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Business Models as Complex Nonlinear Systems: Providing a Conceptual Framework for Growth and Innovation

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Abstract

Purpose: This study conducts a comparative analysis between complex nonlinear systems and business models.

Findings: Drawing from early research and current debates on complex systems, the paper links business models' qualities such as emergent properties, feedback loops, interdependency of its components and sensitivity to initial conditions under the umbrella of complexity theory. The paper also introduces the concept of attractors and non-equilibrium in business models.

Originality/Value: The value of directly addressing the construct's nonlinear dynamic is twofold. First, it will try to resolve the conceptual ambiguity that has traditionally surrounded the discipline of business model and business model innovation by providing a new method to study the construct. Also, by linking the business models' qualities under the umbrella of complexity theory, this paper hopes to resolve the disconnect in the current research effort and to encourage further dialogue and studies on the subject of business model and complexity.

Practical Implications: By attempting to represent the business model construct as complex system, the paper opens up the study of business model to novel possibilities to understand its dynamic and evolution. Also, by introducing the concept of business model's attractors the paper seeks to find a framework to support and understand business model's innovation and evolution.

Research Limitations/Implications: Limitations are inherent to the non-empirical nature of this study. Furthermore, the paper sole objective is to introduce an overview of how different aspects of complexity relate to business models, therefore this study lacks of depth in the analysis of each of aspects.

Keywords: Business Model, Complex Nonlinear Systems, Business Model Innovation.

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The Classical School of Thought: The Linear Business Model

Since the end of the 17th century, reductionism has been the dominant method of enquiry in almost all sciences. In an endless quest for simplicity, the reductionist method argued that the knowledge of the system as a whole, could be deduced from an adequate understanding of its constituent parts, and its macro-dynamics could be inferred by understanding its micro-dynamics.

This same method of enquiry—strictly linked to the concept of linearity and proportionality (Zensho, 2010)—has been implicitly applied to business model studies where, by entrusting a leading role to its components, researchers and practitioners have emphasised the construct's modular characteristics. In this context, business models have been understood and recognised as collections of single units that can be assembled or dismantled upon request. Relevant scholars supported this idea; Osterwalder and Pigneur (2010) created the 'Business Model Canvas' with nine building blocks: value proposition, partners, activities, resources, customer relationships, channels, customer segments, cost structure, and revenue streams; Demil and Lecocq (2010) divided the business model into resources, competencies, organisational structure, and propositions for value delivery; Amit and Zott (2001) split the business model into the design of transactional content, structure, and governance.

The traditional reductionist approach, albeit foundation of numerous scientific methods and discoveries for over two centuries, displays an important limitation—it fails in environments dominated by complex behaviour. Here, tight interconnections, continuous feedback loops, and emergent properties do not allow us to adequately describe the system's global dynamics by breaking it down into its constituent elements. In business model studies, while linearisation is adequate to understand the system's elements in isolation and provide a reliable picture of the status quo, it fails to describe the system's true potential, presenting several important limitations.

First, the business model thus described is only adequate for understanding and predicting the behaviour of single elements, neglecting their intrinsic sense of connection and their continuous interaction with the external environment (Casadesus-Masanell et al., 2010). It has been noted that *the processes through which new business models are created and existing ones transformed take place within the business context* (Ahokangas & Myllykoski, 2014 p.9), and such a process *cannot be assessed in the abstract, as its suitability can only be determined against a particular business environment or context* (Teece, 2010. p.191).

