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Business Models and Complexity

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Abstract

Purpose: To offer a -necessarily non-exhaustive- analysis of the meaning and significance of the notion of a complex system for research on the Business Model (BM).

Design/Methodology/Approach: Conceptual paper

Findings: Drawing from early research in complexity and debates that have inspired work in General System Theory, system thinking and cybernetics, we identify four insights, notably i) modeling of complex systems, ii) interdependencies, iii) nested hierarchies and iv) information processing that, we contend, have the potential to shed light on novel possibilities for understanding BMs. We offer an analysis.

Research Limitations/Implications: Limitation: exclusive focus on early interpretation of the notion of complexity as referring to a characteristic of a system. The paper does not explore the implications of the more modern understanding of complexity as referring to the 'behavior' of a system (complex system vs. complex behavior)

Practical Implications: we may be attempting to represent a system which is very complex, the BM and the organization behind it, at the level of the anatomy, only reflecting its main components. This is subject to inherent limitations.

Originality/Value: To show that, within the line of inquiry understanding the business model (BM) as some reality existing at the level of the firm, a BM may resemble what students of complexity refer to as a complex system. To explore the meaning and significance of the notion of complexity and of a complex system for research on the BM.

Keywords: Business Models, Complexity, Complex Systems

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Introduction

The business model (BM) has captivated scholars and managers for over twenty years. Part of its mystery may be the difficulty organizations exhibit in communicating and adopting business models. In this article, we suggest that these difficulties may partially be due to the fact that a BM can have characteristics shared with what scholars interested in complexity refer to as a *complex system* (e.g., see Anderson, 1999). Generally speaking, and oversimplifying to some degree, a complex system can be defined as a system comprising a large number of parts characterized by non-linear interdependencies (Simon, 1996; Forrester, 1961; Sterman, 1994; Casti, 1986), together creating a whole that is more than the mere sum of its parts.[59] We contend that both the notions of complexity and of complex systems bear important insights for research on BMs that may have not been fully acknowledged. In this brief and necessarily non-exhaustive contribution, we examine some of them. We build on the line of inquiry understanding the business model as a reality existing at the level of the firm and affecting its performance in markets (cf. Amit & Zott, 2001, Zott & Amit, 2008; Massa, Tucci & Afuah, 2017).

We proceed as follows. First, we offer some reasons supporting the view of BMs as complex systems. Second, building on that literature, we offer a short excursus into the notion of complexity applied to systems and a classification of systems into classes of increasing complexity. This allows elucidating why we contend that BMs may rank high in a hierarchy of systems complexity. Third, we identify some insights emerging from this recognition of BMs as complex systems, namely modeling of complex systems, interdependencies, nested hierarchies and information processing, and comment on their meaning and significance for research on BMs.

[59] Recall the Aristotelian argument on unity that "the whole is something besides the parts" (Aristotle, Metaphysics H6, 1045a8–10) and the insights of Gestalt psychology: "The whole is more than the sum of its parts. It is more correct to say that the whole is something else than the sum of its parts, because summing up is a meaningless procedure, whereas the whole-part relationship is meaningful" (Koffka, 1935, p. 176).

Business Models as Complex Systems

Despite the well known ongoing debate, scholars tend to agree, at least at a general level and within the interpretation of BMs as referring to something real at the level of an organization (cf. Massa et al., 2017), that a BM is a *system level concept* (Zott and Amit, 2007; Casadesus-Masanell & Ricart, 2010; Teece, 2010), centered on *activities* (e.g., see Zott and Amit, 2010), *spanning the boundaries* of a focal organization to include exchanges with a network of partners (Amit & Zott, 2001), and overall trying to describe how that organization functions in achieving its goals. The goals are typically conceptualized as creating, delivering and capturing value (Teece, 2010). A system level concept means that the business model focuses on the functioning of an organization as a whole (and not on isolated parts) (cf. Zott, Amit & Massa, 2011). Boundary-spanning activity systems conveys the idea of a focus on activities and exchanges (including the rules governing those exchanges) within the organization as well as between the organization and its network (Zott & Amit, 2008). Overall and at a general level, these considerations intuitively suggest that behind a BM is some (broadly defined) system, comprising the focal firm and its network of exchange partners, and that such system is a complex one, by virtue of the organization being a complex system (cf. Anderson, 1999).

