A SIMULATION MODEL FOR CORPORATE SUSTAINABILITY PERFORMANCES.

MOTIVATED SEARCH, SURVIVAL ABILITY AND LEARNING FEEDBACK.

ABSTRACT

Relying on computer simulation and a contingency approach, we analyze the conditions leading firms to implement robust sustainability programs that would ultimately benefit society. We ask two questions: Under what conditions would a firm implement sustainability programs? What would explain difference in sustainability performances in a population of firms? To answer these questions, we develop a formal model that captures differences in firms' sustainability orientation (economic, legitimacy seeking and ethical orientations), organizational inertia and capabilities. We differentiate sustainability initiatives on three performance dimensions (economic return, legitimacy, and social and environmental value creation) and on their complexity. We found that under standard macroeconomic conditions firms employing simultaneously economic and ethical criteria, not these drivers in isolation, tend to achieve stronger sustainability performances. We also found the relationship between sustainability orientation and sustainability performances to be mediated by 1) the extent to which markets reward firms for social and environmental value creation 2) the extent to which companies are able to turn their intentionality into actions. Three mechanisms explain the results: (i) motivated search, that is the motives that influence individual firms in selecting initiatives; (ii) survival ability of firms in competitive environments;(iii) feedback among initiative implementation, competence building and motivated search.

INTRODUCTION

In this paper we focus on the conditions leading firms to implement *robust* sustainability programs which we define as programs that would ultimately benefit society and or the environment. We ask two questions: First, under what conditions would firms implement strong sustainability programs? Second, what would explain difference in sustainability performances in a population of firms over time? In order to answering these questions and developing preliminary theoretical insights, we rely on computer simulation. Simulation is particularly useful for research involving longitudinal and process phenomena such as ours. The longitudinal and complex nature of the interaction among firms' attitudes, available strategic initiatives and environmental constraints makes deriving its implications fairly ambiguous. Also, simulation is useful when received theoretical insights are sufficient for building a model. In this case, computer simulation supports the rigorous generation of theoretical hypotheses and theoretical insights that are internally robust. This articulation of predictions increases the points of contacts between the theoretical propositions concerning micro-processes and the aggregate empirical data collected. To capture the emergence, the diffusion and the robustness of firms' sustainable strategies, we used an agent-based model (Axelrod, 1984). Agent-Based models preserve heterogeneity and individual attributes. They simulate actions and interactions of autonomous individual entities and build on the hypothesis that the behavior of social systems can be modeled and understood as evolving out of interacting autonomous learning agents. Our agent-based model simulates firms' individual micro-processes of strategic initiatives' selection and learning. Building on the received literature in corporate sustainability and environmental strategies we develop a formal model that captures differences in firms' sustainability orientation (economic, legitimacy seeking and ethical orientations), organizational inertia and sustainability related capabilities. We understand a sustainability program as a portfolio of sustainability initiatives, and differentiate the latter with respect to two criteria: first, on the basis of three performance dimensions (economic return, legitimacy, and social and environmental value creation) and, second, on the basis of their complexity for the firm implementing them. We found that under standard macroeconomic conditions firms employing simultaneously economic and ethical criteria, not these drivers in isolation, tend to achieve stronger sustainability performances. However, we also found the relationship between sustainability orientation and sustainability performances to be mediated by 1) the extent to which society and markets rewards firms for social and environmental value creation and 2) the extent to which companies are able to turn their intentionality into coherent actions rather than falling victims to organizational inertia. In particular, in resource constrained environment, in which the economic return from sustainability initiatives is more ambiguous, only firms with strong economic motivation manage to create social and environmental value. Ethically oriented firms face challenged within these environments. Only in munificent environments, firms with a predominant ethical motivation, develop robust programs. In a nutshell, our study suggests that for firms to implement strong sustainability programs, both economic and ethical criteria should be employed. Three mechanisms explain the results. i) firms selection of sustainability initiatives, ii) survival (firms ability to profit from sustainability as a function of their selection criteria and the environmental munificence) and iii) learning mechanisms associated with the complexity of initiatives selected. This paper proceeds as it follows. We offer a review of the literature and highlight theoretical insights which are foundational to answer the research questions put forth in this study. Building on such insights we propose a conceptual model for corporate sustainability responsiveness (e.g., see Bansal & Roth, 2000), which includes two types of agents: firms and sustainability initiatives. This model is used to run a discrete event simulation which is offered for the analysis of our research questions. The results are analyzed and discussed and avenues for future refinements of the model are identified.

LITERATURE REVIEW: SUSTAINABIITY ORIENTATION AND SUSTAINABILITY INITIATIVES

CS is generally defined as the corporate sector's contribution to achieving the vision depicted in the notion of Sustainable Development (SD) (Bansal, 2005). Although initially considered a synonym of 'green business', CS has become a broader notion that also considers firms' activities beyond the 'eco-efficiency' paradigm (Gladwin, Krause & Kennely, 1995; Pfeffer, 2010), and involves the simultaneous consideration of their performance along economic, environmental and social dimensions (Berry &

Rondinelli, 1998; Bansal, 2005) - the elements making up what has come to be called the ‘Triple Bottom Line’ (Elkington, 1998). Interest in sustainability - and particularly in the managerial notion of CS - has virtually exploded in recent years. As a consequence, the literature in corporate sustainability is now vast and characterized by several research sub-streams (see Etzion, 2007; Sharma & Starik, 2002; Starik, Sharma, Egri, & Buch, 2005 for overviews of the literature in CS). In the sections that follow, we offer a review of the sustainability literature which focuses on clarifying two key theoretical insights which are foundational to the purposes of this study. First, companies differ in their approaches to sustainability and in their sustainability orientations. These are quasi genetic organizational traits that can help explain why companies facing similar conditions within their external environments differ in terms of their sustainability performances. Second, given market externalities and imperfect information, firms are not necessarily rewarded economic profits or granted legitimacy for social and environmental value creation. Symmetrically, firms with a negative social and environmental impact are not necessarily sanctioned by their stakeholders (Crilly, Zollo and Hansen, 2012). Thus, initiatives that are good from a sustainability standpoint are not necessarily profitable for firms and viceversa.

Sustainability Orientation

Inspired by insights from the organizational sense making literature, a research stream has focused on understanding the nature of the mechanisms at the background of the emergence of different orientations toward sustainability. Pressured by the forces exercised by diverse constituencies, managers engage in formal and informal sense making and develop cognitive and linguistic schema and frames (Basu and Palazzo, 2008). The latter may include motives on sustainability, which is how companies justify their engagement in sustainability, as a surface manifestation. The result of these organizationally embedded processes is shared understanding articulating the way the engagement in sustainability is understood (Bansal and Roth, 2000). Overall, this line of inquiry offers two fundamental insights. First, while sense making is an ongoing process within organizations, once shared understanding is agreed upon, it tends to be somehow stable. This is an important insight as suggests that how the company view and justifies its involvement in society can be taken as a predictor of social and environmental responsiveness (see Bansal & Roth, 2000). Second, the emerging narratives, mental models and frames that underlie organizational sense-making influence, in turn, the managerial decision making process by specifying what types of actions are appropriate and how to carry out them. For example, in a study of oil companies and auto manufacturers, Bansal and Roth (2000) found that firms driven by the desire to improve the appropriateness of their actions within an established set of regulations, norms, values, or beliefs, were focused on the stakeholders most influential in prescribing or articulating legitimacy concerns. However, stakeholder engagement was different in companies characterized by different sustainability orientation, such as in companies viewing sustainability as an opportunity for profits, or in companies driven by normative and moral concerns. In a nutshell, linguistic and cognitive frames subtending a sustainability orientation have a performative function, in that they shape modes of corporate behavior as it related to sustainability. Building on these insights, we introduce the notion of sustainability orientation (SO) and formally define it as the underlying paradigmatic view that stems at the background of how a company implicitly understands and articulate the nature of its responsibility toward society.

