

Game theory in entrepreneurship: a review of the literature

Game theory in
entrepreneurs

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81

Abstract

Purpose – The purpose of this paper is to review the utilization of game theory in the entrepreneurship literature. Game theory can potentially be employed to assess strategies incentivizing productive entrepreneurial activities and subsequent economic development. Therefore, the author reviews entrepreneurship articles and explores the application of game-theoretic models and concepts in the literature.

Design/methodology/approach – First, the author provides an overview of the entrepreneurship ecosystem concept, highlighting key challenges in its study. The author also briefly highlights successful applications of game theory in the innovation literature. Second, the author systematically reviews and synthesizes entrepreneurship research employing game-theoretic models and concepts. The author's objective is to provide a state-of-the-art overview of the use of game theory in entrepreneurship.

Findings – Broadly, the author categorizes entrepreneurship-game theory articles into three groups based on their scope and purpose: entrepreneurial policy applications, inter-firm applications and entrepreneurship theory applications. Entrepreneurial policy applications include entrepreneurs and the government or policy as the main players in a game. Inter-firm applications encompass games between entrepreneurs and other private entities. Entrepreneurship theory applications include articles that utilize game theory to advance the author's understanding of entrepreneurial behavior and/or mechanisms in the market.

Originality/value – To the best of the author's knowledge, no previous paper has reviewed the use of game-theoretic approaches and models in entrepreneurship literature. This study addresses this research gap.

Keywords Entrepreneurship, Entrepreneurial ecosystem, Game theory, Entrepreneurship policy

Paper type Conceptual paper

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1. Introduction

Game theory is a mathematical representation of the interactions involving conflict and cooperation among two or more parties in a strategic game (Von Stengel, 2008). It helps in strategic thinking, predicting outcomes and offering decision-makers and policy-makers carefully constructed recommendations (Baniak and Dubina, 2012). Today, game theory is applicable in various social science fields (e.g. Fisk, 1984; Leng and Parlar, 2005; Muggy and Heier Stamm, 2014; Seaberg *et al.*, 2017), among others.

Our objective is to review the utilization of game theory in entrepreneurship literature for several reasons. Firstly, we believe that game theory remains underexplored within entrepreneurship literature. For instance, comparing it to a related field like innovation, a search for journal articles using the terms “*entrepreneur**” and “*game-theory*” on the EBSCOhost research platform yields 88 results, compared to 498 results for “*innovation*” and “*game-theory*”. Secondly, a growing number of entrepreneurship articles are beginning to incorporate game theory, particularly over the last decade. Thirdly, we consider that the incorporation of game theory into entrepreneurship potentially addresses several challenges,



particularly in the context of the entrepreneurial ecosystem (EE) literature. EEs are networks of interconnected actors and components that generate productive entrepreneurship (Acs *et al.*, 2017). Through the EE approach, scholars and policymakers aim to understand the systematic conditions fostering productive entrepreneurship and economic growth (Alvedalen and Boschma, 2017; O'Connor *et al.*, 2018). However, certain limitations hinder the quantitative assessment and practical application of EEs, which poses challenges for policy formulation. From a policymaking perspective, game theory could potentially aid in assessing strategies aimed at incentivizing productive entrepreneurial activity within the EE and subsequent economic development.

