IT'S CONTRIBUTION TO THE NEW ECONOMETRIC MODDELLING OF THE TAX COMMITMENT: CASE OF AGRICULTURAL BUSINESSES IN MOROCCO

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ABSTRACT

Delving into the heart of the dilemmas between taxation and agriculture, this article explores the intriguing perspective of value-added tax (VAT) taxation of farmers in Morocco. Within this complex debate, attention focuses on farmers' perceptions, offering a unique window on how they apprehend tax reforms, asking how do farmers perceive and engage with the introduction of VAT in Morocco's agricultural sector? This article sets out to unveil the subtleties surrounding the vision of agricultural units in the face of VAT. Using an innovative methodology based on information technology to collect and process data, ranging from Multiple Correspondence Analysis to binary logistic regression, our research aims to predict the act of engaging farmers in this new fiscal reality. In this vein, a painless tax promoting the economic viability of farms emerges as a powerful determinant stimulating the commitment of agricultural units to VAT, underlining the importance of designing mechanisms that ease the financial burden on farmers while contributing to public revenues. Based in the Rabat-Salé-Kénitra region, this work explores the intricacies of agricultural perceptions, revealing crucial insights for the future of Moroccan agriculture, where each perception becomes a key piece in understanding the complex dynamics between taxation, competitiveness, and sustainability.

Keywords: *Tax reform, value added tax, tax commitment, agricultural sector, binary logistic regression*

1. INTRODUCTION

Despite the scarcity of natural resources and unfavorable climatic conditions, Morocco has succeeded in developing a diversified agricultural sector thanks to the rational use of water, irrigation and mechanization. The position occupied by this sector is the result of a series of strategies deployed by the Kingdom since independence. These strategies reflect a shift from a state interventionist stance in the agricultural sector to a liberal one, accompanied by strategies to build dams, set up hydro-agricultural infrastructure, boost crop and livestock production, and train farmers. These efforts have led to the diversification of plant and animal production, the capitalization of ancestral know-how and the development of the sector in all its dimensions. Nevertheless, there are many obstacles to the effective development of Morocco's agricultural sector. These include poor governance, ineffective public intervention, weak public-private partnerships, increased centralization to the detriment of territorialization of public action, growing land issues that are detrimental to agricultural investment, inadequate human capital skills and qualifications, and irrational management of water resources.

Faced with rising inflation due to successive years of drought, and the sharp rise in prices of imported agricultural inputs, directly affecting the farming sector, the Moroccan government is seeking to provide tax solutions such as revising the abolition of value-added tax (VAT) on seeds and plant protection products. This approach will seek to improve the competitiveness of agricultural enterprises on national and international markets, create jobs, and alleviate the costs borne by farmers, who have been confronted with soaring prices for agricultural inputs, putting significant pressure on the profit margins of agricultural production units and their profitability.

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In this context, Moroccan value-added tax is an indirect tax on final consumption expenditure, applied to a wide range of products and services. It is a key component of Moroccan tax revenues, and is applied in accordance with article (87) of the General Tax Code (GTC). The latter stipulates that this tax is applied to all operations of an industrial, commercial, craft or professional nature. It also covers imports, real estate development, land subdivisions and all services. However, certain branches remain outside the scope of value-added tax in Morocco, such as the agricultural sector and civil operations with a non-commercial purpose, taking into account Morocco's specific economic and social considerations.

With a view to alleviating the chronic deficit in the ordinary budget balance, this essay will contain a scenario for taxing farmers under the value-added tax. Farmers' perceptions of this type of tax reform are a subject of interest to researchers and policy-makers alike. Tax reforms can have a significant impact on farmers' productivity and competitiveness. They are often designed to improve the efficiency and equity of the tax system. Aside from this, agricultural units can be particularly sensitive to changes in their tax system, which shapes agricultural policies, subsidy allocations and tax rates. However, the writings of Smith, A. and Johnson, B. (2020) [1] have shown that farming units tend to overestimate the negative effects of tax reforms on their agricultural activity. This overestimation may be due to selection bias and perception errors. Farming units with positive experience of past tax reforms are more likely to overestimate the negative effects of new tax reforms. In this vein, Doe, J. and Smith, A. (2021) [2] examined farmers' perceptions of tax reforms using online questionnaires. The results suggested that farmers had positive perceptions of tax reforms, but that these perceptions were influenced by their political orientations and levels of education. Nevertheless, the perception of farming units refers to significantly different impacts on agricultural productivity (Brown, L. and Doe, J. 2022) [3]. In addition, farm units express concerns about tax reforms, the complexity of the tax system and the administrative burden associated with compliance (Bertier A. et al., 2022) [4]. However, taxation of the agricultural sector is a multidimensional issue that goes beyond simply raising revenue for governments. It must take into account the diversity of agrarian structures, the specificities of farms, environmental issues and the needs of local communities.

This essay will explain an attempt to predict the act of commitment of agricultural units with regard to VAT taxation. We will attempt to analyze the impact of an assortment of stimulating determinants of the commitment decision on the act of tax liability with the tax authorities in matters of value-added tax. That is to say, we begin the impact and classification of a set of explanatory variables leading to a probability of commitment of agricultural enterprises to the declaration of value added tax specifically in the region of Rabat-Salé-Kénitra. This study is divided into two phases. The first is devoted to selecting the determinants with the greatest impact on the response variable (act of commitment) using the AFCM (Multiple Factor Correspondence Analysis) method. The second will mobilize generalized linear models, specifically binary logistic regression, to predict the act of commitment of agricultural units in the context of probable V.A.T. taxation.

2. LITERATURE REVIEW

Taxation in the agricultural sector is a dynamic field, constantly undergoing reform and adjustment. Tax reforms, particularly those related to VAT tax systems, play a major role in how farmers perceive their tax burden and the management of their activities. This literature review explores tax trials in the agricultural sector, focusing on tax system reforms, VAT and farmers' perceptions of these changes. Fiscal reforms targeting the agricultural sector often have profound implications for farm financial management. (Afonso A., Jalles J., and Venâncio A. 2021) [5] shed light on this dynamic by examining the impact of structural reforms on the efficiency of public spending. Their study highlights the need to design fiscal policies tailored to the agricultural sector, recognizing its unique contribution to the economy. However, (Buettner T. and Tassi A. 2023) [6] explore the fight against VAT fraud and the use of reverse charge. Their analysis highlights the need to adopt specific tax mechanisms to preserve the integrity of the tax system in the agricultural sector. These mechanisms can influence farmers' perceptions of reforms, particularly with regard to ease of compliance. Value Added Tax (VAT) is a crucial element of fiscal policies, but its impact on the agricultural sector can be complex. (Benzarti N. and Tazhitdinova A. 2021) [7] provide relevant insights by examining how VAT reforms affect international trade flows. Their findings suggest that VAT adjustments can influence the competitiveness of agricultural products on the global market.

Tax reforms in the agricultural sector have attracted growing interest. The debate revolves around the need to modernize tax systems and address the unique challenges faced by agricultural producers. This literature review highlights recent scientific contributions and farmers' perceptions of tax reforms in the agricultural sector. In this regard, the work of (Hodge S. and McCluskey J. 2021) [8] analyzed the impact of tax policies on agricultural producers in the United States. They found that while tax incentives can encourage sustainable practices, they can also create inequalities between farmers. The authors highlight the need for a more balanced and inclusive tax system to support the long-term sustainability of the agricultural sector. As mentioned in the works of (Alognon A., Koumpias T., and Martinez-Vazquez J. 2021) [9], an interesting dimension to VAT has been added. Their analysis highlights the implications of changing payment methods on VAT compliance. These changes can be particularly significant for farmers, highlighting the need to adjust tax policies accordingly. A study by (Gorter H. and Drabik D. 2022) [10] explored the consequences of taxing agricultural emissions in the European Union. The authors argue that taxing agricultural emissions could have a negative impact on farmers' incomes and contribute to higher food prices. They suggest that policymakers should consider alternative approaches, such as subsidies for sustainable practices, to minimize the negative effects on farmers and consumers.

