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The Perception of Earnings Management According to an Econometric-Accounting Analysis: The Case of Tunisia

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Abstract- Accounting information provides support for decisions made by the company's management and its partners. Potential investors, financial backers as well as authorities (financial and judicial) make their decisions based on this information, which itself is supposed to be drawn up in accordance with generally accepted accounting standards and principles. However, the existence of accounting choices and accounting policies that are diversified and standardized by the accounting system create the freedom for managers to manipulate the quality of the information. In other words, a situation of information asymmetry may tempt the managers of failing companies to adopt choices in order to influence the perception of risk by its partners.

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The Perception of Earnings Management According to an Econometric-Accounting Analysis: The Case of Tunisia

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Abstract- Accounting information provides support for decisions made by the company's management and its partners. Potential investors, financial backers as well as authorities (financial and judicial) make their decisions based on this information, which itself is supposed to be drawn up in accordance with generally accepted accounting standards and principles. However, the existence of accounting choices and accounting policies that are diversified and standardized by the accounting system create the freedom for managers to manipulate the quality of the information. In other words, a situation of information asymmetry may tempt the managers of failing companies to adopt choices in order to influence the perception of risk by its partners.

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I. Introduction

Companies that fail financially or who commit violation of legal provisions in terms of accounting or transparency of published financial information are most often listed and classified (AAER of the SEC in the United States or black lists of the AMF in France) . Similarly, information about fraudulent businesses (ranging from fraudulent financial statements to fraudulent bankruptcies) is disclosed instantly and periodically (in developed countries). Therefore, two schemes are important and necessary, to alert and denounce respectively financial failures and fraudulent practices of companies operating in the economy, namely the legal (the judicial authorities) and the financial (the financial authorities). In fact, the subject of companies in difficulty is the privileged domain of the related interests of the manager and the lawyer; the former is interested in the process of forming the accounting result that has led to such distress, and the latter is more interested in the legal-contractual process which has revealed a state of insolvency following a financial default, with, however, as common support of these two processes: accounting. In the United States of America, business difficulties are the catalyst for work that explicitly addresses the impact of the failure as a research context either on the firm's performance or on other variables such as capital structure. Even executive compensation as one can find other research that focuses more specifically on the accounting choices made by managers in a context of financial distress (DeAngelo et al., 1994). The issue of accounting information deserves to be studied through the relationship of failure / accounting, revealing the fundamental dilemma between business secrecy and transparency of accounting and financial information. Moreover, the interest of this subject is related to the more general problematic of the accounting standardization, meaning the capacity of the accounting system to give as much as possible a faithful picture of the economic reality, which of on the one hand, the performance level, can assure the investors as to their investment choices or the donors as for their decision of financing, and on the other hand, can help the judicial authorities as for their decision to pronounce the state of cessation of payment and therefore trigger the procedure of judicial settlement which may lead to legal bankruptcy which can be fraudulent or non-fraudulent.

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II. The Financial Failure Management Process is based on Handling the Accounting Data: Empirical Validation based on a Sample of Companies Listed on the BVMT.

It is important to have an effective information system, that is , to establish sustainable prevention arrangements or to move towards procedures that are more likely to lead to business survival. According to Charreaux (1997), the possibility of detecting the degradation of performance is one of the conditions for designing crisis-prevention corporate governance systems. For Skinner D. and DeAngelo (1994), the provision by managers of sufficient accounting and financial elements would make it possible to identify difficulties and thus to resort to an informal reorganization. This is why one of the privileged fields of research conducted on "accounting-failure of companies" is that of prediction models of bankruptcy vs fraud. At the level of the manipulations of the accounting information in a context of difficulty, one can note that many managers do not resist the temptation to dissimulate to thirds the whole gravity of the situation. According to DeAngelo et al. (1994), the predictions of the positive theory predicts that executives of companies experiencing difficulties make accounting choices to improve the outcome. Two explanations can be given:

- Either they have an incentive to increase the results disclosed, that is, to keep their positions or to avoid the control of donors or regulatory bodies and guardianship.
- Or they can increase the results to avoid violating the contractual clauses related to the indebtedness.

Observing the persistent existence of negative accruals (The behavior of managers is observed through the management of accruals, that is to say the accrual accounts and other products and expenses calculated and offset.), the study conducted by these authors on 76 listed companies results in the distinction of two parts in accruals and their variations. A substantial portion is the result of "real" economic choices made by managers, including a decrease in inventories or changes in technology.

According to the positive theory (A. Scott Keating, Jerold L. Zimmerman, 2000), managers practice an accounting data management that corresponds to the contractual usefulness and the perception that investors will have of the company's situation. Hence its risk. In this logic, the directors of companies at risk of high bankruptcy, manage the accounting data, in a goal of concealment (fraud) financial difficulties. In this approach, the concept of contracts is a crucial piece in the study of managers and stakeholders' behavior . Thus, the latter will manifest through the accounting and financial choices that they will adopt as part of a management strategy on a key variable of appreciation of the company's performance which isn't other than: "the published accounting result". The management of this variable therefore appears as one of the implicit objectives of an accounting policy insofar as the published accounting results, or the balances contributing to its formation, are taken into account in the negotiation of contractual conditions or in the resolution of Conflicts. The accounting policy is therefore the main instrument for the implementation of this results management strategy, the objectives of which are to present a level of performance favorable to the interests of the managers and to mitigate the conflicts and the specific risk of the company. Indeed, for Jensen and Meckling (1976), financial accounting plays a controlling role in contractual relations and the politico-

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contractual approach considers that accounting makes it possible to mitigate the effects of wealth transfer between shareholders and managers and between leaders and creditors (Franco Modigliani, Merton H. Miller, 1958). This allows us to assume that the company at high risk of bankruptcy can be considered as a place of confrontation strategies.

By arbitrating between the preservation of part of their interests and losses related to bankruptcy[1], shareholders and majority creditors (respectively as a percentage of capital and debt) seek compromises (through negotiations) that can maintain control on the company and guarantee their property or financial rights. As for the leaders, relying on the discretionary power they hold, will implement strategies that preserve their interests. In fact, managers are encouraged to make real management decisions that can improve the company's performance or to adopt appropriate accounting choices to act on the firm's image by reducing the external perception of the risk of bankruptcy. They thus instrument the accounting information (result management) to safeguard their interests and consequently those of the company. This assumption stems from a double consideration: the first is that the reality of the company's situation exists and is perceptible by its partners; the second, considers that financial accounting gives a reflection supposed to be reliable and relevant to this reality. The financial difficulties of the company lead all the partners of the company to take measures to avoid bankruptcy by adopting appropriate strategies. Indeed, when the costs of a private renegotiation are a priori cheaper than those related to a judicial bankruptcy, it seems more rational for the company and its partners to avoid triggering the judicial bankruptcy. However, the company can be put to a judicial settlement (by a court decision following a request made to this effect by the directors of the company or its partners - Law 2016-36) when the leaders and the main partners consider that Judicial protection is an optimal solution to ensure recovery and their interests: this is the so-called "defensive" strategy. Conversely, managers can avoid the collective procedure by encouraging the partners to renegotiate the debt and reorganize the capital and structure of the firm: in this case it is the strategy called "d ' offensive ". The implementation of these two strategies will be done through the financial statements through the accounting choices as part of a strategic management of the results modifying the content of these financial statements. From these two strategies follow the basic assumptions of our econometric approach for the rest of this study.

H1: It concerns the existence of result management; it is a question of whether managers of companies with low financial profitability adopt a strategy of management of the result through the accounting choices?