System Complexity

A system can be broadly defined as a set of interacting or interdependent components forming an integrated whole. According to the Oxford dictionary, a system is "a set of things working together as parts of a mechanism or an interconnecting network; a complex whole." Under this general definition, things as different as a house, a train, a computer, but also a cell, an organ, a team, or a community could be all conceptualized as systems. What strikes immediately, however, is that there are inherently important differences among these systems. Among other things, these systems differ in their complexity, with some systems intuitively appearing simpler than others (e.g., a house vs. an organ vs. an organization) (see Kast & Rosenzweig, 1972 for a discussion of general concepts in systems).

The idea that systems differ in their complexity has strong roots in system thinking, General System Theory (GST: Forrester, 1961; von Bertalanffy, 1968), cybernetics and, more recently, in complexity science (see Anderson, 1999 for a review of the evolution of thinking in complexity in relationship to organization theory). Overall, these various facets of approaches to the study of systems found their common denominator in some very basic, yet important, considerations: (1) systems differ in their complexity, implying that it is theoretically possible to build a hierarchy of systems; (2) reductionist approaches, which may work relatively unambiguously with simple systems, have strong limitations in supporting understanding of systems of increasing complexity; and (3) different levels of theoretical model building (explained later) are needed to understand systems of increasing complexity.

A Hierarchy of System Complexity

The notion that systems, broadly defined, differ in terms of complexity, and the corollary that understanding systems with increasing complexity may require different levels of theoretical understanding has been a central concern for system theorists (e.g., Boulding, 1956; Forrester, 1961; Buckley, 1968; Von Bertalanffy, 1968; Kast & Rosenzweigh, 1972). A synthesis and reelaboration of major themes within this line of inquiry led us to propose Figure 1 and Table 1.

The figure illustrates the idiosyncratic characteristics of different classes of systems (i.e., characteristics of that specific class of systems and that are not possessed by systems in a class of lower degree of complexity). For example, self-awareness and self-consciousness are characteristics that are idiosyncratic to human beings as psychic systems (Luhmann 1995), participating in social systems they enforce; nevertheless, these characteristics are not possessed by systems at lower levels of complexity (for example, animals). Thus, systems of higher levels of complexity possess the characteristics of systems of lower levels of complexity (e.g., a human being is also a biological system), but not the opposite.

The figure distinguishes between mechanical, biological, and social systems (Fontana & Ballati, 1999). The distinction between the first and the second classes of systems is that one of life/nonlife. The distinction between the second and third classes of systems is that one of intentionality, self-consciousness and purposefulness which characterize individual beings and communities, including organizations, markets and, more broadly, society.

Mechanical systems are divided into subclasses of systems (Boulding, 1956). At the lowest level of complexity are so-called mechanical non-retroactive systems, such as a chair or a building (static structures incapable of dynamics). At the next level are systems with predetermined, necessary motion (e.g., a lever, a pulley, steam engines, dynamos). The third level is the control mechanism or cybernetic system in which the transmission and codification of information is an essential part of the system. Moving from mechanical to biological systems, we move from non-living towards living systems (with the introduction of properties such as permeable boundaries, ability of the system to "reproduce" and "maintain" itself, metabolism, energy exchanges, increased mobility, teleological behaviors and the like).