Although tax reforms can have positive impacts on the agricultural sector, farmers' perceptions of these reforms are crucial to their success. A study by (Owusu J. and al. 2021) [11] examined Ghanaian farmers' perceptions of tax reforms. The authors found that farmers had a positive attitude towards tax reforms that reduced their tax burden and simplified tax codes. However, farmers were skeptical about tax reforms that would increase their tax burden or introduce new taxes. Similarly, a study by (Mwangi P. and al. 2022) [12] analyzed Kenyan farmers' perceptions of VAT reforms. The authors found that farmers had a positive attitude towards VAT reforms that reduced the cost of agricultural inputs and improved the efficiency of agricultural value chains. However, farmers were concerned about the potential negative impacts of VAT reforms on their incomes and welfare. Similarly (Chrysanthakopoulos G. and Tagkalakis A. 2023) [13] explore the impact of tax rules on the cyclicality of fiscal policy. Their findings suggest that appropriate tax rules can help stabilize farmers' perceptions of seasonal tax variations. This stability is crucial to fostering farmers' confidence in tax policies. How farmers perceive tax reforms is essential to understanding their acceptance and real impact. The writings of (Cirman A. and al. 2022) [14] address this issue by examining how the education of young taxpayers can influence tax morale. Their study highlights that education can play a key role in the perception of tax reforms, highlighting the need for educational initiatives in the agricultural sector.

This literature review highlights the importance of tax reform, VAT and farmer perception in the agricultural sector. These elements are closely interconnected and play a vital role in how farmers manage their activities and perceive their contribution to the national economy. Tax reforms need to be carefully designed to meet the unique needs of the agricultural sector, and to ensure a positive perception on the part of key stakeholders. After a brief overview of previous work on farmers' perceptions and the socio-economic impact of tax reforms in the agricultural sector, one avenue of research remains unexplored by the research and academic community, highlighting the stimulating determinants of the act of engaging agricultural units in VAT taxation. In other words, our work revolves around exploring the determinants that have a positive impact on the willingness of agricultural units to subject themselves to the VAT taxation system, specifically non-taxable agricultural activities, as is the case in Morocco.

Referring by way of example to the stimulating determinants of the act of committing agricultural units to the VAT tax system, "tax neutrality" implies a design of taxation mechanisms that does not significantly influence production and consumption choices, thus promoting the sector's economic efficiency and competitiveness. Tax neutrality remains crucial in the agricultural sector, where distortions can have significant repercussions on economic choices. As highlighted by (Auerbach A. J. and Hines J. R. 2018) [15], "tax neutrality reduces economic distortions and promotes an efficient allocation of resources". Also, "tax proportionality" in the agricultural sector implies that the tax burden is proportional to the level of economic activity. Proportionality promotes equity while encouraging agricultural activity. Research by

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(Saez. E. and Stantcheva S. 2020) [16] highlights the importance of tax proportionality in achieving equity objectives, stating that "proportionality can contribute to fairer tax systems". However, "a painless tax" in the agricultural sector confers to maintain the economic viability of farms while generating necessary tax revenues. (Friedman M. 2018) [17] persists in his plea for painless taxes, stressing that "minimizing economic impact is essential to the legitimacy of tax policies". Also the "elimination of the stopper" in agricultural taxation concerns the removal of administrative obstacles that could hinder the efficiency of the tax system. Eliminating these obstacles promotes simplicity and efficiency in the agricultural tax system. The removal of administrative obstacles in agricultural taxation is put forward by (Sandmo A. 2018) [18] as "an imperative to promote the simplicity and efficiency of the tax system". Nevertheless, the choice of an "indirect tax system" in the agricultural sector implies a preference for taxes that do not weigh directly on income, but rather on consumption or production. This approach aims to minimize the impact on production choices, while still generating tax revenues. Recent advances, such as those reviewed by (Smith P. and Jones L. 2022) [19], continue to support indirect tax systems as an approach to minimizing economic distortions. However, "a reduction in the VAT credit burden" in agricultural taxation aims to minimize financial constraints on industry players. Tax design should seek to mitigate these administrative burdens while ensuring efficient tax collection. Research by (Keen M. and Lockwood B. 2021) [20] examines ways of reducing the administrative burden associated with VAT credits, stressing that "simplifying the system is crucial to its effectiveness".

In the current environmental context characterized by acute global warming, "reducing environmental impact" in the agricultural sector, translates into the design of tax mechanisms to encourage environmentally friendly practices. The writings of (Goulder L. H. and Williams R. C. 2019) [21] highlight the urgency of environmental taxation in the agricultural sector, asserting that "reducing environmental impact should be a central imperative of tax policies". Furthermore, "The Producer's Optimal Choice" in taxation translates an optimal taxation system seeks to align producers' individual interests with collective objectives. The work of (Mirrlees J.A. and Adam S. 2018) [22] highlights the idea that "tax design should seek to create incentives aligned with producers' socially desirable choices". Taxation can also be a source of "productivity enhancement", i.e. taxation can be designed to encourage efficient and sustainable farming practices, thereby boosting productivity. Recent research by (Foster A. and Rosenzweig M. 2021) [23] highlights the crucial role of tax incentives in boosting agricultural productivity, noting that "tax policies can be powerful levers for guiding productive choices". In the same vein, "fiscal balance" refers to a conception of tax policies that generates revenue without compromising the sector's financial stability. The work of (Barro R. J.2019) [24] continues to emphasize fiscal balance as an imperative for long-term economic stability, stressing that "fiscal balance remains a fundamental pillar of fiscal policy". By way of broadening the scope of activities of agricultural units, the determinant "subjection to public procurement", in the context of agricultural taxation, refers to the integration of tax mechanisms with market dynamics. It aims to align tax incentives with market mechanisms to stimulate economic efficiency. Integration with public market mechanisms has become essential in contemporary agricultural taxation, as (Anderson J. 2019) [25] states, "subjection to public markets enables better adaptation to market dynamics, thereby enhancing the effectiveness of fiscal policies". To address our initial problem, we decline the following hypotheses:

H_1: Neutrality has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.

H_2: Being subject to public procurement contracts has a significant impact on the VAT liability of agricultural units with the tax authorities

H_3: The proportionality of the tax has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.

H_4: A painless tax has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.

H_5: A balanced budget has a significant impact on agricultural units' VAT commitments to tax authorities

H_6: Improved productivity has a significant impact on the commitment of agricultural units to the VAT authorities

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H_7: Reducing the impact on the environment has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.
H_8: The optimal choice of producer has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.

H_9: Reduced VAT credit burden has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.

H_{10}: The elimination of the deadline has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.

H_{11}: The indirect tax system has a significant impact on the commitment of agricultural units to the tax authorities in terms of VAT.

3. BINARY LOGISTIC REGRESSION [26]

We consider a population P subdivided into two groups of individuals G_1 and G_2 identifiable by an assortment of quantitative or qualitative explanatory variables $X_1, X_2, \dots X_p$ and let Y be a dichotomous qualitative variable to be predicted (explained variable), worth (1) if the individual belongs to the group G_1, and (0) if he/she comes from the group G_2. In this context, we wish to explain the binary variable Y from the variables $X_1, X_2, \dots X_p$.

3.1 Logit transformation

We have a sample of n independent observations of y_i, with i = 1, 2, ..., n. y_i denotes a dependent random variable presented as a column vector such that, $y_i = (y_1, y_2, \dots y_n)$ expressing the value of a qualitative variable known as a dichotomous outcome response, which means that the outcome variable y_i can take on two values 0 or 1, evoking respectively the absence or the presence of the studied characteristic. We also consider a set of p explanatory variables denoted by the design matrix (X) = $(X_1, X_2, \dots X_p)$ grouping the column vectors of the independent variables, of size $(n \times p)$ and rank (p), where (x_i) is the row vector of these explanatory variables associated with the observation (i) such that, i = 1, 2, …, n, and the column vector (β) of dimension p of the unknown parameters of the model, i.e. the unknown regression coefficients associated with the column vectors of the matrix (X). We consider that y_i (response variable) is a realization of a random variable y_i which can take the values 1 in the case of the termination of the car insurance contract or 0 in the case of the renewal of the car insurance contract with probabilities (π) and $(1-\pi)$, respectively.

