



# MEASURING GOVERNANCE PERFORMANCE BASED ON SUGENO INTEGRAL FOR PUBLIC- OWNED COMPANIES IN MOROCCO

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## ABSTRACT

*The governance performance is a key element in the management of companies, including State-owned ones. In this field, the problem of multi-criteria aggregation raises as a crucial challenge. In this article, we are interested in studying this problem by proposing the Sugeno integral-based approach to support the aggregation of multidimensional relevance. The usefulness of this new approach is twofold: (i) it ables the interactions between different relevance dimensions to be modeled; (ii) it generalizes many classic aggregation functions. The empirical study shows better results when it comes to use our new approach.*

**Keywords:** Gouvernance, efficiency, efficacy, multidimensional pertinence  
agregation, fuzzy measure, Sugeno integral.

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## 1. INTRODUCTION

Morocco has embarked since the early 90s of last century the development of new institutional mechanisms, technical and legal in order to achieve accelerated economic growth enabling it to achieve a social and economic level able to significantly improve its human development indicators.

The authorities have thus committed major structural and sectoral reforms to create the conditions for a modern and rational organization of the national economy able to cope with the requirements of openness and competitiveness to the outside world.

The Public establishments and enterprises (PEE) that make up the portfolio of the state, were among the prime targets of the reforms. These aim to improve the governance of different PEE to increase their performance and control risks of the State portfolio.

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In this context, a code of practice for Public Enterprises in Morocco was established in March 2012. It serves as a basis for improved governance of these companies.

However this code that draws the best practices in the alignment on the principles of the OECD is to define a model system of governance for the EEP nor to propose solutions for the assessment of the effectiveness of a system governance for the above companies.

A review of the literature on the subject, identifies several studies that have formulated definitions of an effective governance system.

In this context, several studies [5], [11], [18], consider governance as efficient if it allows maximizing the value of the firm through better resolution of conflicts of interest between different parties. Therefore, this research has linked the effectiveness of the governance of an entity in compliance with standards related to following criteria:

- The proper functioning of the Board of Directors and its committees.
- The control of risks.
- Improving disclosure of information.

Given the importance of these criteria and their considerable effect on the efficiency of the governance of an entity system is proposed in this work a full Sugeno based approach to aggregating multidimensional relevance in the field of governance. This approach is able to escape the problem of independence criteria laid in conventional aggregation operators.

Based on the concept of fuzzy measure, the main originality of the Sugeno integral is its ability to model all interactions and dependencies that exist between the different dimensions of relevance.

## 2. STATE OF ART IN MEASURING THE PERFORMANCE OF GOVERNANCE

Due to the significant challenge of measuring good governance, several indices and tools have been developed to assess the quality of corporate governance.

A scan on empirical studies on this subject reveals that each study differs from the other by incorporating a specific element of governance. Indeed, several authors [1], [2], [3], [4], [6], [7], [9], [10], [15], [19], proposed governance indexes based on : The organization of the Board of Directors (BD), The presence of independent directors, The operation of the specialized committees and Transparency and disclosure of the information.

Other authors [5], [11], [19] have incorporated the audit committee and internal audit as specific element to their study.

Mohanty [16] adopts a different approach in the calculation of the index of governance. This approach is based on the following principle: "A firm having good governance is a firm that pays taxes to the State."

The Shareholders Service (ISS) high developed in 2003 a governance index calculated on the basis of 57 binary issues including the structure and the functioning of the Board of Directors, responsibility and impartiality of the audit committee, to the discipline of executives and the transparency of information. This index is calculated based on a scale of 1 to 10, where an equals 1 index is assigned to companies whose governance does not sufficiently take into account the interests of stakeholders within the company so that an index equal to 10 is assigned to companies whose governance practices are the best.

The Canadian newspaper "The Globe and Mail" publishes, annually since 2002, an index which overlaps elements concerning good governance for Canadian businesses, including the

independence of the members of the Board and the disclosure of information. The index is divided into four broad categories: (i) The composition of the Board of Directors; (ii) Ownership and compensation (for executives and administrators); (iii) The rights of shareholders; (iv) Disclosure of information.

