Using Mixed-Methods Designs to Capture the Essence of Complexity in the Entrepreneurship Research: An Introductory Essay and a Research Agenda

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Abstract Although entrepreneurships is recognized as a complex field, existing research does not pay enough attention to capturing the essence of its complexity. I argue that mixed methods designs offer a solid foundation for bridging this gap. To build my argument, I review the key assumptions and dimensions that make entrepreneurship a complex scientific field, discuss the structure of complexity and compare and contrast different research paradigms in terms of their ability to capture complexity. I will then show that mixed methods designs based on the pragmatic paradigm are philosophically better suited than mono-method designs to capture complex phenomena in entrepreneurship. The paper concludes with an integrative framework to guide research and practice along this direction and discusses the implications of this view for studying complexity in entrepreneurship.

Keywords Complexity theory • Mixed-methods design • Pragmatism

1 Introduction

Entrepreneurship research is the "scholarly examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited" (Shane & Venkataraman, 2000, p. 218). Entrepreneurship involves various forms of activities embedded in social systems that take place across different levels and are performed by a single person or a team of individuals within established or new firms (McMullen & Shepherd, 2006). Hence, it represents a system of interdependent factors whose understanding is riddled with complexity.

Dismantling complexity requires the ability to decipher interactions among components of a system (Simon, 1962). Traditional attempts to explain complex phenomena have been either to explore underlying mechanisms or processes via

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interpretive qualitative approaches based on the logic of inductive reasoning or to examine the direction and significance of causal relationships between a set of variables via quantitative methods based on the deductive logic.

Both approaches would generate incomplete insights that, at best, offer a partial picture of the reality of entrepreneurship. Take for example studies on the nature of entrepreneurial opportunities (Dimov, 2011; Patzelt & Shepherd, 2011). Entrepreneurial opportunities are complex entities whose formation and exploitation depend on numerous contextual, cognitive and structural factors (Wood & McKelvie, 2015). Qualitative methods can shed light on the processes involved in the formation and exploitation of opportunities. Quantitative methods can, on the other hand, illuminate causal relationships that explain or predict formation and/or exploitability of opportunities. Such mono-methodical approaches are informative but incapable of producing outputs that are both exploratory—as in the qualitative methods (Neergaard & Ulhøi, 2007)—and descriptive or predictive—as in the quantitative methods (Mingers, 2006). Therefore, it is not surprising to see that entrepreneurship is gradually passing the point where we simply examine its inherent complexity by adopting mono-methodical mindsets. In sum, mon-methods research cannot fully capture complexity in entrepreneurial phenomena for at least two reasons: (1) it is based on a set of limited assumptions about the reality of the phenomenon of interest. (2) It is constrained by a set of methods that either generate context-specific inductively derived facts or result in generalizable less context-relevant deductively-produced results among a limited number of factors. Supporting this view, Anderson (1999) argues that, "simple boxes-and-arrows causal models are inadequate for modeling systems with complex interconnections and feedback loops, even when nonlinear relations between dependent and in-dependent variables are introduced by means of exponents, logarithms, or interaction terms" (p. 216).

In light of the above, the key thesis of this chapter is to revisit the methodological side of entrepreneurship by endorsing the idea that mixed-methods designs (MMDs) open new doors to explore different aspects of complexity in entrepreneurship. MMDs adopt a pluralistic and pragmatic view in which qualitative and quantitative data and methods can be combined to create meta-inferences to paint a more complete picture of complex realities (Creswell & Clark, 2007). Because MMDs take many forms from concurrent and sequential, and from qualitative or quantitative dominant (Creswell, Clark, Gutmann, & Hanson, 2007), they afford a great deal of flexibility to the researcher whose primary goal is to draw a more complete picture of the complexity surrounding entrepreneurial phenomena.

The remainder of this chapter is organized as follows. First, an overview of the entrepreneurship research with a specific attention to its dimensions and evolutionary path into a complex multidisciplinary field will be provided. Then, the mono-methodical view will be discussed and its inadequacy and shortcomings for studying complexity in entrepreneurship will be illuminated. Next, I will argue that the preponderance of mono-methods research has largely been caused by an overreliance on traditional philosophical assumptions that are now shifting towards a pragmatic mixed-methods worldview which is more apt to capture complex realities. Subsequently, the role of mixed methods research in complexity science

will be briefly reviewed and an agenda and a guiding framework for future research on the complexity of entrepreneurship using MMD will be proposed.

I hope this chapter will help entrepreneurship scholars escape from the mono-methodical straitjacket in order to tackle the complexity of entrepreneurship by generating a richer and more complete understanding of by who, why, how, when, and under what conditions various entrepreneurial activities are carried out.

2 Entrepreneurship and Complexity: An Overview

2.1 History of the Entrepreneurship as a Field of Scientific Inquiry

The scientific field of entrepreneurship is an expansive body of literature formed around three concepts of "entrepreneurship," referring broadly to the set of activities carried out by an entrepreneur or a field that studies, "entrepreneur(s)" as the agent (individually or in teams) who perform these activities and "entrepreneurial," as the qualifying characteristics or attributes that capture the essence of these activities. Entrepreneurship has its roots in economics. In fact, the notion of entrepreneurship is as old as economics itself (Cole, 1946; Soltow, 1968). The contemporary literature attributes the current understanding of entrepreneurship to the works of Schumpeter (1934), Kirzner (1973), and Knight (1921). It is to be noted that many others including McClelland (1965) and Gartner (1988) have also made impressive contributions to the field of entrepreneurship (see Landström, 2007 for a comprehensive review),[1] however, consistent with McMullen and Shepherd (2006) I focus on Schumpeter, Kirzner and Knight as pioneers of the theory of entrepreneurship and entrepreneurial activities.