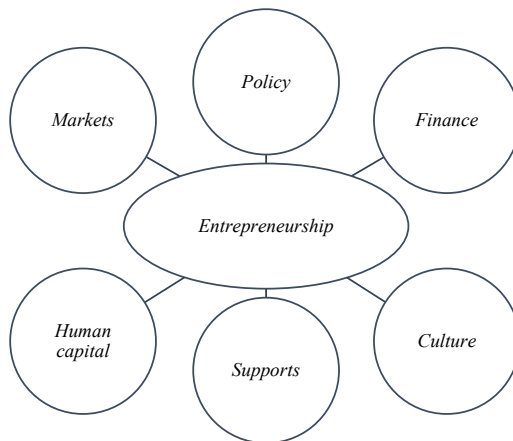
To address these issues, we conduct a review of entrepreneurship literature that integrates game theory approaches and concepts. We aim to explore the extent to which game theory has already been applied to entrepreneurship and EEs, scrutinizing the areas where the two fields have synergized effectively. This analysis enables us to offer insights about the current state of the art. One of our objectives in creating this review is to highlight a promising avenue for future entrepreneurship literature. To the best of our knowledge, no paper has yet undertaken a comprehensive review of game theory's usage in entrepreneurship literature. The remainder of this paper is structured as follows. Chapter two reviews the concept of EEs and their elements, the role of policy and the limitations of the EE approach from a policymaker's perspective. Chapter three delves into game theory and its application within the innovation literature. In chapter four, we systematically review and synthesize articles in entrepreneurship literature that use game theory. Finally, chapter five presents the conclusions drawn from this article, along with its limitations.

2. Entrepreneurial ecosystems

2.1 Overview

The concept of EE is used to describe multiple interdependent actors and components that interact in complex ways to achieve mutually beneficial outcomes. Entrepreneurial activity exists within an ecosystem comprising political, economic, social and cultural elements that are interdependent and interconnected. Ultimately, the goal of a "successful" ecosystem is to generate entrepreneurial activity that contributes value to society and fosters economic prosperity (Acs *et al.*, 2017; O'Connor *et al.*, 2018). Productive entrepreneurship, involving activities that provide net positive value to an economy, stands apart from unproductive entrepreneurship (e.g. rent-seeking), or destructive entrepreneurship (e.g. illegal activity) (Sobel, 2008). The EE approach to studying entrepreneurship aims to understand the factors driving productive entrepreneurial activity. Mason and Brown (2014, p. 6) define EEs as "*a collection of interconnected entrepreneurial actors, entrepreneurial organizations, institutions, and entrepreneurial processes which formally and informally coalesce to connect, mediate, and govern the performance within the local entrepreneurial environment.*"

In this definition, entrepreneurial actors encompass potential and existing entrepreneurs. While entrepreneurial organizations include firms, companies, banks and similar entities; institutions include bodies such as universities and the public sector and processes encompass factors like the new business birth rate and the number of high-growth firms. In short, these are all factors that affect the success and trajectory of entrepreneurial activity (Alvedalen and Boschma, 2017; Mason and Brown, 2014). One of the earlier models describing the elements of EEs was Isenberg's (2011) model, presented in Figure 1. According to Isenberg, this model includes the essential components of a productive EE. The first dimension is *policy*, which includes two key aspects: leadership and government. Ecosystem leaders advocate for innovation and entrepreneurship and provide support for the ecosystem. Moreover, government support is crucial as governments oversee the establishment of institutions and regulatory frameworks that foster innovation and entrepreneurial



Source(s): Isenberg (2011)

Figure 1.
Entrepreneurial
ecosystem elements

opportunities. They also work to eliminate bureaucratic barriers that entrepreneurs encounter. Other critical elements include *cultural aspects* such as tolerance for failure, *human capital* and a skilled labor force, various forms of *financial support* for entrepreneurs, *open markets* with receptive customers and robust networks and finally *support institutions* such as non-governmental organizations (NGOs) with a focus on entrepreneurship (Isenberg, 2011; Maroufkhani *et al.*, 2018).

2.2 Government and policy

From a policymaker's perspective, many issues arise when deciding on governmental strategies or policies to implement. For example, due to the complexity of the ecosystem, it is challenging to determine which policy caused a specific effect in some situations. Another challenge is the uncertainty of whether a policy that benefited one ecosystem's prosperity would yield the same results elsewhere. Nuances in contextual factors within EEs make it hard to find a one-size-fits-all solution for all ecosystems, regardless of location and conditions. Minniti (2008) finds mixed findings regarding the effectiveness of financing tools such as bank loans, mutual credit guarantees, microfinance schemes and attracting new ventures as means of supporting entrepreneurship. Some papers even suggest that some of these tools may have negative effects on entrepreneurial activity. Similarly, manipulating taxation in favor of new businesses to encourage entrepreneurship and regulating trade have yielded mixed results in some instances. In summary, governments have many instruments to intervene in EEs, and these instruments have significant effects on ecosystems. However, copying policies that worked in different ecosystems to foster a productive EE can be challenging.