In addition, the traditional approach encounters significant difficulties in relating the macrosystem (business model) to its microsystems (constituent elements). Assessing a business model's profitability based on a construct of preselected and equally-relevant elements would reduce it to an unequal and distorted representation of the business logic. In fact, the relevance of a given element can only fully emerge from a macro-level picture of the construct and not from a single-element breakdown. For example, evaluating the impact of a specific distribution system on a company's business logic is more important than breaking down equally relevant elements in the business model. As Siggelkow (2002) observed, *the specification of core elements ex ante … assumes that the same elements are equally central or core in all the firms [...] and also implies that the number of core elements is constant across different firms and constant over time for any given firm (p.126).*

The tendency to apply linear models has also led to the recognition of cycles and various types of periodicities (DaSilva et al., 2010, Bertuglia et al., 2003). However, as business models are strictly linked to the environment in which they operate, a repetition of two identical business models with the same degree of profitability and efficiency is highly unlikely. What works in one industry or market may not work in another with different segments or competitors.

Therefore, embracing the idea of a business model *that can be constructed and adjusted to achieve particular ends* (Johnson, 1994. p. 322), ignores both the construct's intrinsically dynamic nature and its ability to interact with the external environmental, thus delivering an inadequate representation of the business logic and failing to create an effective and reliable model for innovation.

From Linear to Nonlinear Business Models

Over the last few decades, academics and practitioners have examined organisations through the lens of complexity theory. Emphasising the need to balance organisational structure and flexibility, relevant authors (among others: Priesmeyer,1992; Lewis, 1994; Johnson et al.,1994; Tetenbaum, 1998; Marion,1999; McCarthy, 2000; Black, 2000; Stacey, 2003; Burnes, 2005) have argued that organisations are complex, nonlinear systems w*hose members can shape their present and future behaviour through spontaneous self-organising [behaviours] underpinned by a set of simple order-generating rules* (Burnes, 2005. p.81). Business model theory has also been evolving in this direction and scholars and researchers have so far implicitly drawn from the notion of complexity and complex systems to better understand the construct. Authors such as Lecocq and Demil (2010), Casadesus-Masarell and Ricart (2010), Abdelkafi and Taeuscher (2015), Foss and Saebi (2017), Velu (2017), Massa, Viscusi, and Tucci (2018) and Dentoni et al. (2021) have relied on the notions of emergent properties, feedback loops, interdependency between components and self-organization tiptoeing around the link between business models and complexity science to explain the dynamic of the business models' constructs.

In the specific, Demil Lecocq addresses the concept of emergent property explaining that the business model's building blocks *"will be continually reacting with each other, and with other constituent parts of the firm's structure... in [a] unique combinations to determine the firm's idiosyncratic bundle of capabilities that differentiate it from others in its sector"* (p. 230);

Casasesus-Masarell (2010) addresses the business model's feedback cycle stating that *organizations affect each other when acting within the bounds set by their own business models [...] leading to consequences for both [in this context] the feedback to the rest of the system is determined not only by the focal firm's choices, but by the choices of the other firm as well. (p. 202).*

The concept of feedback loops in business model was also analysed by Abdelkafi and Taeuscher (2015) that noted how *the relationship between different business model dimensions induces self-reinforcing feedback loops that leads to constant growth* (p.7)

Many relevant authors have also addressed the concept of interdependency in business models.

Foss and Saebi (2017) infers that the relationship between business model components can be described *in terms of their independency or complementarity (pg 16).*

This view was also reiterated by Massa, Viscusi, and Tucci (2018) that refers to the *web of complex interdependencies [that] have important implications for business model innovation (p. 63).* Last but not least, Dentoni 2021 highlights the self-organizing nature of the business model that leads its elements *to spontaneously and continuously reorganize their interactions* (p. 1202). Such view has been also endorsed by Velu 2017 who highlights that *a business model is an activity system consisting of a set of interdependent organizational activities centred on the focal firm and its constituent partners and customers (p.14)*

For analytical tractability, however the construct's nonlinear dynamic has never been considered a viable method of enquiry (Atkova et al., 2020; Anderson, 1999).

Linear models enable relatively precise predictions. They can be broken down, recombined, and do not display sensitive dependence to the initial conditions. However, a system exposed to intense internal and environmental feedback absorbs increased nonlinearity, making it too tangled to be analysed and predicted using traditional analytical tools, or any tool at all. Furthermore, nonlinear systems are also sensitive to initial conditions, generally making them subject only to a wide range of approximations that *worsen the further into the future we try to predict* (Bertuglia et al., 2003. p.45). Such a low degree of control and prediction has troubled researchers and practitioners, who continue to be resistant *to loosely applying nonlinear dynamical theories to organisations* (Johnson, 1994. p.1).

