce titre, prioritaire et retient toute

<sup>1</sup> Ministère des Ressources en Eau (2018).

l'attention des décideurs. La deuxième raison tient au « nombre d'utilisateurs concernés, 98 % des ménages sont aujourd'hui raccordés au réseau de distribution d'eau potable »<sup>2</sup> et l'impact d'une variation de la consommation, même faible au niveau de chaque ménage, peut avoir un impact non négligeable au niveau national (même si les volumes prélevés pour les usagers domestiques sont faibles en regard des volumes prélevés pour l'industrie ou l'irrigation, la consommation nette est importante). S'ajoute à cela, la disponibilité de l'information auprès des gestionnaires des services de l'eau, comme dernière raison et qui tient à la faisabilité de l'étude. Celle-ci concerne essentiellement, les volumes d'eau consommés par les ménages et les prix payés par les usagers de service d'AEP, à chaque tranche de consommation.

Si la politique nationale de l'eau en Algérie a mis l'accent sur l'aménagement et la mise à disposition de volumes d'eau brute supplémentaires, une telle politique d'offre connaît des limites liées aux coûts très importants d'investissement mais également aux possibilités limitées d'exploitation de nouvelles ressources. L'eau est en effet associée à des coûts de transport très élevés, entre différentes régions d'un même pays, ainsi qu'à des contraintes sur sa qualité dans le cas de l'eau potable, qui nécessitent une gestion locale via des services publics locaux de l'eau. Une politique de gestion de la demande est par conséquent un complément indispensable, notamment à court terme, aux stratégies nationales assises sur l'exploitation de nouvelles ressources. Cette gestion consiste notamment à rechercher une limitation de l'augmentation des usages par des tarifications adaptées, et une utilisation optimisée des ressources disponibles par une gestion et une organisation plus efficaces des services d'eau. Dans une telle perspective, l'étude complète de la tarification des services de l'eau potable est une étape essentielle pour des agences de régulation dont l'objectif est de mettre en place des mécanismes de gestion de la demande en adéquation avec les performances des services existants. En particulier, « le mode

---

<sup>2</sup> Source : Idem (1), 2017.

de tarification de l'eau potable et les modalités de sa distribution ont des impacts directs sur la structure et le niveau de la consommation, tout en étant en principe directement déterminés par l'équilibre financier des services de production et de distribution de l'eau potable »<sup>3</sup>.

« La connaissance de la demande pour chacun des types d'utilisateurs (ménages, industriels et agriculteurs) est indispensable pour une gestion de la ressource d'une part, efficace (affecter la ressource en eau à ceux qui la valorisent le mieux) et d'autre part, équitable (garantir l'accès à tous) »<sup>4</sup>, et cela via une tarification particulière de l'eau potable pratiquée en Algérie, permettant d'envisager différentes mesures de prix qui peuvent être confrontées au coût de fonctionnement des services. « L'eau est en effet tarifée selon un système progressif de paliers (*Increasing Block Rate pricing*) »<sup>5</sup>, avec un prix marginal différent pour chaque tranche de consommation. Parler de ces fonctions en eau revient à considérer l'eau comme un bien économique qu'il faut gérer, protéger et partager de façon équitable. Ce caractère de bien économique a été officiellement reconnu lors de la conférence internationale sur l'eau et l'environnement tenue à Dublin (Irlande) en 1992. Cet accord de principe stipule en effet que l'eau a une valeur économique dans tous ses usages concurrentiels et doit être reconnue en tant que bien économique. « La valeur de l'eau pour un usager est le montant maximum que cet usager est prêt à payer pour disposer d'une unité supplémentaire »<sup>6</sup>. Cependant, comme il n'existe pas de marché proprement dit pour l'eau, il est difficile d'en estimer sa valeur. L'on doit alors se limiter à estimer des fonctions de demande et/ou de coût de production afin d'en déduire un indicateur de sa valorisation économique. L'estimation d'une fonction de demande en eau constitue un moyen parmi d'autres de mesurer la valorisation du bien eau pour un usager et de contribuer à la mise en place d'un schéma de partage efficace de la ressource.

---

<sup>3</sup> Zeggagh et al. (2010).

<sup>4</sup> Diakité et Thomas, (2011).

<sup>5</sup> Zeggagh et Ferfera, (2015).

<sup>6</sup> Diakité et Thomas, (2011).

L'objectif de cet article est de faire asseoir une tarification pour l'usage domestique de l'eau, dans une dynamique de changement imposée par l'urgence de faire évoluer les pratiques et les comportements, les modes de gestions et les usages de la ressource en eau, afin de s'adapter aux changements climatiques et d'accélérer la mise en œuvre des objectifs de développement durable (ODD). Cette tarification permettra de contribuer à la mise en œuvre des objectifs de développement durable du point de vue des usagers, tout en tenant compte de la demande et de la structure des coûts d'exploitation des services d'AEP, qui soient plus adaptées aux impératifs de l'heure tout en puisant le meilleur parti de l'existant. L'évaluation de la question de la tarification de l'eau potable implique la nécessité de disposer exclusivement d'évaluations de fonctions de demande et de coût ou, du moins, l'élasticité-prix de la demande ( $\varepsilon_p$ ) et le coût marginal ( $C_m$ ). L'intérêt de cette tarification est d'inciter les usagers à la consommation rationnelle de la ressource en eau, ainsi que de permettre aux gestionnaires de service d'AEP d'assurer la fourniture de service d'eau aux différents usagers tout en respectant les principes de service public. Nous rappelons ici que, l'estimation des fonctions de demande et de l'offre servira davantage à comprendre bien d'une part, la réaction des usagers face à une modification des prix via le coefficient d'élasticité-prix de la demande ( $\varepsilon_p$ ) et d'autre part, à connaître le coût supporté par les établissements de gestion de service d'AEP à travers le concept du coût marginal ( $C_m$ ). « Les performances des services de production et de distribution d'eau sont généralement appréhendées par le concept du coût marginal de production »<sup>7</sup>. Notre objectif principal est alors de faire asseoir une tarification aux ménages, tout en analysant son impact sur le bien être des usagers, à partir des résultats que nous avons obtenus, lors de la modélisation économétrique des fonctions de demande et de coût. Ces fonctions permettent de calculer à la fois, la valorisation du bien eau pour les différents usagers et les variations du bien-être suite à l'application d'une politique économique de hausse des tarifs. L'intérêt premier de ces études est souvent de simuler la politique

---

<sup>7</sup> Zeggagh et al. (2010).



tarifaire, en appliquant l'élasticité-prix de la demande ( $\varepsilon_p$ ) et le coût marginal( $C_m$ ). Ces paramètres clefs seront utilisés pour orienter une politique de gestion de la ressource en eau. Pour cela, il faut faire en sorte d'éviter tout biais dans l'estimation de ces coefficients, car l'élasticité-prix ( $\varepsilon_p$ ) et le coût marginal( $C_m$ ) que nous avons obtenus lors de l'estimation de nos fonctions de demande et de coût, respectivement et qui serviront à prévoir l'impact de toute politique de prix sur la ressource.