Correia and al. [8] developed an index of clean governance to Brazilian companies. Their findings have helped identify four main components: (i) Transparency; (ii) Investor protection; (iii) Remuneration; (iv) The composition of the Board of Directors and ownership structure.

From the foregoing, it emerges that:

1. The calculated index is generally assumed that the different components of governance contribute in the same way in improving the quality of the latter.
2. There is a wide divergence concerning variables used to calculate the governance index.
3. Calculated indices do not reflect the dependence of variables.

Our contribution focuses on the presentation of a new method that takes into account the dependencies between the different dimensions of governance. Moreover, this method allows identifying, among the study population, companies that have a high level of efficiency in governance.

In this context, we apprehend the extent of governance based on four variables related to the internal mechanisms of management and operation of an enterprise, namely:

1. The organization and functioning of the Board of Directors (BD).
2. The functioning of the specialized committees.
3. The disclosure of the information.
4. The maturity of risk mastering system.

The fourth criterion requires special attention (Cf of Emmanuel Boullay et al [12]). Indeed, the BD impulse the risk oversight process in the company. It follows the most significant risks, assess the risk exposure of the company in terms of strategy and ensures the effectiveness of risk management mechanisms.

In this context, the Board of Directors delegated under its responsibility, to a specialized committee, monitoring the effectiveness of internal control systems and risk management. As such, it can particularly recommend a frequency of at least two meetings per year for this committee.

### **3. PROPOSED METHOD**

In the field of information fusion, the two best-known non-additive integrals are integrals Choquet (1953) used on the cardinal scales and integrals Sugeno (1974) used on ordinary scales.

We opted for the use of integrals Sugeno [13] because they are used as qualitative aggregation functions to evaluate items that depend on several criteria. They can simplify the calculation of aggregation, to get faster a clear solution. This method is often used for real-time applications where the computation time is important.

#### **3.1. Method Presentation**

The method used is based on Fuzzy Measurement and Sugeno Integral.

To facilitate understanding, it was considered appropriate to recall notions of Fuzzy Measurement, integral Sugeno and an application example.

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### 3.1.1. Concept of Fuzzy Measurement

For a finite set  $X = (x_1, x_2, \dots, x_m)$ ,  $P(X)$  is the power set of  $X$

A Fuzzy measure noted  $g$  is a function defined from  $P(X)$  to  $[0, 1]$ , satisfying the following properties:

- $\forall A, B \in X$ , if  $A \subseteq B$  and  $g(A) \leq g(B)$
- $g(\emptyset) = 0$ ,  $g(X) = 1$
- if  $A \cap B = \emptyset$  and  $g(A \cup B) = g(A) + g(B) + \lambda g(A)g(B)$  with  $\lambda \in [-1, +\infty[$ .

The parameter  $\lambda$  is obtained by solving the following equation:

$$1 + \lambda = \prod_{i=1}^{i=m} (1 + \lambda g^i)$$

With

$$g^i = g(\{x_i\})$$

Once the specified  $\lambda$  value, evaluates various Fuzzy measure values  $g(X)$  that may be used in the aggregation process by means of the following relationship:

$$g(X) = \prod_{i=1}^{i=m} \left[ \frac{(1 + g^i)}{\lambda} - 1 \right]$$

### 3.1.2. The Sugeno Integral

The Sugeno integral is defined as follows:

$$S_{\mu}(X) = \bigvee_{i=1}^n (x_{(i)} \wedge g(A_{(i)})) = \bigwedge_{i=1}^n (x_{(i)} \vee g(A_{(i+1)}))$$

With

$N = \{1, \dots, n\}$	:	is the set of criteria
$(L, \wedge, \vee)$	:	Totally ordered set $\wedge$ : minimum $\vee$ : maximum 0 : the smallest element      1 : the largest element
$g : \mathcal{L} \rightarrow L$	:	Fuzzy measure
$X = (X_1, \dots, X_n) \in L^n$	:	an alternative ( ) is a permutation on $N$ such that $X_{(1)} \leq \dots \leq X_{(n)}$ $A_{(1)}, \dots, A_{(n)}$ are subsets of $N$ such that for $A_{(i)} = \{(i), \dots, (n)\}$ and $A_{(n+1)} = \emptyset$

The Sugeno integral gives a score between the minimum and maximum partial assessments.

