ABSTRACT SYSTEM DYNAMICS AND ITS APPLICATION TO CORPORATE GOVERNANCE ANALYSIS

Bertrand Rossert

Governance & Policy Coordination Division, European Investment Bank[1]

98-100 Boulevard Konrad Adenauer

L-2950 Luxembourg

LUXEMBOURG

Tel : (+ 352) 437 984 309

rossert@eib.org

Comparing a decision taken by a group to an elementary feedback loop, the paper proposes a typology of group decision-making, by distinguishing whether the input, output and feedback are provided by individuals or by groups. The paper suggests that this can constitute a framework for evaluating the functioning of the corporate governance of a firm.

Introduction

Corporate governance focuses on the implementation of adequate decision-making and of a set of controls to regulate the decision-making process. It deals with decisions about decision-making, including the implementation of controls of decision-making and decision implementation processes.

In recent years, the literature has focused both on the pathology of corporate governance, and the resulting regulation as a response, e.g. (Lütz et al., 2011) and the efficiency gains at firm level that can result from sound corporate governance. The efficiency studies of corporate governance have focused primarily on how corporate governance influences the way in which stakeholders (and in particular investors) perceive the firm e.g. (Carvalhal and Nobili 2011). Most of the studies focus on structure or features of corporate governance, through the constitution of dummy variables or of corporate governance indices. In a seminal article, (Gompers et al. 2003) compiled a "governance index" on the basis of the observance (or not) of 24 corporate governance rules. This, however, gives a measure of the corporate governance set up but not quite of its functioning: this describes the rules of the game but not the moves during the game.

Other studies focus on the behaviour of individuals inside a group (in this case, the group is a corporate governing body, such as a board of directors). (Gabrielsson et al 2007) analyses the functioning of boards on the basis of a Team Production Approach where the individual outputs of

[1] The views presented in this paper solely represent the views of the author and can only be attributed to the author. They do not necessarily represent the views of the European Investment Bank and cannot be attributed to the European Investment Bank.

each member of the team would amount to less than the combined output of the individuals working as a team. (Vandewaerde et al. 2010) analyses boards under the angle of team leadership. This is looking at the behavioural dynamics. (Chatelin-Ertur and Nicolas 2011) examines the level of uncertainty that surrounds individual decisions taken in an organisation, combining this with the fact that governing bodies can either provide support to management ("enabling" mode) or supervise management ("disciplinary" mode), and with the fact that decisions can conform to the standards and traditions of the organisation or break free from this influence. Combining these three factors, Chatelin-Ertur and Nicolas propose a typology of governance styles. This model, which makes ample reference to organisation learning and double-loop learning, describes in fact the degree of autonomy that is left to a decider within an organisation. While (Chatelin-Ertur and Nicolas 2011) advocates a dynamic approach to governance, the authors focus on the individual decision-making process. By contrast, the present paper emphasizes the complementarity between the individual and the group during the course of governance processes and collective decision-making.

A parallel stream of work which does not focus solely on corporate governance but on corporate agents considers how individual judgements can be aggregated when these judgements consist of answers to binary questions ("yes/no", "true/false") that may be interconnected (i.e. two questions are not necessarily independent). This theory of judgement aggregation has led to define the conditions in which majority voting is an acceptable decision-making process as in (List and Pettit, 2011) or (List and Polak, 2010). This has two limitations for the purpose of corporate governance.

A first limitation is that corporate governance decisions are not necessarily binary decisions. Other approaches of aggregation, such as using linguistic term sets based on fuzzy sets as in (Herrera and Herrera-Viedma 2000), propose solutions to address this issue.

However, another limitation of such approaches remains: what happens before and after a decision is made? This matters significantly in corporate governance. A large part of the corporate governance process consists in preparing the decision. However, a significant aspect of corporate governance processes relies on the controls of the decision and of its implementation. Therefore, in addition to the existing approaches, there is a need to develop an analysis of corporate decision-making as a multi-step process.

The present paper proposes a new and complementary approach that considers group decision-making as a process. The aim is to decompose decision-making into a number of steps that are undertaken either individually or collectively. This results in a typology of decision-making processes that can be used to gauge the consistency of the decision-making process with the nature of the decisions taken, i.e. which characterises the corporate governance *style* of the organisation. Section I presents the model that is being used and section II presents as preliminary results a typology of group decision-making.