Sustainability Initiatives: profitability, legitimacy and sustainability performances

Building on evidence that companies approach sustainability employing different strategies, several studies have attempted to categorize companies according to the nature of their strategic approaches to sustainability. For example, Van Bommel (2011) distinguishes among four types of strategies: resign strategy, defensive strategy, and offensive strategy. Resign strategy is adopted by organizations which decide not to begin the implementation of sustainability. A defensive strategy is adopted by organizations that, albeit accepting an engagement in sustainability, adopt a strategy which is instrumental to reduce sustainability related threats and risks, such as sanctions, reputation issues, customers boycotts or the risks stemming from environmental regulation. In contrast, offensive strategies are adopted by organizations, which seek to profit from sustainability. In a similar view, Sharma and Vredenburg (1998) distinguish between proactive and reactive strategies. They studied the oil and gas industry and found that "managers in reactive companies were unable to associate their corporate environmental responsiveness strategies with any positive organizational outcomes other than lower liabilities due to reduction in risk of environmental accidents" (735). On the contrary, managers in proactive companies "perceived a number of competitive benefits emerging from their environmental response. These included, lower costs of processes/inputs/products, innovations in processes/products/operating systems, improved corporate reputation, and relationships with a wide range of stakeholders" (Sharma & Vredenburg, 1998: 735). Overall this stream of research focuses on the identification of general, high level, sustainability strategies and attempts to classify companies according to broad archetypes. At higher level of granularity, students of CS have suggested that firms engage in sustainability by selecting and implementing different types of sustainability related initiatives (Hess & Warren, 2008). Building on prior literature, we define a sustainability initiative (SI) as a specific action or set of actions related to generic sustainability issues. According to a Triple Bottom Line view of corporate sustainability, SIs and sustainability issues are related to the economic, environmental as well as social dimensions of corporate performance. Examples of sustainability initiatives related to the environmental domain include cutting pollution and the use of material and energy resources or preserving biodiversity. SIs also comprise actions that would improve the economic sustainability of the firm, such as mechanisms to reduce financial risk, to avoid conflict of interest or improve transparency of economic transactions, or to prevent corruption and bribery. They finally include initiatives primarily pertaining to the social domain of CS, such as work-life balance programs, gender-equality programs, health related benefits for employees and the like. Sustainability initiatives need not to be directed toward the firm, but could be external to it. Examples of the latter include philanthropy, political lobbying and community involvement initiatives. An important, albeit overlooked, opportunity for categorizing SIs is represented by the consideration that, viewed from the point of view of them firms implementing them, SIs differ in their performance potential along three dimensions: Profitability (p), Legitimacy (r), and contribution to Sustainability (s). Profitability identifies the potential of as SI to strengthen the competitive position of the firm, for example lowering costs, introducing valuable innovations or new products, opening access to new markets. Legitimacy is the potential of a SI to provide the firm with legitimacy, within a system of socially constructed norms and rules of (corporate) behavior. Sustainability is the potential of the initiative to contribute solving environmental and social problems. This categorization of sustainability initiatives is important for two reasons. First, it is theoretically meaningful. As we try to illustrate in this paper it has the potential to help explain the emergence of sustainability performance patterns and differences in sustainability performances according to selection mechanisms, thus providing an analytical link between firms SOs, strategies and performances. Second, it is coherent with theoretical insights on the functioning of real markets. As it is clarified in the next session these insights are critical to help explain why often the performance dimensions of sustainability initiatives – profitability, legitimacy and social and environmental value creation - are often not aligned and, in some instances, can even be orthogonal.

A PRELIMINARY MODEL

Three addition key theoretical features are included in our proposed model. First, the extent to which intentionality (as captured by a firm SO) is translated into coherent courses of action depends on firms' internal coalition's ability to overcome organizational inertia. SO does not necessarily imply action since organizational politics, dominant logics (Prahalad and Bettis, 1986), bounded rationality and neighborhood search (Cyert and March, 1963), and desire to exploit core capabilities (Leonard-Barton, 1992) may bias motives in selection activity so that initiative selection is motivated but looks like an organizational truce (Nelson and Winter, 1982) as well, in which orientation is blended with the aims of different organizational coalitions. In other words, organizational inertia mediates the relationship between SO and the implementation of different sustainability initiatives. Thus, we assume that initiative implementation follows from *motivated selection*, this latter being influenced both by motives and organizational rigidities. Second, as a consequence of implementing initiatives of different nature, firms learn (or fail to do so). We contend that this aspect is critical in understanding firms' sustainability performances and the emergence of differential sustainability performance patterns among firms over time. We thus included a learning feedback in our model, which captures the process of learning by doing. More specifically, initiatives implementation triggers a process of competence building, this latter influencing motivated search by modifying the features of a firm's skill endowment. Third, the extent to which firms sustainability programs are profitable, depends on average macroeconomic conditions and the extent to which markets and society rewards firms for social and environmental value creation. In order to capture this idea we introduced the notion of environmental munificence (EM), and model it as the ration between the average return from an initiative and the average cost of an initiative in the system. Thus, EM allows capturing different macro-economic scenarios defining the average profitability from a sustainability initiative. In other words, we can observe sustainability performances only in firms that survive their competitive environment. There is no prize for ethical firms that are not economically viable. Overall in our model the relationship between SO and sustainability performances is mediated by 1) environmental munificence (EM) that affects a firm's *survival ability*, 2) the extent to which companies can turn their intentionality into actions versus ending up selecting initiatives which are similar to what they have already being doing in the past (γ). (Figure 1).

INSERT FIGURE 1 ABOUT HERE

METHOD

The longitudinal and path-dependent nature of initiative selection dynamics makes deriving its implications ambiguous. It is difficult to explicate how the processes unfold over time in different initial conditions to yield different aggregate results. The unfolding of these processes can be observed, however, in a computer simulation (Davis, Eisenhardt & Bingham, 2007). To explore the non-obvious unfolding patterns of initiative selection we relied on an Agent-Based Model (ABM). Agent-Based Models are an emerging paradigm within the social sciences and, more specifically, in management and organization science (Macal & North, 2010: Aggarwal, Siggelkow, & Singh, 2011; Gavetti, Levinthal & Rivkin, 2005). The ABM methodology has the advantage of allowing modeling very complex systems with relatively simple mathematical and logical structures (e.g. see Davis *et al.*, 2007). In addition it is particularly suited to model adaptation occurring through evolutionary processes (e.g., variation-selection-retention or experiential learning) (Davis, Eisenhardt & Bingham, 2009) and to describe how such processes affect the evolution of different outputs over time. Here the ABM is used because of our interest in gaining insights on the emergence of system behavior form lower level heterogeneity among agents and interaction dynamics. In an ABM, the parts of the simulation model are represented by interacting agents, each one made by some specific attributes. During the simulation lifespan each agent in the simulation produces a series of changes in the simulation state, which is called an event. The model here proposed allows expressing formally (computationally) a number of hypotheses about potential initiative selection processes that may occur in organizations but in a stylised and executable manner such that experiments can be performed to deduce the consequences of those hypotheses when they are combined in complex, adaptive systems. We therefore purposefully present a simplified model in which we hope to capture the kinds of complex dynamics in which we are interested. In order to develop our simulation study, we implemented our model on top of a Discrete Event Simulation (DES)

(Fujimoto, 2000) engine (called GAIA/ARTÌS)[1]. Thus, technically, our model maintains all the typical features of an Agent-Based Model (simulates actions and interactions of autonomous individual entities) but is extremely powerful because the GAIA/ARTÌS engine makes use of a more advanced approach to simulation which is based on Parallel And Distributed Simulation (PADS) [5]. Whereas in a traditional simulation (i.e. a monolithic simulation), a single processing unit (i.e. CPU) is in charge of calculating values of variables, in the case of PADS the simulation model state is shared among different processing units connected by a computer network. With PADS simulation, it is possible to both build very complex models, and experiment models' scalability with a large number of agents. Typical protocols of experiments with Agent-Based Models consider agent populations that range from 100 to 10,000 (Macy & Skvoretz, 1998; Hanaki, Peterhansl & Dodds & Watts, 2007; Deffuant, Huet, & Amblard, 2005) while we experiment with populations in the range 100,000-1,000,000 and obtain simulation results in a shorter time (than with a monolithic simulation). This feature is particularly important in relationship to the study of emergent properties, i.e. behavioral characteristics of the system which emerge over time because of the properties of the parts forming the system and their complex interdependencies. System wise emergent properties are often observed only when a minimal cardinality is guaranteed (i.e., large populations of agents). However, this requirement implies extremely heavy calculations, often not implementable relying on monolithic approaches running on commercial off-the-shelves (COTS) hardware. The architecture of our model allows resolving this issue, without having to oversimplify the model. In a similar way this approach allows for the exploration of very large number of configurations of the system, and to increase the statistical power of the model (with Montecarlo Simulations). Finally, this approach allows reducing simulation execution time improving researchers' ability to efficiently execute very high numbers of simulations when performing sensitivity analysis.

Modelling Agents

Our simulation model includes two types of agents: firms and sustainability initiatives. These differ along a constellation of attributes, which we describe in the next paragraphs.