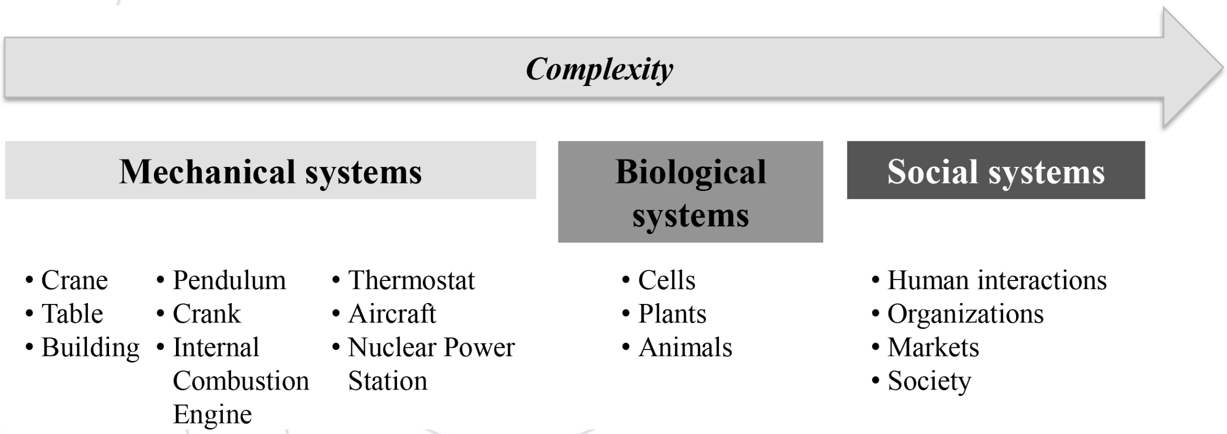

Figure 1: Hierarchy of Systems Complexity

Systems Types	**Mechanical Systems**			**Biological Systems**	**Social Systems**
Systems sub-types	**Static Mechanical non retroactive Systems**	**System with predetermined dynamics**	**Systems with control mechanisms**	**Self maintaining structures**	**Purposeful Systems**
Examples	Crane Table Building	Pendulum Crank Internal Combustion Engine	Thermostat Aircraft Nuclear Power Station	Cells Plants Animals	Human interactions, Organizations Markets Society
Core Properties of the system (CUMULATIVE)	• Static Structures • Modularity (subsystems or components) • Closed Systems • Rigid – well defined boundaries. • Static mechanics • Mechanics of inorganic materials	• Simple Dynamics (motion equations) • Predetermined motion • Stochastic equilibrium • Could be viewed as transformation models or input-transformation-output models (e.g. ICE)	• Feedback loops • Regulation mechanisms	• Autopoiesis • Open System - Exchange of material, energy and information with the environment - principles of conservation of mass and energy - laws of Thermodynamics - Metabolism • Information exchange within the system and between the system and the environment • Negative Entropy • Hierarchy • Division of labor and specialization • (e.g., among cells, organs, etc.) • Increased mobility • Teleological behavior • Adaptation (evolution) • Equifinality • Emergence	• Communication • Operatively Closure • Functional Differentiation • Structural Couplings • Interaction communications • Decisions communications • Understanding • Learning • Sense Making – Interpretation – Purposefulness • Agents with Schemata • Self organized networks sustained by importing energy • Co-evolution at the edge of chaos • Recombination and system evolution

Table 1: a Hierarchy of Systems Complexity

At the nexus between biological systems and social systems are human beings, characterized by self-awareness and self-consciousness (which is, individuals know they know and can engage in partly deliberate acts). Collectivities of human beings form social systems. By comparison with the natural sciences, historically there has been relatively little work on complexity applied to social systems. The notable exceptions are the work of Luhmann on autopoiesis, Arthur, Durlauf and Lane (1997) in economics, and the work on strategy by Lane & Maxfield (1997), Parker & Stacey (1994) and Stacey (1995, 1996, 2000, 2001). However, social systems may have specific characteristics making them different from other complex systems. While biological systems are primarily energy and material bounded, social systems are fundamentally information bounded. As pointed out by Seidl (2004), communication is not considered by Luhmann to be an asymmetrical process of transferring meaning or information from a sender to a receiver, but as selection or distinction. Thus, communication leads to three basic types of autopoietic social systems: (1) interactions, (2) organizations, and (3) society as a whole made up of different subsystems such as the economy, politics, law, science, the mass media, education and religion (Luhmann, 1995; Mingers, 2002; Schoeneborn, 2011; Seidl & Becker, 2006). Among the three types of social systems identified by Luhmann, business models are particularly concerned by organizations, distinguishing themselves within society from society and reproducing themselves on the basis of decisions (communications) as distinct from other communications (Seidl & Becker, 2006).

The key message of Figure 1 (and Table 1) is that the more we move toward systems of increased complexity, the more we need to account for aspects such as the role of information flows and interpretation, purposefulness and intentionality, and, in general, complex interdependencies, if we are to understand how such systems ultimately work. As we propose below, these aspects have largely been ignored within the literature on the BM.