Nonlinear models are characterised by an emergent property only identifiable in the system as a whole. Here, it is not the system's elements in isolation that matter (Meadows, 2008), but the way these elements are assembled, their interlocking, and the nature of their relationship that creates a value greater (or lesser) than the sum of their parts. In a nonlinear system each element is characterised by large-scale structures and cannot be fully isolated from the rest. By blurring the boundaries between single units and the whole, analysing a nonlinear system as a collection of individual parts is nearly impossible (Gabbay et al., 2011). They are all unique, behave quite differently from each other, and need to be understood on their own terms (Gharajedaghi, 2012). An analogous pattern of behaviour can be observed in business models where various building blocks coupled differently, and/or applied to different industries or markets, produce various degrees of profitability and call for different rules. For example, the *lock-in* model may work well in a product-service relationship (Teece, 2010), or for high-end products, but not well enough for products in low-loyalty industries (Brem et al., 2016). Additionally, some business models can be less sensitive to one or more components in one industry, but highly sensitive to the same relationship under different conditions and/or in other industries or markets, making the construct open to various combinations and solutions.

This study focuses on three aspects of nonlinear systems yet to be explored in relation to business model theory: feedback cycle, sensitivity to initial conditions, and equilibrium.

Feedback Cycles

Once in the environment, nonlinear systems are exposed to various influences and forces called feedback cycles**.** Through this mechanism, the system selectively acquires information from the environment in which it operates, only to return a different, processed output to the environment. Here, current inputs are dependent on previous outputs. Current outputs affect future inputs, resulting in a self-reinforcing process of change and evolution of the system and the environment in which it operates.

Abdelkafi and Täuscher (2015) extensively discussed feedback systems in business models. However, it is worth noting here that introducing nonlinearities in the form of positive feedback generates increased growth that can affect the system's operational environment, eventually altering the growth process itself. Here, the nonlinear system displays its ability to *change the relative strength of feedback loops, where the exponential growth caused by a dominant reinforcing loop is followed by a decline caused by a suddenly dominant balancing loop [...], flipping the system from one mode of behaviour* (reinforcing) *to another* (self-correcting) (Meadow, 2008 p.92).

Transposing this dynamic in the context of business models, we see that the introduction of an innovative construct has the potential to significatively change the market and industry in which the company operates. Such changes will, in turn, be fed back to the business model, eventually shaping its future state, and encouraging a different pattern of behaviour. However, if the construct fails to evolve with the market, this dynamic increases the risk of the business model system flipping from one mode of behaviour (i.e. growth and innovation) to another (i.e. non-growth and non-innovation), altering its evolution process and, consequently, the company growth.

Equilibrium

The assumption of nonlinearity also challenges the traditional notion of equilibrium.

Complexity theory demonstrates that complex systems are creative only when they are far from equilibrium, in a specific region known as the *edge of chaos* (Langdon, 1990) where order-generating rules maintain complex nonlinear systems at the border between order and chaos (Burnes, 2005).