Cet article contribue à la revue de la littérature empirique sur les services d'eau potable, à savoir la demande et le coût. L'élaboration d'une structure de tarification d'eau potable dans le cas de l'Algérie, constitue plus d'un élément nouveau dans cette littérature. L'intérêt d'une analyse empirique dans ce pays réside en particulier dans la grande diversité des situations auxquelles font face les services d'eau : l'eau est distribuée aux ménages selon un schéma de rationnement. « Sa distribution se limite à quelques heures dans la journée ou à quelques jours dans la semaine uniquement »<sup>8</sup>. Les fuites d'eau dans le réseau sont estimées à 40% du volume mis à la production<sup>9</sup>. Eaux brutes d'origine superficielle de mauvaise qualité et moins importante pour une population desservie très dense dans le Nord, ressources d'origine souterraine importantes et de qualités réglementaires, pour une population moins dense dans le Sud.

La section 2 de cet article propose un aperçu sur la méthode générale d'évaluation de la tarification à usage domestique de l'eau, basée sur les modalités de sa gestion, intégrant les différents modes de tarification. La section 3 présente en détail les données, utilisées pour l'analyse empirique, provenant de documents comptables de l'entreprise nationale des eaux (ADE) et portant sur 91 communes de six wilayas algériennes sur la période de 16 trimestres (2004-2007). Ces données permettent en particulier d'évaluer les élasticités-prix ainsi que des coûts marginaux et de ses élasticités. La section 4

---

<sup>8</sup> Diakité et Thomas, (2011).

<sup>9</sup> Article de Maya Khelladi, Economiste de l'eau. « Le secteur de l'eau en Algérie: le programme d'assistance technique remboursable » Janvier 2008.

présente les résultats d'évaluation de la structure tarifaire. Les remarques de conclusion figurent à la section 5.

## 2- L'EAU POTABLE : TARIFICATION ET USAGE DOMESTIQUE DE L'EAU

Nous nous intéressons ici à l'évaluation de la structure tarifaire pour les services d'alimentation et de distribution d'eau potable (AEP). Il existe deux approches pour évaluer les performances d'une politique tarifaire : la première approche consiste à tarifier l'usage de services d'eau potable à leur coût marginal ( $C_m$ ), en prenant soin d'inclure tous les coûts d'opportunité, dont ceux liés à la pollution. À tout le moins, nous devrions abaisser les tarifs de façon à assurer le plein accès à ces services essentiels. Cette approche est connue par les économistes sous le nom de solution de premier rang (*first best*). Dans le cas d'un monopole (avec rendements croissants), la tarification au coût marginal ( $C_m$ ) est préconisée par les économistes car elle permet d'atteindre le maximum d'utilité collective. Toutefois, elle présente l'inconvénient de conduire à un déficit budgétaire car les charges fixes ne sont pas financées. L'autre approche s'appuie sur la gestion qui tient compte de la contrainte d'équilibre budgétaire dans la fixation du tarif. Elle est connue sous le nom de tarification à la Ramsey-Boiteux ou solution de second rang (*second best*). Si l'État n'est pas disposé à subventionner le gestionnaire, il peut appliquer la tarification de Ramsey-Boiteux, qui mène à un optimum de deuxième rang, un moindre mal en quelque sorte. « La tarification de Ramsey-Boiteux consiste à appliquer un tarif supérieur au coût marginal ( $C_m$ ) afin de permettre au gestionnaire d'équilibrer ses comptes »<sup>10</sup>. Plus précisément, il s'agit d'appliquer à chaque usager un prix dont l'écart par rapport au coût marginal ( $C_m$ ) est d'autant plus important que les usagers sont captifs : pour simplifier, les usagers paient d'autant plus cher que le service leur est indispensable. Le modèle Ramsey-Boiteux a de nombreuses applications dans la tarification des services pour lesquels il existe un monopole naturel, notamment local (distribution

---

<sup>10</sup> Marcel Boiteux, Haute tension, 1993, Odile Jacob. (Page 67-71). Cahiers de l'évaluation (Mission d'évaluation des politiques publiques) N° 1 – Septembre 2008.

d'électricité, gaz, eau, etc.). Cette solution est aussi proche que possible de celle du premier rang, et qui sert à maximiser le bien être total des usagers en tenant compte de la contrainte d'équilibre budgétaire. Cette tarification, applicable dans les secteurs à coûts fixes, autorise l'équilibre financier en dissuadant le moins d'usagers possible. La tarification à la Ramsey-Boiteux permettra au gestionnaire de service d'eau potable de financer ses charges par les recettes qui proviennent du tarif de ses services. En Algérie, les agences de l'eau ont toujours été peu disposées à appliquer des tarifs efficaces, et qui auraient pu pousser les consommateurs à économiser sur leur approvisionnement en eau potable. La tarification était abordée en ce sens, mais les tarifs très bas sont restés inchangés partout dans le pays depuis 2005 et, malgré la pression démographique, le renchérissement du service de l'eau<sup>11</sup> et la multiplication des usages domestiques qui ont rendu la consommation d'eau potable beaucoup plus sensible au prix et donc l'analyse de ses déterminants beaucoup plus pertinente. La vente de l'eau sur l'ensemble du territoire national se pratiquera à partir d'un tarif variant selon les tranches de consommation. Cette structure a été l'objet de négociations difficiles entre responsables politiques et experts »<sup>12</sup>. Elle n'en constitue pas moins une incitation à l'économie de l'eau de la part de ses usagers et une recherche de régulation des consommations à partir de tarifs adéquats. Elle reste une solution idoine à la raréfaction de la ressource en eau. L'objectif recherché dans le cas de la gestion de service de l'eau potable algérien est double à ce titre ; satisfaire à l'obligation de service universel (*USO, Universal Service Obligation*) pour les besoins primaires (essentiels). Cela garantit l'accès à tous les usagers pour la première tranche (*dite sociale*). Le second point est de faire supporter la plus grande partie des charges sur les utilisateurs disposant de revenus plus élevés pour assurer la continuité de service d'AEP et d'assainissement.

---

<sup>11</sup> MRE Conformément au décret exécutif n° 05/13 du 09 janvier 2005 fixant les règles de tarification des services publics d'alimentation en eau potable et de l'assainissement.

<sup>12</sup> MRE/ SOGREAH-ICEA – (2003) : étude de la tarification de l'eau à usage domestique, industriel et l'assainissement.

### **2.1- Modalités de fixation des tarifs de services d'eau potable**

Comme indiqué ci-avant, la tarification tient compte de la demande pour évaluer la capacité à payer des usagers, ainsi que leur réaction face à une modification des prix. Elle permet d'affecter la ressource aux usagers qui la valorisent le plus, et de procéder à des arbitrages pour que chacun des usagers y ait accès. La tarification considère aussi l'offre, et donc les coûts supportés par l'organisme gestionnaire de la ressource en eau. Les coûts correspondants sont variables dans l'espace. Les conditions naturelles liées à l'état de la ressource en quantité et en qualité, sa localisation, les données climatiques et la topographie constituent des éléments explicatifs des coûts dont la variabilité est forte. La structure des tarifs d'alimentation en eau potable peut être fondée sur le coût moyen ( $CM$ ) ou le coût marginal ( $C_m$ ), dès lors que l'on considère que la recherche d'un optimum est la meilleure façon de satisfaire l'intérêt général. Il est alors optimal de préconiser une tarification au coût marginal ( $C_m$ ), dont la détermination est parfois difficile, du fait de nombreuses situations existantes d'une part et des données nécessaires d'autre part. Le principe de vente au coût marginal ( $C_m$ ) découle donc directement de la recherche de l'optimum économique. La mise en œuvre de la tarification au coût marginal ( $C_m$ ) soulève des difficultés d'ordre pratique. De plus, la demande d'eau est soumise à de fortes variations saisonnières, la consommation estivale étant beaucoup plus élevée que celle d'hiver. La capacité des installations doit alors être ajustée afin de pouvoir faire face à ces périodes de pointe. « La mise en pratique de la tarification au coût marginal ( $C_m$ ) devrait prendre en compte cette caractéristique et aboutir à des tarifs différents selon la période de l'année »<sup>13</sup>. Cependant, la tarification au coût marginal ( $C_m$ ) n'assure pas nécessairement l'équilibre budgétaire<sup>14</sup>. La mise en place d'un tarif binôme, caractérisée par l'introduction d'une prime fixe et le

---

<sup>13</sup> Ces prix sont analogues à ceux pratiqués pour la demande d'électricité, avec des heures creuses et des heures pleines, retenu par EDF.