The distribution of the response variable y_i is called Bernoulli distribution with parameter (π). And we can write $y_i \sim B(1, \pi)$. Let the conditional probability that the outcome is absent be expressed by $P(y_i = 0|X) = 1 - \pi$ and present, denoted $P(y_i = 1|X) = \pi$, where X is the matrix of explanatory variables with p column vectors. The modeling of response variables that have only two possible outcomes, which are the "presence" and "absence" of the event under study, is usually done by logistic regression (Agresti A. 1996) [27], which belongs to the large class of generalized linear models introduced by John Nelder and Robert Wedderburn (1972) [28]. The Logit of the logistic regression model is given by the equation:

$$\text{Logit}(\pi) = \ln\left(\frac{\pi}{1-\pi}\right) = \sum_{k=0}^{p} \beta_k x_{ik}, \quad (1) \quad \text{with} \quad i = 1, .., n$$

By the Logit transformation, we obtain from equation (1) the equation (2):

$$\left(\frac{\pi}{1-\pi}\right) = \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) (2)$$

We evaluate equation (2) to obtain π and $1 - \pi$ as:

$$\pi = \exp\left(\sum_{k=}^{p} \beta_k x_{ik},\right) - \pi \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) (3)$$

$$\pi + \pi \exp\left(\sum_{k=0}^{p} \beta_k x_{ik},\right) = \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) (4)$$

$$\pi\left(1 + \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)\right) = \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) (5)$$

$$\pi = \left(\frac{\exp(\sum_{k=0}^{p} \beta_k x_{ik})}{1+\exp(\sum_{k=0}^{p} \beta_k x_{ik})}\right) (6)$$

$$\pi = \left(\frac{1}{1+\exp(-\sum_{k=0}^{p} \beta_k x_{ik})}\right) (7)$$

In the same way, we obtain $(1 - \pi)$:

$$1 - \pi = 1 - \left(\frac{1}{1+\exp(-\sum_{k=0}^{p} \beta_k x_{ik})}\right) (8)$$

$$1 - \pi = \left(\frac{1}{1+\exp(\sum_{k=0}^{p} \beta_k x_{ik})}\right) (9)$$

$$1 - \pi = \frac{\exp(-\sum_{k=0}^{p} \beta_k x_{ik})}{1+\exp(-\sum_{k=0}^{p} \beta_k x_{ik})} (10)$$

3.2 Estimation of the β parameters of the nonlinear equations of the Bernoulli distribution using the maximum likelihood estimator (MLE).

If y_i takes strictly two values 0 or 1, the expression for π given in equation (7) provides the conditional probability that y_i is equal to 1 given X, and will be reported as P (y_i = 0|X). And the quantity 1-π gives the conditional probability that y_i is equal to 0 given X, and this will be reported as P (y_i = 0|X). Thus, for y_i=1, the contribution to the likelihood function is π, but when y_i=0, the contribution to this function is $1 - \pi$. This contribution to the likelihood function will be expressed as follows:

$$\pi^{y_i} (1-\pi)^{1-y_i} \quad (11)$$

At this stage, we will estimate the P+1 unknown parameters β, using the maximum likelihood estimator (MLE) as follows:

$$L(y_1, y_2, \dots y_n, \ \pi) = \prod_{i=1}^{n} \pi^{y_i} (1-\pi)^{1-y_i} \quad (12)$$

Maximum likelihood is one of the most widely used estimation procedures for determining the values of the unknown β parameters that maximize the probability of obtaining an observed data set. In other words, the maximum likelihood function explains the probability of the observed data based on unknown regression parameters β. This method was developed by the British statistician Ronald Aylmer Fisher between (1912 - 1922) as it was assigned in John Aldrich's book "R. A. Fisher and the making of maximum likelihood 1912-1922 " published in (1997). This method aims to find estimates of the p explanatory variables to maximize the probability of observation of the response variable *Y*.

$$L(y_1, y_2, \dots y_n, \ \pi) = \prod_{i=1}^{n} \pi^{y_i} (1-\pi)^{1-y_i} \quad (13)$$

$$= \prod_{i=1}^{n} \left(\frac{\pi}{1-\pi}\right)^{y_i} (1-\pi) \quad (14)$$

Substituting equation (2) for the first term and equation (8) for the second term, we obtain:

$$L(y_1, y_2, \dots y_n, \ \beta_1, \beta_2, \dots \beta_p, \ ) = \prod_{i=1}^{n} \left(\exp\left(\sum_{k=0}^{p} \beta_k x_{ik'}\right)\right)^{y_i} \left(1 - \frac{\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}\right) \quad (15)$$

So,

$$L(y_1, y_2, \dots y_n, \ \beta_1, \beta_2, \dots \beta_p) = \prod_{i=1}^{n} \left(\exp\left(y_i \sum_{k=0}^{p} \beta_k x_{ik'}\right)\right) \left(1 + \exp\left(\sum_{k=0}^{p} \beta_k x_{ik'}\right)\right)^{-1} \quad (16)$$

For simplicity, we incorporate the Neperian logarithm into the above equation. Since the logarithm is a monotonic function, any maximum in the likelihood function will also be a maximum in the log-likelihood function and vice versa. Thus, considering the natural logarithm of this equation, we obtain the log-likelihood function ℓ expressed as follows:

$$\ln\left(L(y_1, y_2, \dots y_n, \ \beta_1, \beta_2, \dots \beta_p)\right) = \ln\left(\prod_{i=1}^{n} \left(\exp\left(y_i \sum_{k=0}^{p} \beta_k x_{ik}\right)\right) \left(1 + \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)\right)^{-1}\right) \quad (17)$$

$$\ell(y_1, y_2, \dots y_n, \ \beta_1, \beta_2, \dots \beta_p) = \sum_{i=1}^{n} y_i \left(\sum_{k=0}^{p} \beta_k x_{ik}\right) - \ln\left(1 + \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)\right) \quad (18)$$

Deriving the last natural logarithm equation of the likelihood function above, we should write:

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \sum_{i=1}^{n} y_i x_{ik} - \frac{1}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)} \times \frac{\partial}{\partial \beta_k}\left(1 + \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)\right) \quad (19)$$

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \sum_{i=1}^{n} y_i x_{ik} - \frac{1}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)} \times \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) \times \frac{\partial}{\partial \beta_k} \sum_{k=0}^{p} \beta_k x_{ik} \quad (20)$$

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \sum_{i=1}^{n} y_i x_{ik} - \frac{x_{ik}}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)} \times \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) \quad (21)$$

Knowing that:

$$\frac{\partial}{\partial \beta_k} \sum_{k=0}^{p} \beta_k x_{ik} = x_{ik} \quad (22)$$

So,

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \ell'_{\beta_k} = \sum_{i=1}^{n} y_i x_{ik} - \pi . \ x_{ik} \quad (23)$$