### 3.2. Sample and data source

To test the relevance of the proposed method, we selected a sample consisting of 35 Public Moroccan establishments and enterprises (PEE). This sample includes public institutions operating in the market sector and joint stock companies with majority public direct participation.

The distribution of these companies by business segment is as follows:

**Table 1** Distribution of sample companies by sector

Activity area	Number of company	%
<b>Planning and Habitat</b>	3	8,6%
<b>Energy and Mines</b>	6	17,1%
<b>Financial</b>	6	17,1%
<b>Agriculture and Fisheries</b>	5	14,3%
<b>Services</b>	8	22,9%
<b>Infrastructure, Transport and Logistics</b>	7	20,0%

The data are for 2014. They come from various sources including reports from the Ministry of Economy and Finance, [20] the activity reports on the websites of the firms in the sample [ 21], [22] and the reports of the Court of Auditors in Morocco.

### 3.3. Variables used

As mentioned above, the measuring governance is apprehended by four criteria:

1. The organization and functioning of the Board of Directors (BD).
2. The functioning of the specialized committees.
3. The disclosure of the information.
4. The maturity of risk mastering system.

The objectives and the methods of assessment used for the measurement parameters for each criterion are as follows:

#### Criterion 1: Organization and functioning of the BD

Objective: To assess the functioning of the CA including its size, the presence within the independent directors and the frequency of its meetings

**Table 2** Measuring parameters of criterion 1

Parameters	Appreciation	Proposed rating
<b>BD Size</b>	If the number of directors <12	3
	If the number of directors <18	2
	If the number of directors <24	1
<b>Existence of independent directors (ID)</b>	2 ID or more	2
	1 ID	1
	NO	0
<b>Frequency of meetings Board</b>	If the board meeting frequency is $\geq 4$	5
	If the board meeting frequency is equal to 3	4
	If the board meeting frequency is equal to 2	3
	If the board meeting frequency is equal to 1	1

#### Criterion 2: Functioning of the specialized committees

Objective: Assess the operation of the specialized committees through the operation of the Audit Committee, the operationalization of the Strategic Committee and Investment and the existence of other specialized committees (compensation, governance, ...).

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**Table 3** Measuring parameters of criterion 2

Parameters	Appreciation	Proposed rating
<b>Functioning of the Audit Committee</b>	If the year committee meeting frequency is greater than or equal to 4	5
	If the year committee meeting frequency is greater than or equal to 3	4
	If the year committee meeting frequency is greater than or equal to 2	3
	If the year committee meeting frequency is greater than or equal to 1	2
	If the committee exists but is not operational	1
	If the committee does not exist	0
<b>Operationalization of the Strategic Committee and Investment (SCI)</b>	If the SCI is operational	2
	If the SCI exists but not operational	1
	If the SCI does not exist	0
<b>Existence of other specialized committees (other than the Audit Committee and SCI)</b>	The number of specialized committees is $\geq 3$	3
	The number of specialized committees is $\geq 2$	2
	The number of specialized committees is $\geq 1$	1
	non-existence of specialized committees	0

**Criterion 3:** The disclosure of the information

Objective: Enjoy the dimension of transparency of the company through its financial communications in the frequency and quality of their disclosure

**Table 4** Measuring parameters of criterion 3

Parameters	Appreciation	Proposed rating
Quality of information disclosure	No communication	0
	One communication per year unaudited	1
	One communication per year audited	2
	One communication per year certified	3
	Two communication per year with an audited	4
	Two communication per year with an certified	5
	Two communication per year with a certified and audited the other	6
	Four communications per year with a certified	7
	Four communications per year including a certified another audited	8
	Four communications per year with a certified and audited two	9
	Four communications per year audited a certified	10

**Criterion 4:** The maturity of risk mastering system

Objective: Enjoy the risk mastery of processes within the company in three parts: existence of a comprehensive risk management, existence of an entity responsible for monitoring risks, existence of a risk map.