Knight famously conceptualized entrepreneurs as bearers of uncertainty. He distinguished risk from uncertainty by defining uncertainty as incalculable risk. According to Knight, individuals who tolerate uncertainty in hope of gains are entrepreneurs who define and change markets. Schumpeter, on the other hand, was interested in the new theory of capitalism and economic prosperity based on the processes of change and innovation. He proposed that economic wealth is not created by capital accumulation; rather it is generated by innovative activities that use capital in new ways. He called these new ways "new combinations" (Schumpeter, 1934, p. 377) and famously proposed the idea that entrepreneurs drives markets by creating new configurations of asset and destructing the old ones—the process that is famously known as creative destruction. He also distinguished between five types of innovations: new products, new methods of production, new sources of supply, exploitation of new markets, and new ways to organize

[1] I thank an anonymous reviewer for this point.

business or new business models. Accordingly five forms of Schumpeterian entrepreneur can form in markets each requiring a complex configuration of assets.

Schumpeterian ideas were further developed by Austrian economists and most notably Kirzner (1973). According to Kirzner, entrepreneurship is all about discovering and exploiting previously unexploited opportunities by using new combinations of resources. Therefore, Kirzner (1973) shifts the focus of attention from new combinations to opportunities and advocates the study of entrepreneurship as a process rather than an outcome (innovation in Schumpeter's view) (Foss, Klein, Kor, & Mahoney, 2008). According to this view, some individuals have some behavioral or personal elements that enable them to be alert to opportunities and thus they can be called "entrepreneurs." He further assumed that the actions of entrepreneurs lead to a better allocation of resources. By analogy, entrepreneurship leads to better allocation of resources in a market economy (Kirzner, 1973), making entrepreneurship the most important force in today's markets.

Since these classical works, the study of entrepreneurs and entrepreneurship has undergone a metamorphosis (Shane, 2000). The contemporary model of entrepreneurship represents a growing multidisciplinary field that centers on opportunities, risks, innovation and management of complex actions to allocate resources to all sorts of value-creating activities. Therefore one of the most striking challenges faced by students of entrepreneurship is to map the boundaries of the expansive realm of entrepreneurship (Foss et al., 2008; Shane, 2000). In an attempt to define boundaries of this field Shane and Venkataraman (2000) defined entrepreneurship as "the scholarly examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited." (p. 218). This definition is reductionist in that it reduces the domain of entrepreneurship to the nexus of two phenomena: the presence of lucrative opportunities and the presence of enterprising individuals who act alone, in teams or on behalf of small or large organizations to exploit those opportunities. Entrepreneurial opportunities are, hence, the most fundamental component of entrepreneurial activities (Dimov, 2011).

Opportunities in this sense are those situations in which new goods, services, raw materials, and organization methods can be introduced and sold at greater than their cost of production (Casson, 1982). Opportunities arise either in an idiosyncratic manner as a result of errors and omissions of others that cause surpluses and shortages (Casson, 1982), or are the result of technological, political, regulatory, socio-demographic, perceptual, and other unexpected changes in the environment (Korsgaard, Berglund, Thrane, & Blenker, 2015; Patzelt & Shepherd, 2011). Consequently, entrepreneurship involves the study of numerous interacting factors including sources of opportunities; the processes of discovery, evaluation, and exploitation of opportunities; and the set of individuals, the team of corporate actions and social, economic and regulatory factors and conditions that enable or inhibit formation, discovery, evaluation, and exploitation of opportunities (Shane & Venkataraman, 2000). Further, opportunities and associated gains exist in different contexts. For instance, it is already well known that if entrepreneurship is to exploit opportunities for social and environmental gains rather than commercial it becomes

social or sustainable entrepreneurship (Patzelt & Shepherd, 2011). If it is to make better use of political and public resources for the benefit of the society it then becomes political or public entrepreneurship (Lewis, 1988).

In light of the above, it is obvious that entrepreneurship involves various factors at different levels form individuals to socio-environmental and economic into political and regulatory ones. Similarly, as a scientific field it has numerous foci ranging from identification of factors that link entrepreneurs to opportunities, to types of opportunities, types of gains and mechanisms that enable or prohibit these processes. The next section shows that such phenomena and associated fields are complex systems. Accordingly, my thesis is that, entrepreneurship in all its glory as both a multifaceted phenomenon and as a scientific field of inquiry can be best viewed through the lens of complexity.

2.2 Complex Systems and the Science of Complexity

The term 'complexity' comes from the Latin word 'complecti' that translates to grasp, comprehend, embrace (Israel, 2005). Complexity connotes the opposite of simplicity. That is, the world is fundamentally simple and the purpose of any scientific inquiry is to explain it in terms of simple constituent elements (Israel, 2005). To understand the importance of this positioning we need to look at two perspectives that dominate the way scientists look at the world. Let's consider the world around us and phenomena within it as open systems of factors that interact with each other and with their surroundings. Holism is a viewpoint that stresses the behavior of the whole system and seeks explanation in the identification of the simplest explanatory principles (Malansona, 1999). On the contrary, reductionism seeks explanation through the isolation of parts and examination of interactions between pairs of parts (Malansona, 1999).

Although both views are informative they create, at best, only an incomplete understanding of the behavior of a system. Reductionism does not lead to simple principles for the general behavior of a system and holism cannot distinguish among alternative configurations of the building blocks of a system (Malansona, 1999; Stacey, 1995). Thus, both views ideally offer complementary insights into the behaviors of complex systems (Fontana & Ballati, 1999). Furthermore, both views are inherently concerned with the equilibrium or a tendency towards stability, predictability and regularity (Stacey, 1995). That is an unrealistic and over simplistic assumption because many physical, behavioral and social systems are dynamic and largely unpredictable because they are complex. Herbert Simon (1962) defines a complex systems as:

> ....made up of a large number of parts that interact in a non-simple way. In such systems, the whole is more than the sum of the parts, not in an ultimate, metaphysical sense, but in the important pragmatic sense that, given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole. (p. 468)

In the language of complexity, "an in-principle reductionist may be at the same time a pragmatic holist" (Simon, 1962, p. 468). Therefore, when dealing with complex systems scientific inquiries are to be guided by the science of complexity[2] (Anderson, 1999). The science of complexity is the science of complex systems. It aspires to explain how simple processes and interactions derived from reductionism can combine to generate complex holistic systems that interact and coevolve with their surrounding environments (Malansona, 1999). The more complex a system becomes the less knowable it gets (Perrow, 1967).