Previous literature has highlighted several weaknesses in the EE approach in general, two of which are critical for policymakers. The first weakness is that the literature has produced frameworks of components that are supposed to induce productive entrepreneurship. An example of such a framework was presented in the previous section. However, while the components of EEs (e.g. government, networks, universities and human capital ... etc.) influence entrepreneurial activity, the challenge lies in measuring their impact when they function within a complex system, making it ambitious to study cause and effect in EE literature (Alvedalen and Boschma, 2017). The second issue is that policymakers often confuse the concept of the EEs with startups and small businesses. This confusion leads

decision-makers to target their policy interventions toward small and nascent ventures, potentially prioritizing small businesses over the quality of entrepreneurial activity. In other words, the system may not necessarily support scaling up, development, or growth (Brown and Mason, 2017).

Both of these weaknesses reveal the difficulties faced by policymakers when choosing strategies aimed to enhance productive entrepreneurial activity in a country. For example, Brown and Mawson's (2019) article indicates that policymakers generally view the entrepreneurship ecosystem concept as a valuable framework, but find it lacking in accessibility and specific guidelines for operational policymaking to achieve desired entrepreneurship ecosystem results.

Furthermore, quantitative evaluation evidence estimating an EE's effectiveness is often rare to find. In this context, governments encounter challenges because the EE framework lacks insights into strategy payoffs in the short and long terms. The EE is a conceptual framework that does not provide policymakers with a clear understanding of how entrepreneurs and the ecosystem will respond to policy interventions (Brown and Mawson, 2019). The framing of this problem resembles that of strategic games, where the government is a player intending to maximize outputs for itself and EE's entities (entrepreneurs and other ecosystem players), based on its strategy and the strategies of other players. In such situations, a game-theoretic approach can assist policymakers in their entrepreneurship-related policies, particularly because game theory is applied when a player's outcomes depend not only on his/her strategy but also on the strategies of other players (Von Stengel, 2008).

3. Game theory and its application in innovation literature

Game theory was first introduced by John von Neumann and Oskar Morgenstern in 1944 and subsequently evolved considerably through the work of John Nash in the 1950s (Carmichael, 2012). It provides a mathematical representation of conflict and cooperation among two or more parties in a strategic game (Carmichael, 2012; Von Stengel, 2008). Game theory was embraced in economics to fill a gap in the field. While economics primarily focused on describing microeconomics and macroeconomics, it lacked the tools to handle scenarios where each player's decisions affected the outcomes of all other player's decisions (Ozkan-Canbolat *et al.*, 2016). Today, game theory is widely used across various social sciences fields (e.g. see Fisk, 1984; Leng and Parlar, 2005; Muggy and Heier Stamm, 2014; Seaberg *et al.*, 2017).

3.1 Game theory and innovation

Game theory has seen more extensive use in innovation literature compared to entrepreneurship literature. A search for journal articles using the terms "*entrepreneur**" and "*game-theory*" on the Elton B. Stephens Company (EBSCO) host research platform yields 88 results, while the terms "*innovation*" and "*game-theory*" yield 498 results (journal articles/ no time limitation/title or keywords). Moreover, innovation and entrepreneurship are highly interrelated fields of study. Considering their close relationship, insights into entrepreneurship can potentially be obtained by examining game theory within the context of innovation. Baniak and Dubina (2012) classify game theory in innovation into three main levels: *meta-organizational games*, *inter-organizational games* and *intra-organizational games*. In a *meta-organizational game*, the main players typically include policymakers or entities in policy-advisory roles, and the other player(s) are entrepreneurial agents or innovative firms in the market. This type of game is highly relevant to EEs, as it helps policymakers frame the most effective policy configuration to enhance innovation and create value (e.g. Zhao and Bai, 2021).

