Chapter 7
Limits and Criticalities of Predictions and Forecasting in Complex Social and Economic Scenarios: A Cybernetics Key

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Abstract Predictions play a key role in assuring the status of "rationality" in decisions. Nevertheless, in the field of social sciences and economics, predictions fail to correctly depict the oncoming scenarios. Why is it so difficult to achieve quantitative prediction of social and economic systems? Can science provide reliable predictions of social and economic paths that can be used to implement effective interventions? As in the notorious "El Farol bar problem" depicted by Brian Arthur (Am Econ Rev 84:406–411, 1994), the validity of predictive models is more a social issue than a matter of good mathematics. Predictability in social systems is due to limited knowledge of society and human behavior. We do not yet have worldwide, quantitative knowledge of human social behavior; for instance, the perception of certain issues or the predisposition to adopt certain behaviors. Though tremendous progress has been made in recent years in data gathering thanks to the development of new technologies and the consequent increase in computational power, social and economic models still rely on assumptions of rationality that undermine their predictive effectiveness. Through some theoretical and epistemological reflections, we propose a way in which the cybernetic paradigm of complexity management can be used for better decision-making in complex scenarios with a comprising, dynamic, and evolving approach. We will show how a cybernetic approach can help to overcome the fear of uncertainty and serve as an effective tool for improving decisions and actions.

Keywords Cybernetics · Bathometer · Complex social scenarios · Complex economic scenarios

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Ş.Ş. Erçetin and S. Banerjee (eds.), *Chaos, Complexity and Leadership 2013*, Springer Proceedings in Complexity, DOI 10.1007/978-3-319-09710-7_7

7.1 Introduction

For the public, and for the vast majority of scientists themselves, science is typically considered to be able to predict, with theoretically unlimited precision, the future course of natural events on the basis of universal rules.

Many social, economic and managerial decisions are concerned with predictions. Friedman (1953, p. 15) argued that

> Economic assumptions must be judged not in terms of their "realism", but by seeing whether the theory works, which means whether it yields sufficiently accurate predictions.

But are predictions reliable?

There is no doubt that making predictions and forecasting in complex social and economic scenarios are not easy tasks, and are notoriously unreliable. While it is absolutely possible to predict an eclipse thousands of years in advance, predictions about the weather, the stock exchange or other complex phenomena are not reliable. This problem is due mainly to two kinds of problems: the difficulties in forecasting human behaviour (which are the basis of the research field of behavioural economics started with the pivotal work of Simon 1959) and the impossibility of predicting the results of the interactions of a huge number of diverse actors coming across each other in an extensive variety of ways (Sen et al. 1986).

Some may argue that predictions have a key role in assuring that decisions have a "rational" base.

But do we need rationality?

We believe that the rationality of economic agents and consumers is a myth; or, to put it another way, a 'metaphysical' assertion of economic theory. In management, this brings the possibility of making the mistake of believing that there is 'one best way' based on rational choices that can fit all situations, which makes rationality 'irrational'.

Humans are not rational; hence, the intangible and irrational aspects are prominent in human choices, including economic choices. The same existence of marketing implies that the consumer doesn't choose as '*homo oeconomicus*' by considering tangible costs and benefits, but thinks and chooses according to the emotional and symbolic value of the goods (Dominici 2011a). This has an implication for all value creation processes, and consequently, for managerial practices. In a famous experiment, Jensen and Call (2007) applied game theory (ultimatum game) to chimpanzees and pointed out how these primates act in a perfectly rational way according to the postulates of *homo oeconomicus*. Chimpanzees are rational; human beings are not! Chimpanzees would not pay a premium price for something they can get for a few cents, while men do. This is because during evolution, homosapiens acquired an aptitude for empathy and abstraction, which differentiates his behaviour from that of monkeys; policy-makers, consumers and managers are homosapiens and not chimpanzees.

Policymakers and managers still base their actions on these methods of forecasting; are they dumb? Are they trustworthy charlatans?

We believe that while forecasts and predictions are somehow necessary, they need to be handled with care. The foundation of the scientific model is the reproducibility of an experiment; therefore, the result of the experiment must be universally valid and repeatable. While this ‘may be’ the case for natural sciences (at least in the Newtonian framework), it is not the case for complex social systems. Uncertainty, unpredictability, insufficient knowledge and ‘liquid’ contexts in continuous change moved by changing actors (Bauman 2000) are the characteristics of today’s complex social environment (Dominici 2011b; Dominici 2008).

