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A Fuzzy Expert System for Measuring and Managing Corporate Value in a Stakeholder Approach

نظام خبير غامض لقياس وإدارة قيمة الشركة في إطار مدخل أصحاب المصلحة

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Abstract

The objective of this paper is to attempt a solution to two major dilemmas in economics: the social dilemma and its modeling intricacy. Through a mixed theoretical corpus (economic and financial theory, strategic management and business ethics), we were able to adopt a new approach that will enable us to build a model that reconciles both the shareholder and the stakeholder value approaches. At first glance, the proposed model may seem complicated due to the qualitative variables employed to explain the process of creation and sustainability of value. The use of a fuzzy expert system to overcome this second dilemma is the other objective of this paper

Keywords :. Shareholder approach, Stakeholder approach, Corporate value, Fuzzy expert system.

ملخص

الهدف من هذه الورقة هو محاولة حل لمعضلتين رئيسيتين في الاقتصاد: المعضلة الاجتماعية وتعقيد نمذجتها. من خلال مجموعة نظرية مختلطة (النظرية الاقتصادية والمالية ، والإدارة الإستراتيجية وأخلاقيات العمل) ، ولقد تمكنا من اعتماد نهج جديد من أجل بناء نموذج يوفق بين نهج قيمة المساهم وأصحاب المصلحة. للوهلة الأولى ، قد يبدو النموذج المقترح معقدًا بسبب المتغيرات النوعية المستخدمة لشرح عملية إنشاء واستدامة القيمة. الهدف الآخر لهذه الورقة هو استخدام نظام خبير غامض للتغلب على هذه المعضلة الثانية.

الكلمات المفتاحية: مدخل المساهمين، منهج أصحاب المصلحة، قيمة الشركة، نظام خبير غامض.

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1. INTRODUCTION

According to the shareholder value approach, there is value creation if there is a surplus after capital providers have been remunerated, and this surplus returns exclusively to the shareholders. In other words, the company's objective does not go beyond taking full advantage of shareholder value. Nevertheless, issues generated by a system based on free competition and driven by individual selfishness have been dramatic. These include environmental issues, such as pollution, climate change, ecosystems deterioration; social issues due to increasing wealth disparities between countries as well as between social layers within the same country. At the center of these issues, there are economic ones, on top of which come financial scandals. In such a system, the increasing consideration for the interests of shareholders may come at the expense of both those other parties and of society in general.

According to Welch (2009), shareholder value is the dumbest idea on the planet; it is just an ex-post measure of the result, it cannot constitute a basis for strategy and the primary element of the company are its employees, its consumers, and its products. For Jensen (2008: 167), maximizing shareholder value will not maximize the overall value of the company and will not produce social welfare. For his part, Charreaux (2009: 363) contends that the maximization of shareholder value cannot be used as a management guide for reasons related to the complexity of the causal patterns linking this value to the different value creation processes and to the fact that several and often contradictory patterns enabling good performance , require the integration of specific extra-financial aspects.

Based on the observation that the integration of financial and extra financial variables in the management of value requires a profound renewal of the evaluation criteria, our objective is to design a new tool for measuring this value based on a fuzzy expert system. To achieve this, we asked the following question: how can we determine the company value by considering all the stakeholders' interests?

2.The stakeholder value approach

Stakeholder theory proposes that managers should run the business to satisfy the interests of all of its stakeholders - defined here as those who have taken some form of risk by investing some type of capital: human, financial, or something of value, in a company (Clarkson, 1994: 04) - and thus maximize their well-being (Harisson et al., 2010). On the other hand, the shareholder approach suggests that managers should handle the company to maximize the wealth of shareholders leading to higher social well-being. In the dispute on the stakeholder/shareholder approach, the advocates of the second approach point out that it might be impossible to satisfy the interests of each stakeholder group as they are frequently different and could be contrasted.