2.3 General Attributes of Complex Systems

The science of complexity makes four important predictions. First, complex systems are usually hierarchical. This is, composed of "of interrelated subsystems, each of the latter being, in turn, hierarchic in structure until we reach some lowest level of elementary subsystem"(Simon, 1962, p. 468). Second, hierarchical systems not only are easier to study and decompose but also can evolve more efficiently and quickly than non-hierarchical systems of comparable size, making them more interesting for evolutionary investigations (Anderson, 1999; Perrow, 1967; Simon, 1962; Stacey, 1995). Thirdly, looking at hierarchies in complex systems, we realize that in general, interactions among elements within subsystems are more intense and frequent than those of between subsystems make them easier to decompose. This attribute is known as near-decomposability (Simon, 1962) and implies that in the "short-run the behavior of each of the component subsystems is

[2] Interest in studying systems is not new. The holism-reductionism view emerged after WWII which was then completed by Cybernetics and the general system theory (GST). Cybernetics is the study of closed linear feedback loops between a system and the environment [see for example Ashby, R. (1956). *An introduction to cybernetics*. London, United Kingdom: Chapman and Hall] and general system theory is a more complete theory of general systems such as open, close, simple and relatively complex systems in which the linearity assumption between feedback loops and the environments is relaxed [see for example von Bertalanffy, L. (1968). *General system Theory: Foundations, development, applications*. New York, NY: George Braziller]. Ecology theory also addresses the conflict between holism and reductionism by looking at hierarchies in systems but is limited only to middle-number systems those in which component are too many to represent individually and too few to capture statistically in causal models [see Malansona, G. P. (1999). Considering complexity. *Annals of the Association of American Geographers*, *89*(4), 746–753]. So complexity theory represents the most appropriate lens to look at complex systems. Another interesting point is the main difference between normal science (Descartesean scientific method), complexity theory and chaos theory. Normal science explains how complex effects can be understood from simple laws by breaking systems into components and examines them independently using competing theories and add them together in linear fashions to get to the system behavior. Chaos theory, however, stresses the importance of nonlinear relationships and explains how simple laws can have complicated, unpredictable and radically big consequences for the system and the environment. Finally, Complexity theory also subscribes to the nonlinearity of cause and affects and describes how complex causes can produce simple effects.

approximately independent of the short run behavior of the other components and in the long run, the behavior of any one of the components depends in only an aggregate way on the behavior of the other components" (p. 474). Finally, through hierarchies and decomposability complex systems become easier to describe, model and comprehend. The best summary of these four has been stated by Herbert Simon:

> One path to the construction of a nontrivial theory of complex systems is by way of a theory of hierarchy. Empirically, a large proportion of the complex systems we observe in nature exhibit hierarchic structure. On theoretical grounds we could expect complex systems to be hierarchies in a world in which complexity had to evolve from simplicity. In their dynamics, hierarchies have a property, near decomposability, that greatly simplifies their behavior. Near decomposability also simplifies the description of a complex system and makes it easier to understand how the information needed for the development or reproduction of the system can be stored in reasonable compass. (Simon, 1962, pp. 481–482)

The importance of understanding complex systems is reflected in the fact that complex systems are ubiquitous and their ubiquity directly influences entrepreneurship; "...business firms, governments, universities all have a clearly visible parts-within-parts structure" (Simon, 1962, p. 468). In this chapter I focus on social and behavioral systems that are studied in entrepreneurship. These include ventures, business organizations, and individuals who act entrepreneurially alone or in collaboration with each other in the form of venture teams, markets and industries.

2.4 Elements of Complex Systems in Social Sciences

In social and behavioral settings complex systems are generally characterized by four key elements: (1) agents with schemata, (2) self-organizing networks sustained by importing energy, (3) coevolution to the edge of chaos, and (4) system evolution based on recombination (Anderson, 1999).

Agents refer to individuals whose actions define dynamics of systems. Collections of actions shape activity systems that determine how individuals behave relative to each other in social settings. As Anderson (1999) describes, each agents' behavior is defined by a schema that is a cognitive model, framework or a set of assumptions and beliefs that represents its perception of the environment and acts as an information filtering and processing devise to make sense of the surrounding conditions. Different agents may develop and use different schemas given variations in their history, worldviews and personality. In complex systems, schemas can be seen as lower order elements that influence higher order behaviors of agents which partake in the process of spontaneous change in the system and sub-systems (Choi, Dooley, & Rungtusanatham, 2001).

Another fundamental element of complex systems is networks of positive feedback loops. A feedback loop is a circular arrangement of causally connected elements in which each element affects the next, until the last feeds back into the first element, thus completing the loop (Walby, 2003). Feedback loops enhance or

hamper changes that occur in a system. Agents are connected to one another through networks of feedback loops (Anderson, 1999). That is, they observe and act on information acquired form their local connections. Because of these connections behaviors of any agent depends on and influences that of others in a system. In addition, because, no single agent determines the collective behavior of the system, complex systems have an inherent tendency to develop and maintain a self-organizing state of feedback networks (Mitleton-Kelly, 2003). Complex systems involve loops of positive feedback. That is, those that enhance or facilitate changes in the system and lead the system towards disequilibrium (Anderson, 1999). This mechanism is, for example, are manifested in the observation that behaviors of managers of a firm based on the feedback from customers lead to new strategies that change the direction of the firm which in turn affects markets, industries and other businesses in the firm's ecosystem.

The third element of complex systems is their evolution at the edge of chaos. Agents coevolve with one another (Anderson, 1999). Each agent strives to improve its fitness with the environment but the outcome of these attempts depends on the behaviors of other agents (Mitleton-Kelly, 2003). As a result, the adaptive state of each agent constantly changes, causing complex systems to go through temporary equilibrium in the short term or constant disequilibrium in the long term. Consequently, complex systems lie at the edge of chaos (Anderson, 1999; Simon, 1962). Order at the edge of chaos reflects the notion that a complex system possesses an emergent nature that enables it to be productive (Choi et al., 2001). Simple or uncomplex systems are very submissive and stable whereas too complicated systems are chaotic. However, complex systems are positioned between stability and chaos. Hence behaviors of complex organizations are neither definitively predictable nor completely unpredictable (Smith & Humphries, 2004). Some chaos prevents systems from being completely unpredictable and little order makes it productive and functional (Smith & Humphries, 2004).