H2: It relates to the meaning of the adjustments of the accounting variables made by the managers of companies with low financial profitability; it is a question of knowing if in such a business context, the leaders manage upward the results? In this case we can consider two sub-hypotheses:

[1] The different costs of bankruptcy include explicit costs, resulting in cash outflows, such as the legal or administrative costs related to judicial settlement or liquidation procedures (fees, transaction costs incurred to liquidate the assets ...), but also implicit costs, also known as opportunity costs, associated, for example, with the loss of trust of suppliers or bankers, or conflicts of interest between creditors and shareholders. The latter is linked to the agency costs insofar as the shareholders are supposed to be the agents of the creditors who entrust their capital to them.

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• H2-1: managers opt for a defensive strategy manifested by a management of the result upward; they opt for accounting choices to increase the performance indicators in order to avoid the collective procedure.

• H2-2: the managers opt for an offensive strategy that manifests itself through a management of the result downward; they opt for accounting choices leading to a drop in performance indicators or to dispel difficulties in order to encourage partners to renegotiate privately.

The model for estimating accounting variable adjustments is defined to test these assumptions.

We have:

$$AVCRT_{it} = RN_{it} - CF_{it} \quad (1)$$

With,

$AVCRT_{it}$ = Adjustment of accounting variables companies i period t

RN_{it} = Net profit of firm i period t

CF_{it} = Cash flow generated by the firm i period t

The latter variable is the difference between the cash flow from operations (CAF) generated by the company and the change in the working capital requirement (ΔBFR) over two consecutive periods:

$$CF_{it} = CAF_{it} - \Delta BFR_{it} \quad (2)$$

CAF_{it} = Cashable products (except disposals) - disbursable expenditure (except disposals)

It represents the flow of internal equity that remains available to the company to be self-financing before the dividend is paid. This is the initial cash flow resulting from the difference between cashable products and the cash costs with the exception of cash flows related to asset disposals.

We note that the AVCRTs are based on the calculated expenses and revenues and the change in the working capital requirement.

Through the estimation models we have found that only a part of these adjustments to the accounting variables can be manipulated: this is the discretionary component of total accruals. As for the non-discretionary part, it corresponds to all the accounting elements on which the managers do not have decision-making power in matters of accounting policy. Therefore, the following hypothesis is formulated:

The variable $AVCRT_{it}$ of firm i at date t consists of a discretionary part we note $AVCRD_{it}$ and from a non-discretionary part that we note $AVCRND_{it}$

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From where:

$$AVCRT_{it} = AVCRD_{it} + AVCRND_{it} \quad (3)$$

Since the first component ($AVCRD_{it}$) cannot be calculated directly, it is estimated from the calculation of the non-discretionary component and the total adjustments. The following accounting elements are contained in the non-discretionary component:

1. The change in working capital requirements (ΔBFR) changes according to the economic activity of the company. It is measured by changes in inventories, debts and turnover. The change in sales adjusted for actual cash balances is considered a non-discretionary item that reflects the actual business performance of the business. This latter variation is a component of non-discretionary accruals.

2. Depreciation and amortization net of reversals included in the calculation of cash flow depend on fixed assets. There is thus a positive and constant relationship between the amount of endowments and the amount of fixed assets. Fixed assets (gross book value) are retained as a non-discretionary item reflecting the real productive capacity of the company.

3. Monetary flows resulting from offsetting accruals, debt restructuring transactions and receivables are also included in the non-discretionary portion of the accounting variables.

We can therefore formulate the non-discretionary part of equation (3) by the following equality:

$$AVCRND_{it} = f(IMMO_{it} + (Var^{t}_{t-1}CA_i - Var^{t}_{t-1}Cr_i) + FMO_{i,t-1}) \quad (4)$$

With:

$IMMO_{it}$ = Total amount of gross fixed assets of the company i period t

$Var^{t}_{t-1}CA_i$ = Change in turnover between 2 successive years t and t-1

$Var^{t}_{t-1}Cr_i$ = Variation of trade receivables company i between t and t-1

$FMO_{i,t-1}$ = Business cash flow i period t-1

The valuation of the adjustments to the total accrual accounting variables for a firm i at the time t ($AVCRT_{it}$) is derived from the following generalized modified Jones model:

$$\frac{AVCRT_{it}}{TA_{it-1}} = \lambda_0 + \lambda_1\left(\frac{Var^{t}_{t-1}CA_i - Var^{t}_{t-1}Cr_i}{TA_{it-1}}\right) + \lambda_2\left(\frac{IMMO_{it}}{TA_{it-1}}\right) + \lambda_3\left(\frac{\Delta FMO_{it-1}}{TA_{it-1}}\right) + \varepsilon_{it} \quad (5)$$

With:

TA_{it-1} = Total assets of the firm i period t-1

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ε_{it} = The error term (of residuals) this corresponds to the portion of the adjustments of discretionary regularization accounting variables.

The error term ε_{it} in this model represents the discretionary portion of the adjustments to the total accounting variables. It is obtained from equation (5), which is the model estimated over an earlier period, by regressing for each enterprise the accounting variables of adjustments observed on the calculated values of the different variables.

This model makes it possible to test the hypotheses on the existence of management of the result and the direction of the adjustments (hypotheses H1 and H2). Indeed, a Student's statistical test is used to determine if the adjustments of the discretionary accounting variables are significantly lower than zero.

The sign of the relation ($AVCRT_{it} - AVCRND_{it}$) indicates the direction of the accounting choices' orientation allowing us to define the strategies that the leaders want to emit through the published accounting information:

A positive difference indicates that the reported accrual accounting variables of enterprise i at period t are greater than the normal adjustment variables:

$$Accruals_Totaux > Accruals_normaux \Rightarrow stratégie_défensive$$

A negative difference means that the reported accrual accounting variables of enterprise i at period t are lower than the normal adjustment variables:

$$Accruals_Totaux < Accruals_normaux \Rightarrow stratégie_offensive$$

Also :

1. If the discretionary component ($AVCRD_{it}$) is positive, it increases the published earnings and therefore reflects an upward management of the result (defensive strategy);

2. If the discretionary component ($AVCRD_{it}$) is negative, it decreases the published profit and thus translates a management of the result downward (offensive strategy).

The selection of our sample was based on the following criteria:

- A listing period of at least 16 years over the period 1999 - 2014 on the Tunis Stock Exchange;

- A set of financial information such as income statements, balance sheet, activity, and structure and profitability ratios is available in the database that has been collected.

Criteria for selecting the sample:

The sample obtained from these two criteria is of size k = 19, and n = 304 observations, distributed according to the sectors of activity as indicated in the table (0).

Table (1) shows the descriptive statistics of the assets and results of the sampled companies for the period (1999 - 2014).

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According to the results found in table (1), it appears that, on average, the net result is positive over the period (1999 -2014). This indicator, however, has a negative 25 percentile (-604.2), which means that a quarter of the companies in the sample have a loss of over 604.200,000 dinars and another quarter has a net income above 11.618.700,000 Dinars. These proportions reflect the difficulties that the companies face, which cannot be explained by operating problems insofar as the average and the median of the gross operating surplus (EBE) are positive. The median pre-tax income (RAI), which includes financial charges, for a quarter of the companies in the sample is relatively small. The difficulties of the companies thus seem to originate for the most part from excessive indebtedness[2]. We also observe that the difficulties encountered by companies in difficulty are influenced on the one hand by sectoral factors related to the competitive pressure and the post revolution events of 2011, and on the other hand to the narrowness of their market. (A significant number of companies have only a portion of the domestic market).