Putting emphasis on them has the potential to offer fresh insights into research on the BM.

1. **Modeling complex systems** Both scientists and individuals reduce a complex description of a system by engaging in the activity of modeling. Modeling is the "activity of formally describing some aspects of the physical and social world around us for the purposes of understanding and communication" (Mylopoulos, 1992, p. 2). To model is to simplify, to abstract what is unnecessary or minor, with the goal of improving tractability. One advantage of presenting a hierarchy of systems on the basis of their complexity (Figure 1, Table 1) is that it gives some ideas of the appropriateness of different theoretical levels of model building that are required in order to shed light and theorize on the functioning of the system. Mechanical systems can be more or less comprehensively described (and, partly, understood) at the level of their anatomy, or what Boulding (1956) originally referred to as the level of the *framework*. Since no dynamics are involved, a representation of the fundamental elements (components) comprising the static structure, offers an already quite accurate description of the system.

   The more we move from simpler to more complex system, the less the level of the static framework is sufficient in providing a comprehensive picture that would allow understanding the system. This is not to say that such a description is not useful. Rather it is to say that it represents a necessary—perhaps not sufficient—step in theorizing and understanding the system. In the words of Boulding (1956), "the accurate description [at the level of the framework] is the beginning of organized theoretical knowledge in almost any field, for without accuracy in this description of static relationships no accurate functional or dynamic theory is possible" (p. 202).

   At this stage, scholars of the BM may have already noted one of the issues with early research on the BM. Such a literature is fundamentally characterized by efforts to make sense of a system, organizations and their BMs, which is high in the hierarchy of complexity by focusing at the level of the static framework. Early attempts to make sense of BMs by enumerating the fundamental components of a BM have been fundamentally concerned with the anatomy of BMs (Zott, et al., 2011), ignoring many other aspects, such as dynamics, nested hierarchies, flows of information, and the like. While, by definition, "all models are wrong" (Sterman, 2002), received formal models of the BM may be *very wrong*. We believe that such a situation is partly responsible for the lack of agreement on what a BM is and how it could be represented (e.g., see Massa et al., 2017). Symmetrically, this suggests that a promising avenue for future research may be one concerned with looking more closely at what it entails to create formal models of BMs.

2. **Interdependencies** A key feature of complex systems is the importance of interdependencies among components. Among other things, a system is complex by virtue of the architecture of interdependencies among its components. Interdependencies are at the core of two aspects of complex systems: *emergent properties* and *system behavior* (with the possibility that system behavior is an emergent property itself). Emergent properties are properties that cannot be reduced to the properties of the system's components. Rather they are a function of the properties of the components *and* of the interdependencies among the components. In other words, it may not be sufficient to understand the behavior of individual components to understand the behavior of the system as a whole. In the context of research on the BM, this means that shedding light onto how certain BMs result in certain outputs, for example, efficiency or novelty (Zott & Amit, 2010), may benefit from more explicitly focusing on the role played by the interdependencies among BM components and their internal fit—including self-reinforcing mechanisms—in addition to looking at the properties of specific components (Siggelkov, 2002).

   The structure of interdependencies is also critical to explain the behavior and evolution of the system. Consider business model reconfiguration, which is an organization's second (or subsequent) business model (Massa & Tucci, 2014). As noted by Chesbrough (2010), structural barriers, i.e., conflicts with existing configuration of assets, represent one impediment to such a type of innovation (the other one being represented by cognitive barriers). Looking at interdependencies more closely may offer insights into how to better substantiate this high level insight. For example, consider the reconfiguration of a business model that requires changing one component of the business model, for example, the revenue model currently adopted or some other activities (or bundles of activities). How strong are conflicts with existing configuration of assets? One way to think about it is to consider that in a web of complex interdependencies, some components may be more central (which is more interdependent with others and as such more difficult to change) and others more peripheral (which is less linked and as such easier to change). This aspect may have important implications for BM innovation in that innovation that targets central, highly interdependent components may backfire if the changes in the rest of the BM are not appropriately accounted for. A look into interdependencies may help develop hypotheses, operationalize measures, and conduct empirical tests.