The *intra-organizational game* focuses on innovation strategy within firms, with individuals or departments within the same firm as players. The goal here is to optimize the organizational configuration to enhance innovation (e.g. Pandher *et al.*, 2017). Lastly, the *inter-organizational game* involves different firms and can involve cooperative and/or competitive relationships. The goal here is to analyze the best strategies for a firm considering innovation while accounting for competitors and alliances. These decisions or strategies related to innovation encompass decisions like the timing of new product introduction and optimal financial investment for innovation collaborations (e.g. Qiu, 2023). From an EE perspective, interesting insights can be gained from meta-organizational games related to policy and from inter-organizational games concerning cooperation and competition.

Innovation literature provides numerous examples of meta-organizational games focused on innovation policy (e.g. see Moschini and Yerokhin, 2008; Schmidt, 2008). One noteworthy example here is Carayannis and Dubina’s (2014) article, where the players are a policymaker and a firm. In a simplified version of their model, the policymaker’s strategic options are {no tax, low tax and high tax}, while the entrepreneur’s strategic options are {no R&D, low R&D and high R&D}. The simplified game is illustrated in Table 1. The authors demonstrate that in a non-cooperative game, the Nash equilibrium is the {no R&D – high tax} configuration because neither player is incentivized to choose another strategy.

Additionally, in the context of competition and cooperation between firms, there are classic scenarios where firms must make decisions regarding their innovation and R&D strategies. Game theory proves invaluable in such cases because a firm’s R&D strategies can have significant repercussions on other firms (Baniak and Dubina, 2012). A case in point is Qiu (2023) article, which delves into the competition and cooperation strategies of leading patent technology enterprises operating within a closed-loop supply chain characterized by high technological uncertainty. The author’s findings reveal that cooperative innovation improves the investment level in technological innovations and increases the feasibility of innovative technology among patent technology enterprises in a closed-loop supply chain. Such games hold practical value for policymakers seeking to assess how firms formulate their innovation strategies, considering both market conditions and internal factors.

4. Game theory and entrepreneurship

4.1 Methodology

Searching for articles related to game theory in entrepreneurship literature yielded relatively few results. Employing a systematic literature review approach, we used both the EBSCOhost and ProQuest platforms to search for relevant papers published between 1990 and 2021. We used the keywords “*game theory*” + “*entrepreneur**” either in the title, abstract, or keywords. Our search was limited to peer-reviewed journal articles published in English. In the case of the ProQuest engine, we specifically focused on papers identified as related to entrepreneurship under the “subject” category. We also examined Google Scholar to identify any articles that might not have been captured in our initial database search. Figure 2a below

Strategies	No tax	Low tax	High tax
No R&D	0; 0	0; 0	0; 0
Low R&D	0.5; 0	0.25; 0.25	–0.25; 0.5
High R&D	1; 0	0.5; 0.5	–0.5; 1

Source(s): Carayannis and Dubina (2014)

