Uncertainty in the IT Sector of large business organizations

A PhD Research Proposal, by *Bogdan Werth*, (CPM)

RESEARCH AIMS

- To develop modelling techniques using participatory agent-based social simulation (ABSS) to support IT projects in financial institutions with respect to uncertainty issues
- To investigate decision-making under uncertain circumstances in this particular context
- To suggest new metrics for the characterisation of uncertainty in IT projects of the organizations
- To investigate volatility of IT projects in organizations with respect to uncertainty (and/or risk)

BACKGROUND

The technical revolution of the 1990s altered the competitive landscape for financial services companies. [1] IT plays an increasingly important role in the banking area and, despite constant improvement in IT, banks still incur immense expenditure in this sector. As a recent study [2] shows, IT costs reached an all-time high from 2001 to 2002. About 10% of a typical bank's total revenues flow into IT.

Industry is well aware of this problem. Despite the existence of many analytic projects and case studies carried out to find reasons for the frequent failure of IT projects, the answers delivered couldn't prevent any disasters in the subsequent projects. This fact suggests that the issue might have been tackled form the wrong perspective and it is time to shift the focus of investigation from why some particular project failed to small components which might have caused the crucial event. In order to understand the macro-level behaviour of systems it may be necessary to investigate the micro-level behaviour first. A very small event can trigger a cascade of larger events and mushroom into something disastrous. Activities on the micro level often lead to the emergence of patterns on the level which would be hard to predict even if the rules of interaction were given thus bringing uncertainty into the game.

Uncertainty is pervasive in economics, and must be faced continually by policymakers and analysts. Poor quality of data, econometric errors in estimation, unpredictable shocks hitting the economy and social interactions are among many different factors causing the uncertainty within an organization. A human organization is often subject to different kinds of risk in the sense of Knight [3]. Knight used the term *risk* to describe decision situations where agents can be assumed to act as if they have in mind well-defined probabilities on possible outcomes and *uncertainty* for situations where they do not[1]. Following this distinction, uncertainty arises from impossibility of an exhaustive classification of cases considered in decision making. Furthermore, Knight argues that most of the business decisions are made in condition of uncertainty and that this uncertainty is responsible for the profit of an enterprise. So far this distinction was used by neoclassical economists to rule out uncertainty as it is incompatible with the assumption of agents' consistent choice which does not fit into the modern theory of choice [4].

With respect to IT processes the uncertainty arising from social interactions affects financial organization and an ultimate response of senior managers to it is intuition, which is just a fancy name for decisions based upon their past experience [5]. If however, business landscape is not-stationary, the past might not be a good predictor of the future. Nonetheless, status quo is that the conventional apparatus of economics provides and ideal response to risk and risk only, as unpredictable results do not confirm finite variance distribution which is essential for risk – uncertainty still remains and open question. Conventional techniques eliminate uncertainty by neglecting social interactions thus loosing connection of the volatile behaviour on the macro-level form social interactions on the micro-level. Neoclassical calculus, economic modelling or system dynamics rely on unrealistic assumptions, such as perfect or limited information and deploy numerical methods trying to assign numerical values to express extent of belief (operationalisation) [4]. The problem of operationalisation was investigated first by Ramsey [6]. Instead of solving the problem it was suggested to define degrees of belief operationally in terms of betting behaviour in the attempt to model beliefs analytically.

Dissatisfaction with conventional economic (CE) modelling methods and limitations of standard research paradigms gave birth to agent-based computational economics (ACE) in the late 90s. CE uses computation primarily for two purposes: empirical analysis of data and computing equilibria of conventional models. The primary computational tools for these activities are standard numerical analytic tools for solving optimization problems and nonlinear systems of equations [7]. ACE, in contrast, claims to carry out a bottom-up analysis but is still burdened with leftovers of equilibrium and production function-based theories. However due to the arbitrary components used in agents' design, true bottom-up analysis is questionable. Furthermore, the 1991 Nobel Prize award given to Ronald Coase clearly illustrates the trend in the interest of economists from concern about enterprises *qua* production function to enterprises *qua* organization.

Neoclassical economics has many agent based (AB) models of organizations, including agency theory and team theory. However these models are rather restrictive with respect to assumptions applied to agents' behaviour, the number and heterogeneity of agents and the features of the environment due to limited power of analytical methods used [ibid]. ABSS overcomes these limitations but requires a different mindset. One of the benefits of having the AB model of an organization at disposal is that it shows in a very concise form the impact of low-level decisions on the high-level behaviour, therefore allowing the investigation of uncertainty. Abstraction from unnecessary details makes it an ideal starting point for discussing current operational problems and suggesting solutions. Bios, Cap Gemini Ernst & Young and Icosystem Corporation already successfully apply ABSS for their consultancy tasks.