<sup>14</sup> Si les installations fonctionnent dans la zone des rendements d'échelle croissants, alors le coût marginal est inférieur au coût moyen et conduit à un déficit.

maintien de la tarification au coût marginal ( $C_m$ ) s'avère alors une solution satisfaisante. Le tarif binôme permet d'une part, d'assurer l'équilibre budgétaire par la prime fixe qui couvre l'écart entre le coût moyen ( $CM$ ) et le coût marginal ( $C_m$ ), et d'autre part, d'induire le comportement de la consommation souhaité cohérent avec l'intérêt général par la tarification au coût marginal ( $C_m$ ). Le tarif binôme est souvent pratiqué lorsque le coût marginal ( $C_m$ ) est inférieur au coût moyen ( $CM$ ).

## **2.2- Représentation de la structure des tarifs d'AEP par le modèle de Ramsey-Boiteux**

La théorie économique nous enseigne, que pour assurer la maximisation du bien-être des consommateurs, les biens et services doivent être vendus à leur coût marginal social.<sup>15</sup> Toutefois, en présence d'économie d'échelle, ce mode de tarification ne permet pas de récupérer les coûts fixes et par conséquent conduit à un déficit. Une solution possible consiste à combler ce dernier par une subvention. La structure des tarifs d'AEP serait donc constituée de deux formules. La formule qui égalise le prix au coût marginal ( $C_m$ ) conduit à un déficit du monopole. Celui-ci doit être comblé par des subventions financées le plus souvent par l'impôt. Des subventions visant à résorber le déficit d'un monopole public ne peuvent, cependant pas toujours être mises en place, même si ce déficit est justifié par le critère d'optimalité collective que représente la tarification au coût marginal ( $C_m$ ). Des subventions au monopole public sont en effet souvent perçues comme des primes à une gestion peu rigoureuse et de ce fait mal acceptées par les contribuables. Par ailleurs, le prélèvement fiscal qui permet de les financer peut avoir lui-même des conséquences dommageables sur le plan de l'équité ou conduire à modifier le comportement des ménages dans un sens non souhaitable (par exemple lorsqu'on modifie des taux de taxes indirectes). Il est donc peu réaliste de fonder la tarification optimale de monopole public sur un principe pouvant conduire à un déficit

---

<sup>15</sup> Cet aspect du coût marginal social inclut les dommages à l'environnement et les effets pervers pour les autres agents.

systématique de l'entreprise. D'ailleurs, c'est la raison pour laquelle il est souvent plus raisonnable de supposer que le monopole public est astreint à respecter une contrainte d'équilibre budgétaire : financer les coûts de production et de distribution de l'eau potable par des recettes au moins équivalentes, qui devient alors une contrainte dont il faut s'accommoder et qui doit être prise en compte pour définir la politique tarifaire qui est sensée couvrir les charges d'exploitation (ou variables). C'est là l'objectif de la tarification dite de Ramsey-Boiteux, qui maximise le surplus collectif sous cette contrainte additionnelle que constitue l'équilibre budgétaire du monopole. Il s'agit bien alors d'une solution de moindre mal, également appelé un optimum de second rang par opposition à la tarification au coût marginal ( $C_m$ ) qui apparaît comme un optimum de premier rang. Cet optimum de second rang est donc la solution qui maximise le bien-être collectif, tout en assurant l'égalité des recettes aux coûts.

Pour résumer cette formule de Ramsey-Boiteux, nous envisageons un monopole public produisant un bien en quantité  $Y$ . Afin de caractériser l'optimum de second rang nous notons  $S(Q)$  et  $\Pi$  respectivement, le surplus des consommateurs et le profit de l'entreprise<sup>16</sup>. Notre but est ensuite d'estimer les prix de chaque tranche de consommation de la catégorie ménage et leur prix moyen prédit  $\hat{P}_{it}$ . Le surplus des consommateurs s'écrit :

$$S(Q) = \sum_{h=1}^n \int_0^{Y_h} p_h(q) dq - CT(Y_1, \dots, Y_n)$$

avec :

$p_h$  : le prix associé à la quantité du bien en question;

$q$  : la quantité consommée du bien produit;

$CT$  : le coût total du bien produit en quantité  $Y$ .

et le profit :

<sup>16</sup> Cette section s'est largement inspirée de Pierre Picard (2007).

$$\Pi = \sum_{h=1}^n p_h(Y_h)Y_h - CT(Y_1, \dots, Y_n)$$

L'optimum de second rang  $(\bar{Y}_1, \bar{Y}_2, \dots, \bar{Y}_n)$  maximise le surplus  $S(Q)$  tout en respectant la contrainte d'équilibre budgétaire  $\Pi = 0$ . Nous associons un multiplicateur de Lagrange  $\lambda$  à cette contrainte et écrivons le lagrangien du problème à maximiser come suit

$$L = S(Q) + \lambda \Pi$$

Les conditions de premier-ordre (d'optimalité) sont :

$$\frac{\partial L}{\partial Y_h}(\bar{Y}_1, \bar{Y}_2, \dots, \bar{Y}_n) = 0 \quad h = 1, 2 \dots n$$

Elles donnent :

$$p_h(\bar{Y}_h) - \frac{\partial CT}{\partial Y_h}(\bar{Y}_1, \dots, \bar{Y}_n) + \lambda \left[ p'_h(\bar{Y}_h)\bar{Y}_h + p_h(\bar{Y}_h) - \frac{\partial CT}{\partial Y_h}(\bar{Y}_1, \dots, \bar{Y}_n) \right] = 0$$

Nous en déduisons :

$$\frac{p_h(\bar{Y}_h) - \frac{\partial CT}{\partial Y_h}(\bar{Y}_1, \dots, \bar{Y}_n)}{p_h(\bar{Y}_h)} = - \frac{\lambda}{1 + \lambda} \frac{p'_h(\bar{Y}_h)\bar{Y}_h}{p_h(\bar{Y}_h)}$$

Pour  $h = 1, 2 \dots n$ , nous posons :

$$\bar{C}_{mh} = \frac{\partial CT}{\partial Y_h}(\bar{Y}_1, \dots, \bar{Y}_n), \quad \text{et} \quad E_h^d = \frac{p_h(\bar{Y}_h)}{p'_h(\bar{Y}_h)\bar{Y}_h}$$

Plus spécifiquement,  $\bar{C}_{mh}$  représente le coût marginal de la quantité  $h$  évalué à l'optimum de second rang  $(\bar{Y}_1, \dots, \bar{Y}_n)$  et  $E_h^d$  l'élasticité-prix (directe) de la demande de la quantité  $h$ .

