INNOVATION BY COLLABORATION AMONG FIRMS. A NEW METHODOLOGY

Building Theory from Case Study Research and Simulation Models

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Abstract: The purpose of this work is to introduce a methodology known as “multi agent systems” (MAS) and show how it could serve not only a similar purpose when compared to cases by using virtual artefacts instead of real world observations, but also overcome the limitation of case study process. Besides being used for creating new theory, this approach is also effective for teaching and transmitting knowledge in a “maieutical” way, through experimentation on the model and cause-effect analysis of results. After describing the paradigm itself, and how it, along with simulation, can be used in social domains, it will be shown how it could interface the conceptual flow typical of case study analysis. Particular attention will be devoted to the interactivity deriving from the way in which this methodology is conceived, allowing researchers to perform “scenario analysis”, i.e.: a process of analyzing future occurrences by considering alternative possible outcomes, after the baseline experiments obtained through the model have given positive results. In the second part of the paper a case study is presented, obtained by employing MAS methodology. It aims to study enterprise collaboration formation and modification: the goal is to study how innovation management and sharing could bring to non-equity link formation among them. The model is introduced in detail and qualitative results are analyzed, by deriving general concepts from them. Last, some points of strength and weaknesses of this methodology are briefly underlined.

1 USING CASES TO CREATE NEW THEORY: INTRODUCTION

Case data represent one of many possible form of inquiry for inductive theory building; other forms of data include participant observation, document analysis, in-depth interviews, field notes, etc. Many authors have described the process for creating theory using case approach. Glaser and Strauss (1967) described the process giving importance to the ideas of theoretical sampling, theoretical saturation, overlapped coding, data collection, and analysis. Yin (1984) structured the process analysing the notions of case study design, replication logic, and concern for internal validity. Miles and Huberman (1984) concentrate their research on the tools of tabular display of evidence particularly helpful in the discussion of building evidence for constructs. Miles (1979), Miles & Huberman (1984), Kirk & Miller (1986), centred their work on topics such as qualitative data analysis; Yin (1981, 1984) and Mc- Clintock et al. (1979), on case study design and Van Maanen (1988) on ethnography. The creation of process for building theory from case study research has been developed from Kathleen M. Eisenhardt (1989) in contrast with Strauss (1987) and Van Maanen (1988), more concerned on a rich, complex description of the specific cases under study evolve and less on generalizable theory. According to Eisenhardt (1989, p.532-549),the steps for building theory from case studies are summarized in next lines.

2 BUILDING A THEORY FROM CASE STUDY: A TRADITIONAL APPROACH

First of all it is important to fix the research question since it is easy to get overwhelmed by the volume of data. The research question can shift or modify

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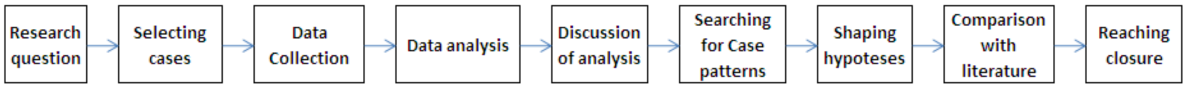

Figure1: Building theory from case study: a traditional approach.