Agent Firms

We model a heterogeneous population of firms who differ in their beliefs and values concerning sustainability and the level of capabilities and resources available. Thus, each firm is characterized by three types of attributes: i) a sustainability orientation (SO) ii) a skill endowment (SE) and iii) a resource budget (RB). In each of the p periods the i firm is confronted with choices concerning the selection (and implementation) of sustainability initiatives (SI) from a set of possible alternatives. At the beginning the n firms are identical and differ only in terms of their sustainability orientation (SO). We therefore

[1] Parallel and Distributed Simulation (PADS) Research Group. http://pads.cs.unibo.it

modeled Most Similar Systems (MSS) (i.e. systems that are identical and differ only along a limited set of variables) with the goal of isolating our phenomenon of interest, i.e. the relationship between motivational forces, firms behavior and sustainability performances, from competing explanations and confounding factors. For example, because we are not interested in industry level explanations of the differences in sustainability performances among firms (e.g. see Etzion, 2007 for a review on the influence of industry factors on firm environmental strategies and performances), we assume that firms operate in the same industry. Similarly we assume that are identical with respect to initial budget and resources, even if these attributes change during the simulation as a function of learning mechanisms and investment decisions. Building on the received literature, we model a firm's sustainability orientation (SO) as a vector of three attributes representing the relative importance of (endogenous) motivational forces for sustainability. Thus each firm is characterized by vector SO (E_i; L_i; ETH_i) where E_i represents the (relative) importance of economic motivation (competitiveness) for firm *i*, L_i the legitimacy motivation (legitimation) and ETH_i the ethical motivation (ethics). Because motives tend to be mixed, we model each motivational force (within SO) as a number ranging from 0 to 1, with $E_i + L_i + ETH_i = 1$. Accordingly, SO captures the relative importance of different motivational forces. In other words, our conceptualization stresses qualitative (rather than quantitative) differences along firms SO, pointing to 'differences in kind' (on the basis of the nature of a firm's motivational structure). Within this conceptualization of SO, there are infinite logically possible combinations of motivational forces leading to infinite types of firms (as differentiated in terms of their motivational structure). However, with dichotomous values, i.e., each motivational force being either 1 or 0, there are 8 logically possible combinations of motivational categories identifying 8 types of firms. This set offers a parsimonious, albeit theoretically meaningful, categorization of the population of firms that nonetheless preserves some of the richness and heterogeneity of organizational approaches to sustainability (Table 1). After dropping the category characterized by all zeros for each one of the motivational variables, which is non-theoretically relevant, we identified 7 types of firms, 3 with a dominant motivation, 3 with a combination of two motivational forces and 1 with balanced motivational variables (See Table 1).

INSERT TABLE 1 ABOUT HERE

These ideal types were used to run and analyzed the model.

The second characteristic of firms is represented by a firm's skills endowment (SE). Consistent with the knowledge base view of the firm (Grant, 1996), we understand SE as a set of heterogeneous resources and capabilities, overall representing the knowhow that enables organizations to reliably perform and extend its characteristic output actions (Collins, 1994). Examples of capabilities include i) skills required to acquire and make efficient use of physical assets and technologies, ii) human resources and organizational capabilities, which include culture, commitment, and capabilities for integration and communication, and iii) the intangible resources of reputation and political acumen (Russo & Fouts, 1998). To capture heterogeneity, we model SE as having 10 features, each assuming values in the range [0,1] (e.g.,[0][1][0.3][0][0.5][0][0.6][0.8][0][0.1]). This is consistent with the notion that capabilities are heterogeneous and that can vary in degrees as firms accumulate experience (Zollo & Winter, 2002). Finally the selection and implementation of a sustainability initiative is subject to resource constraints. We captured resources constraints through a budget (B) which represents firms' uncommitted resources which can be easily mobilized by the firm for implementing the target initiative. When an organization looks to select initiatives, it takes the most preferred initiative and confronts the costs of implementing it with the budget available. If the budget is sufficient, the initiative is implemented and the budget reduced accordingly. If the resources available to the firm are not sufficient the firms skips to the second best, and execute this process until one initiative is selected.

Modeling agents: Sustainability Initiatives

The second class of agents in our model is represented by sustainability initiatives (SI). We define a sustainability initiative as any action or set of actions that the firm is performing related to sustainability issues[2]. Taken together sustainability initiatives define the sustainability landscape (SL). Similarly to others (Davis *et al.*, 2009), we modeled the SL as a flow of heterogeneous sustainability initiatives, each characterized by two sets of attributes: complexity and expected performances[3].

We modeled complexity as the number and amount of skills required for successful implementation of the initiative. Complexity increases the cost of capturing an opportunity because organizations lacking the relative capabilities have to engage in some form of experimentation, learning, and other activities which are costly. Complexity was operationalized as a vector of 10 attributes, each assuming values in the range [0,1] (e.g.,[0.3][0][0.4][0][0.5][0][0.9][0.8][0][1]). Viewing performance of SIs from the perspective of the firm selecting them, and consistently with our discussion of the performance potential of different SIs, we modeled performances as a constellation of three attributes, each identifying a distinct performance dimension: Profitability (p), Legitimacy (r) and Sustainability (s). Each performance dimension was operationalized as a real number in the range [0,10]. Our conceptualization of performances of sustainability initiatives rests on some important assumptions. First, we do not address indirect effects and interdependencies among the three performance dimensions but only consider direct effects. For example, we do not consider the effect of improved reputation on

[2] Note: we purposefully use this definition because it is neutral with respect to the nature of the motivation for selecting the initiative itself.

[3] Sustainability initiative could be differentiated with respect to several (and conceptually different) attributes (For example, an SI can be related – unrelated to a firm s core business (or area of primary involvement with society), short term or long term. They can differ in the geographical reach, also in the types of function involved, SI can be Internal (e.g., employee training, policies for work/life balance) or External (philanthropy, political lobbying).

competitiveness (Russo & Fouts, 1998). While we acknowledge this represents a simplification of reality, it is consistent with notions of bounded rationality and with the idea of managers selecting initiatives primarily on the basis of its more direct contribution and more short term implications without computing secondary and more uncertain effects (Aguilera *et al*., 2007). Second, according to our conceptualization, the S performance dimension does not include the economic dimension which is nonetheless captured by the profitability dimensions. While according to the CS literature (e.g. see Bansal, 2005) and the notion of the Triple Bottom Line (Elkington, 1998) sustainability performances of firms are more rigorously understood as comprising both an environmental, social *and* economic dimensions we purposefully decided to model them separately. This allows unpacking the relationship corporate financial and social (and environmental) performances, an unresolved issue (e.g. see Margolis & Walsh, 2003) and to which our model offers potential contributions. Also, it is consistent with the theoretical goal of the paper, which is to gain insights onto how a firm's SO differently impact the market and the non-market performances of the firm. To gain further insights on the nature of sustainability initiatives and in order to identify theoretically meaningful categories we assumed dichotomous values for each one of the three performance dimensions and generate initial categories of initiatives. With three performance dimensions (i.e., competitiveness, legitimacy and ethics) and two values for each dimension (1 to indicate a positive performance and 0 to indicate a non-positive performance), there are 8 logically possible combinations of performance attributes, identifying 8 (ideal) types of sustainability initiatives. We dropped the category characterized by zeros along each one of the dimensions, because not meaningful from a theoretical stand point[4]. The remaining categories identify different ideal types of sustainability initiatives as shown in Table 2 together with real world examples of such initiatives.

INSERT TABLE 2 ABOUT HERE

Consistently with our prior discussion, sustainability initiatives differ in their alignment between different performance dimensions. The first category of sustainability initiative (i.e., initiatives identified by the vector 1,1,1 in Table 2) represents the set of initiatives that are simultaneously beneficial to firm's profitability, reputation and also contribute solving sustainability issues. For example, introducing green innovations, such as new innovative technologies for green energy, would improve a firm profitability, enhance legitimacy and contribute fostering the transition to low carbon economy. However in many cases there is a divide between what is valuable for society or the environment and what is profitable for firms. For example, Carbon Capture and Storage (CSS) technologies, by limiting end-of-pipe pollution, contribute preserving ecosystem integrity. However,

[4] In the simulation model no firm will select this initiative. Also, we doubt such initiative really exists.