However, Jensen (2002) argues that these theories are not always inappropriate; maximizing company value must remain its main objective. Given that it is logically impossible to maximize in more than one dimension. Two hundred years of work in economics and finance indicate that in the absence of externalities and monopoly, social welfare is maximized when every firm in an economy maximizes its overall market value. He argues that stakeholder theory does not offer a clear scorecard for measuring success and that it is most likely impossible to satisfy all stakeholders with a single decision. On the other hand, by ignoring the stakeholders, the company cannot maximize its value. He argues that maximizing the company value creates the best social welfare; however, it cannot be achieved just by specifying it as a business goal. To reconcile the two competing views, he proposes the maximization of "enlightened value" calculated as the discounted amount of all future profits of the firm (Jensen, 2002: 239). He states, "We cannot maximize the long-term market value of a company if we ignore or mistreat any important constituency" (Jensen, 2002: 246). In other words, fixing the issues emerging from the multiple objectives that accompany stakeholder theory would be a step towards maximizing the long-term value.

Hence, enlightened value maximization was viewed as a "possible third way", an option to strict shareholder primacy and a pluralistic view of stakeholder theory. However, to be sure to achieve social welfare using this measure, Jensen adds that externalities and monopoly should be eliminated by the government. However, "the government is often inefficient" in resolving these issues by itself (Wood, 2008: 162). The individual and collective responsibility that social control system needs to provide -

defined here as the set of social practices that tend to produce and maintain the individual's conformity to the standards of their social group - such as ethical values adopted through social institutions (family, religion, education, business, government…) will certainly contribute to social well-being and enhance the function of government assigned by Jensen. According to Wood (2008: 161), in this era of globalization, it is imperative that all companies achieve their economic goals in a socially responsible and ethical ways. Companies that cannot earn profits legally, ethically and responsibly do not deserve to survive.

This leads us to use ethical values as means of aligning the various stakeholder's expectations in a company because they are based upon their values according to managerial literature (Meyer, 2007: 93). For Harisson and Wicks (2013: 103), the presence of shared standards that transcend self-interest becomes part of what maintains stakeholder cooperation and generates utility for all stakeholders. Ethical values refer to the principles that assist a behavior, and therefore, to a reflection not just on the means employed to achieve a given end but also on the purpose of action and the effects on itself and on the other. For many authors, they are indicators of contribution to the "sense of common well-being" (Bergery, 2011: 46). This is why it is so important to share them, within the company.

The stakeholder value approach that we will therefore adopt in this work is just the maximization of the company's overall value in the long term by making a compromise between the various expectations of the stakeholders. However, the effectiveness of this approach is conditioned by a combination of ethical values as self-regulation mechanism behavior alongside external control (regulation) in the decision-making processes to ensure the merging of individual, organizational and institutional objectives. The idea developed in this research is that the values that the company must share with its stakeholders are likely to fulfill their expectations, increase their degree of cooperation and influence the process of creating sustainable value.

In such a manner, this approach paves the way to operationalize the approach proposed by Jensen, insofar as this value clearly considers the interests of the other stakeholders, while respecting the economic principle of profitability of resources.

3- The value drivers in a stakeholder context

The majority of the economic and managerial literature stimulating the question of value drivers has actually been based on the famous hypothesis of human opportunism, hence the presence of conflicts of

interest between stakeholders (Berle and Means, 1932; Jensen and Meckling, 1976). However, stakeholder theory supports the concept that companies tend to improve when they see stakeholder interests to converge, or at least are mainly interdependent, than companies that view them as primarily conflicting (Freeman, Wicks & Parmar, 2004).

According to Clarkson (1995), Donaldson et Preston (1995) as well as Post et al. (2002), a business can persist over time if it can build and maintain continuous relationships with all stakeholders. These relationships represent vital opportunities that managers should handle since they are the ultimate sources of its value. Besides, the founders of this theory highlight the interdependence of stakeholder interests in the creation of this value and describe the company operations as a mechanism enabling all stakeholders to improve gradually (Harrison and Wicks, 2013: 97).

However, stakeholder management can involve much more than their continued participation in the business (Hillman and Keim, 2001: 127). Reliable stakeholder management can make up intangible, socially complicated, and causally uncertain resources such as reputation, corporate culture, and knowledge (Reece, Pisano & Shuen, 1997).