Section I: Methodology

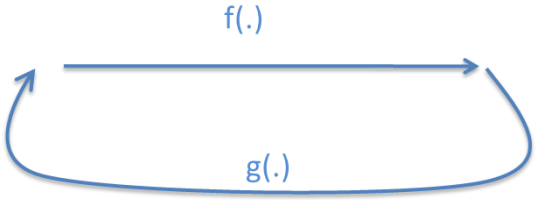
An analysis of the process of decision-making in a governing body can only be qualitative: there is no evidence that an organisation that makes more decisions than another is more efficient or more successful. Similarly, the time taken to make a decision is not a good predictor of efficiency, except, arguably when the decision is so slow that it becomes obviously inefficient.

This paper suggests that even though quantification is not feasible, the representation of group decision-making as a dynamic system with feedback is more than a good metaphor and probably a good fit for what is really happening.

Challenges of abstract systems beyond the simple feedback loop

The question is whether the analysis of a *generic* model can tell us anything about organisations in general and corporations in particular (and corporate decision-making in particular). We will illustrate the fact that beyond the simple feedback loop the analytics becomes intractable.

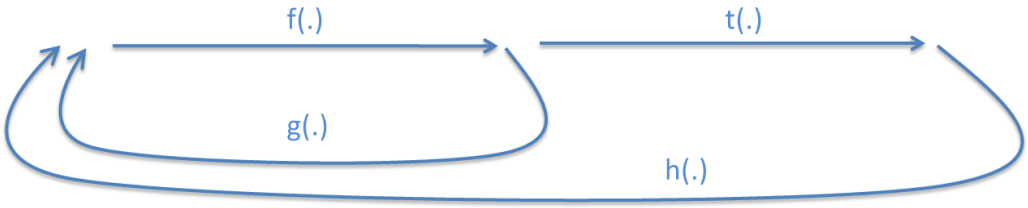
Let us describe a simple system where F(.) is the system, ie a transformation of an element x of a set X into another element of set X. F(.) is the dynamic system expressed as a function from a set X onto itself. f(.) is an input-to-output function and g(.) is a feedback-to-input function. In what follows, we use the notation: $(fog)^n = (fog)o(fog)\ldots..ntimes$



An input x is transformed into f(x) and a feedback g(f(x)) which is "recycled" through f as f(g(f(x))) which can also be written fogof(x) with a residual gofogof(x) which again is recycled until the point where go(fog)^{k}of(x)=0 which means that (fog)$^{k-1}$(f(x))=(fog)^k(f(x)) which can also be expressed by saying that (fog)$^{k-1}$(f(x)) is a fixed point of the function fog(.).

Then F(x) =$f(x) + \sum_{j=0}^{j=k}(fog)^j of(x)$

As long as the system can be thought of as a series of subsystems, the analytics of it is tractable. As soon as nested loops are introduced, the system becomes significantly more complex to analyse.



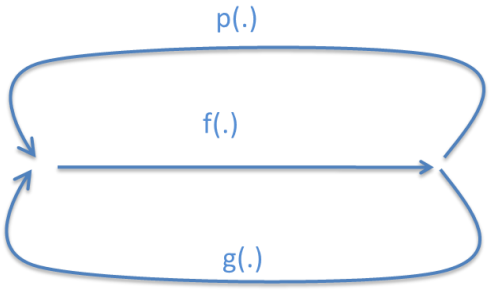
With an input to output function f(.) and a second input to output function t(.), with two feedback loops, g(.) complementing f(.) and h(.) complementing t(.) but, being a feedback to initial output and going back to f(.) (see diagram), the fuction becomes impossible to write:

$$F(x) = to\,f(x) + \sum_{j=0}^{j=\infty} to(fog)^j of(x) + \sum_{i=0}^{i=\infty} tofo(tofoh)^i tof(x) + \ldots$$

Where ... indicates that we would need to include all possible combinations of the sequences composed with (tofoh)^j and (gofoh)^i for all i,j starting and finishing with tof(.).

This means that, while an individual may be able to approximate the outcome of a simple loop (stopping the calculation after a few iterations), this becomes impossible with a nested loop.