during the research thanks to the observation and data analysis. Another element for building theory from case studies is the selection of cases. For the data collection it can be useful to employ multiple investigators (e.g., Pettigrew, 1988). This allows the case to be viewed from the different perspectives of multiple observers. Analyzing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process. However, there is no standard format for such analysis. Quinn (1980) developed teaching cases for each of the firms in his study of strategic decision making in six major corporations as a prelude to his theoretical work. Mintzberg and McHugh (1985) compiled a 383 page case history of the National Film Board of Canada. These authors coupled narrative description with extensive use of longitudinal graphs tracking revenue, film sponsorship, staffing, film subjects, and so on. Gersick (1988) prepared transcripts of team meetings. Leonard-Barton (1988) used tabular displays and graphs of information about each case. Abbott (1988) suggested using sequence analysis to organize longitudinal data. Next step for building a theory is searching for case patterns. The tactic is driven by the reality that people are notoriously poor processors of information. They leap to conclusions based on limited data (Kahneman & Tversky, 1973), they are overly influenced by the vividness (Nisbett & Ross, 1980) or by more elite respondents (Miles & Huberman, 1984), they ignore basic statistical properties (Kahneman & Tversky, 1973), or they sometimes inadvertently drop disconfirming evidence (Nisbett & Ross, 1980). The risk is that investigators reach premature and even false conclusions as a result of these information-processing biases. Thus, the key to good cross-case comparison is counteracting these tendencies by looking at the data in many divergent ways. Shaping hypotheses consists in systematically comparing the emergent frame with the evidence from each case in order to assess how well or poorly it fits with case data. This is a two-part process involving refining the definition of the construct and building evidence which measures the construct in each case. This occurs through constant comparison between data and constructs so that accumulating evidence from diverse sources converges on a single, well defined construct. The central idea is that researchers constantly compare theory and data-iterating toward a theory which closely fits the data. A close fit is important for building a strong theory since it takes advantage from the new insights made possible by data and yields to an empirically valid theory. One step in shaping hypotheses is the sharpening of constructs. An essential feature of theory building is a comparison of the emergent concepts, theory, or hypotheses with the literature. This involves asking what is this similar to, what does it contradict, and why. A key to this process is to consider a broad range of literature. Examining literature which conflicts with the emergent theory is important for two reasons. First, if researchers ignore conflicting findings, then confidence in the findings is reduced. Second and perhaps more importantly, conflicting literature represents an opportunity. The juxtaposition of conflicting results forces researchers into a more creative, frame breaking mode of thinking than they might otherwise be able to achieve. The last step for building a theory from case study is reaching closure. Two issues are important in reaching closure: when to stop adding cases, and when to stop iterating between theory and data. All the process of building theory from case study is described in figure number 1.

From 1995 to 2007, the MAS was use for developing different practice case in different subjects: Tomlin, Pappas and Sastry in (1995) use multi-agent hybrid system for analyzing a conflict resolution for Air Traffic Management; lygeros, Godbol and Sastry (1996) used Hybrid system for automated vehicles; Vassileva at al. (1999) presented a multi agent approach to design of adaptive distributed collaborative and peer help environments; Bonabeau (2001) used agent-based for simulating human systems; Bonabeau (2002) applied Agent Based Modeling for understanding the Business Complexity; Joanna J Bryson, Yasushi Ando, and Hagen Lehmann (2007) used Agent base modeling to develop a case study on social behaviors, Vagnani (2009) used MAS for studing financial market. The construction of theory from MAS approach usually undergoes several phases, ranging from analytical to more practical and technical ones. MAS ‘s phases are listed as follow (fig. n 2): 0- Real world analysis and reduction; 1- Logical framework design (interactions at a micro level and general environmental rules. Metaphors

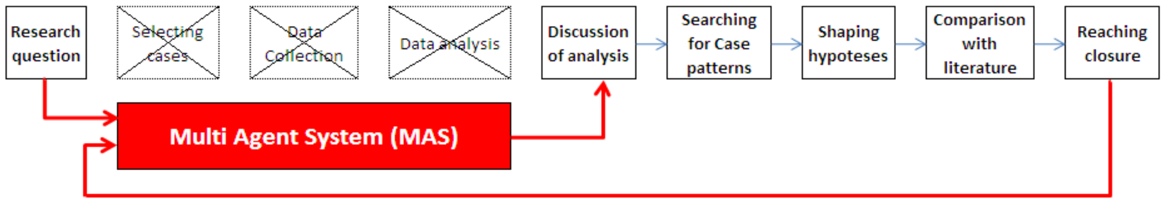

Figure 2: Building theory from case study: a "MAS" approach.