Analysis of accounting adjustment variables:

This is an analysis of adjustment variables that can be adjusted by executives. The decomposition of the total accounting adjustments makes it possible to identify the accounting variables from the following function:

$$AVCRT_{it} = f(\Delta^{t}_{t-1}BFR_{it} + RAP_{it} + PVC_{it} - DAP_{it} - DPRC_{it} - PRIMM_{it}) \quad (6)$$

With:

- $AVCRT_{it}$ = Adjustments of the total accrual accounting variables of enterprise i to period t;
- $\Delta^{t}_{t-1}BFR_{it}$ = The change in the working capital requirement between two successive fiscal years t and t-1 in enterprise i: This variation breaks down as a change in trade receivables ($\Delta^{t}_{t-1}Cr$), changes in inventories ($\Delta^{t}_{t-1}St$) and changes in trade payables and related accounts ($\Delta^{t}_{t-1}FCR$);
- RAP_{it} = Depreciation and amortization reversals of the assets of company i at period t;
- PVC_{it} = Capital gains net of disposal of assets of business i at period t;
- DAP_{it} = amortization and provisions for depreciation of the assets of company i at period t;
- $DPRC_{it}$ = Provisions for contingencies and charges for company i at period t;
- $PRIMM_{it}$ = The fixed productions of company i at period t.

The average of the total adjustments is negative (downwards) and represents 5.53% of the total assets of the previous year. This result seems to indicate the importance of the adjustments made by the directors. The standard deviation being relatively high (26%), there are significant differences in the practice of accounting adjustments in firms in difficulty. The average change

[2] This assumption takes into account the improvement in the financial situation of companies during the study period (1999-2014). Indeed, during this period, the overall trend of Tunisian companies was to increase their investments because of the favorable conditions.

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in WCR is positive (0.7%), which reflects an increase in it. At the same time, there is an increase in operating debts (2, 4%). These evolutions seem to confirm the difficulties of the companies, which constitutes constraints of negotiation with their customers of the faster deadlines of settlement and with their suppliers longer payment periods. Depreciation and amortization provisions and provisions for contingencies and charges represent on average a relatively high proportion of total assets (respectively 5.7% and 0.3%). This finding seems to reflect a manipulation of these items for accounting adjustments. It can be seen that even in a context of good performance and positive net results, managers have to make adjustments. This confirms the results management hypotheses to achieve objectives in order to smooth out the results (Hawariah Dalnial et al., 2014). Lastly, the descriptive statistics show that the variables that have the greatest effect on the accounting adjustments are depreciation and changes in the BFR components, respectively. However, the set of accounting adjustment variables is more or less important to the management of results. This observation shows the methodological interest to study the accounting practice from the synthetic variable of accruals[3] since the managers use a combination of the accounting variables to adjust the level of their net results.

The total accruals thus calculated contain both short accruals (such as the BFR, provisions for depreciation of current assets) and long accruals that correspond to the difference. However, these total accruals are not entirely subject to the discretion of the managers since the discretionary portion is valued by the difference between the first and the non-discretionary or "normal" accruals. Indeed, for Hawariah Dalnial et al. (2014), normal accruals correspond to those of the previous year: discretionary accruals correspond to the change in accruals from one year to the next. However, this approach has a major disadvantage of excluding the economic factors that may explain this variation. In contrast, the model proposed by Jones (1991) as modified by Beneish in 1998 corrected this anomaly, especially since some researchers (Patricia M. Dechow and Richard G. Sloan et al. Jones model (where the change in sales is adjusted by changes in trade receivables) Only the increase in sales with no immediate counterpart in accounts receivable is indicative of normal accruals. possible manipulation of payment deadlines to increase sales and consequently the result is neutralized.

Specification of the Total Accruals Model and Formulation of the Econometric Assumptions:

Take again the equation (5)

$$\frac{AVCRT_{it}}{TA_{it-1}} = \lambda_0 + \lambda_1\left(\frac{Var^{t}_{t-1}CA_i - Var^{t}_{t-1}Cr_i}{TA_{it-1}}\right) + \lambda_2\left(\frac{IMMO_{it}}{TA_{it-1}}\right) + \lambda_3\left(\frac{\Delta FMO_{it-1}}{TA_{it-1}}\right) + \varepsilon_{it} \quad (5)$$

With Exogenous (explanatory) variables:

X1 $= \frac{(VarCA - VarCr)_{it}}{TA_{it-1}}$, this measure normalized by the lagged asset, corresponds to the change in turnover adjusted for any abnormal increase, from enterprise i for year t.

X2 $= \frac{IMMO_{it}}{TA_{it-1}}$, this exogenous variable measures the amount of depreciable capital assets (tangible and intangible) of enterprise i for the year normalized by the lagged total assets.

[3] These are adjustments to accrual accounting variables that result from the difference between accrual accounting and cash accounting. As a summary concept, accruals include all adjustments that move from cash to accrual accounting. These adjustments result from year-end work.

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X3 $= \frac{\Delta FMO_{it}}{TA_{it-1}} = \frac{\Delta CF_{it}}{TA_{it-1}} = \frac{\Delta(CAF^{it}{}_{it-1} - \Delta BFR^{it}{}_{it-1})}{TA_{it-1}}$, this exogenous variable measures the variation, normalized by the lagged asset, of the net cash flows[4] generated by the activity of company i for year t.

As endogenous value (to be explained):

Y $= \frac{AVCRT_{it}}{TA_{i,t-1}}$, this endogenous variable represents the total amount of accruals normalized by the delayed active total of enterprise i for year t.

As constant:

(Constant λ0): the sense of the constant λ0 is that, in the absence of exogenous variables, there are always adjustments, normally explained, of the total regulation accounting variables.

Multiple linear regression is the multivariate generalization of simple regression.

We seek to explain the values taken by the endogenous variable Y $= \frac{AVCRT_{it}}{TA_{it-1}}$ using p (= 3) exogenous variables X_j, $(j = 1; 2; 3)$.

We must estimate the values of (3 + 1) parameters (λ_0 ; λ_1 ; λ_2 ; λ_4) from a sample of n (= 304) observations.

We notice in the model:

$i = 1; \ldots\ldots ; n = 304$ corresponds to the number of the observations;

y_i is the i-th observation of the endogenous variable Y;

x_{ij} is the i-th observation of the j-th variable X_j;

$\mathcal{E}_i$ the error (residue) of the model, it summarizes the missing information which would make it possible to explain linearly the values of Y using the p (= 3) variables Xj

The residual of the estimate corresponds to the share of accruals manipulated discreetly by the leaders (Dechow and Sloan, 1995). The random term $\mathcal{E}_i$ which is called the error or model residual, plays a very important role in the regression. It summarizes all the information that is not taken into account in the linear relationship that we seek to establish between the endogenous variable Y $= \frac{AVCRT_{it}}{TA_{it-1}}$, and exogenous variables X_j i.e. specification problems, approximation by linearity, and summarize the role of missing explanatory variables. However, the properties of the estimators are largely based on the assumptions we make about $\mathcal{E}_i$. In practice, after estimating the parameters of the regression ($\lambda_{j=0,1,2,3,4}$), the first checks concern the error $\mathcal{E}_i$ (residuals) calculated on the data during the modeling. These assumptions weigh on the properties of estimators (bias, convergence) and statistical inference[5] (distribution of estimated coefficients). As for simple regression, the hypotheses will make it possible to determine the properties of the estimators (bias, convergence) and the distribution laws (Student's law for each coefficient taken individually, Fisher's law as soon as we treat a group of coefficients we distinguish two types of assumptions:

[4] Cash flow is the difference between receipts and disbursements due to the business activity.