According to this approach, the creation of value emerges from its ability to combine and coordinate its current resources and skills to build and reconfigure new resources and skills. The characteristics of these skills allow the company to adapt to its environment or to reconfigure itself through organizational learning to ensure its sustainability in a turbulent environment. The organizational learning, defined as a dynamic process of creating, acquiring and integrating knowledge, contributes to enhance responsiveness through a broader understanding of the environment. As a result, the generated mindset leads to collaboration and conflict resolution through relationships with customers, suppliers, and other market participants; improving along the way the companies' ability to reconfigure and focus on emerging opportunities or threats (Lopez, Peon & Ordas, 2005: 227).

Insofar as we remain in an economy where the only certainty is uncertainty, the only source of sustainable competitive advantage remains knowledge and therefore the ability to learn. As a social and collective phenomenon, an idiosyncratic and complicated capacity, difficult to transfer or imitate, organizational learning is considered in our paper as one of the first process determinants of creation and sustainability of company value.

However, joining the idea of Osterloh et al. (2002), the mobilized resource-based view ignores the motivation concerns. It is based on the concept of cooperation and shared knowledge by neglecting any

opportunistic behavior, information issues, as well as asymmetric knowledge issues that can build barriers to this learning. To mobilize the human resources energies in a non-coercive manner, it is clear that motivation is crucial, and it is also important to understand it, in particular by firmly insisting that it appeals to values, aspirations, and human emotions. To complete the proposed model, we have introduced the variable "responsible leadership" which serves as a motivating element for knowledge creation, sharing, and preservation along with a pivotal element for stakeholder engagement for construction, development, and preservation of intangible capital (Nahapet and Ghoshal, 1998).

According to the Globally Responsible Leadership Initiative (GRLI): "... Leadership is the art of motivating, communicating, empowering and convincing people to accept a new vision of sustainable development and the required changes it involves" (The United Nations Global Compact and European foundation for Management Development, 2008: 01). For Maak (2007: 330), responsible leaders are people who know how to handle the complexity generated by the different expectations of stakeholders and combine their energies to create a network of value by activating values such as honesty, integrity, and trust. As the center of relations with all stakeholders, the responsible leader needs to play the role of a conductor who facilitates stakeholder engagement through dialogue, trust, and sharing of common values to build a responsible and sustainable company (Maak, 2007).

With regard to risk, Orlitzky and Benjamin (2001) spotted through their meta-analysis that there is solid evidence concerning a negative correlation between the reputation of a company adopting a stakeholder approach and operational risk.

For its part, the financial theory has been actually very interested in the capital structure and its effect on the company value through the trade-off theory, asymmetric information signaling theory, the agency cost theory as well as the pecking order theory. However, the stakeholder theory of finance initiated by Cornell and Shapiro (1987), Zingales (2000), Charreaux (2002) and others appears to be inconsistent with the approach of the financing structure limited to financial capital. It considers that financial policy should be co-determined by stakeholders other than the funders. It expects that companies engaged in strong relationships with stakeholders are relatively less indebted to better ensure that their demands can be honored. In such a way, we find the hierarchical perspective, which favors at first the internal resources, second the equity, and ultimately the debt. Putting the equity in second place is not at random, because external equity

must be used to strengthen relationships with stakeholders who hold key resources,

However, the works mentioned above and dealing with the capital structure in a stakeholder context have nowhere introduced ethical values as a discipline means and a motivational tool for all stakeholders in a company. Sharing ethical values makes it possible to reverse the results obtained by these authors. In this context, the responsible behavior and the trust that reigns all the relations between the stakeholders permit the company to get into debt as long as the bankruptcy costs are low because of the solid trust relationship between the company and its stakeholders. Agency and cognitive costs are also low, as long as shared values reduce information asymmetry, divergence of interests and promote cognitive diversity.

Our theoretical analysis reveals that the trade-off theory is more suited to our context as long as information asymmetry and agency conflicts should be less important while cognitive diversity is important. However, our analysis does not allow us to draw conclusions on the optimal combination of funding. Appropriately, our theoretical analysis should be supplemented by further experimental studies.