Finally, evolution of complex systems is a function of reconfigurations of agents. That is, the process of entry, exit, formation of new agents and/or formation of new connections between agents. This process creates internal dynamics that lead the system towards its evolutionary fitness (Anderson, 1999; Choi et al., 2001). Even new subsystems or levels of hierarchies may form as "the linkages between agents may evolve over time, shifting the pattern of interconnections, the strength of each connection, and its sign or functional form" (Anderson, 1999, p. 220). Building on this understanding, in what follows I will discuss the importance of complexity in entrepreneurship.

2.5 Complexity in Entrepreneurship

The argument put forward in this section is composed of two interrelated parts. First, entrepreneurial phenomena are inherently complex and many issues in entrepreneurship are embedded in complex systems. Second, the science of complexity

as discussed in the previous section offers a robust theoretical ground upon which to advance both theoretical and empirical frontiers of entrepreneurship.

To understand the complex nature of entrepreneurship, let's consider the case of an entrepreneur who establishes a small venture in a market. A large number of inter-connected factors influence dynamics of this phenomenon from the recognition of the opportunity to the acquisition of various resources to the initial launch of the business and enticing customers to pay for the product and service and adjusting the offerings if necessary to sustain the revenue. The entrepreneur in this case has undeniably a set of relationships with others in the market and industry. This may include friends, family members, colleagues and authorities, whose feedback affects the entire entrepreneurial processes and activities listed above. In addition, the entrepreneur's mental picture of the business, his/her perception of the market, customers, depth and breadth of his/her relationships and his/her skills, knowledge and experience collectively form a schema that acts as an information-filtering and processing device shaping his/her actions. With this picture in mind, social-cultural, economic and political factors are very influential yet out of his/her control. These forces affect the whole market and industry where the entrepreneur is running his/her business. Technological advances and fluctuations in customers' preferences also create a situation where constant adjustments to value offerings and business models lead the entrepreneur and the market as a whole to the edge of chaos.

This simple example illustrates how a basic entrepreneurial phenomenon is in fact a complex one embedded in a complex system of interacting elements distributed across levels. A similar logic can be applied to almost any other entrepreneurial activity from the development of a new product/service, to the design and execution of social and political innovations. Thus, it is not surprising to see that the relevance of complexity to the field of entrepreneurship has long been recognized by scholars. McKelvey (2004), for instance, states that:

> ...unlike traditional scientists, who conduct research under conditions of equilibrium, complexity scientists focus on the study of order creation. Since creation of new economic order in the form of new firms is what entrepreneurs do, complexity science makes much more sense as the preferred kind of science for entrepreneurial research. (p. 314)

Despite this recognition, surprisingly very few have tapped into the power of complexity science for entrepreneurship research. For instance, Lichtenstein, Carter, Dooley, and Gartner (2007) use complexity theory to show when (1) the rate of start-up activities is high, (2) start-up activities are spread out over time, and (3) start-up activities are concentrated later rather than earlier over time, start-up activities will lead to the emergence of new firms. Similarly, Goldstein, Haz, and Silberstang (2008) highlight the contribution of complexity to the social entrepreneurship literature and Schindehutte and Morris (2009) argue that complexity offers better explanations for five key themes of strategic entrepreneurship (exploration–exploitation, opportunity, newness, micro-macro interaction, and dynamics).

In this sprit, I posit that although complexity is at the heart of entrepreneurship, capturing the essence of this complexity is perhaps one of the most fruitful yet

underemphasized tasks of researchers in the field of entrepreneurship. I will not engage in a conceptual nor will I offer a theoretical discussion of this issue. Rather I depart from this literature and shall focus on the methodological side of capturing the essence of complexity in entrepreneurship in hope of stimulating more focused research on this topic.

My thesis is that because many aspects of entrepreneurship are inherently complex they cannot be completely explained with current causal models nor can be described through context-specific exploratory accounts (Schindehutte & Morris, 2009). Therefore, a mixed-methods approach is better suited to capture the complexity of entrepreneurship. Building on this ground, the next section looks at two dominant research paradigms namely: positivism and interpretivism, highlights their shortcomings with respect to the study of complex phenomena and advocates the use of an emerging paradigm known as pragmatism as an alternative for studying complexity in entrepreneurship.

3 Research on Complexity in Entrepreneurship: Mono-Method Versus Mixed Methods Designs

Kuhn (1970) defines science as the constellation of elements such as facts, theories, and methods collected on a set of related phenomena in a particular field of interest (p. 1). Consequently, "scientific development becomes the piecemeal process by which these items have been added, singly and in combination, to the ever growing stockpile that constitutes scientific technique and knowledge" (pp. 1–2). According to Karl Popper (1959) any scientific field has to be falsifiable. That is, its core assumptions and facts should be testable and falsified if necessary by application of sound reasoning and sets of logical methods.[3]

Science advances through research and research is carried out when an appropriate set of research methods is used to generate new knowledge. Research methodology is different from research methods and research design. I shall distinguish them as follows. Methodology is knowledge of methods. That is, a knowledge base, a set of agreed-upon principles and assumptions that guides the choice of research methods. Research methods are standard tools, techniques and approaches used by researchers to collect, analyze and interpret data, whereas research design is the way these methods are combined and joined in a meaningful and purposeful fashion to fulfill research goals or address research questions.

In any scientific discipline there are a number of paradigms that not only show the most appropriate way to link methodology to methods but also guide the entire research design and conduct of the research. Appropriate applications of these paradigms ensures falsifiability of findings and facilitates the progressive accumulation of evidence within a domain of study (Popper, 1959). Kuhn (1970) defines a

[3] I thank an anonymous reviewer for this point.

paradigm as "some accepted examples of actual scientific practice—examples which include law, theory, application, and instrumentation together—provide models from which spring particular coherent traditions of scientific research" (p. 11). A paradigm is also a cognitive framework with "an entire constellation of beliefs, values, techniques and so on, shared by a given [scientific] community" in which "universally recognized scientific achievements . . . for a time provide model problems and solutions to a community of practitioners" (Kuhn, 1962, p. 175). In other words, a paradigm is seen as a temporary theoretical framework and a structure of thought that provides a particular vision of reality. It guides the way we perceive, think and act during our daily researching activities.