There are several reasons as to why economic predictions are so hard to get right. First, we cannot fully understand the continuously changing processes that generate social and economic variables; and second, we cannot correctly measure them because, in many cases, they are immeasurable. Asserting that social systems are complex means that it is impossible to understand them considering the single elements separately, and that there is no possibility to predict the future, but only to grasp and influence the future scenarios proactively (Dominici 2011b).

But what do we mean by ‘complex system’? A definition of complexity is given by the Santa Fe Institute (cited by Ramalingam 2013, p. 18):

> Complexity refers to the condition of the universe, which is integrated and yet too rich and varied for us to understand in simple common mechanistic or linear ways. We can understand many parts of the universe in these ways, but the larger and more intricately related phenomena can only be understood by principles and patterns—not in detail. Complexity deals with the nature of emergence, innovation, learning and adaptation.

In other words, complexity arises when the interactions among the components of the system do not respond to identifiable schemes that can be described by an algorithm, thus resulting in outcomes that are different from the original forecasting (Dominici 2011b; Dominici 2009; Dominici and Palumbo 2013).

A theoretical attempt to assert the reliability of predictions is the still-existing belief that the irregularity of the vast majority of natural phenomena are not real; they are to be regarded as temporary drawbacks caused by imperfect information regarding a large number of variables and parameters that the observer is not able to fully conceive, and that mask some fundamental underlying irregularities. This assertion has been proved to be incorrect by numerous experiments in laboratories under strictly controlled conditions, where ordinary systems, obeying laws understood to the smallest detail, produced unpredicted behaviours similar to the phenomenology of complexity (Nicolis and Nicolis 2007, p. 2).

Another attempt is to distinguish two different kinds of phenomena: those that have deterministic evolutionary rules, and those that do not have probabilistic evolutionary rules or those whose evolutionary rules are unknown (Vulpiani 2004). The latter are due to complex social systems, which are by definition unpredictable; but is it possible to predict the former? In theory, the deterministic evolutionary systems should be predictable, but they in fact are unpredictable because of the effect of chaos (measured by the Lyapunov exponent λ), with the rare exception of a few cases in nature in which the effect of chaos (exponent λ) is negligible, like in planetary movement. Therefore, we can assert that Newton's 'universal laws' are exceptions to the complexity of nature. In the 1960s, Lorenz demonstrated mathematically the impact of 'chaos' in weather forecasting. Even if the atmosphere was to be described with only three variables (due to drastic simplifications), with chaos, every forecast would be unreliable after a certain period. Therefore, complexity is not a mere allegory of something that we do not understand; nevertheless, it is a ubiquitous natural phenomenon.

This is nothing new if we consider that, as early as the nineteenth century, Clerk Maxwell understood that deterministic evolutionary systems did not exist. According to Maxwell (Campbell and Garnett 1982, p. 440):

> It is a metaphysical doctrine that from the same antecedents follows the same consequents. No one can gainsay this. But it is not of much use in a world like this, in which the same antecedents never again concur, and nothing ever happens twice. Indeed, for aught we know, one of the antecedents might be the precise date and place of the event, in which case experience would go for nothing.

> So if even the 'deterministic' scenario is not precisely predictable, how can we make decisions in a complex business environment?

This question is hard to be answered with a general model, but we can find a model to redefine and co-evolve the management of future situations. In this article, we will illustrate a possible way to deal with the future 'as it emerges' (Scharmer 2009; Dominici 2013).

7.2 The Cybernetic Prototype: The Bathometer

Applying the approach of cybernetics to manage future events is consistent with the notion of adapting to a given context. Cybernetics can be a learning tool to aid in trying out solutions to local and specific problems by thinking in order to implement a prototype action as a feed-forward tool for reading the feedback coming from it.

Cybernetics gives us two powerful tools for overcoming the uncertainty about the future deriving from complexity: 'feedback' and 'feed-forward'. As Lee (1997, p. 23) pointed out:

> Interactive component relationships create hierarchical levels of complexity. Protracted over time, component interactions 'feed forward' to produce the macroscopic configuration of components that is discernible at any given point; 'feedbacks' describe the continual accretion of effects from previous interactions, which may in turn alter lower-level interactions and higher-level configurations at the next point in time.

Feedback can be used as a method either of learning by doing, or of learning through mistakes. But before learning from our mistakes, we need to think in order to simplify the complexity of mental schemes, and to have a 'feed-forward' of possible scenarios (Dominici 2013).