This concept is acknowledged in organisational theory, in which numerous authors (Lewis, 1994; Brown & Eisenhardt, 1997; Stickland, 1998; Anderson, 1999; Marion, 1999; MacIntosh & MacLean, 1999, 2001; Siggelkow, 2002; Stacey, 2011) have argued that organisations must operate at the edge of chaos to continuously respond to environmental changes. *By staying in this intermediate zone, [complex systems] never quite settle into a stable equilibrium, but never quite fall apart. Rather [they] exhibit the most prolific, complex, and continuous change* (Brown et al., 1997, p.29). Here, *the organisation is sufficiently rigid to carry information about itself and perform its core task adequately, but at the same time, sufficiently chaotic to allow it to use its information creatively to explore new strategies for survival and change* (Marion, 1999 p.88). In the context of business models, far from the equilibrium and orderliness of any analytical analysis, the edge of chaos is a zone of maximum complexity where disorder and emergence dominate the dynamics driving the construct to innovation. Within this zone, business models are assumed to evolve through spontaneous market dynamics. Instead, they are locked into a mechanical framework in which some components are picked and chosen *a priori* to describe their behaviour. Here, instead of encouraging chaos and evolution, the traditional view anchors the company to past solutions and known paths, generating a gravitational pull towards the status quo and making it difficult to break orbit and move towards new and innovative solutions.

Sensitivity to Initial Conditions

The assumption of nonlinearity also questions the idea of linear causality, showing that the link between cause-and-effect dissolves in the long-term and cannot be identified (Bertuglia et al., 2003). This phenomenon is known as sensitivity to initial conditions, where small input's differences amplify into largely disproportionate differences or not at all. Here, each position of the system is based on a previous movement, making long-term forecasting intrinsically impossible (Priesmeyer, 1992). Sensitivity to initial conditions has profound implications for business models because *two entities with very similar initial states can follow radically divergent paths over time* (Anderson, 1999 p.217) and, as a result, *diverge exponentially rather than converge stably* (Marion, 1999 p.67). For simplicity, let's assume that two business models with similar characteristics operate in the same environment. As they interact with the environment and are exposed to different influences (e.g. consumers, market, industry), they will necessarily evolve following different paths, distancing themselves from one another, *diverging exponentially rather than converging stably* (Marion, 1999 p.67).

Such a high degree of complexity, changeability, and uncertainty exposes business models to an astronomical number of possibilities, making the formulation of a general framework exceptionally challenging, if not impossible.

To fully understand the subtle difference between linear and nonlinear perspectives and the way each impacts business models' dynamics, we use a metaphor already adopted by Ramon Casadesus-Masanell and Ricart (2010, p.197). The authors note that *to make progress towards understanding the dynamics of business models, it is helpful to use the analogy of an automobile made of parts, such as wheels, engines, seats, electronics, and windshields. To assess how well a particular automobile works*, the authors note that, *one must consider its components and how they relate to one another, just as to better understand business models, one needs to understand their component parts and their relationships.*

Taking this analogy and integrating it with the principles of nonlinear dynamic, we note that automobiles are unaware of their past performance (Forrester, 1968); in business models however, present choices and past performances have a significant impact on their future state.

Also, the functioning of an automobile is regulated by linear causality where the relationship between the cause and effect is always proportional and predictable. In business models however, a small change in one element can potentially create a disproportionate effect on its overall functioning and an impact on the overall business landscape, or not at all!

Furthermore, automobiles are regulated by a traditional notion of equilibrium, in which every change is self-corrected to ensure the engine's smooth operation (for example, the transmission system or the cooling system). Business models, on the other hand have a direct impact on the market and the industry in which they operate; here every adjustment has the potential to create a new normal in a never-ending process of change. Not a dynamic we would expect from an automobile, unless we are driving a Transformers! For the readers who are not familiar with the subject, Transformers is a series of American science fiction movies narrating the adventures of a DNA based robots' species, better known as autonomous robotic organisms. Now let's assume we are driving a Transformer instead of a normal car. In this case, when the automobile reaches the inflection point, instead of a balancing mechanism kicking in, the car would change into a whole new state, then into a new one and so on until it settles into a human like shape with human behaviour, by very definition non-linear! No balancing system here, only pure evolution. Exactly what a business model should be considered like.

Lastly, two automobiles with two identical initial conditions will never follow radically divergent paths; they are not affected by the principles of evolution, emergence, adaptivity, and self-organisation, which are recognised characteristics of the business model construct (Dentoni et al., 2021; Atkova et al., 2020; Khodaei and Ortt, 2019; Massa et al., 2018, Lecocq and Demil, 2010), and the Transformers!