A paradigm dictates what is considered rational and relevant. It guides our expectations by telling us what we are expected to see and where to look to see it. Therefore, adoption of a paradigm is both eye-opening and blinding. It is as guiding as limiting. The extent to which researchers agree on a paradigm determines its maturity (Kuhn, 1970). Furthermore, sharing a paradigm by researchers ensues methodological consistency to examine falsifiability of findings (Popper, 1959).

Two paradigms have dominated social sciences: interpretivism and positivism. These two subscribe to two different research designs and promote conflicting sets of research methods. Interpretivism assumes that reality is subjective and constructed through interpretations of the researcher. Hence, there could be various pictures of the same reality. As a result, interpretive research encompasses inductive reasoning and collection of qualitative context-specific data in their natural setting (Ketokivi & Mantere, 2010). It also seeks to explore and explain processes through narratives and rich explanations (Creswell, 2007). Techniques and approaches such as hermeneutics, ethnography, case-study and grounded theory are based on this paradigm. Thus, qualitative entrepreneurship research is predominantly interpretive. As intuitively appealing and powerful as it sounds, qualitative research is incapable of testing causal relations and fails to make generalizable inferences about the population under study. Therefore it cannot be used in examining various aspects of complexity such as cause-and-effects in feedback loops and also direction and intensity of relationships among components of decomposable systems and subsystems.

In contrast, the positivism paradigm advocates objectivity of the reality and assumes that reality is independent of the interpretations of the researcher (Creswell, 2007). Consequently, it offers standard quantitative methods mostly based on deductive reasoning in which inferential, descriptive, experimental and simulative techniques are used to examine and test causal and other forms of relationships among a limited number of variables. Quantitative hypo-deductive research in entrepreneurship is based on this paradigm. Positivism has its own limitations. Most importantly, positivist methods cannot take too many variables into account at once and are unable of providing rich context-specific explanations for dynamics of inter and intra components within and between systems. Table 1 offers a summary of these two mono-methodical paradigms with respect to their

Table 1 Dominant mono-methodical paradigms

	Research paradigms	
Assumptions	Interpretivism	Positivism
Reality	Subjective	Objective
Research design	Qualitative	Quantitative
Data collection methods	Interviews, qualitative observations, textual, audio, visual data	Surveys, quantitative observations, numerical methods
Data analysis methods	Coding, narrative, case studies, phenomenology, ethnography, grounded theory	Quantitative descriptive, inferential (e.g., Chi-square, ANOVA, correlation, regression), simulations, experimental
Form of inference	Rich context-specific explanations of processes, mechanisms and dynamics	General cause-and-effect, direction and significance of association (linear, non-linear) among a limited number of variables
Application in complexity research	Exploring dynamism of sus-systems, exploring how behaviors emerges in specific contexts	Examination of causal relationships between elements within and between hierarchical sub-systems, examining the emergence of fit between the system and its environment
Limitations for complexity research	Incapable of measuring the direction and intensity of relationships among elements	Incapable of capturing dynamic interactions, limited to associations among a small number of variables

Adopted partly from Creswell (2007) and Ketokivi and Mantere (2010)

ability to inform and enable research on the complexity of entrepreneurial phenomena.

As the foregoing discussion suggests, neither positivism nor interpretivism is capable of generating a complete picture of complex systems. Heidegger (1996) argues that each paradigm opens up and closes down a world. Because what we observe is conditioned and mediated by our paradigm (Kuhn, 1970), neither of these paradigms is suitable for grasping the essence of complexity.

The above argument challenges the suitability of mono-methodical paradigms for capturing the essence of complexity in entrepreneurship. More specifically, "differences in the use and the conclusions of interpretive and positivist work have led purists in both camps to assert that these two systems of inference cannot be combined" (Lin, 1998, p. 163). That said, there is a growing recognition that a multi-paradigmatic view in social sciences would enable researchers to mitigate this effect (Scherer, 1998; Watkins-Mathys & Lowe, 2005). In line with this trend, I argue for the value of a more-liberating and less-rigid paradigm, a paradigm that permits combination of inductive (i.e., qualitative) and deductive (i.e., quantitative) methods to grasp the essence of complexity in entrepreneurship in a more meaningful and complete fashion.

3.1 Pragmatic Paradigm and Mixed-Methods Design

Pragmatism is an emerging paradigm that allows the use of both inductive and deductive reasonings through various combinations of qualitative and quantitative data (Creswell, 2008). Pragmatism shares the same root with the terms 'practice' and 'practical'. They all come from 'pragma', a Greek word meaning action (McCaslin, 2008). Pragmatism, is, hence, a philosophical paradigm that views reality as provisional rather than absolute and fixed (Jacobs, 2010). In pragmatism focus is placed on application—'what works'—rather than methods, allowing the researchers to use all approaches from a pluralistic view to understand the problem at hand (Creswell, 2013). Pragmatism does not see the world as an absolute unity permitting researchers to look to many approaches to collecting and analyzing data in contrary to subscribing to only one way as in mono-method approaches (e.g. quantitative or qualitative) (Creswell, 2013). In pragmatic research, truth about the subject under study is what works at the time. More specifically, the truth is not based on a strict dualism between the mind and reality. It is completely independent of the mind as in positivist tradition nor is it constructed by the mind as in the interpretivist tradition. Hence, pragmatic investigations can use both quantitative and qualitative data to provide the best understanding of the research problem. In addition, pragmatism advocates the view that research always occurs in social, historical, political, and other contexts that require multiple worldviews and different assumptions to understand (Creswell, 2013). Therefore, adoption of pragmatism as a research paradigm enables multi methods or mixed methods designs. That is, a purposeful combination of qualitative and quantitative data and techniques to create a more complete picture of the reality. These features make pragmatism and by implication mixed methods research suitable for studying complex issues and phenomena.[4]

Adoption of a mixed-methods approach enables researchers to combine qualitative and quantitative data in different orders and ways. The sequence and importance of qualitative and quantitative data and the stage at which they are integrated lead to a number of standard designs for mixed methods research. Creswell, Clark, Gutmann, and Hanson (2003) proposed the following typology of mixed-methods research (Table 2).