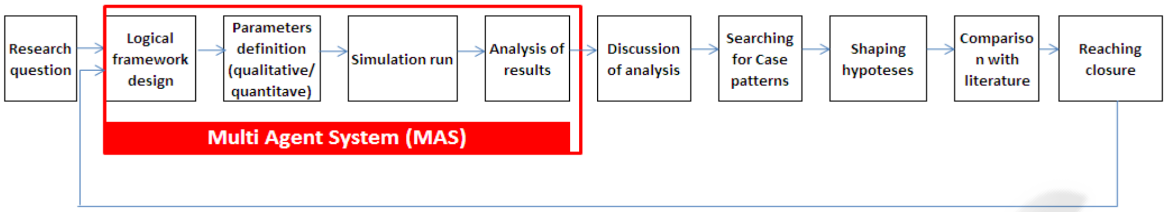

Figure 3: Building theory from case study: logical steps of a "MAS" approach.

building); 2- Parameters definition (qualitative and quantitative); 3- Simulation run and scenarios selection and 4- Analysis of results.

The step "zero" is about studying the real problem that is going to be represented and modeled. Since a model is a scaled down representation of the real world, it's important to identify which parts of the system could be scarified without losing the general behavior of the system at an aggregate level.

The first phase of modeling regards the design of the logical framework, that will constitute the " formal project" to be used as the basis for the next steps. In this phase the agents must be defined, along with the interaction rules at the micro level (agent level) and the general environmental rules, i.e.: those which all the agents must face. This phase is crucial, since MAS modeling is "bottom up", meaning that the aggregate level is an emergent feature and derives strictly from the premises, or better, from the interaction among the agents, and with the environment. Phases two is about formally defining which parameters will be considered in the model, and is a derivation of the previous step. After the model is implemented, through repeated executions and confrontation of the behavior with the real modeled system, the numerical parameters are tuned so that the "baseline scenario" maps exactly the reference one. The third step is actually the most operative and practical one; the model, in this phase, is to be considered an artifact, in the meaning given by H. Simon. This allows users to employ it as a tool for social experiments, exactly how a laboratory would be for natural sciences. In this phase the different scenarios are defined, and simulations are run. The last phase is analytical: the results, be them quantitative or qualitative, are gathered and linked with the premises through cause-effect relations. The importance and influence of individual parameters is tracked by means of "multi-run analysis", i.e.: a ceteris paribus approach consisting of changing one parameter at a time, by leaving the others unchanged. Besides, the aggregate behavior is considered and analyzed at different time steps, allowing the researcher to understand the evolution of the system over time. The comparison of the two methodology is represented in the figure number 3.

3 A PRACTICAL CASE: "THE ANALYSIS OF FIRMS COLLABORATION THROUGH A MAS APPROACH" FOR CREATING A THEORY

3.1 Introduction to the Practice Case and Structure

A model in the field of enterprise management is described in this work. Its main goal is to represent and analyze the dynamics and interrelations among the complex phenomenon of innovation diffusion and firms clusters formation and modifications. After formal description of the model, along that of its main parameters a qualitative results are described. The conclusion is a comparison between case methodology and MAS methodology underline the weakness and strength of each methodology.

3.2 Research Question

The research question is to demonstrate how the innovation diffusion impacts on the collaboration among business enterprises, by creating and changing –qualitatively and quantitatively – ties and partners. For analyzing this issue, it is useful, first of all, to define some concepts used in case developing.