La résolution de ce système aboutit à mettre en place des prix satisfaisant la « règle de Ramsey-Boiteux » donnée par :

$$\frac{p_h(\bar{Y}_h) - \bar{C}_{mh}}{p_h(\bar{Y}_h)} = - \frac{\lambda}{(1 + \lambda) E_h^d} \quad h = 1 \dots n \quad (1)$$

qui traduit le fait qu'à l'optimum de second rang, pour chaque segment du bien produit par le monopole, les écarts relatifs entre prix et coûts marginaux sont inversement proportionnels aux élasticités-prix de la demande<sup>17</sup>.

La règle de Ramsey-Boiteux nous dit que le monopole public soucieux de l'intérêt général, en maximisant le surplus collectif mais astreint à une contrainte d'équilibre budgétaire, doit également fixer des prix dont les écarts relatifs, par rapport aux coûts marginaux, sont d'autant plus élevés que la demande est moins élastique. L'ampleur des écarts entre prix et coûts marginaux doit être choisie pour que les recettes soient justes égales au coût total de production et de distribution : une valeur particulière du paramètre ( $\lambda$ ) correspond à cette situation.

D'après la formule (1), ces écarts relatifs pour chaque bien s'écrivent :

<sup>17</sup> Cette règle rappelle la « règle de l'élasticité inverse » appliquée par un monopole non régulé maximisant son profit et appliquant une politique de discrimination par les prix entre groupes dite également « discrimination du 3<sup>ème</sup> degré ». Il est cependant important de noter que la règle de Ramsey-Boiteux incorpore le « coût fictif » de la contrainte d'équilibre budgétaire (le multiplicateur de Lagrange  $\lambda$ ).



$$\frac{p-c}{c} = \frac{\gamma}{\varepsilon} \dots\dots\dots (2)$$

où  $\gamma$  est un paramètre qui dépend du multiplicateur de Lagrange associé à la contrainte d'équilibre budgétaire<sup>18</sup>,  $\gamma = \frac{\lambda}{1+\lambda}$ ,  $p$  est le prix,  $c$  le coût marginal et  $\varepsilon$  l'élasticité-prix de la demande pour le bien,  $\varepsilon = \frac{\frac{dq}{dp}}{\frac{q}{p}} = \left(\frac{dq}{dp}\right) \left(\frac{p}{q}\right)$ . L'équation (2) se réécrit donc :

$$\frac{p-c}{c} = \frac{\gamma}{\left(\frac{dq}{dp}\right) \left(\frac{p}{q}\right)} \dots\dots\dots (3)$$

et en la multipliant par  $p$ , elle permet d'obtenir :

$$p = c + \left(\frac{\gamma}{\frac{dq}{dp}}\right) \cdot q \dots\dots\dots (4)$$

En notant  $\hat{\beta}$  la valeur absolue estimée de la pente de la courbe de demande,  $\hat{\beta} = \left|\frac{dq}{dp}\right|$ , et  $\hat{c}(q)$  la valeur estimé du coût marginal, nous obtenons :

$$p(q) = \hat{c}(q) + \frac{\gamma}{\hat{\beta}} q \dots\dots\dots (5)$$

D'après ce qui précède et vue la formule (5), nous remarquons que le coût marginal ( $C_m$ ), la pente de la courbe de demande et les

différentes valeurs de gamma ( $\gamma$ ), avec  $\gamma = \frac{\lambda}{1 + \lambda}$ , le paramètre ( $\lambda$ , ) qui représente le coût d'opportunité des fonds publics. Tous ces paramètres déterminent ensemble le prix ( $P$ ). Et donc, à des niveaux différents de  $\gamma$ , ou du moins, nous calculons gamma moyenne ( $\bar{\gamma}$ ),

---

<sup>18</sup> Notons que dans le cadre d'analyse de Ramsey-Boiteux le paramètre  $\lambda$  est « l'utilité marginale sociale » de la contrainte d'équilibre budgétaire qui, dans le cas où elle n'est pas satisfaite, va contraindre le gouvernement à lever des fonds via la fiscalité pour couvrir le déficit. Aussi, quoiqu'endogène, ce paramètre peut être interprété comme un « coût d'opportunité des fonds publics ». Son transformé  $\gamma = \lambda/(1 + \lambda)$ , nous donne donc par conséquent une idée de ce coût des fonds publics.

que nous allons par la suite utiliser dans la formule ci-dessus et que nous supposons constant sur la période de l'étude. Cela nous permet d'élaborer des prix optimaux pour chaque tranche de consommation de la catégorie ménage.

Estimation du prix prédit ( $\hat{P}_{it}$ ) de chaque tranche de la catégorie ménage, et leur prix moyen.

$$\hat{P}_{it} = 3 + (1 + t) * \left[ s_{ih} * \left( p_{it} + \frac{cf}{M_{t1}} \right) \right].$$

, , , , , , ,  
; = ; ; ; ; ; ; ;

$$\hat{P}_{it} = 3 + (1 + t) * \left[ s_{4h} * \left( p_{4t} + \frac{cf}{M_{t4}} \right) \right].$$

En résumé, le prix moyen pour les quatre (4) tranches ménage s'écrit sous la forme suivante :

$$\hat{P}_{it} = 3 + (1 + t) \left( \sum_{i=1}^m s_{iht} * \left( p_{it} + \frac{cf}{mt} \right) \right) \dots\dots\dots(6).$$

$\hat{P}_{it}$  : est le prix moyen prédit,  $s_{iht}$  est la proportion de ménages dans la tranche  $i$ ,  $P_{it}$  est le prix marginal dans chaque tranche,  $cf$  est le coût fixe (c'est-à-dire , abonnement AEP et Abonnement Assainissement) et  $mt$  est la consommation moyenne de la tranche  $j$ .

L'optimum de second rang (prix de Ramsey-Boiteux) est la solution qui maximise le profit du monopole par l'égalité de la recette marginale pour chaque bien. Cet optimum correspond à une solution du moindre mal : les recettes équilibrent les coûts. Le fait que la tarification optimale de second rang conduise à des écarts entre prix et coûts marginaux qui sont d'autant plus grands que l'élasticité-prix de

la demande ( $\varepsilon_p$ )<sup>19</sup>. Les biens dont la demande est peu élastique sont souvent des biens ayant un certain caractère de priorité dans les choix du consommateur. Élever nettement le prix de ces biens peut conduire à pénaliser exagérément les ménages les plus vulnérables car les biens de première nécessité représentent une fraction importante dans leurs dépenses. Le critère du surplus collectif tel que nous l'avons formulé jusqu'ici ignore les préoccupations d'équité. La tarification optimale de second rang (prix de Ramsey-Boiteux) est la solution de l'équation suivante :

$$p(q) = c(q) + \frac{\gamma}{|\hat{\beta}|} \bar{q} ; \text{ Avec } \bar{q}_i, \hat{c}(q) \text{ qui sont respectivement la}$$

consommation moyenne de la tranche ménage, et qui se mesure en m<sup>3</sup>/trimestre, le coût marginal ( $C_m$ )<sup>20</sup>, qui se mesure lui aussi en DA / m<sup>3</sup>, que nous supposons ici constant pour toute la période de l'étude.

### 2.3- Tarification sociale

La ressource en eau en Algérie est relativement rare (faible). Contrairement à d'autres pays où la ressource en eau est abondante (confortable). « La consommation moyenne d'eau potable d'un algérien est de 55 litres par jour, non compris la consommation collective ; c'est-à-dire l'eau utilisée dans les établissements publics »<sup>21</sup>. Ce chiffre n'est qu'une moyenne et la consommation d'un ménage dépend d'un certain nombre de critères liés à l'habitat, au climat, à l'âge, ou tout simplement au mode de vie de chacun<sup>22</sup>.