4- Proposed model

The structure of our model is based on the famous method of discounted free cash flow (DCF) proposed by Gordon and Shapiro in the case of the perpetual growth of free cash flow. The value of the business is calculated as follows:

$$\text{Corporate Value} = \frac{\text{FCFF}_1}{\text{wacc-g}}$$

Where “FCFF” is the free cash flow generated by the firm, “wacc” is the weighted average cost of capital, and “g” is the growth rate of free cash flow. The DCF in this case is only a black box because the determinants of "FCFF", "g" and "wacc" are not enlightened. By doing this, we never know how these numbers are created and the justification is not given as to how these numbers derive from the fundamental determinants and how they are integrated. Our model presented in Fig. 01 in the appendices takes clearly these variables into account by referring to the causal links explained in the previous section as well as to the model presented by Magni, Malagoli, and Mastroleo (2007). The description of each variable of the adopted model is provided in table 01 in appendices.

Nevertheless, the integration of qualitative variables together with the quantitative variables in the model makes the variables measurability issue more difficult. For this reason, we used a helpful tool to manage this type of variables and test the model validity.

5- A fuzzy expert system for measuring and managing value

To measure and manage the company value, we propose the incorporation of a fuzzy expert system. The latter provides a systematic way to use qualitative values rather than precise numbers. We use it in this paper for the following reasons. The complexity of real issues can just be resolved through "unclear" variables and "unclear" interactions that better replicate the human mind. In fact, the mental processes of human beings are imperfect and inaccurate; individuals often act in contexts of incomplete (and unclear) information. Besides, a fuzzy expert system does not require historical data to develop statistical links between the variables. Therefore, it reduces the time needed for system development, since a period of recording and quantitative analysis of data is not required. And the most important reason is that it does not require complicated mathematical models or the slightest mathematics proficiency. It is the know-how of the qualified operator who usually handles the process or the knowledge of experts that is taken into account in setting up the system (Bouchon-Meunier, 2007: 104).

According to Jang (1992: 666), a fuzzy expert system is made up of five blocks: a database, which defines the membership functions of fuzzy sets; a rule base, which brings together the set of fuzzy rules of the type "if-then"; a decision unit or inference engine; a fuzzification and defuzzification interface. Thanks to this, initial quantized values are introduced into the system after having generally gone through a normalization process and are transformed into linguistic values associated with the so-called membership functions, where expert knowledge has been used. There are different types of membership functions such as triangular, trapezoidal, or Gaussian (Jang and Sun, 1993: 378). The resulting linguistic variables end up being fuzzy inputs to the decision-making unit. Then, by applying the "if-then" rules, we get fuzzy output, expressed similarly in linguistic terms. System design and calculations were performed using the Fuzzy Logic Toolbox graphical User Interface (GUI) of Matlab. The system was developed through three stages.

The first step is to represent the model through the "Fuzzy Inference System Editor –FIS Editor-". Each two or more input variables form a FIS, for example, the input variables "R-leadership", "Org-learning" form the fuzzy inference systems "S-cooperation", "R-innovation" and "Reputation". The latter is also input variables for the fuzzy inference systems "Revenues", "Op-costs" and others. The FISs are nested until the main DCF business valuation formula is reached, which links the value of the firm to the three commonly used variables: "FCFF", "g" and "wacc". The

presentation of the FIS "S-cooperation", for example, is done as illustrated by fig. 02 in the appendices.

The next step is to fuzzify the input and output variables of each FIS in the model through the Membership Function Editor. The Membership Function Editor is used to define the forms of all the membership functions associated with each variable. The ranges of speech universe can be determined by expert judgments. Fig. 03 in the appendices presents the example of the "S-cooperation" FIS.