3.3 Collaboration Among Firms: Nodes and Ties

The literature on collaboration clearly demonstrates that whilst firms collaborate for many different reasons the most common reason to do so is to gain access to new or complementary competencies and technologies.The nodes can be similar or different depending on the organizations are competitors or works in different position the value chain. The types of partner's firms engaged in collaboration appears to be related to the type of innovation occurring: incremental innovators rely more frequently on their customers as innovation partners whereas firms that have products new to a market are more likely to collaborate with suppliers and consultants. Advanced innovators and the development of radical innovations tends to demand more interaction with universities. The ties represents the type of relationship among the actors'; ties could be different in structure, type and number. The type and the number of ties could affect collaboration's efficiency: for example, a collaboration composed of relationships with partners comprising few ties among them would enable control for the principle partner. A collaboration of many non-overlapping ties would provide information benefits: in "Interfirm cooperation and startup innovation in the biotechnology industry" (1994), the authors Shan, Walker, and Kogut, suggest that the number of collaborative relationships a firm is involved in, is positively related to innovation output while, conversely, closed networks have been found to foster innovation more than open ones (Coleman, 1988). Numerous other measures of strength have also been used or proposed. These include frequency of contact (Granovetter, Lin et al.) with strong ties assumed to be more frequent ones; and (in research conducted in closed populations, where perceived relationships are studied from both sides) by mutual acknowledgement of contact (Friedkin), with strong ties assumed to be those acknowledged by both parties. Other plausible indicators of tie strength include the extent of multiplexity within a tie (noted by Granovetter,1973), the duration of the contact, the provision of emotional support and aid within the relationship (Wellman), the social homogeneity of those joined by a tie (indexed in terms of occupational status by Lin et al.), the overlap of memberships in organizations between the parties to a tie, and (for closed populations) the overlap of social circles (Kadushin). When the innovation start to circulate, it can affect the collaboration efficiency: firms can decide to cooperate inside the network by developing an external exploration behavior, meaning that a firm decides to be related to other organizations in order to exchange competences and innovations. Otherwise if the firm considers its internal capability to create innovation as a point of strength, or if the cost of external exploration is perceived as higher than that of internal research, then it could prefer to assume an internally explorative behavior in which it tries to create new competences (and possibly innovations) inside the organization itself. During the process of innovation diffusion the collaborations can change in the number of actors (exit and entry), and in numbers and patterns of link information (Steinke, 2006). The collaborations can expand, churn, strengthen or shrink. Each collaboration's change is brought about by specific combination of changes in tie creation, tie deletion, and by changes in an actor's portfolio size (number of link) and portfolio range (numbers of partners) (Steinke, 2006). Also the propensity to collaborate affects innovation diffusion. When firms has a highly collaborative attitude, the innovation tends to diffuse more quickly, if the ties are dense, non redundant, strong and reciprocal. If the firms are collaborative, but the ties are weak or unidirectional, the innovation spreads slowly and could not reach all the nodes in the collaboration. To explore and analyze these complex social dynamics, an agent based model is described in the following paragraphs, that keeps into account most network and enterprise variables.

3.4 Logical Framework Design

Agent based simulation is an effective paradigm for studying complex systems. It allows the creation of virtual societies, in which each agent can interact with others basing on certain rules. The agents are basic entities, endowed with the capacity of performing certain actions, and with certain variables defining their state. In the model presented here, the agents are reactive, meaning that they simply react to the stimuli coming from the environment and from other agents, without elaborating their own strategies. Agents have traditionally been categorized as one of the following types (Grandori, 1997): Reactive; Cognitive/Deliberative; Hybrid. The agents used in this paper are reactive, but organized in the form of a MAS (Multi Agent System), which can be thought of as a group of interacting agents working together or communicating among each other. To maximize the efficiency of the system, each agent must be able to reason about other agents' actions in addition to its own. A dynamic and unpredictable environment creates a need for an agent to employ flexible strategies. Many simulation paradigms exist; agent-based simulation is probably the one that best captures the human factor behind decisions. This is because the model is not organized with explicit equations, but is made up of many different entities with their own behavior. The macro results emerge naturally through the interaction of these micro behaviors and are often more than the algebraic sum of them. This is why this paradigm is optimal for the purposes of modeling complex systems and of capturing the human factor. The model presented in this paper strictly follows the agent based paradigm and employs reactive agents, as detailed in the following paragraph.

3.5 The Model

The model is built in Java, thus following the Object Oriented philosophy and has been engineered and built at the e-business L@B, University of Turin. All the numerical parameters can be decided at the beginning of each simulation (e.g.: number of enterprises, and so on). Everything in the model is seen as an agent; thus we have three kinds of agents: Environment, Enterprises and Emissaries (E^3). This is done since each of them, even the environment, is endowed with some actions to perform.