Mixed methods give researchers more flexibility in the choice of data, designs and methods. Hence, mixed-methods researchers can investigate multifaceted phenomenon, address more complicated questions and tackle a broader range of issues by synthesizing inductive and deductive logics. Tashakkori and Teddlie

[4] Design paradigm is also used in the design of mixed methods research but it is not a philosophical paradigm. Other philosophical paradigms that enable mixed methods research include emancipatory paradigm and critical realism [see Venkatesh, Brown, and Bala (2013), for a review]. We focus on pragmatism because it has been argued to be the dominant and main paradigm for mixed methods research (Creswell, 2007).

Table 2 Mixed methods designs (Creswell et al., 2003)

Design	Implementation	Priority	Stage of integration	Theoretical perspective
Sequential explanatory	Quantitative followed by qualitative	Usually quantitative	Interpretation phase	May be present
Sequential exploratory	Qualitative followed by quantitative	Usually qualitative	Interpretation phase	May be present
Sequential transformative	Either quantitative followed by qualitative or qualitative followed by quantitative	Usually quantitative	Interpretation phase	Definitely present (i.e., conceptual framework, advocacy, empowerment)
Concurrent triangulation	Concurrent collection of quantitative and qualitative data	Preferably equal	Interpretation phase or analysis phase	May be present
Concurrent nested	Concurrent collection of quantitative and qualitative data	Preferably equal	Analysis phase	May be present
Concurrent transformative	Concurrent collection of quantitative and qualitative data	Preferably equal	Usually analysis phase; can be during interpretation phase	Definitely present (i.e., conceptual framework advocacy, empowerment)

(2008) list seven major goals that can be pursued by mixed-methods research as summarized in Table 3.

Drawing on this introduction into the pragmatic paradigm and mixed-methods research, I will discuss how entrepreneurship researchers can use different types of mixed methods to investigate various aspects of complexity in entrepreneurial phenomena.

4 Mixed Methods and Complexity in Entrepreneurship: A Research Agenda and a Guiding Framework

> . . .no single truth is ever sufficient because the world in complex. Any truth separated from its complementary truth, is a half truth. . . (Pascal quoted in Myers, 2000, p. 74)

In this section I briefly explain how mixed methods research can help entrepreneurship researchers better investigate different aspects of complexity in entrepreneurial phenomena. To do so, I review key aspects and elements of complex systems and exemplify some potential ways in which mixed methods designs can be used to explore and explain them in entrepreneurship.

Table 3 Purposes of research methods designs (Tashakkori & Teddlie, 2008)

Purpose	Description	Example
Complementarity	A complementary view of the phenomenon and/or relationships is developed by combining the findings	A qualitative study was used to gain additional insights on the findings from a quantitative study
Completeness	A more complete picture is obtained by mixing methods. The full picture is more complete than the parts created by each method	The qualitative data and results provided rich explanations of the findings from the quantitative data and analysis
Developmental	Question or hypothesis for one method emerge from the other in a sequential form	A qualitative study was used to develop constructs and hypotheses and a quantitative study was conducted to test the hypotheses
Expansion	Understanding obtained by one method is expanded and explained by the other	The findings from one study (e.g., quantitative) were expanded or elaborated by examining the findings from a different study (e.g., qualitative)
Corroboration/ confirmation	The credibility of inferences from one method is assessed by the other	A qualitative study was conducted to confirm the findings from a quantitative study
Compensation	Weaknesses of one meth are compensated for by the other	The qualitative analysis compensated for the small sample size in the quantitative study
Diversity	Divergent pictures of the same phenomenon are obtained, compared and contrasted	Qualitative and quantitative studies were conducted to compare perceptions of a phenomenon of interest by two different types of participants

4.1 Mixed Methods, Hierarchies and Decomposability

Mixed methods research brings about an enhanced capacity to explore dynamics of hierarchical systems and relationships between elements of systems and nested sub-systems simultaneously in one project. Designs such as sequential explanatory, sequential exploratory and concurrent nested (Table 2) are suitable for such investigations. For example, sequential exploratory design can help researchers explore boundaries of hierarchical systems in an organization which is undergoing a major business model renewal (an entrepreneurial phenomenon), key inter- and intra-system mechanisms across levels including management team's dynamics, multifunctional operational teams and forces at the supply chain level such as contracts with suppliers, supply chain risks, demand fluctuation, etc. can all be explored through qualitative methods. Then, quantiative methods such as DEA (data envelopment analysis) can be employed to establish the significance of associations between sets of components including teams' commitment, leadership styles, operational effectiveness and efficiency and how these forces affect each other across levels. In the language of mixed methods design such a research can be

classified as complementary or completing type (Table 3). Both types can generate a more complete and realistic explanation for the complex phenomenon of interest than traditional mono-methodical approaches (either qualitative or quantitative).

Given this example, mixed-methods research can create interesting insights into the dynamics of hierarchical decomposable systems in entrepreneurship. Some complex issues that would benefit from this approach are business models and their transformation, new business model and product development projects in multinational corporations, public entrepreneurship involving new rules and regulations in the public sector, and dynamics of new venture creation by migrant entrepreneurs.

Ubiquity of hierarchical decomposable systems in entrepreneurship points to two general directions for future research: (1) research designed to show how mixed methods designs help us better understand boundaries of sub-systems and delineate interactions between subsystems in entrepreneurial phenomena. (2) Research aimed at showing how mixed methods designs can advance our understanding of decomposability of various systems surrounding entrepreneurial phenomena in social and business settings.