METHODOLOGY

[1] Frank Knight's distinction between risk and uncertainty has entered the jargon of economist and decision theory. At the same time Knight's definition gave birth to probably as many interpretations of it as scholars who have sought to interpret it. In this document we refer to the most common definition with respect to objective and subjective probabilities. See [3] for further references.

The purpose of this thesis is to contribute to the development of novel research methods for understanding uncertainty in IT projects, arising from social interactions, within organizational contexts. So far, the kind of understanding needed cannot be drawn from the rich sources of management sciences because of its narrow functional orientation and concentration upon static organizational structures. [8]

The fundamental questions in this context are: how to reveal this knowledge of the construction and the operation of an organization, how to extract it from the observable surface structures that tend to obscure important bits [ibid]. Organizations are inherently complex – they are their own brand of society [7]. As complex systems are often counterintuitive, safe usage of intuition in this environment [5] is excluded. The distinctive property of organizations is that the active elements are human beings in their role of social individual or subject [8] which match the application field of ABSS. An AB approach views an organization as a complex adaptive system with collection of agents that interact with one another and produce some output. Hence it allows modelling the emergent collective behaviour of an organization or of a part of an organization in a certain context at certain level of description.

Social simulation in business has not been very successful so far, because the bar was set too high and the emphasis was on using it as a predictive tool rather than as a tool for learning. This trend was underestimating one of the biggest advantages provided by ABSS – explanatory qualities about the system itself. Only if we take a system as a whole into account we would be able to understand the effects of local decisions and actions. In order to do so ABSS provides a powerful tool box with respect to the following three issues: (a) *natural description*: "local" description of decision-making /of risk factors (applied to agents), qualitative as well as quantitative validation is made easier (b) *emergence*: emergent properties result from interactions among agents; (b) *scalability*: "classical" model quickly becomes inflexible as its size increases, level of complexity of the agents can be tuned (adaptability, learning, evolution), number and type of characteristics of each agent can be tuned; (c) *stakeholder participation:* users can more easily connect to the tool, important from a self-assessment perspective, counter-intuitive results are easier communicable.

A constructive and modular approach to research design is to be adopted. The first research stage (6 months) consists of collaborative fieldwork with BCG branch in Cologne/Germany: gathering of relevant data, developing the structure and focus of the future models. Subsequently a set of declarative agent-based fine grained uncertainty-decision-making models, based on the data from banks participated in [2], will be developed (6 months). Exploration of the models' results will happen in a feedback-loop manner together with domain experts leading to changes and addition of relevant organizational modules. Finally, the experience and insights gained form the work on the fine grained models will be incorporated in the development of the resulting more general coarse grained composite model(s) (6 month). Following, the coarse grained model results will be directly mapped to the target domain through the use of statistical evidence (BCG benchmarking [2]) and augmented with qualitative insights gained through case-study analysis. The results of these models will be published in the following year's BCG benchmarking report (6 months).

The expansion of aforementioned fine grained models will proceed in collaboration with BCG research group. As an outcome of this collaboration a generic model(s) is generated which explains the pathway of decision making in financial organizations with respect to risk and, what is more important, to uncertainty arising as a result of social interactions. This model(s) is anticipated to provide insights into managerial processes of decision-making under uncertainty situations in IT projects (end of 2nd year).

The first prototype agent-based model has already been developed in order to directly show and investigate the possibilities arising from the use of the modelling technique addopted. The model attempts to explain the pathway leading to vulnerability to droughts in West Africa and serves as an example of mixing declarative and procedural modelling styles. This model arose out of the CAVES[2] project and has been accepted to two conferences.

CASE STUDY

A benchmarking study [ibid] conducted by BCG will serve as a case study for the project. Eleven leading European banks provided data, which was collected in the second half of 2003. The report covers actual business and IT data for 2001 and 2002 as well as provides 2003 estimates. It is intended by BCG to conduct a study on IT costs in banks every year henceforth, so it would be possible to validate developed models against recent data.

With agent-based models of organizations, based on real case studies, and validated quantitatively (through statistical tools) and qualitatively (through feedback loops with domain experts and stakeholders) we expect to provide a reliable framework for uncertainty investigation in the context of organizational structure and processes with respect to IT. Furthermore, it is attempted to contribute to the work at the field of computational agent-based research of organizations as work at this field is very much in explanatory phase.

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