Therefore, the estimation of the parameters $\hat{\beta} = (\widehat{\beta_0}, \ \widehat{\beta_1}, \ \cdots, \widehat{\beta_p})$ that maximize the log-likelihood function can be determined by canceling each of the *P +1* equations of ℓ' (gradient of ℓ) as mentioned in equation (12), and verify that its Hessian matrix (second derivative) is negative definite, i.e. that each element of the diagonal of this matrix is less than zero. The Hessian matrix consists of the second derivative of equation (12). The general form of the second partial derivative matrix (Hessian matrix) can be written as follows:

$$\frac{\partial^2 \ell(\beta)}{\partial \beta_k \partial \beta_{k'}} = \frac{\partial}{\partial \beta_{k'}} \sum_{i=1}^{n} y_i x_{ik} - \pi . x_{ik} \quad (24)$$

$$\frac{\partial^2 \ell(\beta)}{\partial \beta_k \partial \beta_{k'}} = \frac{\partial}{\partial \beta_{k'}} (- \ \pi . x_{ik}) \quad (25)$$

$$\frac{\partial^2 \ell(\beta)}{\partial \beta_k \partial \beta_{k'}} = - \ x_{ik} \frac{\partial}{\partial \beta_{k'}} \left(\frac{\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}\right) \quad (26)$$

$$\ell''_{\beta_k \beta'_k} = - \ x_{ik} \ \pi(1-\pi) \ x_{ik} \quad (27)$$

To solve the (*P +1*) nonlinear β equations (12), we use the Newton-Raphson iterative optimization method, referring to the Hessian matrix. Using this method, the estimation of the β parameters starts with the first step of choosing a starting point β^{0} or β^{old}. The second step consists in mentioning the way the method works by posing: $\beta^{k+1} = \beta^{k} + A_k \times \nabla L(\beta^{k})$, and finally stop when the condition $\beta^{k+1} \approx \beta^{k}$ or $\nabla L\beta^{k+1}) \approx \nabla L(\beta^{k})$ is realized. The result of this algorithm in matrix notation is:

$$\beta^{new} = \beta^{old} + [-\ell''(\beta^{old})]^{-1} \times \ell'(\beta^{old})$$

By putting $\hat{\beta} = (\widehat{\beta_0}, \widehat{\beta_1}, \cdots, \widehat{\beta_p})^t$ we have:

$$V(\hat{\beta}) = (-\frac{\partial^2}{\partial \beta^2} \ln L(\beta, Y))^{-1} \|_{\beta=\hat{\beta}} = (X^t W X)^{-1}$$

To simplify this equation above, we substitute the value of $\ell'(\beta)$, and $\ell''(\beta)$ with another matrix form in the following way:

$$\beta^{new} = \beta^{old} + (X^t W X)^{-1} \times X^t (Y - \mu)$$

$$\beta^{new} = (X^t W X)^{-1} \times X^t W (X\beta^{old} + W^{-1}(Y - \mu))$$

$$\beta^{new} = (X^t W X)^{-1} X^t W Z$$

Where, $Z = (X\beta^{old} + W^{-1}(Y - \mu))$

Where, $Z = (X\beta^{old} + W^{-1}(Y - \mu))$ is a vector, and W is the vector of weights of the values of the diagonal of the inputs $\widehat{\pi}_i(1 - \widehat{\pi}_i)$. We can also write:

$$\beta^{new} = \beta^{old} + (X^t W X)^{-1} \times X^t (Y - \mu)$$

With:

$$X = \begin{pmatrix} 1 & x_{1,1} & \cdots & x_{1,p} \\ 1 & x_{2,1} & \cdots & x_{2,p} \\ \vdots & \vdots & \vdots & \vdots \\ 1 & x_{n,1} & \cdots & x_{n,p} \end{pmatrix}$$

$$\hat{V} = \begin{pmatrix} \widehat{\pi}_1(1-\widehat{\pi}_1) & 0 & \cdots & 0 \\ 0 & \widehat{\pi}_2(1-\widehat{\pi}_2) & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & \widehat{\pi}_n(1-\widehat{\pi}_n) \end{pmatrix}$$

And:

$$W = \mathrm{Diag}\ \widehat{\pi}_1(1-\widehat{\pi}_1), \cdots, \widehat{\pi}_n(1-\widehat{\pi}_n),$$

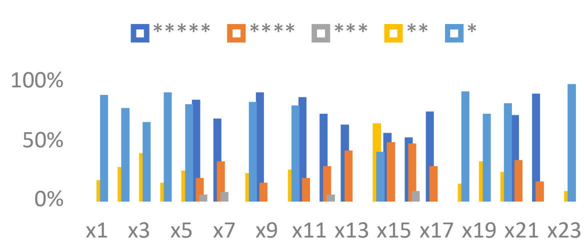
4. RESULTS

4.1 Selection of determinants significantly associated with the act of commitment

With a view to selecting the stimulating determinants of farmers' act of commitment to VAT taxation, we opted for a qualitative study adopting the directive interview technique based on a model of twenty-three specific and closed questions, carried out with fifty farmers (n = 50 farmers) located in the Rabat-Salé-Kenitra region. In line with the objectives of our survey, it was essential to conduct these interviews in order to justify the choice of the most relevant variables in the explanation of our response variable. In fact, the use of directive interviews enabled us to better identify the viewpoints of our interviewees, thus eliminating the least explanatory variables to reduce doubt during the elaboration of our evaluation, taking into account only those explanatory variables deemed judicious.

The directional interviews used were based on a Likert scale containing a gradation of five response choices, with a rating ranging from 1 to 5 to qualify the degree of impact of an assortment of explanatory variables on farmers' decision to engage in VAT taxation. These explanatory determinants can be presented as follows: unification of tax systems (x_1) fair competition (x_2) free movement of goods (x_3) harmonization (x_4) efficient distribution of income (x_5) neutrality (x_6) public procurement (x_7) tax fairness (x_8) tax proportionality (x_9) regressivity of the tax (x_{10}) a painless tax (x_{11}) balanced budget (x_{12}) improved productivity (x_{13}) poverty reduction (x_{14}) reduced environmental impact (x_{15}) optimal producer choice (x_{16}) reduce VAT credit burdens (x_{17}) financing public services (x_{18}) the efficiency of commercial circuits (x_{19}) optimal VAT rate (x_{20}) the elimination of the (x_{21}) an indirect tax system (x_{22}) and the elimination of parafiscal levies (x_{23}). After collecting responses from the 50 farmers, the graph below shows the degree of impact of the potential determinants of commitment to VAT taxation.

Graph 1: Summary of responses on the degree of impact of potential drivers of commitment to VAT taxation



*****: Always

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**** : **More often**
*** : **Occasionally**
** : **Rarely**
* : **Never**
Source: Author

Having collected farmers' reactions to a set of determinants likely to introduce the taxation commitment initiative, we note from the outset that prospects are extremely influenced by an assortment composed of eleven explanatory variables, such as, Neutrality (X_6), public procurement (X_7), a painless tax (X_{11}), a balanced budget (X_{12}), improved productivity (X_{13}), reduced environmental impact (X_{15}), optimal producer choice (X_{16}), reduced VAT credit burden (X_{17}), the elimination of the stop tax (X_{21}), and the indirect tax system (X_{22}). On the other hand, the other factors likely to have a stimulating effect on taxation had little impact on farmers' commitment to value-added tax (VAT).

4.2 Multiple Correspondence Analysis (MCA)

Before opting for modeling, it seems essential to select the explanatory variables that will best predict the response variable. In addition to the descriptive statistics developed above, we use the Multiple Correspondence Factor Analysis (MCAF) method for this purpose, with the aim of grouping factors that have an impact on the commitment initiative and those that do not. Multiple correspondence factor analysis identifies groups of individuals with common characteristics. This analysis method uses tables of individuals noted X based on two axes, where the rows represent the individuals in the selected sample n, and the columns carry the set of qualitative explanatory variables p that describe them. Observations are xij are coded 1 if individual i is influenced by the explanatory antecedent and 0 if not. For a more detailed explanation of the AFCM method, please consult the book by Escofier B. and Pagès J., "Analyses factorielles simples et multiples", published by Dunod (2008). For this purpose, we used SPSS Statistics (version 23), to plot the explanatory variables in a factorial design as shown in the figure below. We note the appearance of two separate groups of explanatory variables. A group on the right associated with the "act of farmers' commitment to VAT taxation" and another on the left linked to the "disengagement" decision. In other words, the decision to engage initiated by farmers can be triggered by the "eleven" explanatory variables forming the point cloud on the right. On the other hand, the scatter plot on the left groups together "twelve" independent variables with little impact on the act of commitment decided by farmers.