[5] Statistical inference consists in inducing the unknown characteristics of a population from a sample from this population. The characteristics of the sample, once known, reflect with a certain possible margin of error those of the population.

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- Stochastic hypothesis[6]
- Structural hypothesis[7]

Stochastic hypothesis:

First the hypothesis on endogenous variables ($Y = \frac{AVCRT_{it}}{TA_{it-1}}$)

And exogenous ($X_j = \left(\frac{Var^{t}_{t-1}CA_i - Var^{t}_{t-1}Cr_i}{TA_{it-1}}\right), \left(\frac{IMMO_{it}}{TA_{it-1}}\right), \left(\frac{\Delta FMO_{it-1}}{TA_{it-1}}\right)$).

X_j and Y are digital quantities measured without error. X is an exogenous data in the model.

Y is random via $\mathcal{E}_i$ ie d. the only error we have on Y comes from the inadequacies of X_j to explain its values in the model. In other words, we formulate the stochastic hypotheses as follows:

H1 _ X_j are not randomx_{ij} they are observed without error.

H2 _ E (ε_i) = 0, the expectation of the error is zero. On average, the model is well specified.

H3 _ V(ε_i) = σ^2_ε, the variance of the error is constant, it is the hypothesis of homoscedasticity.

H4 _ $COV\left(\varepsilon_i;\ \varepsilon_j\right) = 0, for\ i \neq i'$, the errors are independent, it is the hypothesis of non-auto-correlation of the residues.

H5 _ $COV\ (\ x_j\ ;\ \varepsilon_i) = 0$, the error is independent of the exogenous variables.

H6 _ $\varepsilon_i \equiv N(0, \sigma_\varepsilon)$, the errors are distributed according to a reduced normal centered law.

Structural hypothesis:

We often find a model matrix writing in the literature

$Y = X\lambda + \varepsilon$,

$$X = \begin{pmatrix} 1 & x_{11} & \cdots & x_{1,p} \\ \vdots & & \ddots & \vdots \\ 1 & x_{n1} & \cdots & x_{n,p} \end{pmatrix}$$

The dimensions of the matrices are respectively:

$Y \rightarrow (n, 1)$
$X \rightarrow (n, p + 1)$
$\lambda \rightarrow (p + 1{,}1)$
$\varepsilon \rightarrow (n, 1)$

- H7 _The matrix $X\ de\ taille\ (n, p\ +\ 1)$ contains all the observations on the exogenous (Burcu Dikmen, Güray Küçükkocaoğlu), with a first column formed by the value 1 indicating that we integrate the constant λ_0 in the equation.
  The matrix (X'X) is regular i.e. and (X 'X) ≠ 0 and (X' X) ((-1) exist. It indicates the lack of collinearity between the exogenous. We can also see this hypothesis from the angle $rang(X)\ =\ p\ +\ 1\ et\ rang(X'X)\ =\ p\ +\ 1$.

[6] The classical calculation of probabilities concerns tests where each possible result (or realization) is measured by a number, which leads to the notion of random variable. A stochastic process or random process or random function represents an evolution, discrete or continuous time, of a random variable. This notion is generalized to several dimensions. An important special case, the Markov random field, is used in spatial analysis.

[7] As in simple regression, the hypotheses make it possible to determine the properties of the estimators (bias, convergence); and their distributions (for interval estimates and hypothesis tests), there are two main categories of assumptions: Structural Assumptions and Stochastic Assumptions.

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- H8 _ ((X'X)) / n tends to a non-singular finite matrix when n → + ∞.
- H9 _ n> p + 1, the number of observations is greater than the number of parameters to be estimated.

In the case where n = p + 1, we have an interpolation, the line passes exactly by all the points. When n <p + 1, the matrix (X'X) is no longer invertible.

- The results of the regression of equation (5) are formulated in Table (3)
- The regression vectors and the residuals of the estimate are formulated in Table (4).
- The objective of the ordinary least squares linear regression (as BLUE estimator) is to estimate the parameters of equation (5) as best as possible by minimizing the deviations $(\hat{\varepsilon} = y - \hat{y})$ between the values observed and the values predicted by the model of the endogenous variable: $Y = \frac{AVCRT_{it}}{TA_{it-1}}$.

The error (or residue) observed ε must therefore verify the hypotheses H2 to H6. When the prediction is perfect (extreme situation), we have the following equality:

$$SCR = \sum_{i=1}^{n=304} \hat{\varepsilon}_i^2 = \sum_{i=1}^{n=304} (y_i - \hat{y}_i)^2$$

$$SCT = \sum_{i=1}^{n=304} (y_i - \bar{y}_i)^2 = \sum_{i=1}^{n=304} (y_i - \hat{y}_i + \hat{y}_i - \bar{y}_i)^2$$

$$= \sum_{i=1}^{n=304} (y_i - \hat{y}_i)^2 + \sum_{i=1}^{n=304} (\hat{y}_i - \bar{y})^2 + 2. \sum_{i=1}^{n=304} (y_i - \hat{y}_i)(\hat{y}_i - \bar{y})$$

But in the regression with constant and only in this case, we show that:

$$2. \sum_{i=1}^{n=304} (y_i - \hat{y}_i)(\hat{y}_i - \bar{y}_i) = 0 \qquad équation\ (6)$$

$$SCT = \sum_{i=1}^{n=304} (y_i - \hat{y}_i)^2 + \sum_{i=1}^{n=304} (\hat{y}_i - \bar{y})^2 \qquad équation\ (7)$$

$$SCT = SCR + SCE \qquad équation\ (8)$$

This tie is intercepted as follows:

• SCT is the sum of the total squares. It indicates the total variability of Y i.e. the information available in the data.

• SCE is the sum of the squares explained. It indicates the variability explained by the model ie. the variation of Y explained by X.

• SCR is the sum of the residual squares. It indicates the unexplained (residual) variability by the model ie. the difference between the observed values of Y and those predicted by the model.

Two extreme situations can occur:

- In the best case, SCR = 0 and therefore SCT = SCE:
  The variations of Y are completely explained by those of X.
  We have a perfect model, the regression line passes exactly through all the points of the cloud : $(\hat{y}_i = y_i)$.

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- In the worst case, SCE = 0: X does not provide any information about Y.
  Thus, $(\hat{y}_i = \bar{y}_i)$ the best prediction of Y is its own mean.
- The coefficient of determination R^2, a synthetic indicator derived from the variance analysis equation (6), indicates the proportion of variance of $Y = \frac{AVCRT_{it}}{TA_{it-1}}$

  The endogenous variable explained by the model (5), we have:

$$R^2 = \frac{SCE}{SCT} = 1 - \frac{SCR}{SCT} \qquad \text{Équation (9)}$$

- The closer it gets to 1, the better will be the model: the knowledge of the values $\boldsymbol{x_{ij}}$ of the exogenous variables X_j makes it possible to better predict those y_i of the explained variable $Y = \frac{AVCRT_{it}}{TA_{it-1}}$.
- The results of model regression (5), displays a coefficient of determination $(R^2 = 75.94\%)$, in other words, the variability of total accruals $(Y = \frac{AVCRT_{it}}{TA_{it-1}})$ Is explained by the exogenous variables $X_j = \left(\frac{Var^t_{t-1}CA_i - Var^t_{t-1}Cr_i}{TA_{it-1}}\right), \left(\frac{IMMO_{it}}{TA_{it-1}}\right), \left(\frac{\Delta FMO_{it-1}}{TA_{it-1}}\right)$ in a proportion that is close to 76%. On the other hand, this indicator does not answer the question: is the regression globally significant?
- To answer this question, we will extend the study of variance decomposition by completing the analysis of variance table (Table 5) by the degrees of freedom.