A particular case of nested loops is the case of "parallel" feedback loops. If we go back to our simple model, where f(.) is an input-to-output function and g(.) is a feedback to input, then a parallel loop would be a function p(.) that would be also a feedback to input. Here again, we would need to include all possible sequences of $(fog)^j$ and $(fop)^i$ for all i,j. Yet, this is a very common form of organisation in a bureaucracy. It appears for three main reasons. Sometimes, there is simply coordination failure: those who implement feedback p(.) simply do not know that feedback g(.) already exists. Sometimes, it is the result of a power struggle: two distinct part of an organisation, knowing that the implementation of a control is going to result into an increase in the number of employees for the service that will be entrusted with the tasks associated with the new control, both try to implement it in parallel. Sometimes, it is dissatisfaction with the existing control and the difficulty to reform a process in a bureaucracy that leads to the creation, in parallel, of a similar control. There are, sometimes, efficient controls running in parallel to inefficient controls. Then, it is no surprise, when confronted with an organisation that has established parallel feedback loops, that the outcome is unpredictable.



This also means that, in the governance of a firm, no two entities should be entitled to make similar decisions. To be more specific, the board should not make decisions that a Chief Executive normally takes and should not make decisions that the managers of the firm are normally entrusted with. The border is sometimes thin, however, between monitoring decisions and influencing decisions, and between influencing the decision a little and influencing a decision more substantially. Conversely, the managers and the chief executive should not try to pre-empt the decisions of the board. In other words, nested loops and parallel loops allow the definition of pathology of corporate governance.

Another insight into organisation which is given by the mere abstract definition of a system is the crucial role of continuity. As Border (1985) shows, fixed point theorems crucially depend on continuity. Therefore, it follows from the discussion above that the existence of fixed points in systems or subsystems also depend on continuity. Without continuity, the outcome is difficult to predict. This is known, both explicitly and instinctively, in organisations and this may explain why large organisations tend to be so change resistant: unless change is a continuous change, i.e. a gradual and controlled change, it is characterised by discontinuity and therefore unpredictability. Large organisations in general and bureaucracies in particular tend to be resistant to change that is not purely incremental (i.e. which does not preserve continuity). This may also explain why board compositions change so slowly.

What is the flow through a system modelling collective decision-making?

If decision-making in a corporation is to be described as a system, then it is necessary to identify what flows through that system. Here, we argue that the flow through a decision-making model can be best described as a flow of *states of the world*. The concept of *State of the world* is used in game theory, for instance in (Myerson 1997) to designate each of the possible configurations of the environment which the game players evolve in. Selecting the states of the world that are more likely to occur is an important phase of making a decision in a game.

By analogy, we propose to view a decision-making process as the selection of the most likely configurations of the environment and of the actions of the participants.

The Group Decision Making model based on fuzzy preferences, proposed by (Herrera-Viedma et al 2007) sees the decision as the ultimate preference: what is preferred to all other alternatives is what is decided. This is a traditional approach of social choice.

We would like to suggest a distinction between choice and decision. A choice is the selection of an alternative among several within one state of the world. A decision is the selection of all the parameters within the control of the decider that will establish the state of the world preferred by the decider, or at least increase the probability that this state of the world will materialise. In other words, deciding means selecting the states of the world that are more desirable. In this context, decision-making can be thought of as a system in which the flow is a set of states of the world; deciding then consists in selecting the *preferable* states of the world. In this approach, decision-making consists in capturing and then filtering the states of the world, where capturing consists in gathering the elements and identifying their interaction, i.e. going from fragmented information to models, and then selecting the most relevant models by filtering out the less relevant ones.

What is *preferable* is eminently subjective. Here again, we would like to propose a distinction between choosing and deciding. Making a choice means "ranking" the alternative and selecting the best one according to the order relation so defined. However, our experience, as practitioner of decision-making, is that, except in the bureaucratic rationalisation that a business case constitutes, decisions do not occur from a systematic ranking of alternatives. Decisions emerge from the definition of an "ideal" state of the world and the definition of the distance between that ideal and the actual or attainable states of the world. This is actually consistent with epistemological descriptions of the process of discovery: the ultimate destination is often known when the path to reach it is still unclear.