because such technologies are costly, *ceteris paribus* firms introducing them are worst-off than competitors not doing it. We captured initiatives of this type in the group identified by the vector (0,1,1). Firms can still decide to implement such initiatives, for example directing part of their budget for philanthropic activities to internally oriented initiatives (thus addressing their primary area of responsibility toward society). Another interesting class of initiative is represented by the ideal type (1,1,0,) which captures initiatives which are profitable, have the potential to improve legitimacy, but that actually have a negative impact on society. These initiatives resemble our previously discussed example of windmills with permanent magnets. Asymmetry of information, the social construction of norms and rules depicting what is considered appropriate coupled with the role of media supporting them, can generate distorted perceptions of the real worth of sustainability initiatives. While in some cases what is actually bad from a sustainability stand point can be perceived as legitimate, in other cases the opposite situation is encountered. Consider nuclear power. While we do not aim at entering the debate on the worth of nuclear power, some researcher agree that nuclear power is actually less polluting than other sources of energy (Boyle, Everett, & Ramage, 2003). As research in energy systems reveals, the environmental impact of nuclear energy is comparatively good, when compared with other sources over a life cycle (Boyle *et al.*, 2003). Table 3 offers some real world examples of initiatives that would fall in our ideal types. We model sustainability initiatives to consider not only differences ‘in kinds’, as captured by our effort to identify ideal types, but also differences ‘in degree’. The latter refers to the extent to which similar initiatives, that is, initiatives belonging to the same class, differ in terms of performances. For example, consider the ideal type corresponding to the performance vector (0,1,1). This category identifies the set of initiatives with positive sustainability and legitimacy performances but either negative or null implications for firms’ competitiveness. For example, introducing Carbon Capture and Storage technologies to limit pollution or selecting suppliers with high sustainability performances represent real-world instances of sustainability initiatives falling in the (0,1,1,) category. Both these initiatives, depending on contingent factors, can have different performance implications in terms of magnitude of performance. Which is, the costs, potential impact on firms’ legitimacy, and social and environmental performances of implementing such type of initiatives can vary, depending for example on the particular CSS technology used, the current configuration of the technological assets of the firm, etc. In a nutshell, qualitatively similar initiatives are heterogeneous with respect to the magnitude of their performances. Building on these insights, we modeled the different performance dimensions of every sustainability initiative as real numbers ranging from 0 to 10. We used a uniform distribution ranging from 1 to 10 to generate the performance value of those performance dimensions which differ from 0 in the initiatives category. Which is, if an initiative is of the (ideal) type (0,1,1) then its performance values for the L and S dimensions are taken from a uniform distribution ranging from 1 to 10, while its P dimension (which for this ideal type is 0) is set to 0. The third and last characteristic of SIs is represented by their complexity. For example, changing processes to improve environmental performances, developing new greener products, or innovating a firms’ business model, as Interface did when it moved from selling to lease its carpets (Lovins, Lovins & Hawken, 1999) are more complex activities than engaging in philanthropy or introducing ‘end-of-pipe’ pollution abatement technologies. Complexity is theoretically important for two reasons. First, by affecting the costs of implementing initiatives it shapes decision processes at the background of their selection. Second, complexity also affects firms’ potential to develop valuable capabilities as a by-product of initiatives implementation and, accordingly, it is a fundamental pillar for understanding the evolutionary trajectories of performances. As Russo and Fouts (1997) noted, certain initiatives involves more comprehensive and socially complex processes, which necessitate significant employee involvement or cross-disciplinary coordination and integration. Other interventions are achieved simply relying on self-contained, off-the-shelf readily available hardware, which does not require developing new capabilities (Groenewegen & Vergragt, 1991; Kemp, 1993). For example, “the addition of pollution-removing or filtering devices to the existing assets of a firm does not require the firm to develop expertise or skills in managing new environmental technologies or processes” (Russo and Fouts, 1997; 538). Which is, an initiative such as the introduction of pollution removing or filtering devices arguably pertains to an easy-to-implement category of initiatives. Complexity was operationalized as the number of skills that are required to implement a sustainability initiative. To capture heterogeneity along the complexity dimension, we modeled each opportunity as having 10 features that can be in the range [0, 1] (e.g.,[0][1][0.3][0][0.5][0][0.6][0.8][0][0.1]) and which represent the skills (capabilities) required to implement a given initiative. Finally, we model the relationship between performances and complexity of SI on the insight that, in competitive markets, initiatives with higher potential form impact are more difficult to implement. Let P, L and S indicate the performance dimensions of the *j* sustainability initiative. We compute $F_j = (P_j+L_j+S_j) / 30$ to indicate the percent value of skills that are necessary for an initiative. Thus F represents a normalized score, which can assume values ranging from 0 to 1. When all the performance dimensions are at maximum (i.e., P=10, L=10, S=10), F equals 1, meaning that all the different types of capabilities are required for implementing that initiative. Similarly, with P=5, L=0 and S=10, F=0,5 meaning that a firm has to activate 50% of the skills to implement the initiative. The association between F and the number of skills required is performed by mean of rounded approximations. With this operation, every initiative is associated a number of skills within 10 intervals, employing minimum distance criteria. For example, if F is equal to 0,16, than it is approximated to 0,2 which represents the closest boundary of the interval 0,1/0,2 (in which 0,16 falls). Similarly, if F = 0,32 it is approximated to 0,3 and the firm is required to activate 30% of the skills to implement the initiative. In a nutshell, in our model the complexity of an initiative is endogenous with respect to its expected performances, and the two are tied by a relationship of direct proportionality.

MODEL DESCRIPTION

Opportunity search and selection

In most realistic strategic decisions the complexity of forecasting the environment precludes the definition of optimal strategies. Building on insights from the behavioral theory of the firm and a well-established tradition of bounded rationality (Cyert and March 1963/1992, Simon 1982), we assume that agents firm evaluate and select initiatives relying on intendedly rational but simple decision heuristics. Thus in our model agent firms attempts to select the best initiative. However their rationality is bounded. We make three related assumptions highlighting the cognitive limitations that bound the rational adjustment of decision making. First, when evaluating alternatives firms are unable to envision al possible courses of actions: rather only a fraction of them is considered. Second, ambiguity and environmental complexity prevents firms from fully understanding the consequences of each course of action. Third, in the tradition of Simon (1962), Cyert and March (1963), Nelson and Winter (1982), the agents makes decisions using relatively simple routines and heuristics because the complexity of the environment coupled with cognitive limitations and the cost of gathering information exceeds the ability to optimize. Thus agents only satisfy. The first assumption is consistent with the notion that 'firms cannot hope to find optimal strategies [...] since all alternatives cannot be considered' (Nelson & Winter, 1982: 255). Grounding on this suggestion, we modeled firms' inability to observe all possible courses of actions by randomly assigning to each firm a subset of all possible initiatives generated at each time step. At every time step t, each *i* firm only observes the set of initiatives s_t*, with s_t*<s_t, where s_t represents the set of all possible initiatives at time t. In other words, s_t* represents a subset of s_t comprising those initiatives which are visible to firm *i* at time t and varies with time (i.e. $s_{t+1}* \neq s*$). The second assumption is consistent with the notion that return from sustainability initiatives is ambiguous. Let (p_j, r_j, s_j) represent the performance dimensions of initiative j. The actual return from implementing the initiative j for the firm *i* is given by:

$$p_{ij}^* = p_j + N_{ij}^* \tag{1}$$

$$r_{ij}^* = r_j + N_{ij}^* \tag{2}$$

$$s_{ij}^* = s_j + N_{ij}^* \tag{3}$$

where N_{ij}^* represents a noise term, normally distributed $N(0;\ \sigma_{ij}^2)$. We choose a normal distribution with mean zero to capture the idea that firms' expected return evaluation process is unbiased and free from systematic errors (i.e. probability of underestimation or optimistic estimation is symmetric). We included in the search and selection process the idea that as firm accumulate experience with implementing sustainability initiatives their ability to correctly estimate the return from an initiative of similar characteristics improves. Experience with past courses of actions reduces ambiguity. This feature of the model is coherent with a robust body of literature and a panoply of experimental studies suggesting that learning is possible that improve judgment and, at least partially, reduce biases. Kagel and Levin, for example, (1986) show a reduction in biases in bidding behavior as feedback from past actions accumulates. In a similar vein Neale and Northcraft (1989) suggest that biases in decision-making may be reduced as expertise accumulates. Same emphasis on the value of generalization from past experience is reported in the experiments conducted by Thompson (2001).Grounding on these experimental findings, we assume that skills and capabilities endowment are accumulated with experience and expertise improve firms' ability to correctly estimate the return from sustainability initiatives. In order to capture this assumption, we modeled the variance of the noise term at each point in time *t* as a depending on the distance between a firm skill endowment (SE) and the skills required to implement an initiative. In equation (4) the term σ_{ij} is functionally dependent on a constant a, which captures the exogenous, systematic component of the noise term, and the term $\left[\sum_{l=1}^{10}\left(SR_{lj}-SE_{li}\right)\right]^{\lambda}$. The latter goes zero when firms implement initiatives for which they own the necessary capabilities[5].

$$\sigma_{ij} = a + \left[\sum_{l=1}^{10}\left(SR_{lj}-SE_{li}\right)\right]^{\lambda}, 0 < \lambda \leq 1, \forall \left(SR_{kj}-SE_{ki}\right) \geq 0 \qquad (4)$$

The third assumption concerning opportunity search and selection is that firms rely on simple decision heuristics in order to perform this task. Building on insights from the behavior decision theory we thus modeled evaluation and selection of opportunity as relatively simple and informed by two principles: simple minded search (Cyert & March, 1963:170-171) and quasi resolution of conflict (1963:164). More

[5] In order to compute the parameters in equation (4) we proceeded by imposing two constraints and solve the relative equations for a and λ. First, we assumed that while firms' ability to correctly estimate the return from an initiative improves as firms acquire experience with implementing sustainability initiatives of similar characteristics, uncertainty (error in estimation) is not fully eliminated. Rather the noise term includes a systematic error a, which captures exogenous risk (i.e. risk that cannot be anticipated by firms, independently of their experience with sustainability initiatives). We set a to be not more than 30% of the total noise term (i.e. a: $\left[\sum_{l=1}^{10}\left(\mathrm{SR}_{\mathrm{lj}}-\mathrm{SE}_{\mathrm{li}}\right)\right]^{\lambda}$ = 30:70). In the worst case scenario, when the initiative is fully similar to a firms skill endowment the term $\left[\sum_{l=1}^{10}\left(SR_{lj}-SE_{li}\right)\right]$ is equal to 10. This leads to formulate the first constrain as $a : 10^{\lambda} = 30 : 70$ Second, we assumed that, in the worst case scenario, the standard deviation of the noise term is such that the total error committed by the firm in estimating the return from an initiative is not more than 1,5. We calculated 1,5 by reasoning in probabilistic terms. With an average return from sustainability initiative being equal to 5, a maximum error of 1,5 (corresponding to the standard deviation of the error term) ensures that the real return from an initiative will be comprised in the range [2-8] (i.e. two standard deviations) with a probability of 95% (and, similarly, in the range [3,5-6,5] with a probability of 68%). Again, in the worst case scenario, when a firm implements an initiative that requires a knowhow and capabilities fully divergent from firms' current knowhow and capabilities, the term $\left[\sum_{l=1}^{10}\left(SR_{lj}-SE_{li}\right)\right]$ equals 10. This leads to formulate second constraint as $a + 10^{\lambda} = 1{,}5$. Solving the equations corresponding to the two constraints for a and λ leads to a = 1.008 $\lambda = 0.02$.