In the third step, we will build the rule base through the rule editor proposed by the GUI as illustrated by the example of the FIS "S-cooperation" in the following table:

Table 02: Example of fuzzy inference rules of the FIS "S-cooperation"

1- If (R-leadership is low) and (Org-learning is low) then (S-cooperation is low)
3- If (leadershipR is low) and (Org-learning is medium) then (S-cooperation is mediumlow)
10- If (leadershipR is medium) and (Org-learning is medium) then (S-cooperation is medium)
12- If (leadershipR is medium) and (Org-learning is high) then (S-cooperation is mediumhigh)
25- If (leadershipR is high) and (Org-learning is high) then (S-cooperation is high)

Source: Composed by us using the GUI of Matlab

The construction of the rules base is a task which also falls exclusively to the expert who establishes cause and effect relationships between the various input and output variables of the model. At this point, we can say that the fuzzy expert system intended to evaluate the value index of the company is ready to use.

6- Illustrative examples and corroboration model

The model we have built needs corroboration. To this end, we tested reliability through a series of simulations by changing the value of one or more value drivers at the same time, while leaving the others fixed. The greater the number of simulations, the greater the degree of model corroboration. For reasons of space, only two simulations are described in this section.

The first simulation shows different value indices for different values of "Org-learning" while the other drivers are kept fixed. The values of "Org-learning" are changed from 0.1 to 1, while the other variables are held fixed

at the following levels: "R-leadership" = 0.1; "P-sensitivity" = 0.6; "Tax" = 0.3; "Competition" = 0.7; "Coverage" = 0.8; "Op-leverage" = 0.2; "E-sensitivity" = 0.1; "ReinvRate" = 0.1; "ROI" = 0.04; "IFC" = 0.1; "GWC" = 0.1. Table 03 shows 10 columns corresponding to 10 different cases.

Table 03: The effect of variation of "Org-Learning" on the value

Cas	1	2	3	4	5	6	7	8	9	10
Org-Learning	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
Revenues	0,16	0,23	0,24	0,24	0,30	0,40	0,50	0,59	0,65	0,65
Op-costs	0,85	0,78	0,77	0,77	0,69	0,61	0,50	0,38	0,25	0,25
Op-results	0,17	0,24	0,25	0,25	0,30	0,40	0,50	0,62	0,74	0,74
FCFF	0,38	0,43	0,43	0,44	0,50	0,55	0,60	0,66	0,76	0,76
Wacc	0,52	0,41	0,40	0,40	0,39	0,39	0,38	0,38	0,30	0,30
Value index	0,29	0,34	0,34	0,35	0,40	0,45	0,46	0,46	0,54	0,54

Source: Execution results of the firm value calculation program via Matlab

As expected, the increase in Org-learning caused several intermediate variables to vary and this in turn led to a change in the final value. The first effect that we can notice is a positive effect that affects the variable "FCFF". The increase in FCFF is due to the increase in the variables "S-cooperation" and "R-innovation" where were increased because of a direct positive effect. For its part, the intermediate variable "Revenues" increased because of a positive effect. However, the increase in the variables "S-cooperation" and "R-innovation" reduced "Op-costs", hence a double positive effect on "Op-results" as well as "FCFF". On the other side, We notice a negative effect of the increase in "R-Leadership" and "Org-learning" concerning the capital cost through the decrease in the "Op-risk" and "financialrisk" variables via the decrease in "businessrisk" and "specificrisk" because of the continuous increase in the "reputation" variable. Increasing the "FCFF" and decreasing the "wacc" while keeping the growth stable will increase the total firm value index from (0.29) to (0.55).

The first simulation confirms that the final output reacts correctly (both in terms of correlation and in terms of magnitude) when one of the value drivers varies. The second simulation aims to test a less simplified relationship by changing simultaneously two value drivers ("Op-leverage" and "P-sensitivity") while leaving the others fixed at the following levels: "R-leadership" = 0.1; "Tax" = 0.3; "Competition" = 0.7; "Coverage" = 0.7; "Org-learning" = 0.1; "E-sensitivity" = 0.1; "ReinvRate" = 0.4; "ROI" = 0.03; "IFC" = 0.1; "GWC" = 0.1. In this second simulation, the "Op-leverage" and "P-sensitivity" variables are set exogenously at the different levels, and the corresponding values of the "FCFF", "Wacc", the value index and the other intermediate variables are calculated using the proposed simulation model. The results are displayed in table 04.