4.2 Mixed Methods and Agents with Schemas

Agents in entrepreneurship exist in many forms. They can be individuals or teams of entrepreneurs working privately to establish and grow a business or be executives of publicly listed firms whose job is to boost innovativeness, creativity and growth prospects of their business in domestic or international markets. Other types of agents can be angel investors, venture capitalists and even authorities whose actions and decisions affect the way entrepreneurs pursue they dreams. Agent populate complex systems and their actions shape behaviors of systems and sub-systems. Every agent has a mental picture of its task environment and develops a set of assumptions about his/her tasks. Social interactions provide agents with information that help them adjust or reinforce these assumptions which in turn affect their subsequent behaviors and actions of other agents with whom they interact in the business ecosystem.

Take for example the case of a scientist who intends to commercialize his patented invention. His plan may involve a fund-raising phase through angel investors and venture capitalists. This plan is based on an action plan that is guided by an evaluation of his relationships with friends, family members and colleagues as well as suitable venture capitalists in the industry. On the other hand, these investors may develop different perceptions of both the entrepreneurial potential and drive of the scientist and marketability of his technology. These similarities and differences in schemas directly affect the entire entrepreneurial process. In general, dynamics of networks, flow of information among agents and changes in markets and technological side of the industry cause these agents to constantly adjust their

schemas in favor or against the technology. The question is how these agents with schemas can be effectively studied.

Mixed methods design enable researchers to capture these dynamics. Qualitative methods are suitable for exploring unmeasurable, unobservable aspects of mental models, schemas and cognition such as cognitive frames, assumptions, and cognitive maps that shape schemas and quantitative methods are suitable for measuring associations between aspects of perceptions, attitudes, beliefs and assumptions to explain how schemas and subsequent actions are related among a set of agents. Sequential or concurrent combinations of these methods in a complementary or developmental fashion enable researchers to generate better explanations as to why, when, how and under what conditions schemas affect the way agents interact and communicate toward entrepreneurial goals.

There are still many unexplored territories and unaddressed questions about the dynamics of shared mental models and collective cognition in entrepreneurial teams (Klotz, Hmieleski, Bradley, & Busenitz, 2014), networks and eco-systems (Isenberg, 2010) that can be addressed by mixed methods research. In sum, future research can tap into the power of mixed methods to explore and explain how mental models and cognitive underpinning of agents in a complex system affect formation and success of entrepreneurial initiatives.

4.3 Mixed Methods and Networks of Positive Feedback Loops

Because entrepreneurs coevolve with markets, their behaviors are organized by positive feedback loops (McKelvey, 2004). These loops are "deviation-amplifying" mechanisms that facilitate changes in markets (Anderson, 1999; McKelvey, 2004). A key feature of systems with networks of positive feedback is that they involve unpredictable emergent patterns. Some examples of such patterns in entrepreneurship are innovations that bread new innovations, disruptive technologies that result in new disruptive responses, emergence of new markets and new business models and collaborative and co-opetitive activities that create new markets, new offerings and new chains of entrepreneurial initiatives.

A fundamental aspect of positive feedback loops is that they are usually nonlinear and involve complex processes (McKelvey, 2004). So, neither quantitative methods nor qualitative ones are solely capable of explaining them. Exploring complex systems are not just about understanding dynamics of interdependencies among factors across levels. More important is to explore why and how interdependencies spawn new phenomena (Buchanan, 2004). Mixed methods designs, in particular, sequential with complementary and developmental goals are valuable tools in the hand of researchers to explore and examine formation and mechanisms of positive feedback loops and emergent dynamics of systems in entrepreneurship.

4.4 Mixed Methods and Order at the Edge of Chaos

As previously discussed, order at the edge of chaos suggests that complex systems are not completely unpredictable and are, to some predictable extent, productive and functional. Therefore complex systems are not entirely understandable by positivist approaches, neither are they completely understood by interpretive methods.[5] Today's markets are perfect examples of such conditions. Constant shifts in consumers' preferences and continuous waves of technological advances and disruptive innovations drive markets to the edge of chaos. Under these circumstances lie opportunities as well as risks that facilitate or hinder entrepreneurship. Exploring dynamics of forces that underpin markets and examining approaches taken by entrepreneurs to take advantage of market imperfections are at the core of entrepreneurship (Mahoney & Qian, 2013).

Mixed methods designs are in particular suitable for such investigations. Qualitative data can provide rich and context-specific explanations about forces that drive a system to the edge of chaos and quantitative data can be analyzed to examine associations that give order to such a system. Take for example, continuous business model innovations in high-tech industries. Fast-moving markets and technological innovations create opportunities for both established firms and new entrants. Entrepreneurs either develop new business models or adjust their current business models in response to new disruptive technologies or to tap into new markets. These mechanisms drive the market away from equilibrium towards the edge of chaos where market trends are not completely chaotic and unpredictable but are moving fast at an understandable pace and direction (Brown & Eisenhardt, 1997). Qualitative research such as case studies and thematic analyses are strong tools to explore and describe boundaries and conditions of such movements but are also incapable of making general meaningful conclusions about causal relationships among forces that drive markets towards disequilibrium and different factors that are employed by entrepreneurs to take advantage of chaos. Mixed methods designs, therefore, help researchers address a combination of questions such as: (1) what factors do drive an entrepreneurial system towards chaos? How do entrepreneurs succeed at chaos? And what attributes and characteristics define success at the edge of chaos? among others to develop more compelling accounts for entrepreneurial phenomena at the edge of chaos.

4.5 Mixed Methods and Evolution by Recombination

Schumpeter (1934) argued that entrepreneurship is essentially a function of creative recombination of resources by innovative individuals. In addition, markets and industries evolve through the entry, exist and growth of firms that are established,

[5] I thank an anonymous reviewer for this point.

managed and led by entrepreneurs. Therefore, recombination of resources and firms through entrepreneurial talents, skills and abilities lies at the heart of evolutionary processes in entrepreneurship. Exploring how agents, firms and resources are recombined is an undeniably complex issue that can be better understood when exploratory and explanatory techniques are mixed. Therefore, future research can benefit from mixed methods designs to find how, when and under what conditions recombination of resources at individual, organizational or inter-organizational levels take place in complex entrepreneurial systems.