Another way to think about our suggested question is to reason in terms of the *type* of linkages (e.g., being linear unidirectional, non-linear, involving a dyad, multiple connections, etc.) as well as the *nature* of linkages, for example the extent to which two or several components are interlinked by virtue of processes and activities, strategic complementarities (e.g., see Brandenburger and Stuart, 1996), information flows, or simply political interests and power of coalitions within the organizations (Mintzberg, 1985). For example, one component may be peripheral when interdependencies are understood as processes of activities. Which is, from an operations or process standpoint, conflicts with other components may be limited. However, the same component may be very central (and, as such, more difficult to change without unintended consequences) when interdependencies are understood from the point of view of sustaining the interest of powerful coalitions in the organization or from the point of view of information processing. These examples are speculative, and would require a serious research program. However, we contend they illustrate some ways in which a closer look to interdependencies can advance BM research.

Overall, we believe that appropriate accounting of BMs may require going beyond the sub-systems or components to also include an account of the interdependencies among them. To our knowledge, the perspective offered by Casadesus-Masanell and Ricart (2010) which examines the BM as a system of choices and their consequences (and the interdependencies among choices by virtue of the consequences they engender) is one of the few attempts to model interdependencies within the fields of strategy and strategic corporate entrepreneurship (IS and computer science have devoted effort to develop modeling languages which, however, have not main inroads in more mainstream business model research). We believe that much is to be gained by moving beyond a discussion of BMs that focuses on its static representation and rather starting to theorize on the interdependencies. The complexity lens, and in slightly more advanced effort, insights from from System Dynamics (SD) and Complex Adaptive Systems (CAS) models coupled with Agent Based Models (ABM) may offer a language to do that.

3. **Nested Hierarchies and the organization behind a BM** Another important aspect of complex systems is that they are organized as *hierarchies* as briefly discussed above. Looking at BMs as real-world phenomena, a parallel could be drawn with respect to hierarchies in a BM. At the lowest level there are individual workers performing activities being organized into teams, into departments, into divisions, into a firm. These activities can be described at different levels of abstraction (Massa & Tucci, 2014). A first consequence of this consideration may be that understanding how BMs function dynamically may require opening the black box of the organizational model behind a BM, an aspect which to date has often been neglected. BMs may be functioning in certain ways because of non-obvious organizational practices behind them, some of which may also be occurring at the level of the informal organization (cf. Ferriani, Gernsey, Lorenzoni, & Massa, 2015).

Shedding light on how BMs are managed and run may require a more explicit emphasis on organizational practices, routines, capabilities, and other organization-level concepts that have often been overlooked by students of the BM. In addition, this hierarchical structure may also require assessing the extent to which it is appropriate to refer to a single BM as a collection of hierarchically nested *models* together comprising one BM. A BM may be a higher order system comprising lower order systems, each functioning with localized logics (or models), such as a *marketing logic*, the *logic of revenues*, the *logic of customer relationship management*, etc., In other words, embracing the notion of nested hierarchies suggests questioning the conditions under which it is meaningful to refer to a firm's BM as a monolithic entity, or as a system resulting from several, perhaps different and yet related, subsystems operating at lower levels of granularity.

4. **BMs and Information Systems** As we have seen above, information and computation are two core concepts and constructs in complexity studies (Mitchell, 2009) and play a key role in social systems (Luhmann, 1995). Social systems are fundamentally interpretive systems, being information bounded (Garajedaghi, 2011), in addition to energy and material bounded (as in biological systems). Information and computation have been specifically investigated in the field of research focusing on information systems (IS). Such a line of inquiry offers some opportunities for better understanding BMs. Examining the definitions provided throughout its history (Hirschheim & Klein, 2012), IS emerges as having several characteristics commonly represented in a BM. Nevertheless, the information system of an organization is usually not explicitly considered a key element in representations of BMs, at least in the domains of strategy, technology and innovation management, strategic entrepreneurship, and sustainability.