specifically, organizations select initiatives by trading-off between two criteria: 1) desirability, as captured by initiative congruence with firms' SO and 2) proximity, as captured by the distance between an initiative and firms existing capabilities. Such a conceptualization of firms' selection routine is consistent with the notion of firms' engagement in sustainability programs of different forms to be contingent on their motivation and ability to do so. While motives capture the propensity to implement a given initiative, the extent to which the skill required to implement it are distant from the firm's existing skill set and capabilities determines the firm's ability to actually engage in a that course of action. In addition, this assumption resonates with the portray of organizations that use simple search routines that are primarily directed in the neighborhood of current alternative and that are biased by past experience (Cyert and March, 1963: 170-171). Finally, it is consistent with the idea that organization tradition and culture bias decision-making (Morecroft, 1988) so as to justify past courses of action and confirm past choices (Staw, 1980), overall leading to a tendency to over commit to past courses of actions (Staw, 1981). Organizations adopt routines that accommodate different, often conflicting, organizational goals. In this light, routines are truces that prevent conflict among goals from being *expressed in highly disruptive forms* (Nelson & Winter, 1982). In equation (5), grounding on the principle of quasi resolution of conflict (Cyert & March, 1963: 164), firms estimate the return on each visible sustainability initiative by trading-off between their motives and their capability endowments.

$$T_{\mathrm{j,i}} = (1-\gamma) * R_{ij} + \gamma * S_{ij} \qquad (5)$$

$$R_{\mathrm{j,i}} = E_i * p_{ij}^* + L_i * r_{ij}^* + ETH_i * s_{ij}^* \qquad (6)$$

$$S_{i,j} = \sum_{l=1}^{10}\left(z_{lj}\right) \; where \; z_{lj} = \frac{SE_{li}}{SR_{lj}} \leftrightarrow SE_{li} < SR_{lj}, 1 \; otherwise \qquad (7)$$

In equation (6), E_i, L_i and ETH_i represent the relative importance of economic, legitimacy and ethical motives, respectively, for firms *i*, while p_{ij}^*, $r_{ij}^*$and s_{ij}^* represent firm's *i* estimated expected returns of the *j* initiative in terms of competitiveness, reputation and social and environmental value creation respectively. Thus in equation (6) the *i* firm estimates its preferences on the set of visible initiatives on the basis of their adherence to its motivational structure. Equation (7) captures organizations' attitude to select opportunities that do not dramatically diverge from existing capabilities. Let SR_j be the required skills (capabilities) for implementing the *j* initiative. As previously noted, we model each opportunity as having 10 attributes each requiring a certain amount of a specific skill. Each attribute can be in the range [0, 1] (e.g.,[0][1][0.3][0][0.5][0][0.6][0.8][0][0.1]). Thus we model SR_j as a vector of 10 elements taking values in the range [0, 1]. When an attribute scores one that attribute is particularly salient and it requires the highest currently available knowledge connected to a specific skill. Symmetrically, a firm's skill endowment (SE) is a vector of L=10 skills that can be in the range [0, 1]. When a given a skill is one the firm has full knowledge on that specific skill, when it is zero the firm has no knowledge at all (it has to acquire it through a learning process). Let $SE_{i,t}$ represent the skill endowment of firm *i* at time

t. $SE_{i,t}$ is a vector of l=10 elements taking values in the range [0, 1]. $SE_{i,t}$ depends on time given that firms modify their skill set thanks to learning processes (see Below). In equation (5), the terms $R_{\mathrm{j,i}}$ and $S_{\mathrm{j,i}}$are weighted using a parameter γ that allows mimicking different organizational attitudes to emphasize either conflict resolution or neighborhood search. Finally the firm ranks order the initiatives on the basis of $T_{\mathrm{j,i}}$, and it selects the most preferred initiative subject to the additional constraint that it there is sufficient budget to sustain the relative implementation costs (see next session for an explanation of how costs are computed). Let B_i be the budget available for firm i and let $C_{\mathrm{i,j}}$ represent the cost of implementing the j initiative for firm i. The most preferred initiative as ranked through $T_{\mathrm{j,i}}$ is implemented if $B_i - C_{\mathrm{i,j}} \geq 0$. Otherwise the firm skips to the second best. The process is repeated until one initiative is identified that meets the firm's requirements. According to Nelson and Winter 'a widely used procedure seems to begin by developing lists of projects that if successful would have high payoff, and the screening this list to find those projects that look not only profitable if they can be done, but doable at a reasonable cost' (1982: 255). Thus, we depicted decision-makers that define what is feasible under budgetary constraints (Cyert and March, 1963: 96).

Cost of initiatives implementation

Initiative implementation is costly. Yet, not all initiatives are equal, with some initiatives more costly than others. Implementation costs depend primarily on initiative's complexity. We compute complexity as endogenously determined relatively to a firm's skill set. More precisely, costs are proportional to the heterogeneity between a firm's required (SR) and available skills (SE). Let $C_{i,j}$ represent the cost of implementing the j initiative for the i firm: then:

$$C_{i,j} = \epsilon(AC + \sum_{l=1}^{10} K_l\,)$$

where $$K_l = 0 \ \leftrightarrow SE_{li} > SR_{lj}\,,\ K_l = \left(SR_{lj} - SE_{li}\right) \leftrightarrow\ SE_{li} \leq RS_{lj} \qquad (8)$$

We model the cost of implementing an initiative as the sum of two distinct components; an absolute (exogenous and fixed) cost (AC), plus a relative (endogenous and variable) cost which is endogenous to a firm's skill endowment SE_i. This formulation allows us to capture the idea that while learning reduces costs of implementing an initiative, it does not eliminate it. We treated AC as a scalar quantity and calibrated it so that the overall cost reduction achieved by firms with full capabilities is not greater than 30% the overall cost. The calculation leads to a value for AC of 23.3[6]. This is consistent with

[6] We calculated AC by imposing that the overall cost reduction achieved by firms with full capabilities is not greater than 30% the overall cost. At best, when a firm's capabilities are all at 1, the term $\sum_{l=1}^{10} K_l$ equals 10. We therefore imposed AC:10 = 0.7:0.3. This leads to a value for AC of 23,3. We followed a similar process to rescale costs Cij. While the maximum economic return from an initiative is 10 (as p can range from 0 to 10), the maximum cost is 33,3, corresponding to 23,3 (AC) to 10 (the maximum possible value for the term $\sum_{l=1}^{10} K_l$. This formulation of the model leads to a situation in

empirical evidence that cost reduction due to experience accumulation in various industries is typically in the range of 10 to 25 per cent (Hax & Majluf, 1982). In order to obtain cost estimates of similar order of magnitude than the returns from implementing a sustainability initiative we rescaled the cost line and introduced the parameter ϵ to do so. ϵ is a rescaling coefficient that allows to re-scale costs to values that are comparable with returns from an initiative. In addition we modeled ϵ to be dependent on a parameter *A*, which captures environmental munificence. We define environmental munificence through the ratio a between the average return from an initiative and the average cost of an initiative in the system. Thus, *A* allows capturing different macro-economic scenarios defining the average profitability from a sustainability initiative (A=Average Return / Average Cost). A low value of A corresponds to situations in which the average return from an initiative is systematically lower than the average cost. This captures situations in which profitability of sustainability initiatives is very limited or negative. Symmetrically, high value of A capture instances in which the average return from an initiative is systematically higher than the average cost. This captures situations in which firms are systematically rewarded from implementing sustainability initiatives or munificent environments. Let β_1, β_2, β_3, β_4, β_5, β_6, $\beta_7$capture the relative prevalence of type 1, type 2,...,type 7 categories of sustainability initiatives. At every step, the average economic return Ƥ from available sustainability initiatives is thus: Ƥ = β_1 * ƥ + β_2* ƥ + β_3* ƥ + β_4* ƥ + β_5* ƥ + β_6* ƥ + β_7* ƥ = ($\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7$) * ƥ where ƥ represents the average economic return from the average initiative. Because only initiatives of type 1, 2, 3, and 4 have positive economic returns, and because ƥ =5 (drawn from a uniform distribution defined on the range 0,10], equation above can be rewritten as Ƥ = ($\beta_1 + \beta_2 + \beta_3 + \beta_4$) * ƥ. Similarly the average cost of an initiative is given by: $C_{i,j} = \epsilon(AC + \sum_{l=1}^{10} K_{l\ average})$. Substituting x+1 and x+2 into (a) we obtain: a = $\frac{(\beta 1 + \beta 2 + \beta 3 + \beta 4) * ƥ}{\epsilon(AC + \sum_{l=1}^{10} K_{l\ average})}$. Introducing the values for $\beta 1 + \beta 2 + \beta 3 + \beta 4$ (Table 2) we obtain Ƥ = 2,05. Introducing the simplifying assumption that the term $\sum_{l=1}^{10} K_l$ is equally distributed between 0 and 10, the term $AC + \sum_{l=1}^{10} K_{l\ average}$ = 28.3. Substituting and solving for ϵ we thus obtain: $\epsilon = \frac{2.05}{28.3 * a}$. By expressing ϵ as a function of a, our formulation of the cost function allows to express different scenarios of environmental munificence. As described in equation (8), to compute variable, skills-dependent costs we assess the heterogeneity between a firm's required and available skills by calculating the distance between the vector of required skills (SR_j) and the vector of available skills (SE_i). Previously, Chang and Harrison (2005) used the difference between an agent's goal and method vectors to capture the performance of a social system. The higher the heterogeneity between goals and methods to achieve the

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which costs of initiatives systematically exceeds economic returns from initiatives, a situation which is not only unreal, but also unsustainable for the purposes of modeling firms' evolutionary behavior over time. We rescaled costs so that the maximum cost for implementing an initiative is comparable in magnitude to economic returns from an initiative. In order to do so we introduced the rescaling coefficient ϵ .

goals, the lower the performances of the system. We used a similar logic to portray the distance between a desired state (the availability of all required skills) and an actual state (the really available skills). The fixed cost serves two purposes. First, if a firm has 0 budget will not implement the initiative. Second, it avoids that, at the limit, when a firm owns the entire skill set at 1, implementing initiatives becomes costless.