4.6 Towards an Organizing Framework

As the previous section delineates, applications of both mixed-methods and complexity theory are incipient in entrepreneurship research. Thus, a synthesis of them holds even a greater potential to advance entrepreneurship. In line with this fact, the foregoing discussion is, at best, a short and suggestive list of some fruitful directions for future research. Researchers who are willing to take this path need an organizing framework or a roadmap not only to choose the right mixed methods design for directing their research along suggested paths but also to explore new directions that address novel and more fine-grained questions aimed at enriching the complexity domain in the entrepreneurship literature.

Taken together, I believe that, the application of mixed methods research and the choice of the right mixed methods design to capture complexity of entrepreneurial phenomena involves four phases:

1. Identification of a complex topic. That is, an entrepreneurial phenomenon involving a large number of interconnected elements or agents with schema whose actions and networks of feedback loops shape dynamics of the phenomenon under investigation.
2. Specification of systems and subsystems that constitute the totality of the phenomenon under study.
3. The choice of the right combination of qualitative and quantitative data and methods. In this phase, researchers should justify why mixed methods designs are superior to mono-methodical ones and what the main objective of their research is and why it cannot be achieved using a qualitative or quantitative method alone. As explained earlier, a mixed-methods design can be to complement, complete, develop, expand, corroborate or illuminate diverse aspects of a phenomenon.
4. The last phase is to specify the most appropriate design based on the objective of the research. This step involves two choices: the choice of the sequence and the priority of qualitative and quantitative data in order to leverage the power of both methods to maximize the payoff of mixing them in the project. By integrating

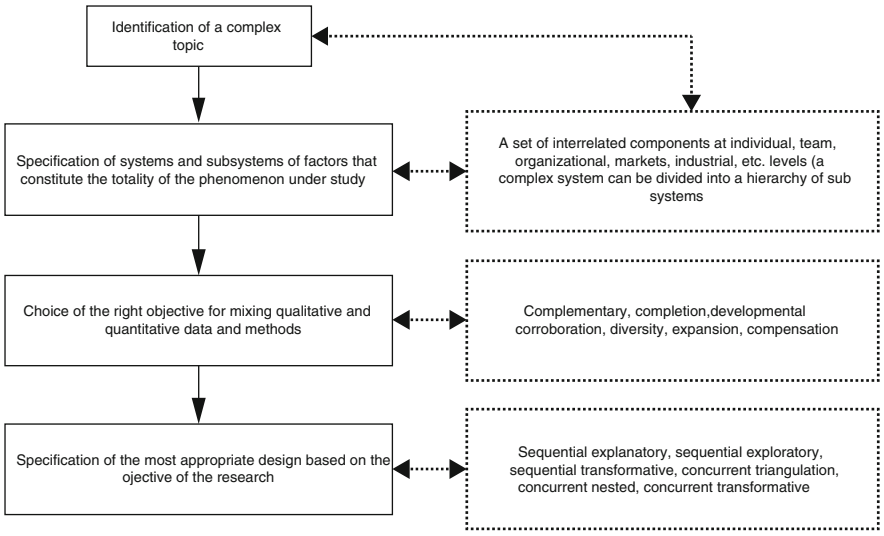

Fig. 1 An organizing framework for the application of mixed methods designs in the complexity research in entrepreneurship

these four into a framework researchers can plan and conduct mixed methods research more confidently to study complex issues in entrepreneurship. Figure 1 illustrates a schematic view of this framework.

4.7 Final Thoughts on the Framework[6]

Although the above framework highlights the potential of mixed methods research for studying complex phenomena in entrepreneurship and helps researchers design more effective research in this direction, it is prudent to discuss two of the key challenges faced by researchers when using this framework. First, as a methodology involving incompatible data and divergent analytical methods, assumptions and tools, mixed-methods designs are more resource-consuming than mono-method ones. Thus, mixed-methods is not as simple as it sounds. Mixed-methods researchers require more resources, a more carefully laid out plan, luxury of time and a wider range of research skills to conduct their research (Creswell, 2007). This is amplified by the fact that collection of qualitative and quantitative data for entrepreneurial research in one project is a challenge on its own (see Short, Ketchen, Combs, & Ireland, 2010 for a list of challenges in entrepreneurship research). Second, although mixed-methods designs afford flexible design choices and are gaining momentum in entrepreneurship (see Molina-Azorín, López-

[6] I thank an anonymous reviewer for suggesting to add this section.

Gamero, Pereira-Moliner, & Pertusa-Ortega, 2012 for a review), the complex side of entrepreneurship seems to be overlooked by mixed-methods researchers. A reason could be the fact that complex phenomena tend to have blurred boundaries (Simon, 1962). Hence, the key challenge here is not the identification of a complex phenomenon rather the specification of its boundaries. This issue should be addressed before making any choice about the type of the mixed methods design and its features. Absence of established norms for studying complexity in entrepreneurship is perhaps the main barrier in this regard. Therefore, researchers interested in using this framework are encouraged to carefully demarcate their topic of interest and clarify its theoretical and conceptual boundary by properly contextualizing it in the context (Welter, 2011) or the broader complex system in which it is taking place or embedded. Then they should assess the availability of resources and skills required by a fitting mixed-methods design. Despite these challenges I believe that the future of complexity research in entrepreneurship will be shaped by a stream of cumulative research that taps into the benefits of multiple methods.

5 Conclusion

Entrepreneurship is a complex field of research and entrepreneurial phenomena are inherently complex. Furthermore, complex systems are ubiquitous in entrepreneurship. This paper showed that traditional mono-methodical approaches based on the positivist or interpretivist paradigms offer, at best, incomplete ways to capture the essence of complexity in entrepreneurship. It further suggested that mixed methods designs are, in particular, suitable for exploring and explaining complexity in entrepreneurship because they benefit form advantages of both paradigms. Subsequently, a suggestive list of research directions and an organizing framework for designing mixed-methods research to study complexity in entrepreneurship were proposed. It is my hope that the arguments made here will motivate future research directed toward a more carefully designed use of mixed methods for studying a vast galaxy of complex issues in the entrepreneurship universe.

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