Another practical observation, which would need to be confirmed through systematic assessment, is that individuals and groups *invest* in the decision, i.e. they tend to act to increase the probability that the state of the world that they predicted actually realise. It is not just that individuals in the group that took a decision ought to act consistently with the decision they made; it seems that they tend to favour events that confirm this state of the world and be obstructive against what could contradict or modify this state of the world. Individuals create a sort of "ratchet effect" once they have decided.

Whether a group decides to act or not will depend on a complex system of incentives: when an action reduces the distance between the ideal and the actual state of the world, then an individual (or a group) will have an incentive to act. However, because the incentives are several and complex, an

individual within a group structure may have contradictory or opposite incentives. These incentives, i.e. these measures of the distance between ideal and potential (or ideal and real) are feedback loop on the transformation of the existing state of the world into a different state of the world.

So a decision-making process can be seen as a filtering process on states of the world. This means that it can be modelled as a dynamic system, with a flow of "states of the world" of differing complexity depending on how detailed the decision sought is, and with possible states of the world as input, acceptable or desirable states of the world as output, and a feedback process that filters out the states of the world that would not be desirable (in so far as the actions under the control of the decision-making group can influence it and change it) or feasible.

In the next section, we abstract from what exactly flows through the decision-making system and considers a simple feedback loop where an input is converted into an output and feedback is provided. Depending on who is active during these three basic steps, the decision process may be different.

Section II Group decision-making in a corporation: insights from the abstract model

The description of corporate decision-making as a simple system of input, output and feedback allows to establish a typology of forms of collective decision-making by distinguishing whether each of the three phases (input, output, feedback) are undertaken individually or collectively. The resulting taxonomy contains eight (2^3) categories:

Input: ideas	**Output: decision**	**Feedback: correction or reinforcement of the decision**	**Name**
Group	Goup	Group	Consensus
Group	Group	Individual	Individual censor
Group	Individual	Group	Guide
Individual	Group	Group	Creative leadership
Individual	Individual	Group	Separation of power
Individual	Group	Individual	Guru
Group	Individual	Individual	Consultative
Individual	Individual	individual	Individual roles or dictatorship

At one extreme is what we have called "*Consensus*" where every step of the decision-making process is undertaken by a group. The proposed name reflects the fact that, as every step of the decision is undertaken by a group, no individual can settle possible disagreements or stalemate

between sub-groups; therefore for this type of universally collective decisions, the only way to reach a decision is to find a consensus. This is typical of the governance of many international organisations.

This category consists of five subcategories depending on whether the three steps of the decisions are undertaken by three separate groups (one possibility), two separate groups one of which undertakes two steps (three possibilities) or by one single group (one possibility). Therefore there are five subcategories which all result in truly distinct dynamics.

These subcategories themselves can be subdivided into two, depending on whether each step is undertaken by the same group every time or whether it iterates between different groups. When steps are undertaken by the same group, there is an element of recall. It is tempting to assume total recall but memory, whether individual or collective, is sometimes faulty. It would therefore be worth probabilising (i) whether the situation is identified as close to a situation assessed previously by the group and (ii) whether the situation is correctly remembered or confused with another[2].

These details are of practical importance in the diagnosis of how a decision is actually made inside an organisation where all decisions are collective in all of their phases. The imperfection of memory can explain a number of quirks in the system. The changes in groups, and thus the absence of recall, may sometimes be described as a sign of "disorganisation". However, a thorough assessment of the quality of the decisions taken would be needed to be able to be prescriptive in the way a group decision-making system is organised and to identify further pathologies of corporate governance.

The groups involved in decision-making will themselves express preferences regarding the way a decision-making process is carried out. In our simple example of a function f(.) with g(.) as feedback, a group strongly in favour of f(.) will describe g(.) as resistance to change (if g takes the form of a balancing feedback loop) or as support to the decision (in the case of reinforcing feedback loop). If g(.) is strongly favoured by the group, the f(.) will be branded an error and g(.) will be a correction mechanism. In other words, there will be preferences attached by a group (or a governing body) to the various steps of the decision-making process. Some governing bodies will focus on feedback (typical case of an audit committee), while others will focus on output or on input. These group preferences about the decision-making process tend to be reflected in the decision-making process itself because the internal resources (managers and other employees) will want to contribute to the steps that are most favoured by the governing bodies. This illustrates how the culture of a governing body influences the culture of the company as a whole.