<sup>19</sup> L'élasticité prix de la demande ( $\varepsilon_p$ ) est obtenue par la formule suivante :  $\varepsilon_p = \frac{\partial q}{\partial p} \frac{p}{q} = \frac{\partial \ln q}{\partial \ln p}$ .

<sup>20</sup> Pour une forme fonctionnelle Translog, le coût marginal du bien i est donné par l'expression suivante :  $C_m = \frac{\partial CT}{\partial y_i} = \frac{\partial \ln CT}{\partial \ln y_i} \frac{CT}{y_i}$ .  $C_m$ , CT et  $y_i$  ces symboles dénotent respectivement le coût marginal du bien i, le coût total du service et la production du bien i.

<sup>21</sup> MRE/SOGREAH-ICEA, (2003).

<sup>22</sup> 40% de l'eau produite à usage domestique est perdue selon les estimations du MRE.

L'Algérie se caractérise par une consommation domestique moyenne très modeste. Cela se justifie par le niveau de ressource renouvelable par habitant qui est relativement faible. L'intensité de l'usage de l'eau est encore expliquée par la composition du foyer, l'équipement des logements et les comportements des consommateurs.

La distribution des volumes d'eau par ménage s'explique par plusieurs scénarios à savoir, le nombre de personnes présentes dans le foyer et par les équipements dont dispose le ménage. Entre les logements collectifs et les logements individuels, les différences sont importantes. La tarification associée à cette catégorie ménage est celle par tranche progressive qui pour objectif de protéger la ressource, de la préserver et de la partager entre les différents usagers pour permettre à chacun d'eux d'y avoir accès. Selon la base mondiale, le grand consommateur d'eau est l'agriculture avec 70% des prélèvements, puis, l'industrie environ 20% et l'usage domestique absorbe seulement 10% de tous les prélèvements annuels d'eau (*UN World Water Development Report, 2014*).

L'utilisateur domestique consomme de l'eau pour des usages qu'on peut qualifier d'abord de premières nécessités : la boisson, la préparation des aliments et les soins d'hygiène corporelle. Ensuite, l'eau vient pour qu'elle soit utilisée, à l'intérieur du logement, pour faire fonctionner un ensemble d'ustensiles électroménagers (lave-linge, lave-vaisselle...), que l'on regroupera sous le terme « d'équipement d'économiseur d'eau ». Les ménages ont intérêt à introduire ces équipements car ils permettent d'économiser la ressource en eau. L'eau potable est aussi parfois utilisée à l'extérieur du logement. Les volumes consommés peuvent être très variables selon que l'eau sert ou non au lavage des voitures ou à l'arrosage du jardin.

**Tableau N°1.** Usages domestiques de l'eau

Usage domestique	Part	Consommation moyenne
<b>Alimentation</b>		
Boisson	1%	besoin alimentaire : 2 litres
préparation de la nourriture	6%	préparation alimentaire : 8 litres
<b>Hygiène</b>		
bains, douches	39%	douche de 4 à 5 minutes : de 60 à 80 litres
		bain : de 150 à 200 litres
Sanitaires	20%	chasse d'eau : de 6 à 12 litres
<b>Nettoyage et autres</b>		
Linge	12%	lave-linge : de 70 à 120 litres
Vaisselle	10%	vaisselle à la main : de 10 à 12 litres
		lave-vaisselle : de 25 à 40 litres
lavage de la voiture	6%	lavage de la voiture : 200 litres
et arrosage du jardin	6%	arrosage du jardin : de 15 à 20 litres par m <sup>2</sup>
Source : CIEAU, (2010)		

Le tableau 1 nous résume que la répartition de la consommation d'eau potable s'établit selon trois paliers. L'usage domestique fait l'objet d'une attention particulière de la part de la puissance publique. Pourtant celui-ci est souvent mal connu des gestionnaires qui le considèrent en règle générale comme un élément incompressible. Si, pendant longtemps, l'usage domestique en eau a en effet visé la satisfaction de besoins essentiels, le progrès technique et l'augmentation constante des niveaux de vie ont abouti à ce que

seulement 7 % de l'eau consommée par le ménage est utilisée pour son alimentation. Les usages de nettoyage (linge et vaisselle) contribuent à hauteur de 22%, c'est là, que l'Agence Nationale de l'Eau (ADE), devrait mener des campagnes d'économies d'eau pour cibler l'hygiène et le nettoyage. Ces campagnes visent des changements de pratiques, par exemple, (douche à privilégier par rapport au bain) et préconisent aussi des appareils économes en eau, (source CIEAU, (2010)). Les usagers domestiques peuvent donc réagir à des mesures de restriction ou d'ordre tarifaire en ajustant leurs niveaux de consommation de manière à privilégier des usages qu'ils considèrent comme prioritaires. La mesure de la sensibilité des usagers domestiques constitue désormais un élément incontournable de toute politique de gestion intégrée de la ressource.

### **3 - LES DONNEES**

Les données sur les consommations, les prix et les abonnés ont été collectées auprès de l'entreprise nationale de l'eau (ADE). L'échantillon contient 91 communes dont le service d'AEP est géré par l'Algérienne des Eaux (ADE), sur la période suivante : 2004-2007 (16 trimestres). Six wilayas sont concernées : Alger, Bejaia, Constantine, Oran, Ouargla et Sétif. Nous disposons d'une base de données de panel de 1456 observations. Les données sont essentiellement issues des rapports réalisés par les établissements de gestion de l'eau (ADE) au niveau de chaque wilaya, à partir des bilans financiers établis trimestriellement par les gestionnaires du service d'alimentation en eau potable. Ces bilans contiennent des informations pertinentes sur les données commerciales : les abonnés, la structure des tranches de la catégorie ménage, les volumes de consommation par tranche et le prix associé à chaque tranche. Des variables utiles à mobiliser pour une comparaison avec les coûts marginaux estimés sont également calculées. Nous construisons les variables concernant les prix unitaires ou moyens de l'eau facturée (Prix), les prix marginaux, c'est-à-dire avant les taxes ( $P_m$ ), la consommation moyenne (*Cons\_moy*) et les proportions des tranches ménage (*Prop\_tranch*) à partir des données de facturation (obtenues des services commerciaux). Le prix moyen

( $PM$ ) exprimé en dinars /  $m3$  est obtenu en divisant le total des factures de la catégorie «consommation résidentielle» (ménages), calculé en sommant la valeur des quatre tranches qu'elle contient, par le total des volumes facturés de la même période. Pour le prix marginal ( $P_m$ ) la procédure est la même mais en ne tenant pas compte des taxes forfaitaires suivantes : ( $RFA\_EAU$ ) et ( $RFA\_ASS$ ) (respectivement, redevance fixe eau et redevance fixe assainissement). La consommation moyenne ( $Cons\_moy$ ) exprimée en  $m3$  / ménage est définie comme le rapport entre le volume de la catégorie «ménages» et le nombre d'abonnés de cette catégorie. La proportion des tranches ( $Prop\_tranch$ ) exprimée en pourcentage (%) / abonnés est définie aussi comme le rapport entre les abonnés de la tranche « ménage » et le nombre d'abonnés de toute la catégorie. La fréquence et les plages horaires de distribution (*Jours* et *Heures*). Ces deux dernières variables sont exprimées en jours par semaine et en heures par jour respectivement et permettent de caractériser la qualité du service de distribution d'AEP.