Our brains have limited capabilities (e.g. Beer 1974, p. 58); hence, simplification is necessary for every human decision and action. When the decision-maker observes the other agents in context, he watches them from 'outside', considering them to be black boxes, of which he does not and cannot know all of the inner dynamics. When the observer is situated 'outside', he treats the observed system as an uncomplicated entity, ascribing a number of attributes and studying its interactions with its context (Espejo and Reyes 2011, pp. 9–10). This kind of simplified description is sometimes necessary to make it possible to deal with complexity (Dominici 2013).

The necessity of simplifying complexity in order to make decisions and take actions has been deeply analysed by the neurophysiologist Berthoz (2012), who introduced the neologism 'simplexity'. Simplexity explains how living organisms (and hence, complex social systems) necessitate finding conceptual maps that allow them to deal with information and circumstances, while considering past experiences and anticipating future ones. Using feed-forward, the decision-maker can eventually change his or her map and elaborate new solutions that are suitable to different situations (Dominici 2013).

Therefore, provisions are necessary to build a set of maps that can be used to make decisions and act in the midst of the uncertainty (Pitasi and Dominici 2012). In other words, the feed-forward is the intuitive prediction that allows the kybernetes to find new maps that allow him or her to grasp the variations that a certain input could present in a possible and desired final state. At the same time, the feedback works both as a regulatory mechanism inside the chosen conceptual map and, at a higher recursive level of decision, supplies inputs as a starting point from which to adjust the feed-forward planning and change the map (Dominici 2013).

To put this cybernetic framework into practice, we need to think and develop prototypes that explore the future, by doing something small and rapid that generates feedback from all the key stakeholders (Scharmer 2009). Prototypes reduce the risk of failure in uncertainty, hence increasing the resilience of the system.

In other words, the prototype should work as a 'bathometer' (Dominici 2013). A bathometer is an instrument used to measure the depth of the sea beneath a sailing vessel. After deciding the route (through feed-forward), the captain (decision-maker) can use the bathometer to continuously check whether or not the sailing waters are safe. The bathometer monitors the depth of the sea by plunging into the water, thus helping to avoid the catastrophe that might occur if a route were followed blindly without checking what is happening beyond the range of the captain's perception.

The bathometer has several functions: probing the depth of the sea; discovering what is not visible to the captain; taking the risk out of what is under the sea and cannot be seen from the ship; giving feedback about the bottom of the sea; and supplying inputs for feed-forward to modify the route of the ship.

The feedbacks obtained with the prototype can give clues about the true merits of changes of the outcome of decisions. It enables the decision-maker to obtain feedbacks that help better develop the prototype, and that can be used for feed-forward thinking, changing the root.

Moreover, using a bathometer or prototype, the risk is limited only to the bathometer or prototype, thus avoiding more serious damage to the ship. To be useful, a bathometer or prototype must also: be clear and possess a single focus, while being easy to read and interpret, so that it can supply unambiguous feedback; and be resistant to whatever threatens to impede its functioning within its context in order to be able to provide the required feedback.

7.3 Conclusions

Uncertainty, unpredictability, lack of information and continuously changing contexts are the characteristics of complex social and economic contexts. Predictions seem to be somehow necessary to overcome the fear of acting that arises in such circumstances. The decision-maker is required to deal with different models of depicting and manipulating new scenarios in the 'mare magnum' of complexity.

This portfolio of models and conceptual maps is crucial to the establishment of plans and procedures that can help the decision-maker reveal something impossible to grasp by the application of a single model.

The conceptual maps must be tested to prove their validity through action in the real world, and by learning from mistakes using prototypes. Building prototypes is crucial in helping the decision-maker to choose the direction properly and continuously learn from his or her mistakes. The key to success is organizational resilience, which is the ability of the system to return to the previous (or desired) state after an unexpected perturbation occurs.

In summary, the main criteria for a good manager or kybernetes in the twenty-first century should be knowledge, an aptitude to action, the ability to learn from mistakes and psychological resilience, which allows eventual failures to be damped and absorbed, the ability to learn from these failures and the ability to start up again and decide and act better than before.

We can call this ability to 'navigate through' complexity 'intelligence of complex phenomena' and describe it as a form of strategic intelligence, which is not limited to the mere knowledge of strategies, but is a more general way to manage knowledge and the future.

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