Variance Analysis Table - Determination Coefficient R2 / R2 - Adjusted and Fisher Statistics:

The overall significance test of the model (5) through the coefficient of determination R^2 passes through the statistics $F_\alpha\ (1, n-p-1)$ of Fisher and his p-value at the significance level $\boldsymbol{\alpha}$. To carry out this test we must go through the decomposition of the variability SCT of the variable $Y = \frac{AVCRT_{it}}{TA_{it-1}}$ in variability explained SCE by the model (5) and residual variability SCR, since we estimate p + 1 = 4 parameters, we extend the table (table 5) of analysis of the variance by the degrees of freedom (ddl[8]), The variance part of Y explained by the model is translated by the coefficient of determination $R^2 = \frac{SCE}{SCT} = 1 - \frac{SCR}{SCT}$ $avec$ $0 \leq R^2 \leq 1$

$$R^2 = 1 - \frac{4.88602516}{20.47793973} = 0.76$$

The Fisher statistic is defined as $F = \frac{CME}{CMR} = \frac{\frac{SCE}{P}}{\frac{SCR}{n-p-1}}$ $\qquad$ $équation\ (10)$

[8] The most accessible definition of dll is to understand them as the number of terms explained in the sums (the number of observations, here n = 304) minus the number of parameters (here p = 3 not counting the constant) involved in these sums.

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This statistic indicates whether the explained variance is significantly greater than the residual variance: $si\ R^2 = \frac{SCE}{SCT} > \frac{SCR}{SCT}$

The F statistic can be expressed as a function of the coefficient of determination R^2

$$F = \frac{SCE\ (n-p-1)}{SCR.p} = \frac{R^2.SCT.(n-p-1)}{p.(1-R^2).SCT} = \frac{R^2.(n-p-1)}{(1-R^2).p} = \frac{R^2/p}{(1-R^2)/(n-p-1)}$$

$$F = \frac{R^2/p}{(1-R^2)/(n-p-1)} \qquad équation\ (11)$$

Under the hypothesis H0, the sums:

$SCE\ is\ distributed\ according\ to\ a\chi^2(1), \qquad SCR\ according\ to\ one\ \chi^2(n-p-1)$

And,

$F \equiv \mathcal{F}(1, n-p-1)\ a\ Fisher\ law\ to\ (1, n-p-1)ddl$

The region criticizes the test, corresponding to the rejection of H0, the risk α is deficient for the abnormally high values of F, in other words:

RC[9] $: F > F_{1-\alpha}(3{,}300)$, This α-critical probability (p-value) is provided by EViews software in Table (3), it corresponds to the probability that Fisher's law exceeds the calculated statistic F:

$$F - statistique = \frac{0.761752/3}{(1-0.761752)/300} = 319.730 \quad pour \quad \alpha = 1\%\ ,$$

$its\ probability \quad p - value\ \alpha' = 0.000000 < 1\%,$

We conclude that the linear relationship between the endogenous variable (to be explained) and the exogenous (explanatory) variables is representative of a phenomenon that actually exists in the population.

However, the coefficient of determination R^2 does not seem to be a very good tool for evaluating the role of the additional explanatory variables when comparing the nested models (the trivial one and the one studied). Indeed, by increasing the number of Explanatory, we increase in a mechanical way the value of R^2 but at the same time, we decrease the number of ddl. To remedy this disadvantage, we integrate the number of ddl to counteract the systematic evolution of this coefficient. This is precisely the role of $R^2 - ajusté = \bar{R}^2$ Defined as:

$$\bar{R}^2 = 1 - \frac{CMR}{CMT} = 1 - \frac{SCR/(n-p-1)}{SCT/(n-1)} = 1 - \frac{SCR.(n-1)(1-R^2)}{SCR.(n-p-1)}$$

$$= 1 - \frac{(n-1)}{(n-p-1)}.(1-R^2)$$

$$\bar{R}^2 = 1 - \frac{(n-1)}{(n-p-1)}.(1-R^2) \qquad équation\ (12)$$

[9] Critical region: R.C.

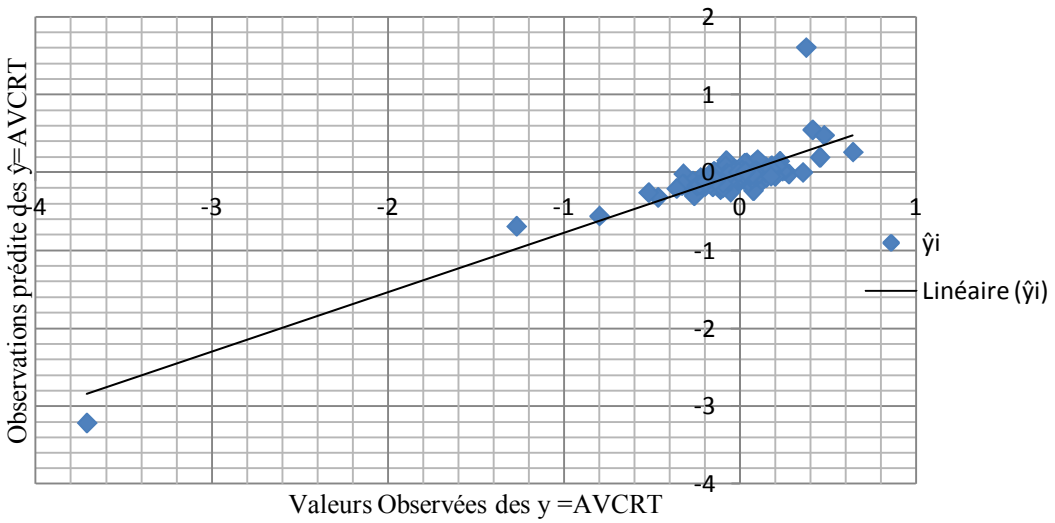
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$$\bar{R}^2 = 1 - \frac{(303)}{300}.(1 - 0.761752) = 0.75936952,$$

This corrected coefficient presents an advantage allowing to compare nested models, in other words, it allows to answer the question: does the introduction of new exogenous induce a "significant" increase in the coefficient of determination R^2 ? So it serves to determine the significance of a group of variables. Indeed, its square root $R = \sqrt{R^2}$corresponds to the multiple linear correlation coefficient that is to say the linear correlation coefficient between the observed values (y_i) and the values predicted by the endogen $(\hat{y}_i)$:

$R = \sqrt{R^2} = \tau_{y,\hat{y}},$

$\tau_{y,\hat{y}} = 0.87278,$



Graph 1: y observed and ŷ predicted - Multiple Linear Correlation Coefficient - Adjustment of Total Regulatory Accounting Variables - AVCRT - (R = 0.87278)

This correlation coefficient suggests the graphical construction of the cloud of points comparing the observations (y_i) and the predictions $(\hat{y}_i)$ of the model: if the model is perfect, then the points would be aligned on the first bisector (Graph 1):

Indeed, this graph reveals that our model is very well specified and globally significant. The explanatory power of the exogenous, taken as a whole, is very significant on the endogenous.