A Sneak Peek into the Business Model's Macro View: Business Model's Attractors

The process through which new business models are created and existing ones transformed occurs within the business context (Ahokangas & Myllykoski, 2014); therefore, the study of business models must be executed with the attractors and their dynamics in mind.

Attractors represent a fundamental concept in dynamical system theory. Merrion 1999 (p.100) noted that *systems are composed of units that interact with one another and form complex networks of interdependency. Units form networks, networks settle into attractors, and a network of attractors forms [once again] a system*. In other words, attractors maintain order in larger dynamical systems by breaking them into smaller aggregates.
Attractors have the important property of stability; systems revolving around the same attractor, in fact, tend to follow a stable route around its orbit even when subject to pressure from the external environment. In a space dominated by nonlinear interactions, attractors remain stable and can return to their original state if disturbed. However, being the product of nonlinearity and interactivity between the system components and their external environment, they never exhibit the same behaviour, displaying a trajectory that never repeats itself (Marion, 1999).

Researchers, including Vincenti et al. (2012), Stecey (2011), Stickland (1998), Stacey (1995) and Wheatley (1992), have discussed the notion of attractors within an organisational context. However, in business models studies, the notion of attractors has rarely been acknowledged (Atkova & Ahokangas, 2020). Instead, authors refer more frequently to general concepts such as *business model's ecosystem* (Halecker and Hartmann, 2013; Teece, 2010), *external environment* (Demil and Lecocq, 2010) or *macrolevel perspective* (Velu, 2017).

Taking a high-level perspective of the business model's dynamic we see that, by interacting with each other's, business model's building blocks shape the business model's construct. In turn, the totality of the business models form a complex network of interdependent entities around the identifiable area of the attractor. In this scenario, the whole network of attractors forms the broader market system. Business models that display common characteristics and synergistically intermesh, lie in the gravitational orbit of the same attractor and operate within a range of points known as the basin of attraction. Here, the business model performs within the boundaries and parameters established by the attractor, showing common behavioural traits and recursive structures comprising (among all the possible options) only a reduced set of activities compatible with the attractor's general trend (Anderson, 1999; Bertuglia et al., 2003; McDaniel and Driebe, 2005). Business models operating in this region are connected by feedback loops that interact in a diffuse and nonlinear fashion acting on information derived from the others to which they are connected (Andersen 1999) (see paragraph on feedback cycles).

In this evermoving landscape, a change in one or more elements will resonate within the industry, among similar products and in the broader market, encouraging continuous non-disruptive change (by adding to its normal fluctuation) and/or inspiring non-continuous disruptive change (by introducing one or more elements that considerably deviate from the attractor's standard operational parameter). Pulled into a vortex of never-ending change, business models eventually reach a critical point where they 'spontaneously' self-organise to produce a different structure and/or behaviour that could not have been predicted from its initial state (Stacey, 2011). In this context, the business model that presents an unprecedented dynamic when compared to existing incumbents (Amit and Zott, 2012) is pulled out of the attractor's orbit, crossing over an invisible boundary and moving towards a different one (Marion, 1999). As evolution proceeds, business models scatter themselves across the attractor's orbit, join a different one, or create a new one altogether, eventually altering the network's dynamic. By growing or shrinking to encompass a broader or narrower range of behaviour, attractors can alter their appearance or fade away (Marion, 1999), ultimately reshaping the market and industry landscape.

Business models, like any other dynamical system, do not have the capacity to spontaneously move from one attractor to another. Nevertheless, they do so by the property of *self-organisation*, where structural and organisational change[s] arise 'spontaneously' over time (Stacey, 2011). Notably, in the natural world, self-organisation is an automatic process driven by order-generating rules (Lewis, 1994; MacIntosh and MacLean, 1999, 2001; Stacey, 2011). However, in companies, the process is propelled by a combination of human order-generating rules and an appropriate company structure (MacIntosh and MacLean, 1999, 2000). Self-organisation in business models is the leitmotif behind both the emergence of their informal structure (Anderson,1999) and the fast company's operational changes made against slower policy changes. It is exceptionally difficult to predict which business concept will lead to a new attractor, when a company will move from one attractor to another or create a whole new dynamic within the same attractor. This dynamic is dominated by tightly intertwined elements of randomness, choice, and chance combined with the natural properties of the nonlinear system of sensitivity to initial conditions, evolution, and emergence.