Table 04: The effect of changes in "Op-leverage" and "P-sensitivity" on firm value

Cas	1	2	3	4	5	6	7	8	9	10
Op-leverage	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
P-sensitivity	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
FCFF	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44
Specific risk	0,26	0,29	0,37	0,44	0,54	0,61	0,69	0,76	0,80	0,92
Op-Risk	0,26	0,30	0,37	0,40	0,40	0,39	0,43	0,51	0,56	0,66
Financial Risk	0,33	0,36	0,38	0,39	0,39	0,39	0,39	0,39	0,39	0,39
Wacc	0,33	0,37	0,39	0,40	0,40	0,40	0,42	0,52	0,58	0,59
Value index	0,38	0,36	0,35	0,35	0,35	0,35	0,34	0,34	0,34	0,33

Source: Execution results of the firm value calculation program via Matlab

As we can read from the previous table, the increase in "Op-leverage" and "P-sensitivity" did not affect "the FCFF" or "g" however it increased "wacc". Table 04 allows us to notice that the decrease in value from (0.38) to (0.33) is due to the increase in the cost of capital from (0.33)

to (0.59). The increase in "Op-leverage" and "P-sensitivity" therefore caused an increase in the cost of capital through the increase in specific risk, which also caused the increase in operational risk and financial risk. We also notice that "wacc" is always included between "Op-risk" and "financialrisk".

7- Conclusion

This paper presents a fuzzy expert system for measuring and managing corporate value in a stakeholder context. The system adopted in this work is based on a varied theoretical and technical compilation. First, the theory of stakeholders and the interest of stakeholders management is the framework chosen for our tool. The organizational learning approach and responsible leadership theory have actually been the core of the creation and corporate value sustainability. To model this approach, we used the discounted cash flow method. the DCF methodology just helps us in the final step but it does not tell us how many drivers are considered or how they are aggregated. Their direct or indirect financial impact is not specified either. The introduction of extra-financial value drivers alongside financial drivers to assess value is closer to reality; however, it makes the evaluation problem more complicated, especially when we lack precise values. The introduction of expert knowledge and judgments is interesting but requires appropriate handling techniques. Finally, fuzzy expert systems were used to facilitate the manipulation of such a tool and the validation of the proposed model.