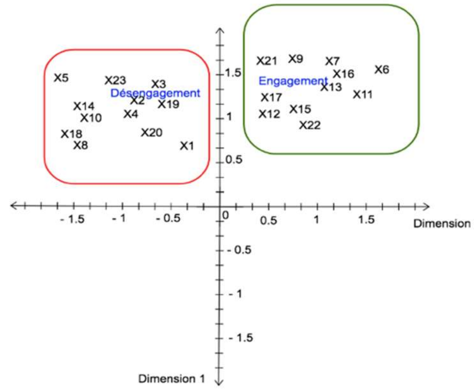

Figure1: Multiple correspondence factor analysis on the profile of variables with a high and low impact on the act of commitment
Source: Author

To sum up, the flat-sorting study and the factorial analysis of multiple correspondences enable us to dissociate the explanatory variables into two types of profiles: those with a strong influence on farmers' decision to engage in value-added tax (VAT) taxation, and those with a weak or negligible impact on this initiative. The MCFA carried out on the variables likely to drive the act of engagement brings out two dimensions, the mapped projection of which is presented in the figure below. The MCFA provides measures of discrimination in a two-dimensional plane in which the variables that cause the same tendencies and attitudes in individuals' responses are grouped together in a way that is close to one another. However, the diagram below shows two clearly identifiable sets of explanatory variables. The first dimension (dimension 1) refers to variables with a low impact on the decision to engage. The second dimension (dimension 2), on the other hand, refers to variables with a strong impact on the decision to tax. Once again, we confirm the results quoted above on the existence of two categories of determinants: those with a highly significant impact and those with a low impact.

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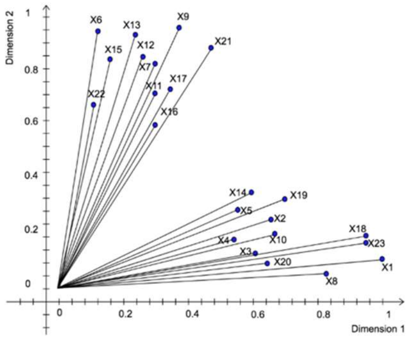

Figure 2: Discrimination measurements
Source: Author

5. PREDICTION OF THE ACT OF COMMITMENT OF AGRICULTURAL UNITS TO VAT TAXATION

In an attempt to engage agricultural units in the tax system specifically value-added tax, our essay focused on analyzing and assessing the impact of an assortment of determinants stimulating farmers' engagement with the tax authorities. However, we also undertook a wide- ranging investigation of the various determinants that drive the commitment of these units to the ultimate goal of registering with the tax authorities for taxation purposes. This theorizing has enabled us to outline the different explanatory variables of commitment. Having selected the explanatory variables with the greatest impact on the latter, we proceeded to design an online questionnaire aimed at agricultural units, in order to collect their responses in terms of their feedback on tax commitment behavior.

The construction of the questionnaire used in this research was inspired by the literature of several authors' works and books. The survey covers two main areas. The first deals with information on the farming unit, while the second includes questions on the determinants of tax commitment, i.e., the factors that stimulate farmers' commitment to the tax authorities. However, information on agricultural units is private and would not be disclosed. We use careful sampling to check the representativeness of the sample (simple random sample). The sample is made up of 1100 farmers, taking into account the size of the population surveyed. After deducting the questionnaire from the 1100 originals, we obtain a total of 1000 valid questionnaires. The first introductory part of the questionnaire is dedicated to the respondent's personal information. The second part is reserved for answers to multiple-choice questions relating to the explanatory determinants of the dependent variable, using a Likert scale.

5.1. Reliability

To assess the reliability of internal consistency between dimensions, authors usually compare the estimate of $\alpha\hat{\alpha}$ to a conventional threshold set at 0.70 (Nunnally J. C. 1978), such as, $\hat{\alpha} > 0{,}70$. In our study we will attempt to analyze the impact of an assortment of stimulating determinants of "farmers' act of commitment to VAT taxation" (variable to be predicted). Before introducing the independent variables into the "Logit" model to measure the impact of each dimension on the response variable: Farmers commitment to VAT taxation", it is essential to assess their degree of reliability in order to guarantee consistent results.

Table 1: Reliability test

Cronbach's Alpha	Cronbach's Alpha based on standardized elements	Number of elements
0.822	0,821	11

Source: Author

From the reliability test, we note that the value of the coefficient $\hat{\alpha} = 0{,}82$ far exceeds the conventional minimum threshold of $\hat{\alpha} = 0{,}70$ (Nunnally J. C. 1978), (Darren and Mallery 2008) revealing that we obtain, for this assortment composed of seven items, a satisfactory internal consistency. Indeed, Cronbach's Alpha ($\hat{\alpha}$) is merely an empirical construct resulting from a set of psychometric studies that are more subjective than scientific, characterized by the non- existence of a precise distribution to be able to rule on its acceptance or refutation (Evrard Y., Pras B., and Roux E. (1997)). Furthermore, several works by theorists such as Feldt L. S., Woodruff D. J. and Salih F.A. (1987), Barnette J. J. (2005) [29], Van Zyl M. J., Heinz N. and Nel D. G. (2000) [30], Iacobucci D. and Duhachek A. (2003) [31], etc., have highlighted statistical procedures concerning the distribution of this coefficient and its confidence interval. Designing a confidence interval for Cronbach's Alpha ($\hat{\alpha}$) requires rigorous statistical analysis, and provides additional information for the research community. However, the work of Feldt L. S., Woodruff D. J. and Salih F. A. (1987) and that of Iacobucci D. and Duhachek A. (2003) [31], have enabled the development of this type of interval, except that in our study we will confine ourselves to the approach of Feldt, Woodruff and Salih (1987). The writings of Feldt, et al. (1987), demonstrated that the distribution of values of ($\hat{\alpha}$) follows the "Fisher" distribution (F) with degrees of freedom

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ddl_1 = (n-1), and $ddl2$ = (n-1) (k-1), where n denotes the sample size, and k the number of variables used. However, for a sample size of (n), a scale made up of (k) variables, an observed Cronbach's Alpha coefficient ($\widehat{\alpha}$) and a degree of significance (γ), the bounds of the confidence interval according to Feldt, et al. (1987), can be realized as follows:

- $IC_{inf} = 1 - [(1- \widehat{\alpha}) \times F_{(1-\gamma)/2}, ddl_1, ddl_2]$
- $IC_{sup} = 1 - [(1- \widehat{\alpha}) \times F_{(\frac{\gamma}{2})}, ddl_1, ddl_2]$

Where *F* represents the Fisher statistical value for the percentiles γ/2 and (1 - γ)/2 respectivelywith ddl_1 = (n - 1), et ddl_2 = (n -1) (k - 1).

Table 2: Intra-class correlation coefficient

Correlation Intra-class		Interval 95% confidence		Fisher Test			
		Terminal Lower	Terminal Superior	Value	ddl_1	ddl_2	Sig.
Measures Unique	0.397	0.370	0.425	5.611	109	1090	0.000
Mesures Averages	0.822	0.804	0.838	5.611	999	5994	0.000

Source: Author

From the above result, we can see that the observed Cronbach's Alpha coefficient $\widehat{\alpha}$ = 0,822 ∈ $IC^{5\%}$= [0.838, 0.804], with a sample size *n* = 1000, a number of independent variables *k* = **11** constituting the scale used, a ddl_1 = (n - 1) = 109 and a ddl_2 = (n - 1) (k - 1) = 1090. We also note that the values obtained are highly significant with a $p = 0.000 < 0.05$.

5.2. Chi-square test

The chi-square test (χ^2), is a non-parametric test based on the (χ^2) initiated by British mathematician Karl Pearson in (1990), as discussed in Stephen Stigler's "Karl Pearson's theoretical errors and the advances they inspired" published in (2008). These types of tests are applied only to categorical variables, whether nominal, ordinal, grouped into classes, or even binary. Tests of (χ^2) tests are primarily designed to compare distributions. However, there are three categories of (χ^2) tests, such as the (χ^2) test, the (χ^2) test of fit, and the (χ^2) test of independence. The latter test is used to demonstrate the statistical relationship between the explanatory variables used and the response variable on the same sample of size *n*. In other words, this test is used to verify the absence or presence of a statistical link between two qualitative variables X, assumed to be explanatory, and Y, to be explained. Being a hypothesistest, let H_0 the null hypothesis describing the independence of the distribution of the two variables. In terms of *p-value*, the null hypothesis H_0 is generally rejected when $p < 0.05$. Note:

H_0 : The two variables X and Y are independent.