Initiative implementation and budget change

When a firm implements an initiative, the budget will be eroded accordingly. Let firm *i* implements the initiative *j* at time *t*-1, the budget $B_{i,t}$ will be calculated as described in equation (9):

$$B_{i,t} = B_{i,t-1} - C_{j,t-1} \tag{9}$$

Also, at the end of each period the budget is increased by the profitability p_j of the initiative *j* implemented in period *t*-1, that is:

$$B_{i,t} = B_{i,t-1} + p_{j,t-1} \tag{10}$$

As the result of initiative implementation, firms may increase their contribution to sustainable development. Thus, at the end of each period, we compute a performance function expressing the firm contribution to sustainable development ($CSD_{i,t}$) as it follows:

$$CSD_{i,t} = f(s_{j,t-1}) \tag{11}$$

The overall contribution of the firm *i* to sustainable development after *p* periods is therefore given by:

$$CSD_{i,t=p} = \sum_{t=1}^{p} s_{j,t} \tag{12}$$

Learning

When implementing a *j* initiative, the firm *i* learns. We model the relatively passive process of learning by doing, rather than deliberate learning (See Zollo & Winter, 2001). Firms an unaware of the learning potential associated with an initiative, and do consider it as a criteria in selecting initiatives. This is consistent with the idea of managers selecting courses of actions primarily on their short term, more direct benefits, rather than on indirect and more ambiguous forms of return. While skills are passively acquired as a consequence of action on certain initiatives, they are not sustained indefinitely. Rather they erode over time. Equation (13) simply states that a firm's skill endowment at time *t* is equivalent to the firm's skill endowment at the prior period t-1 plus learned skills (L) minus eroded ones (E).

$$SE_{i,t}^{l} = SE_{i,t-1}^{l} + L - E \tag{13}$$

Learning is proportional to the distance between resource required to complete a task and a firm's resource endowment. The larger the gap the greater learning opportunities. Parameters β and ε in equation (14) represent the learning rate and the erosion rate respectively[7].

$$SE_{i,t}^{l} = SE_{i,t-1}^{l} + \beta\left(RS_{j,t}^{l} - SE_{i,t-1}^{l}\right) - \varepsilon\, SE_{i,t-1}^{l}\ ,$$
$$\text{if } \left(RS_{j,t}^{l} - SE_{i,t-1}^{l}\right) > 0 \quad \text{with} \quad 0 \le \beta \le 1, \quad 0 \le \varepsilon \le 1 \qquad (14)$$

RESULTS AND DISCUSSION

We run the simulation model with 1000 agents (100 initiatives, 900 firms) for 1000 periods (i.e., simulation time-steps). At bootstrap each initiative has an initial budget of 30 units. In order to get statistically valid results, each output measure was calculated as the average of 10 independent executions (Law & Kelton, 2000). We computed the following output measures: 1) evolution of sustainability performance relative to firm types, 2) evolution of average budget relative to firm types, and 3) evolution of learned capabilities relative to firm types. We run different simulations as a function of two parameters: i) environmental munificence and ii) relative importance of motivations related and capabilities related search routines.

Sustainability orientation (SO) and Sustainability Performance

We begin by examining the role of sustainability orientation (SO) in explaining differences in sustainability performances and restrict our analysis two three ideal types of firms: firms with a predominant economic motivation (E), firms with a predominant sustainability motivation (ETH) and firms with both economic and sustainability motivation (E+ETH) which in this section we refer to as mixed-motives firms (MMF). To isolate the effect of SO, this simulated experiments further consider firms that select initiatives only on the basis of their orientations (γ=0) and that operate in a relatively munificent environment (EM=0.6). The simulations are run over 1000 periods. In the graph, we observe that higher sustainability performances are obtained by MMF. This experiment breaks down and allows to separately scrutinize two mechanisms at work that are difficult to disentangle when observing aggregate empirical data. The first mechanism is the *motivated selection*, which refers to the ability of firms to pursue specific aims. The second mechanism is the *survival effect*, which accounts to the ability of firms to survive given a specific competitive environment. As shown in the picture, lower sustainability performances are obtained by firms of group E. Expectedly, these firms do not have sustainability among their aims; thus, only occasionally seize initiatives that include sustainability performances. For these firms, completing initiatives that produce sustainability performances is a

[7] The parameters β and ε were initialized to 0.2 and 0.01 respectively to capture the ideas that 1) firms do not learn too quickly and 2) that capabilities erosion rate is of an order of magnitude less that learning rate.

byproduct of the features of the subset of initiatives available to each firm in each step of the simulation. When these firms face a subset of initiatives, in which there are no initiatives with only economic returns, they will select the initiatives with the highest economic return but that may bring about portions of returns of other types, for example sustainability returns.

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INSERT FIGURE 2 ABOUT HERE
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Having in mind the working of the motivated selection mechanism, the graph in figure 2 conveys a puzzle. Why MMF firms obtain higher sustainability performances in respect to firm only focused on sustainability performances? The conundrum is explained by the second mechanism: the survival effect. While focused firms individually obtain higher sustainability performances, their focus deemphasizes economic performances and makes these firms less resilient to competitive pressures. Thus, whereas individual sustainability performances are higher, the size of the population of the focused firms is smaller. This survival effect explains results in graph 2. Firms in the MMF group associate motivated selection and survival ability. They pursue sustainability because they have ethical motives but they resist to competitive pressure because they also maintain economic motives. Associating motivated selection and survival ability, MMF firms, on aggregate, have larger sustainability results.

Environmental Contingencies

The interaction between motivated selection and survival effect produces a number of behaviors that can be investigated using simulation experiments. In figure 3, the horizontal axis reports a number of experimental values for the strength of environmental competitive pressures, which we previously referred to as environmental munificence; on the left-hand side environmental pressure are strong, the right-hand of the continuum portrays more favorable environments.

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INSERT FIGURE 3 ABOUT HERE
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The simulation experiments reported in figure 3 highlights three patterns. First, MMF and firms in group E are relatively insensitive to environmental pressures due to their attitude to control for economic performances. Second, MMFs are able to maintain higher sustainability performances in the complete range of environmental conditions explored. This result call to a further revision of the empirically observed link between economic and sustainability performances. Whereas the link has been generally explained as ‘doing good is doing well’, actually the opposite might be true: ‘only doing well firms can do good’. This finding asks for an empirical analysis on the direction of the causality between firms’ motivations and performances of different nature. In figure 3, the sustainability performances of MMF are constantly above those of other types of firms by combining motivated selection and economic focus to fend off selection effect. Third, sustainability performances of firms in group ETH are sensitive to the feature of the environment. For environments with strong competitive pressures, selection effect prevails and the sustainability performances are very low. As competitive pressures are relaxed, survival effect weakens and motivated selection effect dominates the unfolding behavior. So, when EM take the value of 0.5, sustainability performances of firms in group ETH grow and, for very low levels of competitiveness, get closer to those of MMF firms.