From the participative democracy model, where groups take part in every step of the decision-making process, we can move to three types of models that could be described as mainly collective, because they contain two collective steps (i.e. steps that are undertaken by groups) and one individual step (i.e. a step undertaken by an individual). These models are the *creative leadership*, the *guide* and the *individual censor*.

In the *creative leadership* model, a single individual feeds the group with ideas that are transformed into decisions by the group. Of course, there are times when the group is surprised or disagrees and provides negative feedback or on the contrary times when the group is so enthused that it continues building on the ideas and decisions proposed by the leader. This model seems to be the underlining one of many success stories although more research would be needed to prove it. The model needs

[2] Although this is not repeated when examining the other types of group decisions, this also applies to them.

to be viewed in its dynamics: the (individual) input step rapidly becomes a "feedback on the feedback" and thus a way of steering the creativity of the group.

In the *guide* model, the proposals come from the group, the decision is made by a single individual and then the feedback on the decision comes from a group (not necessarily the one that made the proposals at the start). This is perhaps best exemplified by inefficient parenting models where a group of kids make proposals, a parent decides and the kids start complaining about the decision, or, on the contrary, all become enthusiastic about the decision and are rushing into it. This is also the sort of leadership that emerges from teenage groups: proposals spark from everywhere, then the leader makes a decision, and the group either contests or endorses the decision.

The *individual censor* lets the group organise its thoughts and come to a decision but reserves the power to alter the decision or to reinforce it. The individual censor remains in control to varying degrees. This model can be found in education or in training in particular. It also exists in other forms of corporations whenever an individual basically regulates the group without taking part in the actual definition of the decision.

Three other models have one collective step and two individual ones. These are the *separation of powers*, the *guru* and the *consultative model*.

The *separation of powers* is a situation where the feedback on an individual's ideas and actions is collective, typically with a vote. A variant consists in one individual making ideas and another individual making decisions while they both receive collective feedback. This model also exists in corporations. For instance, an architect makes plans, a contractor makes the decisions to implement these, and a group of builders carry out the implementation while providing either praise or criticisms.

The *guide* model is the exact opposite of the *guru* model of decision-making, whereby an individual acts as creative leader and also as censor, but forces in the meantime the group to come up with decisions. Of course, the decisions are then constrained at both ends and it is easy to see how pathological this can be: the group decision creates an illusion of freedom while the power of proposition and the power of rejection held by the guru means that, in fact, a single individual is in control. A milder form occurs if the individual who makes proposals is not the one who makes corrections. Then, one of the two functions dominates and we are back either to the *creative leader* or to the *individual censor*.

The *consultative model* is a system whereby a group makes requests and an individual makes decisions and controls the decisions. Here again, there are two possible sub-models, depending on whether the same individual decides and controls or whether two separate individuals do so. The case where one individual decides and controls is a more authoritarian form but the second still separates those who decide and control from the rest of the group. These models are typically found in organisations of sales forces.

The final model is either an individualisation of roles, when one individual comes up with ideas, another makes decision and a third provides comments. It can also, if all three are carried out by the same individual, be the model of dictatorship: someone proposes ideas, decides to implement these and writes in a totally controlled press about these. There are in fact five different variants to the individual model. The pattern (Individual,individual,individual) can mean that three different persons are involved. It does not need to be the same person. In fact that gives us even more

possibilities of organising decision making: the three roles of input, output and feedback can be held by (i) three separate individuals (ii) two separate individuals one of whom has two roles (three possibilities) (iii) one individual with three roles, i.e. five possibilities in total. When all the roles are taken up by one person, we have a "dictatorship" model. When the individual roles are shared, we have a division of labour. The five sub-models are therefore markedly different.