3.6 Heat Metaphor and the Agents

In order to represent the advantage of an enterprise in owning different competences, the “heat” metaphor is introduced. In agent based models for Economics, the metaphor based approach (Remondino, 2003) is an established way of representing real phenomena through computational and physical metaphors. In this case, a quantum of heat is assigned for each competence at each simulation turn. If the competence is internal (i.e.: developed by the enterprise) this value is higher. If the competence is external (i.e.: borrowed from another enterprise) this value is lower. Heat is also expendable in the process of creating new internal competences (exploitation) and of looking for partner with whom to share them in exchange of external competences (exploration). At each time-step, a part of the heat is scattered (this can be regarded as a set of costs for the enterprise). If the individual heat gets under a threshold, the enterprise ceases its activity and disappears from the environment. At an aggregate level, average environmental heat is a good and synthetic measure to monitor the state of the system. In order to formally describe the model, a set of equations is described in the following. The multi agent system at time T is defined as:

$$\mathrm{MAS_T} = < \bar{\mathrm{E}}, \bar{\mathrm{e}}, \bar{\varepsilon}, \overline{\mathrm{link}} > \quad (1)$$

Where $\bar{\mathrm{E}}$ represents the environment and is formed by a grid $\mathrm{n} * \mathrm{m}$, and a set $\bar{\mathrm{k}}$:

$$\begin{cases} \bar{\mathrm{E}} = < n * m, \bar{\mathrm{k}} > \\ \mathrm{n}, \mathrm{m} > 0 \end{cases} . \quad (2)$$

Where the set $\bar{\mathrm{k}}$ definines the heat for each cell, $\bar{\mathrm{e}}$ is the set of enterprises with cohordinates on the grid, and $\bar{\varepsilon}$ is the set of the emissaries, also scattered on the grid:

$$\begin{cases} \bar{\mathrm{k}} = < \mathrm{k_{i,j}} > \\ \bar{\mathrm{e}} = < \mathrm{e_{i',j'}} > \\ \bar{\varepsilon} = < \varepsilon_{\mathrm{i'',j''}} > \\ 0 < i, \mathrm{i'}, \mathrm{i''} \leq \mathrm{n} \\ 0 < j, \mathrm{j'}, \mathrm{j''} \leq \mathrm{m} \end{cases} . \quad (3)$$

Each enterprise is composed by a vector $\vec{\mathrm{c}}$, and an emissary (ε_e). The vector $\vec{\mathrm{c}}$ defines the owned competences, with a length L and competences $\mathrm{C_l}$ represented by a boolean variable (where 1 means that the $\mathrm{l^{th}}$ competence is owned, while 0 means that it’s lacking):

$$\begin{cases} \mathrm{e_{i,j}} \ni \vec{\mathrm{c}}, \varepsilon_\mathrm{e} \\ \vec{\mathrm{c}} = (\mathrm{L}, \mathrm{C_l}) \\ 0 \leq \mathrm{l} \leq \mathrm{L} \\ \mathrm{C_l} = \mathrm{Boolean} \end{cases} \quad (4)$$

In $\mathrm{T} = \mathrm{t} > 0$, $\mathrm{k_{i,j}}$ that’s the heat of each cell on the grid, depends on the heat produced by the enterprises ($\mathrm{K_e}$) and the dispersion effect (d). The heat of each enterprise is function of the competences it possesses and of the behavior it carried on in the last turns ($\mathrm{b_e}$).

$$\begin{cases} k_{i,j} = f(K_e, d) \\ K_e = f(\vec{c}_e, b_e) \\ b \in \bar{b} \\ \bar{b} = < \textit{set of behaviors} > \end{cases} \quad (5)$$

In particular, a certain behavior can be successful, meaning that at the end of a phase of internal or external exploration, a new competence (internal or outsourced, respectively) will be possessed. Otherwise, a it's unsuccessful when, after some steps of research and development (internal exploration) or external market research to find a partner, nothing new is found, and thus the l^{th} competence remains zero.

$$\begin{cases} \text{if } (b = \text{success}) \text{then } C_l = 1 \\ \text{else } C_l = 0 \\ b \in \bar{b} \end{cases} \quad (6)$$

At each time-step the set of links (connecting two enterprises together) is updated basing on the competences of the enterprises.

$$\begin{cases} \overline{\text{link}} = < link\left(e_{i,j}, e_{i',j'}\right) > \\ \text{link}\left(e_{i,j}, e_{i',j'}\right) = f(\overrightarrow{c_{e_{i,j}}}, \overrightarrow{c_{e_{i',j'}}}) \end{cases} \quad (7)$$

Specifically, when an enterprise does external exploration, it looks for a good partner, i.e.: an enterprise with a number of competences to share.