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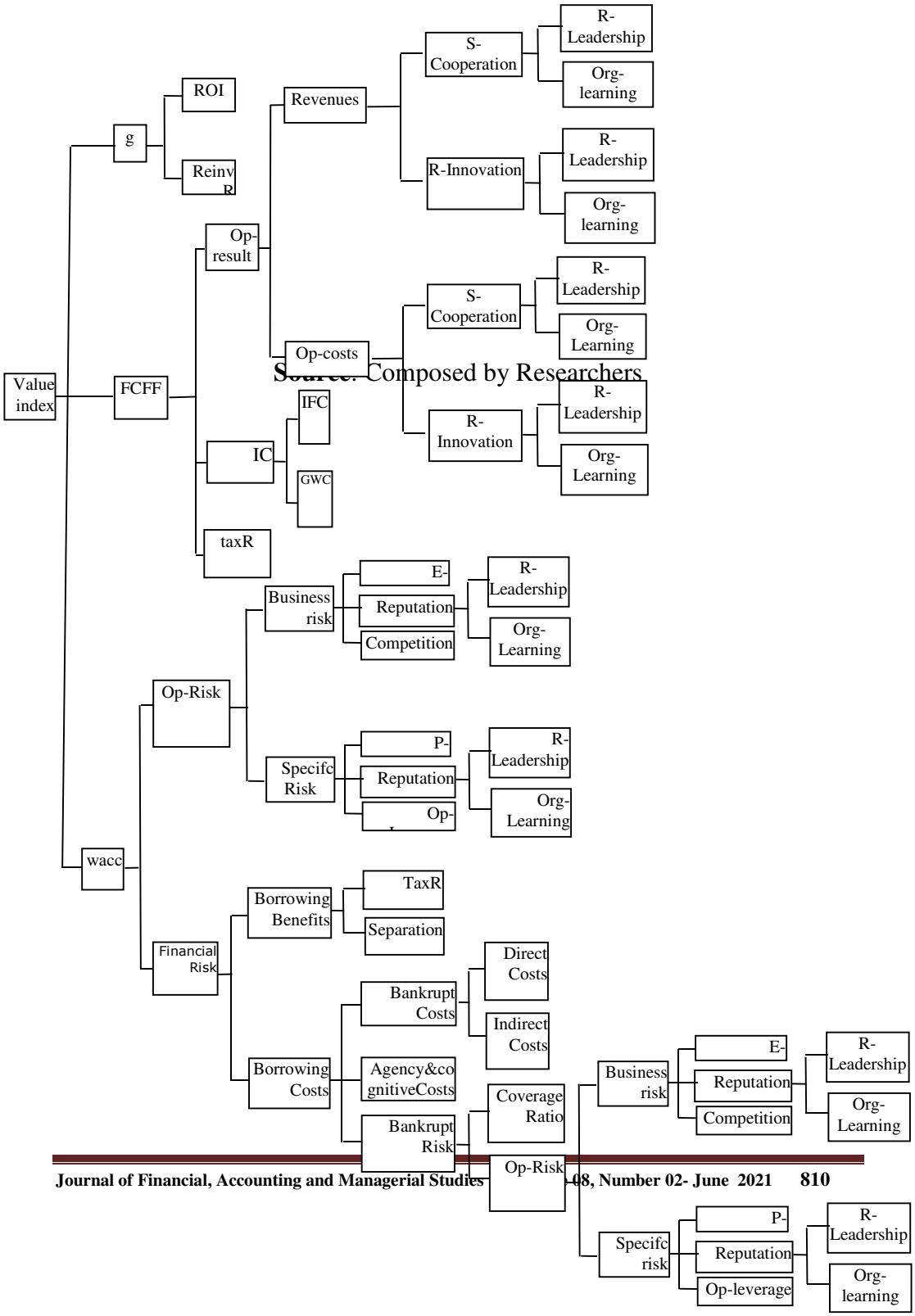
FIG. 1: THE PROPOSED MODEL

9. Ap



Source: Composed by Researchers

Table 01: The value drivers and intermediate variables designation

Values drivers		Intermediate variables	
Agency& cognitivecosts	Agency and cognitive costs (qualitative variable)	**Bankrupt costs**	Costs of firms going Bankrupt
IFC	Net Investment in Fixed Capital (quantitative variable).	**Bankrupt risk**	Bankruptcy risk or Insolvency risk
GWC	Growth in Working Capital (quantitative variable).	**Business risk**	Risk of industry
Competition	Competition Rivalry among existing firms (qualitative variable)	**IC**	Invested Capital
Coverage	The coverage ratio or the ratio EBIT / financial expenses (quantitative variable).	**FCFF**	Free Cash flow to the firm
Directcosts	Direct costs of Bankruptcy (qualitative variable).	g	Growth rate
E-Sensitivity	Sensitivity to macroeconomic variables (qualitative variable).	**Op-costs**	Operating costs
Indirectcosts	Indirect costs of Bankruptcy (qualitative variable).	**Op-result**	Operating result
Op-Leverage	Operating Leverage or the proportion of fixed costs on total costs (quantitative variable).	**Op-Risk**	Operating risk
Org-Learning	Organizational Learning(qualitative variable).	**R-Innovation**	Responsable Innovation
P-Sensitivity	Sensitivity to Price (qualitative variable).	**S-Cooperation**	Stakeholders Cooperation
ReinvR	Reinvestment Rate, a quantitative variable which can be calculated by the ratio (IFC - A + ΔGWC) / [EBIT].	**Specific risk**	Risk related to the firm specific characteristics

R-Leadership	Responsible Leadership (qualitative variable).	**Value index**	Firm value index
ROI	The return On Invested Capital or the ratio EBIT (1-τ) / capitaux investis.	**Wacc**	Weight average cost of capital
Separation	Separation between management and control (qualitative variable).		
TaxR	Tax rate (quantitative variable).		

Fig. 02 : The inputs and output variables of « S-Cooperation » FIS