**Table 5** Measuring parameters of criterion 4

Parameters	Appreciation	Proposed rating
risk management system maturity level	Awareness of the importance of risk control but not materialized	1
	Some risks identified but not risk existing device	2
	Device existing risk but unrealized	3
	risk materialized device but not operational	4
	operational risk device	5
	Existence of a risk mapping but not used by the risk of device	6
	Device risk controlled via a mapping of risk	7
	Good management of the risk but no control device	8
	Existence of Global Risk Management	9
	Global management of operational risk, taking account of feedback	10

## 4. EMPIRICAL STUDY AND RESULTS

### 4.1. Calculation of governance scores by the method of Sugeno Sugeno

#### 4.1.1. Basic data

In the context of our method, we are faced with a consensus on the classification of a group of companies  $E_i$  from a total set  $E = \{E_1, E_2, \dots, E_{35}\}$  against a set of criteria  $i$ .

Each criterion  $i$  belongs  $N = \{1, 2, 3, 4\}$  to all relevant dimensions.

$w_i$  is the relative weight criterion  $i$ .

In our study we hold the following weights:

$$w_1 = 0,7 \quad w_2 = 0,6 \quad w_3 = 0,5 \quad w_4 = 0,8$$

Moreover, the implementation of the method for Assessing measurement parameters Provided For Each criteria in subsection 3-3 Above Was used to evaluate-all the companies forming the sample with respect to Each criterion. The results of this assessment are presented in the Following table:

**Table 6** Business Evaluation by criteria

Compagnie	F(X <sub>1</sub> )	F(X <sub>2</sub> )	F(X <sub>3</sub> )	F(X <sub>4</sub> )	Compagnie	F(X <sub>1</sub> )	F(X <sub>2</sub> )	F(X <sub>3</sub> )	F(X <sub>4</sub> )
E1	0,7	0,7	0,5	0,3	E19	0,7	0,8	0,3	0,2
E2	0,4	0,3	0,1	0,1	E20	0,4	0,5	0,1	0,3
E3	0,3	0,4	0,1	0,1	E21	0,5	0,5	0,1	0,1
E4	0,5	0,2	0,1	0,6	E22	0,2	0,4	0,1	0,1
E5	0,5	0,2	0,1	0,1	E23	0,3	0,1	0,1	0,1
E6	0,8	0,7	0,6	0,9	E24	0,2	0,3	0,1	0,1
E7	0,4	0,8	0,8	0,8	E25	0,9	0,8	0,5	0,6
E8	0,8	0,7	0,8	0,7	E26	0,5	0,2	0,1	0,2
E9	0,5	0,2	0,1	0,6	E27	0,5	0,3	0,1	0,2
E10	0,5	0,1	0,1	0,1	E28	0,5	0,1	0,1	0,1
E11	0,4	0,5	0,8	0,9	E29	0,5	0,6	0,1	0,2
E12	0,5	0,5	0,1	0,3	E30	0,5	0,2	0,1	0,1
E13	0,6	0,4	0,1	0,3	E31	0,6	0,6	0,1	0,1
E14	0,7	0,9	0,8	0,8	E32	0,6	0,7	0,1	0,1
E15	0,3	0,1	0,1	0,1	E33	0,8	0,7	0,1	0,4
E16	0,2	0,3	0,1	0,1	E34	0,5	0,2	0,1	0,1
E17	0,4	0,4	0,1	0,1	E35	0,5	0,4	0,1	0,1
E18	0,6	0,6	0,3	0,3					