Table 3: Chi-square test

Explanatory variables	χ^2 value of Pearson	Likelihood ratio	Linear by linear association	ddl	Asymptotic significance (two-sided)
X_6	61.341	59.291	47.001	10	0.000
X_7	58,209	55.376	50.501	10	0.000
X_9	47.129	40.673	38.242	10	0.000
X_{11}	63.304	58.479	51.112	10	0.000
X_{12}	39.199	31.200	29.470	10	0.000
X_{13}	51.783	47.490	41.190	10	0.000
X_{15}	56.482	52.094	50.297	10	0.000
X_{16}	67.938	62.038	51.509	10	0.000
X_{17}	45.039	40.837	37.872	10	0.000
X_{21}	58.202	50.891	43.170	10	0.000
X_{22}	72.013	60.303	56.209	10	0.000

Source: Author

The Chi-square test shows that the relationship between the explanatory variables, namely Neutrality (X_6), public procurement (X_7), a painless tax (X_{11}), a balanced budget (X_{12}), improved productivity (X_{13}), reduced environmental impact (X_{15}), optimal producer

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choice (X_{16}), lowering the VAT credit burden (X_{17}), the elimination of the stop tax (X_{21}), and the indirect tax system(X_{22}), and the response variable **"farmers' act of commitment to value-added tax"** is highly significant, with an asymptotic (two-sided) significance of p = 0, 000 < 0.05. These results lead us to reject the null hypothesis H_0. In other words, the explanatory variables chosenin this study have a significant relationship with the response variable, i.e. an important influence on actors' tax liability decision.

5.3. Cramer test

In addition to the Chi-square test, which reveals whether variables are related, the Cramer test measures the strength and intensity of this relationship. Let X and Y be two qualitative variables, , $k_1$and $k_2$respectively, and n the size of the valid sample, Cramer's *V,* based on Pearson's test statistic χ^2 test statistic, can be formulated as follows:

$$V=\sqrt{\frac{\chi^2}{n\times min\,(k_1-1,\ k_2-1)}}$$

Table 4: Cramer's V test

		Value	Approximate meaning
Cramer's V	X_6	0.490	0.000
	X_7	0.349	0.000
	X_9	0.320	0.000
	X_{11}	0.435	0.000
	X_{12}	0.422	0.000
	X_{13}	0,389	0.000
	X_{15}	0.351	0.000
	X_{16}	0.398	0.000
	X_{17}	0.411	0.000
	X_{21}	0.302	0.000
	X_{22}	0.450	0.000

Source: Author

Table 5: Interpretation of Cramer's V

Absolute value of Cramer's V	Intensity of relationship betweenvariables
Between 0 and 0.10	Negligible connection
Between 0.10 and 0.20	Very weak bonding
Between 0.20 and 0.40	Moderate link
Between 0.40 and 0.60	Relatively strong bond
Between 0.60 and 0.80	Strong bonding
Between 0.80 and 1	Very strong bonding

Source: Our own work, inspired by Louis M. Rea and RichardA. Parker (1992))

The absolute value of Cramer's |V| varies in the interval [0,1]. In our case, we can see that the explanatory variables have a strong impact on the variable to be explained. **Farmers' commitment to VAT taxation. As mentioned in the Cramer test, Cramer's V of explanatory determinants,** neutrality (X_6), the subjection to public procurement (X_7), painless tax (X_{11}), a balanced budget (X_{12}), productivity improvement (X_{13}), reduced environmental impact (X_{15}), optimal producer choice (X_{16}), lowering the VAT credit burden (X_{17}), the elimination of the stop tax (X_{21}), and the indirect tax system (X_{22}), all have a threshold greater than 0.30, explaining a significant relationship with agricultural units'commitment to VAT taxation.

5.4. Test R^2 adjusted

*Table 6: Test of **R2** adjusted*

2 Log de Verisimilitude	R-two of Cox and Snell	R-two of Nagelkerke	R square of the sum of squares	R square (Adjusted) ofthe sum of squares (R^2)
396.009	0.339	0.611	0.848	0.886

Source: Author

The model summary provides the values of (-2LL), Cox and Snell's R-two and Nagelkerke's R-two for the complete model. The value of (-2LL) for this model is 396.009. This value was compared to that of the base model using the chi-square test to reveal a highly significant decrease between the two (p = 0.000 < 0, 05). This degradation justifies that the new model is significantly better adapted than the null model. Furthermore, the R-two values tell us approximately how much variation in the outcome is explained by the model. The Cox and Snell R-two for the full model is 0.339, indicating that only 33.9% of the variation in the probability of a farmer being able to commit could be explained by all the explanatory variables. Furthermore, Nagelkerke's R-two, which is an adjusted version of Cox and Snell's R-two and therefore closer to reality, stands at 0.611. It can therefore be said that the explanatory variableshelp to explain 61.1% of the variation in the probability of a farmer being able to make a VAT commitment to the tax authorities. On the other hand, a high value for the coefficient of R^2 adjusted or interpolated coefficient of determination refers to a better fit of the model to the data used. In our case, the coefficient of determination R^2= 0.886, i.e. 88.6% of the dispersionis explained by the binary logistic regression model. Note the following:

$$R^2 \text{ Adjusted} = R^2 - \frac{K(1-R^2)}{N-K-1}$$

Hence:

- N : Sample size
- K : Number of explanatory variables
- R^2 : Coefficient of determination

5.5. Estimation of coefficients $\hat{\beta}$

Consider a sample *n* divided into two groups of farmers G_1 and G_2 identifiable by a set of independent variables, Neutrality (X_6), the subjection to public procurement (X_7), a painless tax (X_{11}), a balanced budget (X_{12}), improved productivity (X_{13}), reduction of environmental impact (X_{15}), optimal producer choice (X_{16}), lowering the VAT credit burden (X_{17}), the elimination ofthe stop tax (X_{21}), and the indirect tax system (X_{22}). Let Y be the dichotomous qualitative variable to be predicted (response variable) expressing: Farmers' commitment to VAT taxation.Y has the value (1) if the farmer belongs to the group G_1. and (0) if he comes from the group G_1 Also noting that the G_1 is dedicated to farmers who choose to commit to VAT taxation, and G_2 dedicated to those who refuse this commitment and decide to opt out. From which we canwrite

Y = 1: Agricultural units' commitment to VAT taxation.
Y = 0: Act of disengagement of agricultural units from VAT taxation.

The selected explanatory variables can be explained as follows:

- X_6: Neutrality
- X_7: Public procurement
- X_9: Proportionality of the Tax
- X_{11}: A painless tax
- X_{12}: Balanced budget
- X_{13}: Productivity improvement
- X_{15}: Reducing environmental impact
- X_{16}: Optimal choice of producer
- X_{17}: Reducing VAT credit burdens
- X_{21}: Bumper removal
- X_{22}: Indirect tax system

In this study, we have tried to identify the variables that predict the act of commitment and to measure the impact of each of these variables on farmers' decision to be subject to VAT taxation. However, the predictor variables introduced into the model are qualitative. Statisticalanalysis of the data was carried out using IBM SPSS Statistics version 23.