The effect of Organizational Rigidities

A further set of simulation experiments explore the role of organizational rigidities. The idea underpinning the experimental design is that motives do not necessarily imply action since organizational politics, dominant logics (Prahalad and Bettis, 1986), bounded rationality and neighborhood search (Cyert and March, 1963), and desire to exploit core capabilities (Leonard-Barton, 1992) may influence motivated selection so that initiative selection looks like an organizational truce (Nelson and Winter, 1982) in which motives are blended with other aims connected to different organizational coalitions. To show the role played by these inertial forces, we report a set of simulation runs generated by gradually increasing from zero to 1 the value of the parameter γ. The parameter crystallizes the pressures of rigidities on motivated selection. For example, when γ is equal to one, firms ignore the evaluation of the returns of the initiatives available to them and select solely on the base of what fits their skill endowments. We especially focus on two experiments. In figure 4 we report simulations in which γ is set equal to 0.5 and, in figure 5, γ is set equal to 0.75. In figure 4, we notice that the increase of γ only influences sustainability performances of firms in group ETH. By increasing γ, the motivated selection mechanism is weakened, thus, it is intuitive that the impact on sustainability performances will be higher for the firms that especially rely on this mechanism. Only when environment is very favorable (EM>1), and the number of firms in group ETH grows, motivated selection increases the aggregate sustainability performances of this groups of firms. On the other hand, for firm in group E, since sustainability performances is a byproduct of their search for initiatives with economic performances, the inhibition of motivated selection will not impair their sustainability performances. The drive to search for economic opportunities, even if weakened, allow these firms to survive and occasionally pursue initiatives that produce sustainability performances. As for firms in group MMF, their calibrated balance between motivated selection and survival is not weakened enough by organizational rigidities. To further articulate the interaction between motivated selection and survival effect, it is interesting to notice patterns reported in figure 5 when γ is set to 0.75 and, thus, organizational rigidities increase. In this scenario, in general, performances of all types of firms deteriorate. The weight of motivated selection in selecting initiatives is only 25 percent and firms almost lost their ability to scan environment, evaluate initiatives' performances and select. What is happening here is that firms may not find any initiative that fits their skill endowments and, consequently, they infrequently complete initiatives. Motivated selection is used to scan and select only a limited set of potentially available initiatives.

INSERT FIGURE 4 ABOUT HERE

INSERT FIGURE 5 ABOUT HERE

In this context, in figure 5, we notice that higher sustainability performances are obtained by firms in group E. These firms are focused on economic performances and this motivation, even if weakened, allow them to survive and occasionally complete initiatives. This survival effect preserves population size; thus, it is more likely that firms in this category have a chance to select initiatives with some outcome in terms of sustainability. Of course, the weakening of the economic motivation decreases survival ability in the group and, consequently, the performances, both economic and in terms of sustainability, are smaller than in the other scenarios. More complex is the interpretation of the performances of firms in groups ETH and MMF. For values of EM smaller than 0.8, aggregate sustainability performances are larger for firms in the group ETH, when EM is larger than 0.8, the opposite occurs. When EM<0.8, we are simulating an environment that may be fairly competitive and is associated to high organizational rigidities (γ =0.75). In this setting, the focus on economic returns of MMF allow this population to maintain a larger size than the population of ETH-focused firms. Yet, the economic focus is weakened and the size of the population MMF is not as larger as it used to be for γ=0.5. Thus, the survival ability effect is not large enough to bust up the number of completed initiatives that bring about sustainability performances. On the contrary, the firms in the population ETH are a few but their focus on sustainability, even if weakened, produce larger aggregate sustainability performances. In other words, the combined pressures of environmental competition and organizational rigidities wears off the survival advantage of firms in the population MMF. Being focused on sustainability returns, ETH firms are small in number but are more focused to preserve motivated selection and, on aggregate, are able to produce more sustainability performances. When the environment became less competitive (EM>0.8), competitive pressures recede and the MMF population grows much larger that the population ETH. The difference in size of the two populations become considerable and survival effect in favor of population MMF becomes stronger than the motivated selection effect in favor of population ETH. Thus, on aggregate, sustainability performances are larger for the population MMF. To investigate further the interaction between environmental pressures and organizational rigidities, we report results from a sensitivity analysis that searched the space of parameters γ and EM. As shown in figure 6, firms in population E have a strong survival advantage and this allows them to be more resilient to variation both in environmental pressures and organizational rigidities. Of course, in general, sustainability performances are lower but more stable across the parameter space.

INSERT FIGURE 6 ABOUT HERE

On the other hand, in figure 7, we notice that population of firms ETH have higher performances of the population E in terms of sustainability but only for very specific combination of the parameter EM and γ. Finally, figure 8 reports that firms in population MMF, by combining motivated selection and survival capability, are able to produce high sustainability performances in a much large area of the parameter space.

INSERT FIGURE 7 and 8 ABOUT HERE

Organization Rigidities and the Learning Feedback

Another important finding that emerges from computer simulations is the role of the learning feedback represented in figure 1. An outcome of our experiments concerns the high sustainability performances of MMF. As seen, these firms are those that perform better in a wide range of environmental and organizational contexts. For example, looking back at figure 3, we notice that, when an highly munificent environment is simulated, MMF firms earn higher sustainability performances than ETH firms. This should not be the case. Since we know that ETH firms are more focused on sustainability performances, they enjoy an advantage in motivated search. Thus, the higher sustainability performances of MMF cannot be produced by an advantage in motivated search Why, then, when competitive pressures are artificially taken out from the picture, a survival effect should reward MMF firms? The learning feedback that in figure 3 connects initiative implementation, skill endowment, core rigidities and motivated search brings about an hypothesis to unveil the underpinning causal mechanism. The MMF firms can rely on another advantage. Since they search for initiatives that blend different types of returns, these firms chase complex initiatives that require heterogeneous skills. As a consequence, during the simulation, they build a vast repertoire of skills that allow them to reach a wider range of initiatives. In simulations where organizational rigidities are absent or relatively weak, as in figures 3 and 4, the search of MMF firms is more effective. This ability to rapidly learn and build a rich repertoire of skills assigns an additional survival advantage. Interestingly, on the other hand, when organizational rigidities are very high, as in figure 5, the learning feedback is weakened because the very characteristic that distinguishes MMF is inhibited by organizational rigidities.

The interaction between Survival advantage, Motivated Selection and Learning Feedback

Our simulations score two key results. First, experiments suggest that the causality between economic and sustainability performances may be more complex that usually described. More precisely, not only sustainability performances produce economic returns but the opposite may be true as well: only pursuing economic returns it is possible to have enough robustness to carry on initiatives with ethical flavor. Further empirical studies should investigate the direction of this causal relationship. Second key finding of our simulations is that the influence of motives on sustainability performances is mediated by environmental and organization contexts. More importantly, the effect of these contexts on sustainability performances is conveyed by the means of two mechanisms: motivated selection and survival advantage. These mechanisms explain how motives, organizational features and environmental pressures interact to produce sustainability performances.Table 3 captures the working of these mechanisms. In the horizontal dimension we report three levels of organization rigidities (γ=0; γ=0.5; γ=0.75) and in the vertical dimension we report three levels of environmental munificence (EM=0.4, EM=0.8; EM=1). Each box represents a combination of the two parameters. Above the diagonal we report the population achieving higher sustainability performances and below the diagonal is the mechanism that produced the aggregate sustainability performances.

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INSERT TABLE 3 ABOUT HERE
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We notice that for low and medium levels of organizational rigidities, MMF population always obtain the highest sustainability performances. To achieve these performances, population MMF mix motivated selection, survival advantage and learning feedback. As organizational rigidities increase to become high, the two mechanisms become difficult to combine. The focus on economic returns is weakened and the survival advantage decreases; on the other hand, the motivated selection is eroded as well and the ability to select initiatives with sustainability returns fades away. In this scenario, only population E, due to its survival advantage, maintains fairly high sustainability performances. They concentrate on the selection of initiatives with economic returns and are able to survive, in turn survival allows them to complete initiatives that may bring about, as a byproduct, sustainability returns.

CONCLUSIONS

The proposed simulation study offers to shed light on the conditions leading firms to implement robust sustainability programs that would ultimately benefit society. Building on the insight that different firms implement sustainability programs for different reasons and following different approaches, we proposed a model that analytically and conceptually links firms SO, firms strategies (the selection of different sustainability initiatives) and firms sustainability performances, and includes learning mechanisms to explain firms patterns of evolution over time. The principal motivation for this study was represented by the desire to gain a better understanding on the nature of the strategies that business could employ in order to contribute building a more sustainable society. The study underlines the importance of selection of sustainability initiatives in explaining different firms' behavior and performances. Such a selection mechanism is both theoretically and practically relevant in light of the consideration that real markets are characterized by imperfect information and externalities, with the corollary that sustainability initiatives differ in their performance potential along three dimensions that could be decoupled. Accordingly, future development of this study have the potential to contribute not only to theory, but also to inform business as well as public policy in relationship to the corporate sector contribution to achieving the vision depicted by the notion of sustainable development.