#### 4.1.2. Construction of Sugeno integral

The weights are selected for each criterion

$$\begin{cases} w_1 = g(\{x_1\}) = g^1 = 0,7 \\ w_2 = g(\{x_2\}) = g^2 = 0,6 \\ w_3 = g(\{x_3\}) = g^3 = 0,5 \\ w_4 = g(\{x_4\}) = g^4 = 0,8 \end{cases}$$

To find the  $\lambda$  parameter, we solve the polynomial equation:

$$1 + \lambda = \prod_{i=1}^{i=4} (1 + \lambda g^i)$$

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Which give

$$0,168 \lambda^4 + 1,066 \lambda^3 + 2,51 \lambda^2 + 1,6 \lambda = 0.$$

Of this equation the solutions are:

$$\begin{cases} \lambda_1 = -2,6793636 + i(1,5732273) \\ \lambda_2 = -2,6793636 - i(1,5732273) \\ \lambda_3 = 0 \\ \lambda_4 = -0,986510964 \end{cases}$$

As  $\lambda \in [-1, +\infty[$  and if  $\lambda = 0$  the model is additive, then holds:

$$\lambda = -0,986510964$$

As such, the equation:

$$g(A \cup B) = g(A) + g(B) + \lambda g(A) \times g(B)$$

gives the following results:

**Table 7** Calculation of the fuzzy extent to subsets

A	g (A)	A	g (A)	A	g (A)
{x <sub>1</sub> }	0,7	{x <sub>1</sub> , x <sub>3</sub> }	0,8547212	{x <sub>1</sub> , x <sub>2</sub> , x <sub>3</sub> }	0,9488061
{x <sub>2</sub> }	0,6	{x <sub>1</sub> , x <sub>4</sub> }	0,9475539	{x <sub>1</sub> , x <sub>2</sub> , x <sub>4</sub> }	0,9866905
{x <sub>3</sub> }	0,5	{x <sub>2</sub> , x <sub>3</sub> }	0,8040467	{x <sub>1</sub> , x <sub>3</sub> , x <sub>4</sub> }	0,9801677
{x <sub>4</sub> }	0,8	{x <sub>2</sub> , x <sub>4</sub> }	0,9264747	{x <sub>2</sub> , x <sub>3</sub> , x <sub>4</sub> }	0,9694860
{x <sub>1</sub> , x <sub>2</sub> }	0,8856654	{x <sub>3</sub> , x <sub>4</sub> }	0,9053956	{x <sub>1</sub> , x <sub>2</sub> , x <sub>3</sub> , x <sub>4</sub> }	1

The construction of the Sugeno integral is calculated according to the following equation:

$$S_{\mu}(E_i) = \text{Max}_{i=1}^{i=n} [\text{Min}(f(x_i), g\{A_i\})]$$

With

$$f(x_i) \leq f(x_{i+1}) \leq \dots \leq f(x_n)$$

Thus, we have the following results:

**Table 8** Calculation of governance scores by the method of Sugeno

Compagnie	S <sub>μ</sub>	Compagnie	S <sub>μ</sub>	Compagnie	S <sub>μ</sub>	Compagnie	S <sub>μ</sub>	Compagnie	S <sub>μ</sub>
E1	0,7	E8	0,8	E15	0,3	E22	0,4	E29	0,6
E2	0,4	E9	0,6	E16	0,3	E23	0,3	E30	0,5
E3	0,4	E10	0,5	E17	0,4	E24	0,3	E31	0,6
E4	0,6	E11	0,8	E18	0,6	E25	0,8	E32	0,6
E5	0,5	E12	0,5	E19	0,7	E26	0,5	E33	0,7
E6	0,8	E13	0,6	E20	0,5	E27	0,5	E34	0,5
E7	0,8	E14	0,8	E21	0,5	E28	0,5	E35	0,5

### 4.2. Results analysis

On the analysis of governance scores calculated on a Sugeno identifies six groups. The scores per group range from 0.3 to 0.8. The arithmetic average of 0.5543 while the median is 0.5.