Table 7: Variables in the equation

	$\hat{\beta}$	E.S	ddl	Sig.	Exp ($\hat{\beta}$)	95%confidence interval for Exp ($\hat{\beta}$)	
						Inf.	Sup.
X_6	2.11	0.20	1	0.00	8.24	8.01	8.43
X_7	0.87	0.10	1	0.00	2.40	2.22	2.61
X_9	1.50	0.21	1	0.00	4.48	4.28	4.62
X_{11}	2.20	0.092	1	0.00	9.03	8.82	9.28
X_{12}	1.98	0.12	1	0.00	7.24	6.94	7.49
X_{13}	1.32	0.11	1	0.00	3.77	3.53	3.91
X_{15}	1.29	0.37	1	0.00	3.66	3.43	3.82
X_{16}	1.55	0.14	1	0.00	4.72	4.50	4.93
X_{17}	1.71	0.04	1	0.00	5.52	5.32	5.73
X_{21}	1.88	0.05	1	0.00	6.59	6.39	6.70
X_{22}	1.11	0.31	1	0.00	3.05	2.92	3.20
C	-10.2	0.77	1	0.03	0.00	-	-

Source: Author

This table provides the regression coefficients $\hat{\beta}$, the odds ratio (exp **($\hat{\beta}$))** also known as the odds ratio for each explanatory variable, and finally the confidence interval for each odds ratio (OR). Looking first at the results, we see a highly significant effect of all the predictor variables on the response variable **"decision to commit agricultural units to VAT taxation"**. However, the asymptotic significance (two- tailed) ***p*** of the explanatory variable "neutrality (X_6) "is 0.008 < 0.05, ***p*** "public procurement liability (X_7) " = 0.001 < 0.05, ***p*** "Proportionality of Tax (X_9) " = 0.000 < 0.05, ***p*** "Painless Tax (X_{11}) " = 0.005 < 0.05, ***p*** "balanced budget (X_{12}) "= 0.000 < 0.05, ***p*** "improved productivity (X_{13}) "= 0.000 < 0.05, ***p*** "Reduced environmental impact (X_{15}) " = 0.006 < 0.05, ***p*** "optimal choice of producer (X_{16}) " = 0.000 < 0.05 , ***p*** "Reducing the burden of VAT credit (X_{17}) " = 0.001 < 0.05, ***p*** "the elimination of the stopper (X_{21}) " = 0.000 < 0.05, and ***p*** "the indirect tax system (X_{22}) " = 0.007 < 0.05.

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However, it's easy to interpret the p-meanings, but the question at this stage is how to interpret the regression coefficients $\hat{\beta}$. What does this coefficient correspond to, and how can it be interpreted? Nevertheless, the regression coefficient $\hat{\beta}$ can only explain the direction of fluctuation between the explanatory variable and the response variable. That is, a positive sign of the coefficient $\hat{\beta}$ refers to a change in the same direction between the predictor variable and the dependent variable, while a negative sign confers to a change in two opposite directions of the two variables. Apart from the coefficient $\hat{\beta}$ is not really interpretable. Yet the exponential of " $\hat{\beta}$ " (exp ($\hat{\beta}$))" endorses a meaning easily interpretable by statisticians. The "exp($\hat{\beta}$) also called odds-ratio (OR), odds ratio, odds ratio, or also close relative risk, designating a statistical measure, disclosing the degree of dependence and effect of an explanatory factor in relation to the response variable.

The column exp ($\hat{\beta}$) (Odds Ratio) tells us that the different explanatory variables each influence the variable to be predicted in a distinct way. In line with our case, we can claim that the determinant "neutrality (X_6) " can generate an eightfold greater chance (OR (X_6) = 8248, IC5% = [8.017, 8.437] that agricultural units are likely to engage with the tax authorities regarding VAT taxation, than to remain uncommitted. In the same vein, "Public procurement liability (X_7)" also makes it twice as likely (OR(X_7)) = 2.403, IC5% = [2.225, 2.611]) that they will choose to initiate their liability commitments. Thus, the "Proportionality of Tax (X_9) " determinant is four times more likely (OR(X_9) = 4.486, IC5% = [4.283, 4.627]) that he will opt for this decision. Similarly, the determinant "Painless tax X_{11}" has a greater impact on agricultural units committing to VAT taxation, with a ninefold greater chance (OR(X_9) = 9.034, IC5% = [8.820, 9.283]) of expressing their refusal.

However, "Balancing the budget (X_{12}) " offers a sevenfold greater chance (OR(X_{12}) = 7.242, IC5% = [6.948, 7.492]) that these farming units will be able to accept their value-added tax commitment. Again, "Improving productivity (X_{13}) " is three times more likely (OR(X_{13}) = 3.773, IC5% = [3.539, 3.918]) for these agricultural actors to accept the idea of registering with their tax authorities. Similarly, "Reducing environmental impact (X_{15}) " is three times more likely (OR(X_{15})) = 3.661, IC5% = [3.430, 3.829]) to lead to a decision to engage with the tax authorities. Similarly, "Optimal producer choice (X_{16}) " is four times more likely (OR(X_{16})) = 4.720, IC5% = [4.502, 4.939]) to express acceptance of the new tax vision. Nevertheless, "Reducing the burden of the VAT credit (X_{17}) ", "Eliminating the stop (X_{21})", and "Indirect tax system (X_{22}) ", respectively indicate five (OR(X_{17}) = 5.528, IC5% = [5. 320, 5.739]), six (OR(X_{21})) = 6.592, IC5% = [6.392, 6.702]), and two (OR(X_{22}) = 3.058, IC5% = [2.922, 3.202]) times more likely to agree with the new attempt at VAT taxation of agricultural activities.

5.6. Sigmoid function

Before delving into the concept of the sigmoid function, it is important to remember that logistic regression does not seek to strictly simulate the dichotomous responses of agricultural units, but to model the probability of engagement of each of the two terms of the response variable Y, such as the decision to engage/disengage in VAT tax taxation, as a function of an assortment of explanatory variables. This probability of engagement cannot take the form of a straight line,as it lies between the two values 0 and 1. This probability of realization cannot take the form ofa straight line, as it lies between the two values 0 and 1. However, it can take the form of a sigmoid function, also known as an S-shaped function, which also represents the distribution function of the logistic law. Nevertheless, it is a mathematical function that can accept any realvalue of R and map it to a value between 0 and 1, resulting in a function in the form of the letter S. The logistic function has two asymptotes, such that Y= 1 and Y= 0, and is thus defined by:

$$Y = \pi = \frac{exp^{\left(\sum_{k=0}^{p} \widehat{\beta_k}\, x_{ik}\right)}}{1 + exp^{\left(\sum_{k=0}^{p} \widehat{\beta_k}\, x_{ik}\right)}} = \frac{1}{1 + exp^{\left(-\sum_{k=0}^{p} \widehat{\beta_k}\, x_{ik}\right)}}$$

Furthermore, if the value of x tends towards plus infinity ($x \rightarrow +\infty$), the value of Y tends towards 1 ($Y \rightarrow 1$), expressing a scenario that reflects the possibility of commitment. On the other hand, if x tends towards minus infinity ($x \rightarrow -\infty$), the value of Y tends towards 0 ($Y \rightarrow 0$), indicating a possible refusal of commitment. We also choose to label probabilities of realization above the threshold of 0.5 with class 1 and classify probabilities below 0.5 with class 0. Note:

$$\pi > 0.5 \rightarrow \text{Classe } 1$$
$$\pi \leq 0.5 \rightarrow \text{Classe } 0$$

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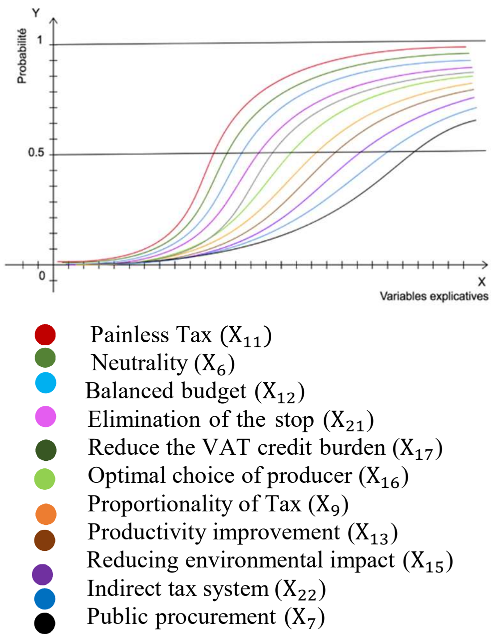