Le tableau 2 présente les statistiques descriptives des variables de notre échantillon. En raison d'observations manquantes pour certaines communes à certaines dates, le nombre total d'observations utilisables dans les estimations est de 1139.

**Tableau N°2.** Statistiques descriptives sur l'échantillon

Variables	Unité	Moyenne	Écart-type	Minimum	Maximum
$P_{t1}$	DA / $m3$	6,27	2,067	3,789	62,64
$P_{t2}$	DA / $m3$	20,124	3,524	8,447	22,121
$P_{t3}$	DA / $m3$	34,112	6,025	3,741	37,432
$P_{t4}$	DA / $m3$	40,42	7,065	12,553	55,135
$M_{t1}$	$m3$ / ménage	12,5	0	12,5	12,5

$M_{t2}$	m3/ménage	39,5	0	39,5	39,5
$M_{t3}$	m3/ ménage	68	0	68	68
$M_{t4}$	m3/ ménage	135,936	0	135,936	135,936
Prop_tranch1	% / abonnés	0,64232	0,1366447	0,0660668	1
Prop_tranch2	% / abonnés	0,2527097	0,0915306	0	0,9320456
Prop_tranch3	% / abonnés	0,0534006	0,0368044	0	0,2857143
Prop_tranch4	% / abonnés	0,0515697	0,0589423	0	0,6680162

Source : calcul de l'auteur, (2012)<sup>23</sup>.

Notes. 1139 observations. Les symboles,  $P_{t1}, \dots, P_{t4}$ ,  $M_{t1}, \dots, M_{t4}$ , et  $Prop_{t1}, \dots, Prop_{t4}$  dénotent respectivement le prix appliqué à chaque tranche ménage (Prix\_tranche) exprimé en DA /m<sup>3</sup>, la consommation moyenne de chaque tranche (Cons\_moy) exprimée en m<sup>3</sup> /ménage et par trimestre. La proportion des tranches (Prop\_tranch) exprimé en pourcentage (%) / abonné.

L'élasticité-prix de la demande ( $\varepsilon_p$ ) par rapport à la consommation d'eau d'un ménage, que nous avons estimée est égale à **-0,37091**<sup>24</sup>. Par contre, la pente de la courbe de demande qu'on a estimée à l'aide d'un modèle à effet fixe est égale à **= - 0,42678**. La pente de la courbe de demande étant négative, tout comme l'élasticité-prix de la demande ( $\varepsilon_p$ ), et elle s'écrit sous la formule suivante en valeur absolue:

$$|\hat{\beta}| = \frac{dq}{dp} = 0,426.$$

Le coût marginal ( $C_m$ ) que nous avons estimé par rapport au volume d'eau distribué aux abonnés est égal à **= 7,52 DA/m<sup>3</sup>** <sup>25</sup>. Le tableau 3 présente les résultats d'estimation des paramètres Gamma ( $\gamma$ ), pour chaque tranche de consommation au point des prix estimés de toutes les tranches de la catégorie ménage indiquées ci-avant.

<sup>23</sup> Voir partie 3 de ma thèse soutenue à l'Université d'Alger 3.

<sup>24</sup> Les cahiers du CREAD n° 112/2015, p 51.

<sup>25</sup> Idem (24), n° 92/2010, p 147.



**Tableau N° 3.** Estimation des paramètres Gamma  $\gamma$  et calculer leur moyenne  $\bar{\gamma}$ .

Variables	Unité	Moyenne	Écart-type	Minimum	Maximum
<b>Gamma_moy</b> $\bar{\gamma}$	DA	0,135	0	0,135	0,135
<b>Gamma<sub>1</sub></b> $\gamma_1$	DA	-0,042	0	-0,042	-0,042
<b>Gamma<sub>2</sub></b> $\gamma_2$	DA	0,135	0	0,135	0,135
<b>Gamma<sub>3</sub></b> $\gamma_3$	DA	0,166	0	0,166	0,166
<b>Gamma<sub>4</sub></b> $\gamma_4$	DA	0,103	0	0,103	0,103

**Source :** calcul de l'auteur, (2012)<sup>26</sup>.

Notes. 1139 observations. La moyenne des paramètres **Gamma**  $\gamma$  est obtenue par la formule suivante:  $(\text{Gam\_moy}) \bar{\gamma} = (\gamma_2 + \gamma_3 + \gamma_4) / 3$ . Pour le calcul de Gamma moyenne ( $\bar{\gamma}$ ), on enlève les observations aberrantes :  $\gamma < 0$ . les valeurs de gamma sont calculées au point du prix estimé pour chaque tranche ménage

#### 4 - RESULTATS D'ESTIMATION

Comme indiqué plus haut, le modèle de Ramsey-Boiteux est estimé comme un système d'équations simultanées avec le surplus des consommateurs  $S(Q)$  et le profit de l'entreprise  $\Pi$ <sup>27</sup>. Nous cherchons à maximiser le surplus des consommateurs, en tenant compte de la contrainte d'équilibre budgétaire  $\Pi = 0$ . Cela va permettre à l'entreprise d'éviter un déficit de monopole. Maintenant, il nous reste à remplacer les paramètres de la formule ci-dessus par leur valeur pour calculer les prix optimaux à chaque tranche de

<sup>26</sup> Idem (23).

<sup>27</sup> Pierre Picard « Eléments de micro-économie » théorie et application. Edition Montchrestien, année 2007.P375-376.

consommation ménage. Les résultats d'estimation sont présentés dans le tableau 4.

**Tableau N°4.** Résultats d'estimation

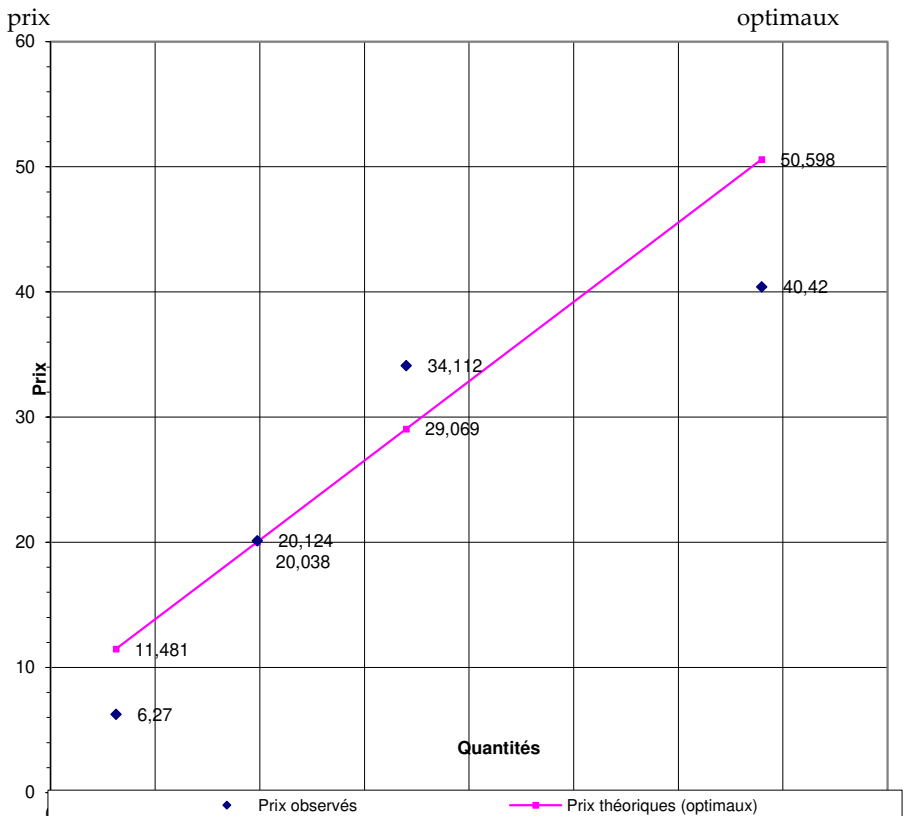
Tarification d'AEP et d'Assainissement								
Catégorie	Moyenne des tranches (Mt)	$C_m$	$\gamma = \frac{\lambda}{1 + \lambda}$	Prix optimaux $(p^*)$ / m <sup>3</sup>	Prix observés $(\bar{p})$ / m <sup>3</sup>	RFA Eau	RFA Assainissement	Prix TTC EN DA
<b>Ménage</b>	Mt1= 12,5 m <sup>3</sup> / Trim	7,52	0,135	11,48	6,27	240	60	311,48 DA
	Mt2= 39,5 m <sup>3</sup> / Trim	7,52	0,135	20,03	20,124	240	60	320,03 DA
	Mt3= 68 m <sup>3</sup> / Trim	7,52	0,135	29,06	34,112	240	60	329,06 DA
	Mt4=136 m <sup>3</sup> / Trim	7,52	0,135	50,59	40,42	240	60	350,59 DA