The following table shows the list of companies by group.



**Table 9** Companies by group governance score by the method of Sugeno

Groups	S <sub>μ</sub>	Compagnie													
		Number	Part	Listing											
Groupe 1	0,3	4	11,4%	E15	E16	E23	E24								
Groupe 2	0,4	4	11,4%	E17	E2	E22	E3								
Groupe 3	0,5	11	31,4%	E10	E12	E20	E21	E26	E27	E28	E30	E34	E35	E5	
Groupe 4	0,6	7	20,0%	E13	E18	E29	E31	E32	E4	E9					
Groupe 5	0,7	3	8,6%	E1	E19	E33									
Groupe 6	0,8	6	17,1%	E11	E14	E25	E6	E7	E8						

The analysis of results allows the following conclusions:

- Groups 1, 2 and 3 contain companies representing more than 54% of the sample. These companies, whose scores are below the average of the sample, operating in the sectors of Agriculture and Maritime Fishing, Services and Land and Housing. These companies require sustained efforts to professionalize their Boards of Directors and development of their governance practices.
- Group 4, consisting of companies with a score of 0.6, representing nearly 20% of the study population. The corporate governance each device forming this group requires in particular the operationalization of the specialized committees, improving transparency and financial reporting and control of the risk management system.
- Group 5 consists of 3 companies operating in the Infrastructure and Transport sector. These companies had the score of 0.7 with dynamic functioning of their Boards of Directors and their special committees. However, efforts are still needed, particularly in terms of information disclosure and risk management.
- Group 6, which represents nearly 17% of the study population, contains companies recording the highest governance score of 0.8. This group is distinguished, compared with other groups, by the strong performance of its companies on risk management and practices of transparency and dissemination of information. Among the companies in this group, four belong to the financial sector, a company in the mining sector and business in the air transport sector.
- It should be noted that:
  - ✓ Companies operating in the financial sector are subject to the guidelines required by Bank Al-Maghrib, in light of the Basel Committee standards that include the establishment of a system of governance adapted to the risk profile of these entities and their systemic importance.
  - ✓ The mining operation is none other than OCP SA is the largest company in Morocco and also a world leader in the phosphate sector.
  - ✓ The business aviation sector is the Company Royal Air Morocco This ranking confirms the efforts within the Moroccan state bonding program contract for this business, especially with regard to the establishment of an efficient system of governance. This company is characterized by the presence of two independent directors on its Board of Directors.

Moreover, this analysis allowed us to identify four classes on maturity of the governance system:

- Class 1: composed of the companies forming the groups 1 and 2, representing nearly 23% of the sample. This population is characterized by the fragility of its governance system.

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- Class 2: composed of companies with a governance score according to the method of Sugeno around the sample mean and represent almost 54%. The governance of these enterprises device is considered average.
- Class 3: composed of companies with a governance score according to the method of Sugeno, above average. This population is characterized by a relatively high maturity of its system of governance.
- Class 4: composed of companies with a governance score according to the method of Sugeno, the highest and representing 17%. This population is broadly in line with the best practices in governance.

This classification is in itself a technical instrument and a good indicator that will allow the state shareholder to modulate its means of intervention depending on the maturity of the governance system of any public companies.

### 5. CONCLUSION

In this research, we have proposed the governance measuring using four variables related to the internal mechanisms of management and operations of a company. These variables are the organization and functioning of the Board of Directors and its committees, disclosure of information and the maturity of the risk management system. For this problem of aggregation in the Advanced area of governance, we selected a sample of 35 Moroccan public companies we have collected information on governance characteristics. To address this problem, we proposed a new method based on the theory of fuzzy measure and Sugeno Integral.

The results show the relevance of our proposal. Companies with the best governance scores are actually companies that have good governance. Moreover, we were able to show a classification for the maturity of the system of governance of Moroccan public companies. This classification would allow the state shareholder to modulate its means of intervention depending on the maturity of each SOE governance system.

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