Global Significance Test:

This test consists of checking whether the model, taken as a whole, is relevant.

The null hypothesis corresponds to the situation where none of the exogenous ones conveys useful information in the explanation of the endogenous; the test is written:

$$\begin{cases} H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0 \\ H_1 : \exists j \; such \; as \; \lambda_j \neq 0 \end{cases}$$

If H0 is true, we know that λ_1 , the constant is equal to the average of the endogenous observations, which is why we did not include the constant in the Wald test. (Including it in the test would distort the results).

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Fisher Statistics Test:

It is written: according to equation (10),

$$F = \frac{CME}{CMR} = \frac{\frac{SCE}{p}}{\frac{SCR}{n-p-1}} \ , \ F = \frac{\frac{R^2}{p}}{\frac{(1-R^2)}{(n-p-1)}}$$

Under

H_0 F *follows a Fisher law* $\mathcal{F}(p, n-p-1)$. *At the risk of* α, *the critical region ie rejection of* (H_0) *of the test corresponds to exceptionally large values of* F :

$R.C. : F > F_{1-\alpha}(p, n-p-1)$

Applying this to our data, we get:

$$F = \frac{R^2/p}{(1-R^2)/(n-p-1)} = \frac{0.761752/3}{(1-0.761752)/300} = 319.730$$

Using the variance analysis table, we obtain:

$$F = \frac{SCE/p}{SCR/(n-p-1)} = \frac{15.59191456/3}{4.88602516/300} = 319.112$$

The result obtained is almost the same as the one obtained with EViews software (Table 3). In an Excel calculation we compared this observed value of F with the order quantile 0.95 for a Fisher test at 5% ie $F_{0.95}(3, 300) = 2.6347$ (Table 7). Therefore at 5% risk, we conclude that model (5) is globally significant.

This statistic indicates whether the explained variance is significantly greater than the residual variance. In this case, we can consider that the explanation led by the regression reflects a relationship that really exists in the population (Bourbonnais, page 34 - http://fr.slideshare.net/JeromeYounan/econom trie-rgie-bourbonnais-9me- edition).

Significance Test of a Coefficient:

After determining the overall significance of the regression, we evaluate the relevance of the variables taken individually.

Let's assume that:

$\varepsilon_i \equiv \mathcal{N}(0, \sigma_\varepsilon)$ This hypothesis is justified by the results of the estimation (graph 3)

We then have:

$\frac{\hat{\lambda}_j - \lambda_j}{\hat{\sigma}_{\hat{\lambda}_j}} \equiv \mathcal{T}(n-p-1)$ *avec* $n = 304$, $p = 3$, $\lambda_j =$ *parameter to be estimated for* $j = 1, .., p$

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From these data we can formulate the tests of significance by tests of conformity to a standard (the confidence interval) by opposing the hypotheses:

$$\begin{cases} H_0: \lambda_j = 0 \\ H_1: \lambda_j \neq 0 \end{cases} \quad the\ test\ statistic\ is\ written: t_{\hat{\lambda}_j} = \frac{\hat{\lambda}_j}{\hat{\sigma}_{\hat{\lambda}_j}}\ and\ the\ region\ criticize\ R.C.\ for\ a\ risk\ \alpha\ written: \left|t_{\hat{\lambda}_j}\right| > t_{1-\frac{\alpha}{2}}(n-p-1)$$

These tests are provided by the regression of equation (5) in Table (3) from which the Student's tests are extracted for the significance of the coefficients of the regression $\hat{\lambda}_j$ in Table (8).

We did not integrate the constant into the procedure. Indeed, as we have emphasized before, calling into question the constant modifies the nature of the regression. For each variable, we calculated the test statistic (Table 8). The significance test of a coefficient (the three parameters $\hat{\lambda}_j\ j = 1,2,3$ shows that the coefficients are very significant at the 5% threshold and therefore the contribution of the exogenous variable X_j in the explanation of the endogenous

$Y = \frac{AVCRT_{it}}{TA_{it-1}}$ is significant for each of these exogenous variables. In other words, all our exogenous variables are relevant. Each vehicle explains the adjustments of the total accruals of the companies in the sample studied.

Interpretation of Coefficients:

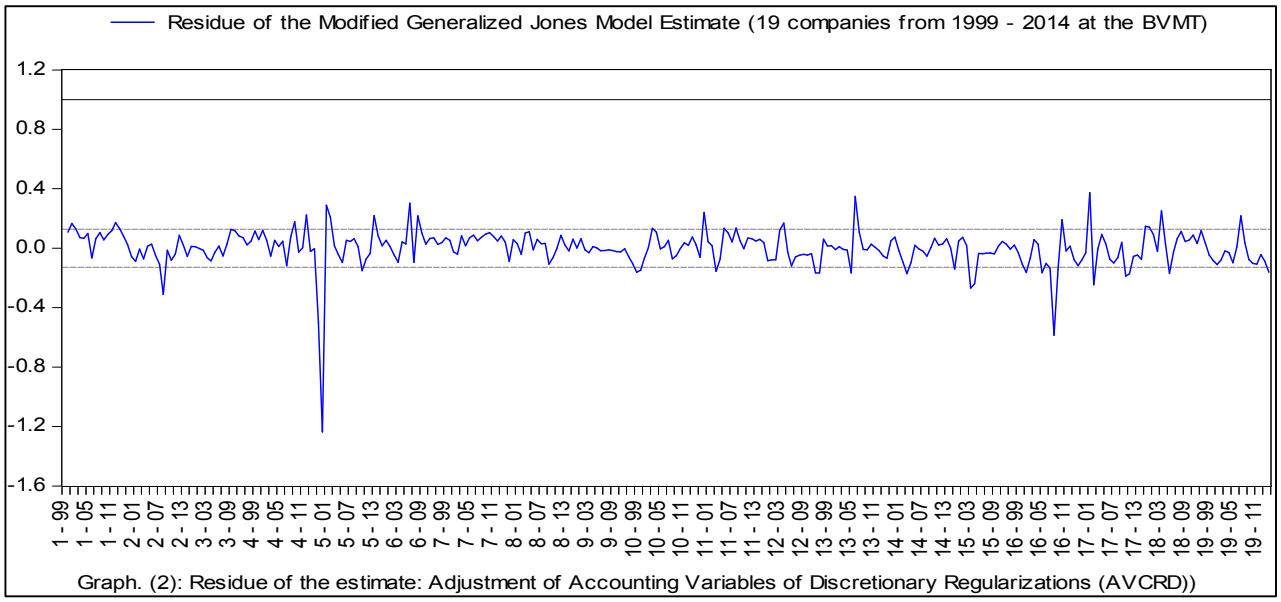
The variable "change in sales normalized by deferred assets" is positively correlated (0.079061) with the adjustments of the accounting variables of total adjustment (total accruals). In other words, a marginal variation of 7.91% of the change in turnover corresponds to a marginal variation of one unit of total accruals;

The variable "asset normalized by lagged assets" is negatively correlated (-0.160681) with total accruals, which means that a marginal variation downwards of -16.07% of this variable results in a marginal change in the opposite direction of a unit of total accruals;