Figure 3: Logistic functions (sigmoids)
Source: Author

We can see from the logistic curves presented in the figure above that the determinant "Painless tax (X_{11})" is a powerful factor with a highly significant influence on agricultural units, encouraging them to engage with their tax authorities in matters of value-added tax (VAT). However, the sigmoid curve appropriate to this commitment antecedent was the first to changethe direction of its variation and exceed probability π = 0.5 from π = 0 expressing disengagement to reach class 1, hence probability π = 1 expressing the commitment ofagricultural businesses, noting that the$\hat{\beta}$ (***Painless Tax***) = 2.201 and the OR = 9.034. However, the second curve returns to the "***neutrality*** (X_6)" factor, marking the crossing of probability π= 0.5 just after the "***Painless tax"*** determinant curve, placing it in class 1. This second rank is represented by the coefficient$\hat{\beta}$ (***neutrality***) = 2.110 and OR = 8.248. Third and fourth place went respectively to the two antecedents of commitment, namely "***balanced budget***" and "***elimination of the buffer***". These two antecedents of commitment are respectively characterized by the regression coefficients$\hat{\beta}$ (***budget balance***) = 1.980 and $\hat{}\beta$(***elimination of the buffer***) = 1.886. Thus, odds ratios OR (***budget balance***) = 7.242, and OR (***elimination of the buffer***) = 6.592. What's more, both their curves are ahead of the probability π = 0.5 just after that representing "***neutrality***". On the other hand, the last-ranked commitment determinants are represented by sigmoid curves crossing the probability π = 0.5, such as the function of the commitment drivers "***environmental impact reduction***", "***indirect tax system***" and "***public procurement",*** with odds ratios OR = 3.661, OR = 3.058, and OR = 2.403 respectively.

After a broad overview of the literature review and previous work, several unexplored avenues of research were identified. However, previous writings have mainly dealt with exemptions for agricultural activities and their repercussions on micro-economic variables, specifically farmers, and macro-economic variables such as economic growth, the encouragement of investment, and the coverage of national consumption as well as net external demand for agricultural products. Except, our prospection aims to change this path of investigation, by focusing on the exploration of determinants likely to stimulate the fiscal commitment of agricultural units. In other words, this essay attempts to predict the act of engagement of these businesses with the tax authorities in VAT matters. The aim is to improve tax revenues and, consequently, balance the State budget, combat money laundering in this sector, ensure a fair distribution of wealth, challenge agricultural idleness, and lower the rate of capital channelled into low-value-added, exempt agricultural activities, so that it can be channelled into other, more competitive sectors.

Our research aims to propose concrete solutions to remedy an assortment of anomalies, as cited above. By exploiting information technologies in data collection, processing and analysis operations, our research offers a viable solution for draining tax receipts from state treasuries, derived from agricultural income hitherto exempt under Moroccan tax legislation. The results obtained are not limited to a simple answer to the questions posed, but open up new prospects for improving the country's budgetary situation by revising the tax policies surrounding the agricultural sector, and making up for other shortcomings. Nevertheless, despite the tax exemption for the agricultural sector supported by the public authorities with the aim of improving its added value, the results obtained indicate a contrary reality. By shedding light on the challenges associated with agricultural taxation and proposing concrete means of improvement, this work is intended as a reference for decision-makers, researchers and players in the agricultural sector, contributing to an understanding of the mechanisms essential to overcoming the country's socio-economic challenges and guiding public policies in favor of a more sustainable and competitive Moroccan agriculture.

The critical eye is often considered the indispensable companion of the research community. After having mobilized information technologies to predict the act of tax liability of agricultural units with regard to VAT, and the proposal of a new econometric model measuring the impact of the determinants of tax liability on this decision of liability, it is notorious to underline the main limits of this test. In addition, the results obtained do not present a generalized model of the behavior of agricultural enterprises in Morocco, due to their concentration at the regional level of the Rabat-Salé-Kénitra area. Also, no segmentation was carried out in terms of the size and strategic field of activity of the companies surveyed

By highlighting the shortcomings of our article, several avenues of research are opened up for the consideration of researchers and academics in this discipline. However, this study can be carried out in a broader context, in order to design a generalized model of the behavior of agricultural businesses with regard to tax liability. Similarly, with reference to the principle of tax fairness, artificial intelligence can play an important role in taxing farmers in proportion to their income in terms of VAT, income tax and corporation tax. Researchers in information technology can also delve deeper into these topics of public interest, and design a model of agricultural taxation that contributes to improving the country's macro and micro economic magnitudes.

6. CONCLUSION

At the end of this in-depth exploration of the determinants influencing agricultural units' commitment to VAT taxation, a more nuanced understanding of tax dynamics in the Moroccan agricultural sector emerges. Through a careful analysis of factors such as tax neutrality, subjection to public procurement, tax proportionality, a painless tax, a balanced budget, improved productivity, reduced environmental impact, optimal producer choice, lower VAT credit burden, elimination of the stop-gap and the indirect tax system, our study aims to shed light on the complexities of the relationship between agricultural actors and the tax framework.

The results, highlighted through logistic curves, underline the crucial role of the "Painless Tax" determinant as a powerful incentive. The significant influence of this factor on farming units' commitment to VAT suggests that tax design, seeking to minimize the economic impact on farms, may play a determining role in farmers' willingness to comply with tax obligations. The "painless tax", by promoting the economic viability of farms while generating much-needed tax revenues, emerges as a promising avenue for tax reforms in the agricultural sector. The legitimacy of tax policies appears to be closely linked to the minimization of economic impacts, underscoring the importance of designing mechanisms that ease the financial burden on farmers while contributing to public revenues.

In addition, our results reiterate the importance of aligning tax policies with market dynamics, underlined by the determinant "subjection to public procurement". The integration of tax mechanisms with market realities appears to be an essential strategy for enhancing the effectiveness of agricultural tax policies, thus promoting better adaptation to economic fluctuations. However, "tax proportionality", while not emerging as the most influential determinant in our results, remains a crucial aspect in ensuring fairness while encouraging agricultural activity. Tax policies must aim to maintain a balance that does not excessively burden farms, while making a fair contribution to public revenues. Furthermore, the search for "budgetary balance", the promotion of "productivity improvement" and the "reduction of environmental impact" appear as complementary objectives for sustainable tax policies. These aspects demonstrate the interconnection between the economic, environmental and social dimensions of the agricultural sector, underlining the need for holistic approaches to tax reform. Optimal producer choice" also emerges as a crucial dimension in the design of tax policies. Creating incentives aligned with farmers' socially desirable choices can contribute to greater acceptance of reforms and greater effectiveness of tax policies. From a more practical perspective, the research suggests that "lowering the VAT credit burden", "eliminating the stopper" and "adopting an indirect tax system" can be levers for simplifying the agricultural tax system. These adjustments aim to minimize administrative obstacles, thus contributing to better compliance by farmers.

This study offers a significant contribution to understanding the determinants of agricultural units' commitment to VAT. These findings, based on in-depth analysis and empirical data, can guide policymakers in designing tax reforms better adapted to the specificities of the Moroccan agricultural sector. The importance of the "Painless Tax" as a major driver of tax compliance suggests the need for more inclusive tax policies, seeking to ease the burden on farmers while promoting a fair contribution to the national budget. Thus, this prospecting is not limited to a theoretical exploration of determinants, but offers practical insights to guide future tax reforms in the agricultural sector. It underlines the importance of considering the operational realities of farmers, and of designing policies that stimulate the sustainability, competitiveness and resilience of Morocco's agricultural sector in a constantly changing economic context.

By pointing to the empirical results of this study, our essay not only provides answers to the hypotheses and questions raised above, but also enriches the body of knowledge in the field of agricultural taxation in Morocco, proposing new strategic visions to the tax authorities in antagonism to those that preceded them. Using information technology tools, responses from agricultural units were collected via online questionnaires and grouped into specific platforms, facilitating their processing through data processing and analysis software. In particular, the proposed Logit model, more specifically binary logistic regression on software (IBM SPSS Statistics 29), enabled us to understand and measure the impact of each tax liability determinant on the act of tax commitment in the agricultural sector. These results provide a solid basis for orienting future research and guiding public policy in favor of a more sustainable and competitive Moroccan agriculture.

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