The purpose of establishing such a typology is twofold. First, it illustrates the fact that beyond the understanding of the process of group decision making by aggregation as in (List & Pettit 2011) or (Herrera & Herrera-Viedma 2000), i.e. what happens in the "collective" output step. It seems in fact possible to characterise the decision-making process by what happens before and after the pure act of expressing a collective decision. We also point out that a group decision making can, in some cases, take place without the decision being collective (if the input or the feedback is collective). Second, the characterisation of the collective decision-making pattern inside an organisation can have practical implications and provide insights into the governance process and culture of the organisation. In fact, it is characteristic of the *corporate governance style* of an organisation, defining style in this case as the interaction between preferred behaviours and processes.

(Ebersberger et al. 2007) refer to *corporate governance style* as a factor of differentiation between firms when owners come from different cultures. (Chatelin-Ertur and Nicolas 2011) develop the concept of corporate governance styles as the defining factor in the degree of autonomy that is left to an individual decider within an organisation. Our approach is complementary by defining the corporate governance style by reference to the governance process and collective decision-making.

Conclusion

We have put forward a typology with eight different models of collective decision-making and a number of sub-models (two to five depending on the original model). Identifying the model has already value in itself because it makes the pattern of decision-making more explicit. It helps characterise the *corporate governance style* of an organisation by reference to its preferred patterns of governance process and collective decision-making.

Bibliography

Kenneth Arrow "*Social Choice and Individual Values"* Yale University Press, 2nd edition (1970) 144pp.

Marco Becht, Patrick Bolton, and Ailsa Röell "*Why bank governance is different"* Oxford Review of Economic Policy 27-3 (2012) 437-463

Kim C. Border "*Fixed point theorems with applications to economics and game theory*" Cambridge University Press (1985) Cambridge, 129p.

Andre Carvalhal and Carolina Nobili "*Does Corporate Governance matter for Stock Returns? Estimating a Four-Factor Asset Pricing Model Including a Governance Index"* Quantitative Finance 11-2 (2011) 247-259

Céline Chatelin-Ertur and Eline Nicolas "*Gouvernance et Décision: Proposition d'une Typologie*

des Styles de Gouvernance des Organisations" Revue des Sciences de Gestion 251-5 (2011) 131-144

Bernd Ebersberger, Bernhard Dachs and Hans Lööf "*The Innovative Performance of Foreign-owned Enterprises in Small Open Economies"* CESIS Working Paper Series (2007) 21p.

Jonas Gabrielsson, Morten Huse, Alessandro Minichilli "*Understanding the Leadership Role of the Board Chairperson through a Team Production Approach"* International Journal of Leadership Studies 3-1 (2007) 21-39

Paul Gompers, Joy Ishii, and Andrew Metrick, *Corporate Governance and Equity Prices* Quarterly Journal of Economics 118-1 (2003) 107-155

Enrique Herrera-Viedma, Francisco Chiclana, Francisco Herrera and Sergio Alonso "*Group Decision-Making Model with Incomplete Fuzzy Preference Relations Based on Additive Consistency"* IEEE Transactions on Systems, Man and Cybernetics – 37-1 (2007) February p. 176-189

Francisco Herrera and Enrique Herrera-Viedma "*Linguistic Decision Analysis: Steps for Solving Decision Problems under Linguistic Information"* Fuzzy Sets and Systems 115 (2000) 67-82

Christian List and Ben Polak "*Introduction to Judgement Aggregation*" Journal of Economic Theory 145 (2010) 441-466

Christian List and Philip Pettit "*Group Agency: The Possibility, Design and Status of Corporate Agents"* Oxford University Press (2011) 248 p.

Susanne Lütz, Dagmar Eberle and Dorothee Lauter "*Varieties of private self-regulation in European Capitalism: Corporate Governance Codes in the UK and Germany"* Socio-Economic Review 9 (2011) 315-338

Roger Myerson "*Game Theory: Analysis of Conflict"* Harvard University Press (1997) Cambridge 568p.

John Sterman "*Business Dynamics, system thinking and modelling for a complex world"* McGraw-Hill (2000) Boston, 982p.

Maarten Vandewaerde, Wim Voordeckers, Frank Lambrechts and Yannick Bammens "*The Board of Directors as a Team: Investigating the Influence of Shared Leadership on Board Task Performance*" in Panka, Ewa & Kwiatkowska, Aleksandra (Ed.) Proceedings of the 6th European Conference on Management, Leadership, and Governance, Academic Publishing Limited (2010) 455p