So, if an enterprise with a vector like $\boxed{1}\boxed{0}\boxed{0}\boxed{0}\boxed{1}$ meets one with a vector like $\boxed{0}\boxed{1}\boxed{1}\boxed{1}\boxed{0}$ then there is a perfect match and the two enterprises will create a link among them, to share the reciprocally missing competences. This is the perfect situation, but not the only one in which two enterprise can create a link; in fact, it's enough that there is at least one competence to reciprocally share. The strength of the link is directly proportional to the exchanged competences. This set of equations and rules is enough to explore the effects on the network of the behaviors of the enterprises, namely the way in which the firms are managed (externally or internally focused). Though the model allows also to explore the effects on innovation (i.e.: a competence that's possessed only by one enterprise). In $T = t' > t$ a radical innovation can be metaphorically introduced in the system (this is called "shock mode", since this is decided by the user, at an arbitrary step) by means of increasing the length of the vector of competences of a specific enterprise:

$$\begin{cases} L \leftarrow L + 1 \\ C_{l+1}(\boxed{e}) = 1 \\ C_{l+1}(\bar{e} - \boxed{e}) = 0 \end{cases} . \quad (8)$$

Meaning that the competence C_{l+1} will be possessed by only one enterprise, at that time, while the same competence will be lacking to all the others; though, all the enterprises' vectors will increase in length, meaning that potentially all of them will be able to internally develop that new competence through R&D, from then on. The vector length metaphorically represents the complexity of the sector (industry) in which the enterprises operate; an highly technological sector has many more potential competences than a non-technological one. So, another kind of "shock effect" to the system is that of increasing the length of the vector by more than one component, and by leaving all the new components to zero for all the enterprises. In this way, they'll have to develop themselves the new competences by means of internal exploration. The analysis phase is carried on after several steps after t', in order to see how the introduction of the innovation impacted the network and the enterprise in which the innovation was first introduced. So we have an analysis phase in $T = t'' > t'$ defined as:

$$\begin{cases} MAS_{t'} \text{vs } MAS_{t''} \\ I \rightarrow d\theta\, \text{link};\ d\theta\, e; d\theta\, k \end{cases} \quad (9)$$

Namely, the comparison among the system at time $t'$and the same system at time t'', since the innovation has differential effects on the number (and nature) of the links, on the number of enterprises and the heat of the cells composing the environment, always depending on the managerial behavior of the involved enterprises. At the beginning of a simulation, the user can change the core parameters, in order to create a particular scenario to study and analyze.

At the beginning of a simulation, the user can change the core parameters, in order to create a particular scenario to study. Some of the parameters are constituted by a scalar value, others are in percentage, others are used to define stochastic (normal) distributions, given their mean value and their variance.

3.7 Analysis of Results

The impact of innovation diffusion on the network depends on the collaboration degree of the system. If the network is collaborative the diffusion of innovation strengthens the ties and increases the number of the links among organizations (figure 4).

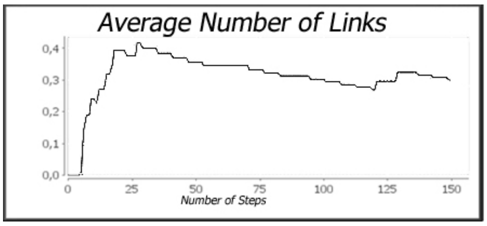

Figure 4: A sample of quantitative output E³ simulation model.