Source : (calcul de l'auteur)

Ces résultats nous renseignent en premier lieu sur l'information concernant le coût marginal ( $C_m$ ) qui n'est pas loin du prix appliqué à la première tranche. Ceci dit, la première tranche est même cédée à un prix inférieur au coût marginal de mètre cube produit. Ce tableau fournit également la liste des tarifs optimaux (théoriques), et tarifs observés en mètres cubes des services publics d'AEP et d'assainissement. Ces tarifs ont toujours gardé la même structure que ceux qui sont déjà connus du public. Par contre, les niveaux des tranches de consommation sont modifiés afin d'atteindre l'objectif du chiffre d'affaires. Le tarif moyen hors abonnement est de 27,79 DA/m<sup>3</sup> HT. Le tarif le plus bas est de 11,48 DA/m<sup>3</sup> HT et le tarif le plus haut est de 50,59 DA/m<sup>3</sup> HT. L'analyse des écarts pourrait se faire, seulement au niveau des prix correspondants. Ces tarifs sont croissants avec les volumes consommés, et donc sont en accord avec la pratique observée, voire plus, qu'ils répondent aux attentes de la

tarification par tranches progressives. Ils ont pour but d'assurer l'accès à tous les usagers par le tarif appliqué à la première tranche, mais aussi donnent un signal aux usagers que ces tarifs vont dans le sens de préserver la ressource en eau par les tarifs appliqués aux tranches supérieures. Toutefois, le tarif de la dernière tranche portant sur un volume élevé (136 m<sup>3</sup>/trimestre) n'est pas assez dissuasif (50,59 DA/m<sup>3</sup>). L'ajustement des prix de vente pratiqués par rapport aux prix théoriques (optimaux) sont présentés dans la figure ci-dessous.

**Figure N°1.** Ajustement des prix de vente appliqués vis-à-vis des optimaux



Source : (calcul de l'auteur)

Cette figure nous affiche, non seulement la position des prix de vente observés par rapport à la droite d'ajustement qui représente les prix optimaux (théoriques). Mais également, elle nous renseigne sur l'écart de prix qui pourrait faire l'objet d'une politique alternative à la gestion des services d'AEP et d'Assainissement.

**Différentiel de prix ( $\Delta p$ ).**  $Ecart (\Delta) = (\bar{p}_1 - p_1^*) \times M_{i1} \times prop1 + (\bar{p}_2 - p_2^*) \times M_{i2} \times prop2 + (\bar{p}_3 - p_3^*) \times M_{i3} \times prop3 + (\bar{p}_4 - p_4^*) \times M_{i4} \times prop4.$

La contribution des variables observées dans le différentiel de prix dépend de la différence dans les moyennes de consommation  $M_{i4}$ , selon le mode de gestion, les proportions de chaque tranche  $Prop_{i1-4}$ , ainsi que la différence entre les prix observés et les prix théoriques. L'écart du prix pour l'ensemble des tranches de la catégorie ménage est présenté dans le tableau 5.

**Tableau N° 5.** Comparaison des tarifs pour la catégorie ménage

Comparaison des tarifs pour la catégorie ménage								
Eléments	Prix observés (pratiqués)			Prix optimaux (théoriques)			Ecart	
	$S$	$\bar{P}$	$S \times \bar{P}$	$S$	$P^*$	$S \times P^*$	+ ( FAV )	- ( DEF )
S1 = Mt1 *								
prop1	8,029	6,27	50,34	8,029	11,48	92,17		
S2 = Mt2 *								
prop2	9,982	20,12	200,87	9,982	20,03	199,93		
S3 = Mt3 *								
prop3	3,631	34,11	123,86	3,631	29,06	105,51		
S4 = Mt4 *								
prop4	7,013	40,42	283,46	7,013	50,59	354,78		
<b>Total</b>			<b>658,54</b>			<b>752,41</b>		<b>93,871</b>

Source : (calcul de l'auteur)

Si nous étudions de façon plus précise la comparaison des prix observés (*pratiq  s*) aux prix th  oriques (*optimaux*), pour la cat  gorie m  nage, nous pouvons en tirer de pr  cieux enseignements : d’abord, faire appara  tre un   cart que nous allons analyser sur le plan   conomique pour bien   valuer le service d’eau potable et d’assainissement mis en   uvre par l’entreprise nationale de l’eau (ADE). Ensuite, conclure s’il y a un syst  me de compensation des prix par rapport aux diff  rentes tranches de consommation. Enfin, avoir de l’enthousiasme de recommander les r  sultats auxquels nous sommes confront  s    l’Alg  rienne des Eaux (ADE), pour but d’apporter des solutions alternatives    la facturation des services d’AEP et d’Assainissement en vigueur.

## 5 - CONCLUSION

Dans cet article, nous avons analys   les performances de la tarification    usage domestique sur la base d’un   chantillon de services d’eau potable alg  riens g  r  s par l’ADE.    partir de la mod  lisation   conomique des d  cisions des gestionnaires en charge de l’exploitation des services d’AEP et d’Assainissement ainsi qu’   l’aide d’  lasticit  -prix ( $\epsilon_p$ ) de la demande domestique et du co  t marginal ( $C_m$ ) de production et de distribution d’AEP, nous avons r  sum   les diff  rentes informations sur la structure des tarifs d’AEP et d’assainissement, pour l’  chantillon total des communes desservies par les diff  rentes agences de l’eau. L’estimation d’  lasticit  -prix de la demande ( $\epsilon_p$ ) et le co  t marginal ( $C_m$ ) nous permet de faire asseoir une structure tarifaire qui r  pond aux imp  ratifs de l’heure tout en tirant le meilleur parti de l’existant. Ceci dit, l’entreprise pourrait financer ses d  penses et assurer la p  rennit   de service au profit de l’usager, d’autant plus que l’eau potable doit   tre garantie en qualit   et en quantit   en tout lieu et    tout moment. Au vu des r  sultats pr  sent  s dans cet article, nous pouvons tirer plusieurs enseignements sur la structure des tarifs des services d’AEP, dans le but d’une r  gulation efficace de la ressource en eau. La tarification progressive est caract  ris  e par un prix au m  tre cube diff  rent en fonction de la

tranche de consommation atteinte. Plus la tranche de consommation est haute, plus le prix au mètre cube est élevé. Ce type de tarification revient à faire payer relativement plus cher les «gros consommateurs » tout en subventionnant les usagers de la tranche de consommation la plus basse.