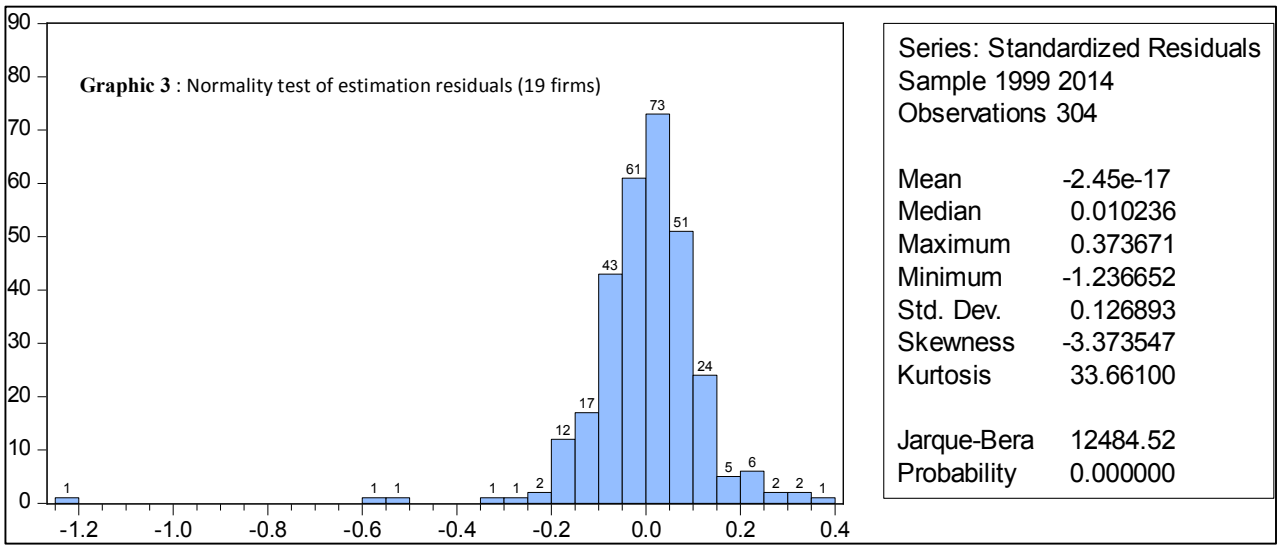
The variable "change in net cash flows normalized by lagged total assets" is also negatively correlated (-0.401971) with total accruals, a marginal variation downwards of -40.20% of this exogenous implies a marginal variation in the opposite direction of a unit of the endogenous;

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These explanatory variables, which correspond to non-discretionary accruals, ie accounting variables that have been subjected to accounting manipulations according to the NPCGAs[10], vey information related to the formation of the part normally obtained from the net accounting



Graph. (2): Residue of the estimate: Adjustment of Accounting Variables of Discretionary Regularizations (AVCRD))



The normality assumption of errors is a key element for statistical inference. Indeed, the graph illustrates this normality ($\bar{\varepsilon}_i = -2.45e-17$) which implies that our sample has the same characteristics of the target population. And therefore the model (5) is robust to this assumption and that our estimators are unbiased. Discretionary components of the adjustment variables ($AVCRD_{it}$) are derived from equation $AVCRT_i = AVCRND_i + AVCRD_i$ (3)

Take the equation (4):

$$AVCRND_{it} = f(IMMO_{it} + (Var^{t}_{t-1}CA_i - Var^{t}_{t-1}Cr_i) + FMO_{i,t-1}) \quad (3-4)$$

[10] Norms and Accounting Principles Generally Accepted.

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From the results of the regression estimates (Table 3) we obtain Jones' modified estimated model of the following non-discretionary accounting adjustments by equation (13)

$$\frac{\hat{AVCRND}_{it}}{TA_{it-1}} = 0.024224 + 0.079061\frac{(\Delta CA - \Delta Cr)_{it}}{TA_{it-1}} - 0.160681\frac{IMMO_{it}}{TA_{it-1}} - 0.401971\frac{\Delta FMO_{it-1}}{TA_{it-1}}$$

From this model, therefore, we have been able to calculate the discretionary part of the accounting adjustments $(AVCRD_{it})$ made by the companies in the sample studied, which corresponds to the difference between the observed value of the total adjustments $(AVCRT_{it})$ and the calculated value of the so-called normal adjustments. is formulated by equation (14)

$$\frac{\widehat{AVCRD}_{it}}{TA_{it-1}} = AVCRT_{it} - (0.024224 + 0.0079061\frac{(\Delta\widehat{CA} - \Delta CR)_{it}}{TA_{it-1}} - 0.160681\frac{\widehat{IMMO}_{it}}{TA_{it-1}} - 0.401971\frac{\widehat{\Delta FMO}_{it}}{TA_{it-1}})$$

With:

$(AVCRT_{it})$ Calculated from net income and cash flows

Is : $AVCRT_{it} = RN_{it} - CF_{it}$ and $CF_{it} = CAF_{it} - \Delta BFR_{it}$ [11]

III. Conclusion

Accounting information provides support for decisions made by its partners. Potential investors, financial backers as well as authorities (financial and judicial) make their decisions based on this information, which itself is supposed to be drawn up in accordance with generally accepted accounting standards and principles. However, the existence of accounting choices and accounting policies that are diversified and standardized by the accounting system create the freedom for managers to manipulate the quality of the information. In other words, a situation of information asymmetry may tempt the managers of failing companies to adopt choices in order to influence the perception of risk by its partners. Based on this assumption of the positive theory (Watts and Zimmermann, 1986-1990), which considers that the directors of companies in financial difficulty, exploit the accounting information in their interests, we adopted an econometric approach to detect accounting manipulations by the method of management of the result and by estimating, according to ordinary least squares, the Modified Generalized Jones model, it was possible to confirm the existence of discretionary accounting manipulations at the level of the accounting results published by the companies forming our sample studied. The analysis of the significance and relevance of the model used allowed us to validate empirically this hypothesis concerning the management of the result. Other significant results relating to the residue of the estimate were revealed by the regression conducted on the Jones model. Indeed, the terms of the residual of the estimate, which summarize all the discretionary accruals or all the other exogenous variables not taken into account in the modeling, do indeed satisfy the stochastic and structural assumptions (relating to the bias and the convergence), in other words these terms are governed by a normal, centered, reduced law, and therefore, the studied sample perfectly induces the characteristics of the population it

[11] CF_{it} = cash flow generated by the business activity i period t, This last variable is the difference between the cash flow from operations (CAF) generated by the company and the variation in the working capital requirement ΔBFR over two consecutive periods: $CF_{it} = CAF_{it} - \Delta BFR_{it}$

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represents in terms of mean and variance. This led us to push the residue analysis by distinguishing companies that manipulate discretionary accruals upwards from those that manage it downwards, which allowed us to. This will be the subject of a new exploration of characteristic variables and This approach is interesting in the sense that it made it possible to check the correlation between the financial default and the upward management of the result (defensive strategy).