4 CONCLUSIONS

As for every methodology, creating and developing a theory by using case study features points of strength and weaknesses. One point of strength of theory building from cases is its likelihood of generating novel theory. The likelihood of valid theory could be high because the theory-building process is so intimately tied with evidence that it is very likely that the resultant theory will be consistent with empirical observation. Besides it's possible to create more theories starting from the same case, and a case can be analyzed under different viewpoints. Obviously this is made possible thanks to the many acquired underlying data. Regarding the points of weakness, an important one is that the intensive use of empirical evidence can yield to theory which is overly complex. The result can be a theory which is very rich in details, but lacks the simplicity of an overall perspective. Another weakness of cases is the impossibility of repeating the case if the first analysis is not coherent with the research question. Another point of weakness is that building theory from cases may result in narrow and idiosyncratic theory. Case study theory building is a bottom up approach such that the specifics of data produce the generalizations of theory. The risks are that the theory describes a very idiosyncratic phenomenon or that the theorist is unable to raise the level of generality of the theory. For example, Gersick (1988) presented a model of group development for teams with project deadlines, Eisenhardt and Bourgeois (1988) developed a mid-range theory of politics in high velocity environments, and Burgelman (1983) proposed a model of new product ventures in large corporations. Such theories are likely to be testable, novel, and empirically valid, but they do lack the sweep of theories like resource dependence, population ecology, and transaction cost. Perhaps "grand" theory requires multiple studies-an accumulation of both theory-building and theory-testing empirical studies. Finally the case study will be linked always to the practice case that develop, soak in the context and scenario that describe. The use of MAS as a methodology for analyzing real world situations and creating new theory, thus moving from the particular scenario to the general case. First of all, since the model has to represent a scaled down situation, and not the whole reference system, it's quite easy to track down the data necessary to build the reference scenario. This reflects also on the fact that a limited range of real world data is used, thus preventing misleading aggregate results deriving from too many data, contributing to create white noise during the traditional analysis. Since the agent based methodology relies on metaphors, it's potentially possible to represent any social situation, if the proper computational transitional function is found and implemented. For example, in the model presented in this work, the heat metaphor is used to evaluate the general health of the system, and is the unity of measurement, the payoff and the cost that the enterprises must face during their own business. This is easily translatable into formal programming language, since it's based on physics and thus on mathematical functions. So it's up to the creativeness of the designer and any case study could be potentially recreated in a dynamic and interactive way. The most important feature of a model based on agent is the possibility of repeating the experiment several time, by changing one or few variables at a time, by leaving the other ones unchanged. This is referred to as "what if" analysis or "ceteris paribus" methodology. This has a double worthiness: on the one side, this can be used to track the cause-effect relationships among variables and results. On the other, it can be used to fine tune the results in order to make it as reliable as possible, when compared to real world ones. In social observations, this kind of approach would be impossible. Human factor and changing context would simply make it unworthy to replicate experiments or measurements, unless the confidence interval is kept at a very large range. This leads to the fact that from one base scenario, other scenarios can be created, if the right parameters are changed. This allows different case study, by starting from the same model. Another interesting possibility, when using MAS to represent social systems, is to create qualitative situations that have not been directly studied in the real world, through data harvesting. This means that, when observing a trend in a real scenario, this could be represented in the computational model; after that, data can be collected from the model itself and studied, as if they came from the real situation, if the overall trend has been respected. This is the case of such situations heavily dependent from randomness or, simply, from too many variables to be tracked in the real world case. Last but not least, models based on MAS have an important educational power; ranging from simple models, that could be perceived as games (e.g. business games) to be used into schools and universities, all the way up to complex models to be used for implicit knowledge formalization, knowledge transfer and management within enterprises. The "maieutilcal" approach allowed by a model of this kind is evident when dealing with organizational theories about Management and Economics: students can "learn by doing" using the model as an artifact on which carrying on their own experiments, thus directly discovering theories, without simply studying them by heart, and taking them as "dogmas" coming from books. In this way, the model becomes a virtual laboratory and the experiments can be done in a supervised (by teachers) or unsupervised way by the learners.

This approach doesn't want to substitute the practice case but just to integrate and overcome the limitation of practice case approach for supporting the creation of new economic theory.

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