- 1- L'idée de la tarification par tranche progressive est multiple : d'abord, elle permet l'accès à tous les usagers au regard du prix pratiqué à la première tranche qui est égal à 6,30 DA/m<sup>3</sup>, voire inférieur même au coût marginal ( $C_m$ ) qui est estimé à 7,52 DA. Ensuite, elle incite les usagers à la consommation rationnelle, c'est-à-dire, à faire adapter ou ajuster la consommation aux besoins. Voire, surtout à ne pas gaspiller la ressource disponible car les prix augmentent selon le volume consommé et de façon substantielle. Enfin, notre choix s'est alors porté sur ce type de tarification car les usagers qui se trouvent dans les paliers supérieurs viennent en aide aux usagers qui sont dans les tranches inférieures. Il s'agit par conséquent, d'un système de compensation entre les prix pratiqués dans les différentes tranches.
- 2- Les proportions des abonnés de la catégorie ménage sont importantes dans les deux premières tranches. La proportion des abonnés dans la première tranche représente 64,23% de toute la catégorie. Elle suit la deuxième tranche avec 25,27%. Au final, les deux dernières tranches viennent avec seulement 5% chacune. Ceci dit que la plupart des ménages se retrouvent dans les deux premières tranches et ce, par rapport à la disponibilité limitée de la ressource en eau. Ces deux proportions d'abonnés nous confirment exactement en pratique observée la rareté de la ressource dont dispose le ménage.

- 3- La question de l'équité émerge dans ce type de tarification (*tarification par tranche progressive*) au regard des prix appliqués sur les différents paliers. Il s'agit bien de possibilité de subventions croisées entre les groupes de consommateurs. S'ajoute à cela, que cette tarification par tranche progressive s'impose, dans le cas où la ressource renouvelable par habitant est relativement faible. Et donc, ce choix me semble judicieux.
- 4- L'analyse classique des écarts globaux entre prix observés et prix optimaux ne serait utile qu'en ce qui concerne l'écart sur prix (on voit ici qu'on a facturé la première tranche à 45 % de moins et que cela a coûté 41 DA). La motivation qui a guidé le choix de parler de la première tranche est la concentration des abonnés car 64,23 % de ces derniers se retrouvent dans cette tranche. Globalement, quant l'écart est négatif, cela veut dire qu'on fait payer les usagers moins chers par rapport à ce qu'ils devraient payer. Autrement dit, en moyenne le prix de vente pratiqué est inférieur au prix moyen optimal (théorique). Ceci signifie que nous disposons de marge de manœuvre pour apporter des corrections attendues à la gestion de ce service d'AEP et d'assainissement.
- 5- La concentration des abonnés autour des deux premières tranches est liée à la rareté de la ressource essentiellement, du fait que l'application du prix aux différents paliers de consommation en tant qu'instrument de régulation de la consommation risque d'être peu efficace pour inciter les consommateurs à consommer moins d'eau. Par ailleurs, c'est un bon instrument pour recouvrer les charges d'exploitation de service de l'eau et de sa mobilisation tout en protégeant les petits consommateurs, d'autant plus que, les paramètres associés à la fréquence et plage horaire de distribution sont tous deux de signe négatif. Ces élasticités ont obtenu lors de la publication de notre article sur l'évaluation économique des

performances des services d'eau potable algériens<sup>28</sup> (-0,3495 ; et -0,12184) et qui représentent jours et heures respectivement. Cela nous laisse conclure que la ressource disponible par habitant reste relativement faible en Algérie, contrairement à d'autres pays où la ressource renouvelable par habitant est confortable. On préfère associer ce signe négatif à la rareté de la ressource en eau dans ce pays. Un effet négatif de la durée de service de distribution sur le coût des services d'alimentation en eau potable a également obtenu par Nauges et Van Den Berg (2008), qui estiment l'élasticité du coût moyen par rapport à la durée (en nombre d'heures par jour, équivalent de notre variable heures) à -0,207.

- 6- La tarification par tranche progressive constitue, cependant un instrument suffisamment efficient, et donc économiquement efficace, parce qu'elle permet d'atteindre les objectifs de préservation de la ressource à moindre coût. De plus, son objectif est de protéger les consommateurs les plus vulnérables, puisque leur consommation sera ainsi subventionnée par les tarifs appliqués aux tranches inférieures. En revanche, les tarifs sont croissants avec le volume consommé et suivent une logique de préservation de la ressource en eau.
- 7- Globalement, ces résultats sont encourageants en ce qui concerne leur application directe en termes de décisions politiques.

La modification dans les tranches de consommation et le maintien de la tarification par tranche progressive aux services d'eau potable algériens s'avère une solution socialement juste et économiquement efficace. En effet, la tarification constitue un levier commercial important pour l'établissement qui gère le service d'AEP et d'assainissement, mais également pour l'économie dans son ensemble.

#### Références bibliographiques

---

<sup>28</sup> *Les cahiers du CREAD* n° 92/2010, p 148.



- **Centre d'Information sur l'Eau (CIEAU (2010))** « *la réglementation de la qualité* ».
- **Diakité, D. et A. Thomas (2011).** «La demande domestique d'eau potable : une étude sur un panel de communes ivoiriennes ». *L'Actualité Économique*, vol. 87, N°3, 269-299.
- **Marcel, B. (1993)**, Haute tension, Odile Jacob. « Cahiers de l'évaluation (Mission d'évaluation des politiques publiques) ». (Page 67-71), N° 1 – Septembre 2008.
- **Maya Khelladi, (2008).** *Economiste de l'eau. Le secteur de l'eau en Algérie: le programme d'assistance technique remboursable.* Janvier.
- **MRE / Ministère des Ressources en Eau (2018).** « *Direction de l'alimentation en eau potable* ». Accès à l'eau et à l'assainissement en Algérie.
- **MRE / SOGREAH-ICEA- (2003).** « *Etude de la tarification de l'eau à usage domestique, industriel et l'assainissement* ». Algérie.
- **Nauges, C. et C. van den Berg, (2008).** « *Economies of density, scale and scope in the water supply and sewerage sector : a study of four developing and transition economies* ». *Journal of Regulatory Economics*, 34,144-163.
- **Picard, P., (2007).** « *Élément de microéconomie théorie et application* », Edition Montchrestien.
- **Rapport du MEDD, «Direction des Etudes Economiques et de l'Evaluation Environnementale».** Série Etudes 05-E06, Paris.
- **WWAP.2014.** *UN World Water Development Report 2014: water and energy.* Paris, UNESCO.
- **Zeggagh, A., M.Y. Ferfera, (2015).** « *Estimation de la demande domestique d'eau potable en Algérie* », *Les Cahiers du CREAD*, N°112, p. 31-59.
- **Zeggagh, A., A. thomas et M.Y. Ferfera, (2010).** « *Evaluation économique des performances des services d'eau potable algériens* », *Les Cahiers du CREAD*, N°92, p. 119-152.

- **Zeggagh, A., (2012).** *« Tarification des services d'eau potable, durabilité de la ressource et accès des usagers »*. Cas de l'Algérie. Thèse de Doctorat, Université d'Alger 3.