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TABLES AND FIGURES

	Sustainability Orientation	**Economic**	**Legitimacy**	**Ethics**
Predominant	Predominant economic	1	0	0
	Predominant legitimacy	0	1	0
	Predominant ethics	0	0	1
Combination of two forces	Economic – Legitimacy	0,5	0,5	0
	Economics and Ethics	0,5	0	0,5
	Legitimacy and Ethics	0	0,5	0,5
Balanced	Balance across the three forces	0,33	0,33	0,34

TABLE 1: Sustainability Orientation ideal types

P	**R**	**S**	**Label**	**Examples**
1	1	1	Good for all	New green product Strategic alliance (to help scale and commercialize clean tech more rapidly)
1	1	0	Competitiveness and Legitimacy	Permanent magnets wind turbines
1	0	1	Sustainability and competitiveness	Nuclear
1	0	0	Business Initiatives	
0	1	1	Legitimacy and Sustainability	Carbon Capture Storage Technologies and end of pipe filtering technologies. Fair treatment of employees (in low wages country with no rights for employee). Selection of suppliers.
0	1	0	Only legitimacy (symbolic)	New green website, certifications Investigation (through research agreement) of carbon capture and storage methods (no implementation)
0	0	1	Sustainability	Responsible initiatives with no visibility (no potential for legitimacy)

TABLE 2: Sustainability Initiatives ideal types. P profitability, R legitimacy and S contribution to sustainability (social and environmental value creation)

Environmental Munificence \ Organizational Rigidities	L	M	H
L	MMF Motivated Selection Survival Advantage Learning feedback	MMF Motivated Selection Survival Advantage Learning feedback	E Survival Advantage
M	MMF Motivated Selection Survival Advantage Learning feedback	MMF Motivated Selection Survival Advantage Learning feedback	E Survival Advantage
H	MMF Motivated Selection Survival Advantage Learning feedback	MMF Motivated Selection Survival Advantage Learning feedback	E Survival Advantage

TABLE 3 Mechanisms

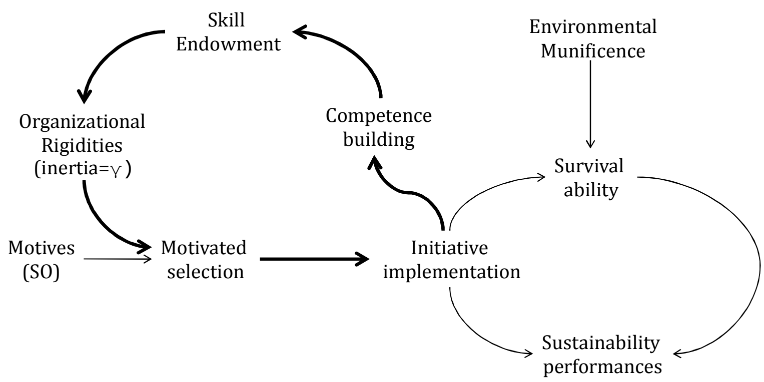

FIGURE 1: schematic representation of the proposed formal model

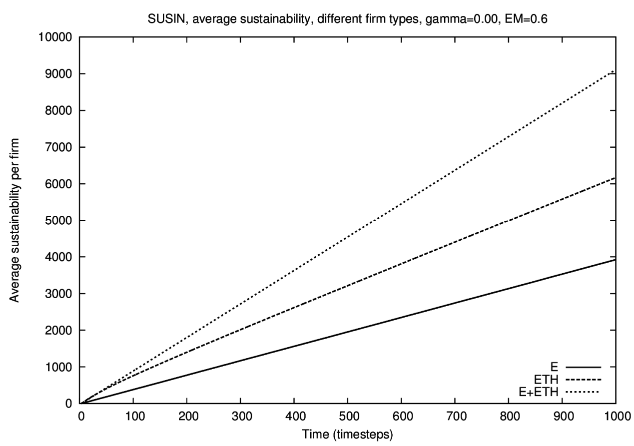

FIGURE 2: Average sustainability per firm, γ= 0, different firm types (multiple runs, averaged results)

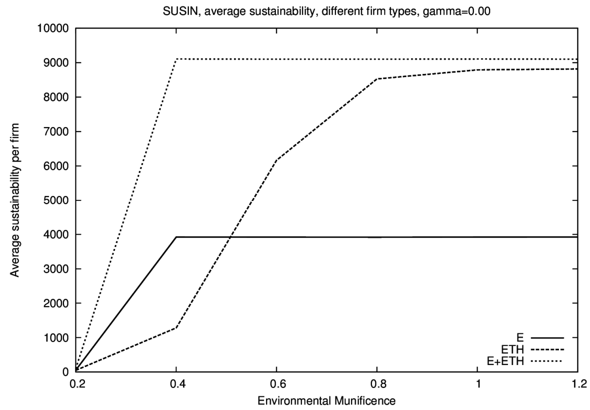

FIGURE 3: Average sustainability per firm as a function of environmental munificence, different firm types γ= 0, different firm types (multiple runs, averaged results)

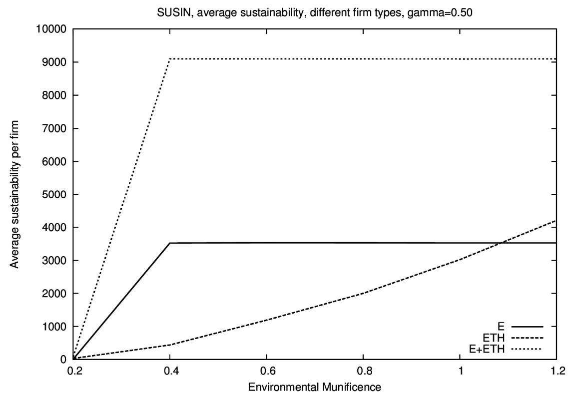

FIGURE 4: Average sustainability per firm as a function of environmental munificence, different firm γ= 0.5, different firm types (multiple runs, averaged results)

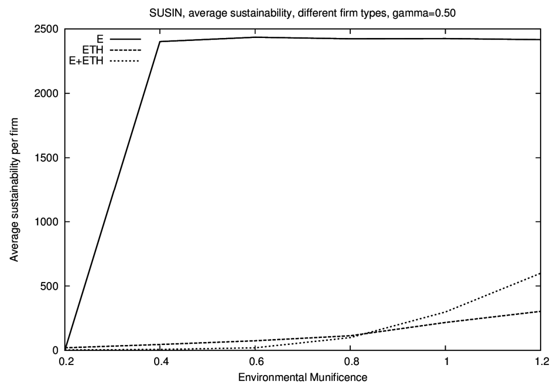

FIGURE 5: Average sustainability per firm as a function of environmental munificence, different firm types, γ=0.75 (multiple runs, averaged results)

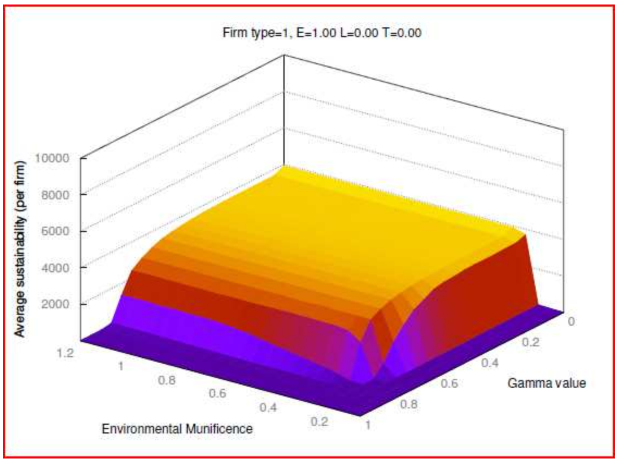

FIGURE 6: Average sustainability per firm, environmental munificence and selection criteria, firm type E (multiple runs, averaged results)

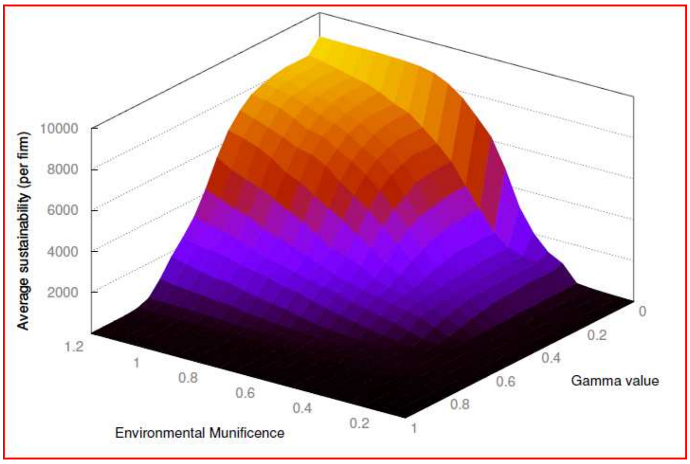

FIGURE 7: Average sustainability per firm, environmental munificence and selection criteria, firm type ETH (multiple runs, averaged results)

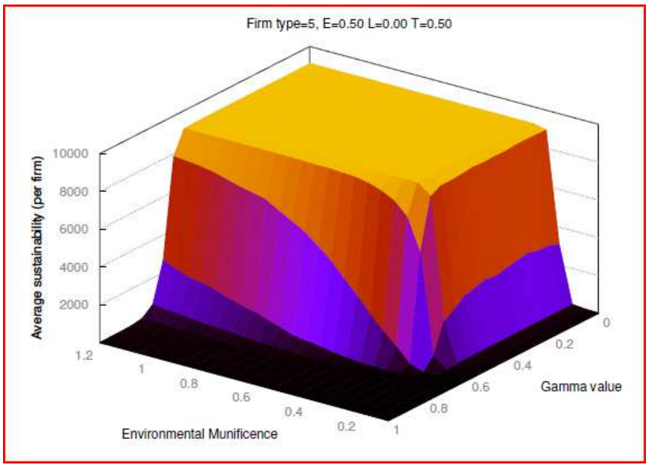

FIGURE 8: Average sustainability per firm, environmental munificence and selection criteria, firm type E+ETH (multiple runs, averaged results)