An oversimplified illustration of this macro-level dynamic is as follows: Jeff Bezos came across a statistic that the Internet was growing at a rate of 2.300% (element of randomness, source Amazon.com). Impressed, he dived into the world of E-commerce, creating the online bookseller Amazon.com (element of choice and chance).

While the e-commerce attractors grew, an increasing number of companies, including Ebay and Etsy, added new and different business concepts to e-commerce attractors; Netflix was born on the premise that *Amazon.com was having good luck with books, and why not films*? (Hasting, 2020, p. 24).

Over a decade later, Netflix broke the orbit of e-commerce to create a new attractor when, in 2007, it announced the launch of its streaming service. By 2011, several competitors such as Amazon Prime, Apple TV, and Disney Plus emerged and joined the newly-created attractor of *streaming services*.

Recently, we observed a similar dynamic in the aviation industry. Until the end of the 90s, the full-service airline was the main business concept in the industry. Scattered on this attractor, carriers offered a multitude of services compatible with the concept of *full-service*. Following a heavy market deregulation, Ryanair left the full-service attractor to create the European *low-cost airline* attractor. By the early 2000s, the low-cost attractor was populated by different airlines competing within the same basic concept of low cost. As the low-cost business model attractor grew, in 2000, Air Berlin and Vueling created a new *hybrid* business model by combining business characteristics from both the low-cost carrier and the established full-service carrier. This new attractor reinvigorated the macro dynamics in which companies could now choose among different business models and compete on different levels.

Conclusion

To date, in the attempt to establish a common and widely accepted language to understand and study the business model construct, researchers and practitioners have tried to reconcile the two conflicting notions of analytical thinking and nonlinear behaviour. As result, the concept of *business model* was enclosed within the boundaries of the mechanistic framework of Newtonian legacy.

This approach shaped the business model literature, resulting in the misleading idea of change as a standardised process that can be controlled by calculating its proportional effects and outcomes. Reinforcing a monochrome conceptualisation of change (Guastello et al., 2009), the classical Newtonian approach has, in time, become a conceptual obstacle to innovation, fostering companies' continuity within a market that encourages discontinuity (Foster & Kaplan, 2001). The two approaches (linear and nonlinear) are in fact based on two very different predicaments. The traditional method is guided by analytical instruments and aims to pursue stability, equilibrium, reduce complexity and create order out of chaos. On the other hand, complexity turns order into chaos (Tetenbaum, 1998), with instability and non-equilibrium being the ultimate birthplace of innovation. In this context, managers are *required to work with it instead of trying to reduce it* (Olmedo, 2010 p.80) and moving the focus of their activity from *controlling the outcome* to *optimising uncertainty* and from *stability* to *instability*.

The shift in perception has been reinforced by the emerging discipline of nonlinear management and a general shift in business focus, strengthening the dichotomy between economies of scale, which is based on traditional mass production, and economies of scope, which is based on continuous innovation to produce fewer products in a cost-effective manner (Helaakoski et al., 2006).Trying to resolve the conceptual ambiguity that has traditionally surrounded the discipline of business model and business model innovation, this very humble contribution wants to provide a new perspective and a new method to study the subject. Also, by linking business models' qualities (emergent properties, feedback loops, interdependency of its components, sensitivity to initial conditions and notion of equilibrium) under the umbrella of complexity science, the author of this paper hopes to resolve the traditional disconnect in the research effort and to encourage further dialogue and studies on the subject of business model and complexity science.

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