Tableau 0: Caractéristiques de l'Echantillon (19 entreprises observées sur la période 1999 – 2014)

Sample	Firm Ei	Activity sector		Distribution by sector of activity	
	COMPANY CODE	DETAIL OF THE SECTOR	% IN THE SECTOR	SECTOR	% IN RELATION TO ALL SECTORS
Industrial	E1	CHEMICAL INDUSTRY	10.00%	I	5.26%
	E2	CHEMICAL INDUSTRY	10.00%	I	5.26%
	E3	MECHANICAL INDUSTRY	10.00%	I	5.26%
	E4	CHEMICAL INDUSTRY	10.00%	I	5.26%
	E5	HOUSEHOLD INDUSTRY	10.00%	I	5.26%
	E8	ELECTRIC INDUSTRY	10.00%	I	5.26%
	E9	PHARMACEUTICAL INDUSTRY	10.00%	I	5.26%
	E10	GLASS INDUSTRY	10.00%	I	5.26%
	E13	PNEUMATIC INDUSTRY	10.00%	I	5.26%
	E14	MILK INDUSTRY	10.00%	I	5.26%
subtotal 1	**10**		**100%**	**10**	**52.63%**
Commercial	E6	AGRO-FOOD TRADE	16.66%	C	5.26%
	E7	DISTRIBUTION TRADE	16.66%	C	5.26%
	E12	WHOLESALE	16.66%	C	5.26%
	E15	DISTRIBUTION TRADE	16.66%	C	5.26%
	E16	COMMERCE DE GROS	16.66%	C	5.26%
	E17	DISTRIBUTION TRADE	16.66%	C	5.26%
subtotal 2	**6**		**100%**	**6**	**31.59%**
Service provider	E18	TELECOMMUNICATION SERVICES	33.33%	S	5.26%
	E20	REAL ESTATE PROMOTION	33.33%	S	5.26%
	E21	AIR TRANSPORT	33.33%	S	5.26%
subtotal 3	**3**		**100%**	**S**	**15.78%**
Total	**19**		**100%**	**3**	**100,00%**

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Table 1: Descriptive statistics of assets and sample results

Variables		Total assets Immobilized TAI	Total assets TA	Turnover CA	Added value VA	Gross operating surplus EBE	Result before taxes RAI	Net profit RN	Cash flow CAF
Average		99683,7	179402,5	147890,3	63864,2	7816,3	5683,2	4842,7	16375,2
Median		90234,8	168185,1	145876,6	67545,2	8025,4	7170,5	6214,9	17047,5
Standard deviation		45701,6	77693,4	74738,4	32475,0	11392,9	10705,1	10719,9	12586,5
	25	58725,3	110240,9	76523,4	25462,9	1630,2	40,2	-604,0	8782,3
percentiles	50	90234,8	168185,1	145876,6	67545,2	8025,4	7170,5	6214,9	17047,5
	75	137760,2	236867,0	201592,8	87479,8	15506,1	12854,2	11618,7	23698,5

Table 2: Descriptive statistics of the accounting adjustment variables of the sampled companies Period 1999 – 2014

Variables	$\frac{AVCRT}{TA_{t-1}}$	$\frac{\Delta BFR^{t}_{t-1}}{TA_{t-1}}$	$\frac{VarCr^{t}_{t-}}{TA_{t-1}}$	$\frac{VarSt^{t}_{t-1}}{TA_{t-1}}$	$\frac{VarDT^{t}_{t-1}}{TA_{t-1}}$	$\frac{D°AM.PR.DEP.AC}{TA_{t-1}}$	$\frac{D°PR.RISQ.CH}{TA_{t-1}}$
Average	-0,053	0,007	0,021	0,020	0,024	0,057	0,003
Median	-0,046	0,003	0,008	0,007	0,010	0,051	0,000
Standard deviation	0,260	0,251	0,100	0,102	0,101	0,037	0,016
Minimum	-3,711	-3,142	-0,208	-0,237	-0,332	-0,006	-0,085
Maximum	0,6415	0,7470	1,1467	1,1467	1,2574	0,3486	0,0839

Table 3: Regression coefficients and significance tests of model (5)

Dependent Variable: $\frac{AVCRT_{it}}{TA_{it-1}}$

Variables Y_i, X_j/constante	Coefficients $\lambda_{j=1,2,3,4}$	Std. Error	t-Statistic	Prob.
$\frac{Var^{t}_{t-1}CA_{i} - Var^{t}_{t-1}Cr_{i}}{TA_{it-1}}$	0.079094	0.026625	2.970692	0.0032
$\frac{IMMO_{it}}{TA_{it-1}}$	-0.160501	0.033202	-4.834114	0.0000
$\frac{\Delta FMO_{it-1}}{TA_{it-1}}$	-0.401996	0.013680	-29.38496	0.0000
Constante C	0.024211	0.017024	1.422167	0.1560

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R-squared	0.761752	Mean dependent var	-0.052978
Adjusted R-squared	0.759369	S.D. dependent var	0.259969
S.E. of regression	0.127526	Akaike info criterion	-1.267928
Sum squared resid	4.878837	Schwarz criterion	-1.219020
Log likelihood	196.7251	Hannan-Quinn criter.	-1.248364
F-statistic	319.7300	Durbin-Watson stat	1.515915
Prob (F-statistic)	0.000000		

Table 4: Simplified table of analysis of the variance

Explained	$SCE = \Sigma(\hat{y}i - \bar{y})^2$
Residual	$SCR = (yi - \hat{y}i)^2$

Tableau 5: Tableau *d'analyse de la variance pour la régression multiple*

Source of variation	**Sum of squares**	**ddl**	**Middle squares**
Explained	$SCE = \Sigma(\hat{y}i - \bar{y})^2$	$P = 3$	$CME = \frac{SCE}{p} =$
Residual	$SCR = (yi - \hat{y}i)^2$	$n-(p+1) = n-p-1 = 300$	$CMR = \frac{SCR}{(n-p-1)} =$
Total	$SCT = (yi - \bar{y})^2$	$n - 1 = 303$	-

Table 6: Simultaneous nullity test of the regression coefficients of equation (5)

Wald Test : $\lambda_2 = \lambda_3 = \lambda_4 = 0$

Test Statistic	Value	df	Probability
F-statistic	328.5873	(3, 300)	0.0000
Chi-square	985.7620	3	0.0000
Null Hypothesis: C(2)=C(3)=C(4)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(2) λ_2		-0.160501	0.033202
C(3) λ_3		-0.401996	0.013680
C(4) λ_4		0.024211	0.017024

Restrictions are linear in coefficients.

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Tableau 7: Test de Fisher pour la significativité globale de l'équation (5)

Source of variation	R^2	Sum of squares	ddl	Middle squares	Middle squares Values	Statistique-F $F = \frac{CME}{CMR} = \frac{(\frac{SCE}{p})}{(\frac{SCR}{(n-p-1)})}$
Explained	$\frac{SCE}{SCT} = 1 - \frac{SCR}{SCT}$ 0,76140055	$SCE = \Sigma(\hat{y}i - \bar{y})^2$	p = 3	$CME = \frac{SCE}{p}$	5,197304 85	319,1124493 $LOI.F(0{,}05; 3; 300)$
Residual		$SCR = (yi - \hat{y}i)^2$	$n-(p+1) = n-p-1 = 300$	$CMR = \frac{SCR}{(n-p-1)}$	0,016286 75	2,634700804 $p - value = Loi.F(319{,}112; 3; 300)$
Total		$SCT = (yi - \bar{y})^2$	n -1 = 303	$\frac{CMT}{SCT} = \frac{}{(n-1)}$	0,067583 96	= 5,41074E-93
The Fisher test justifies the overall significance of the model (5)						Then: the null hypothesis is rejected

Table 8: Significance tests of the coefficients of the regression of equation (5)

Coefficient : $\hat{\lambda}_j$	Std. Error : $\hat{\sigma}_{\hat{\lambda}_j}$	t-Statistic : $\frac{\hat{\lambda}_j}{\hat{\sigma}_{\hat{\lambda}_j}}$	p-value $Loi\ Student\ (x;\ dll;\ bilateral)$
0.079094	0,026625	2,970692	0,003211476
-0.160501	0,033202	-4,834114	0,000000000
-0.401996	0,01368	-29,38496	0,000000000

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