   One of the arguments for the gap seems to be that IS is not a key issue to be designed coherently in a value proposition. In other words, IS design is often considered to be a consequence of the design of the main components of a BM and the implementation of the supporting technological infrastructure. However, this stance seems to imply a narrow perspective on IS as comprising only its technological aspects. On the contrary, most of the components of an IS are actually considered in traditional BMs conceptualizations (e.g., the system perspective by Zott & Amit, 2010) and most BM representations have been produced in IS-related areas (Osterwalder, Pigneur, & Tucci, 2005). In addition, BM representations as a result of business modeling have been investigated to provide a tactical and strategic perspective to requirements engineering and business process management (Andersson et al., 2006; Gordijn, Akkermans, & van Vliet, 2000; Osterwalder, Parent, & Pigneur, 2004; Pigneur, 2002). Taking these issues into account, and accepting the argument that BMs are also models (Baden-Fuller & Morgan, 2010), leads one to question the relationship between a wide perspective on information systems and BM representations.

Even if BM innovation may occur without technological innovation (as in the case of "just in time" production (Baden-Fuller & Haefliger, 2013)), management of information flows and exchanges have a relevant role there as well as in BMs seen from an activity system perspective (Casadesus-Masanell & Ricart, 2010; Zott & Amit, 2010). However, at the state of the art management scholars seem not to consider the above mentioned IS related perspectives. This gap may be a consequence of the double bind nature of business model, intersecting business strategy and a company's operations, business processes, and the information and communication technology (ICT) infrastructure, namely a company IS (Al-Debei & Avison, 2010). Nevertheless, the IS field is flourishing in terms of contributions to the research on BM. As summarized by the analysis done by Al-Debei & Avison (2010, pp. 371-372) most of them point out, on the one hand, the relevance of BMs as "conceptual tool of alignment" or "interceding framework" between the design and development technological artifacts and the implementation of strategic goals; on the other hand, BM is often considered as a "strategic-oriented knowledge capital" showing how business rules and practices used to perform the business activities. Therefore, considering BMs as complex social systems would lead to considering not only (1) the organization behind them, and their nested hierarchies, but also (2) the information system that characterizes interdependencies in terms of information flows and decision communications, thus improving the capacity to face the challenges of modeling BMs.

As pointed out by Merali (2006), the vocabulary of complexity has been used to articulate the different facets of the network economy and the consequent networked world, and the actual information *network-in-use* can be viewed from an IS perspective as the informational representation of the interactions of agents situated in a social, economic, political, informational, and technological context. Consequently, the *informational complexity* of networks is determined by variable connectivity over time, the diverse and multifaceted information transmitted, the heterogeneity of nodes; whereas the actual network is shaped by the feedback cycles generated by its nodes as well as by path dependencies related to their history and learning dynamics (Merali, 2006, p. 217). Relating this to BMs, the *decisions* and *activities* within an organization depend on the bounded and limited knowledge of the state of the network at a given time and the information they can gather on and from the network itself. Overall, we think that to the extent that managers attempt to make sense of BMs from a complex social system perspective, the more attention should be paid to the role of information and communication.

Conclusion

Complexity has been a central construct in the language of organization scientists for several decades. Yet, and perhaps surprisingly, scholars interested in the business model seem to have only implicitly drawn from the notion of complexity and of complex system to better understand business models. While part of the reason may be disagreement on what business models are, we contend that within the boundaries of a view of the business model as an organizational level construct referring to some property of real firms there is an opportunity in referring to complexity science and relative insights. Complexity science is a broad domain. This very humble contribution suggests that rich insights can be derived from better appreciating the characteristics of complex systems (vis-à-vis non-complex ones) and how such characteristics determine the appropriateness of different levels of theoretical model building to advance knowledge creation. In this early contribution we offer some preliminary and necessarily non-exhaustive insights. We believe that this is just a first step in a longer and hopefully insightful journey, and hope this short article offers an opportunity for scholars to better reflect on this possibility.

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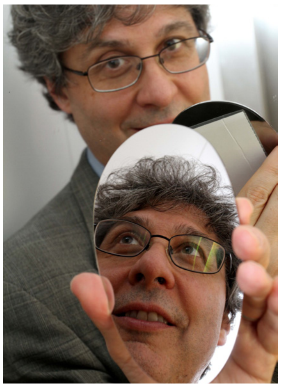

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