Table 1.
Payoff matrix for innovation tax policy

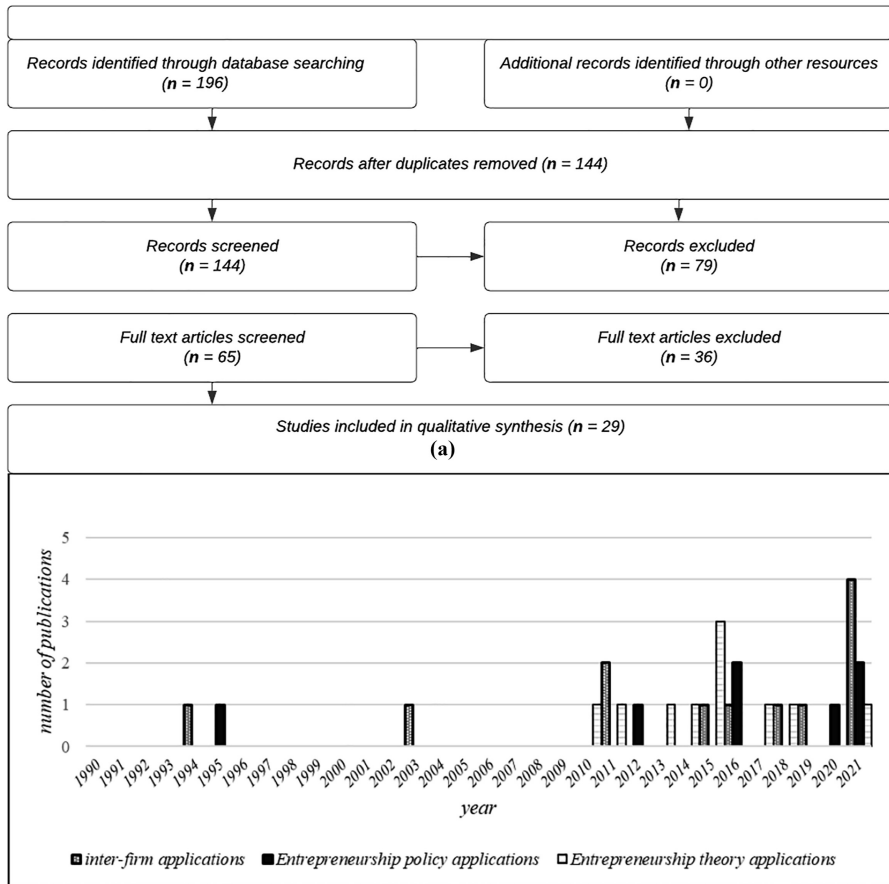


Figure 2. (a) Author's results based on the PRISMA flowchart; (b) game theory in entrepreneurship publications 1990–2021

Source(s): Figure by authors (b)

illustrates a flowchart of the review process, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart methodology (Page et al., 2021).

Initially, we identified 144 records after removing duplicate articles. Following a careful screening of these records, we excluded 79 articles for various reasons, such as being in a different language, unavailability, not being a journal article, lacking relevance to the subject, or having been retracted by the journal. Subsequently, we carefully screened the remaining 65 full-text articles and finally identified 29 papers to include in our synthesis. The following section provides detailed results from our analysis. It is important to note that we only considered articles that utilized game theory models or concepts and were focused on entrepreneurship and entrepreneurial processes and activities. Articles exclusively focused on entrepreneurship education and pedagogy were excluded, as they fell outside the scope of this review.

4.2 Results of the systematic analysis

Broadly speaking, we categorize entrepreneurship-game theory articles into three groups based on their scope and purpose in utilizing game-theoretic concepts and models. These

three groups, following [Baniak and Dubina's \(2012\)](#) classification, are (1) *entrepreneurial policy applications*, (2) *inter-firm applications* and (3) *entrepreneurship theory applications*.

Entrepreneurial policy applications include models involving entrepreneurs, government, or policy as the main players. Inter-firm applications encompass games played between entrepreneurs and other private entities (e.g. investors). Entrepreneurship theory applications include articles utilizing game-theoretic concepts or models to advance the theoretical understanding of entrepreneurial behavior and/or mechanisms in the market. [Figure 2b](#) presents the number and category of publications per year between 1990 and 2021. The figure highlights the increasing trend in entrepreneurship-game theory publications, especially post-2010. In total, there were 12 inter-firm articles, 10 entrepreneurship theory articles and only 7 entrepreneurship policy articles in the dataset.

4.2.1 Entrepreneurship policy. In our analysis, we identify seven entrepreneurship policy articles. Entrepreneurship policy applications of game theory investigate entrepreneurs and policymakers/government as two players from a game-theoretic perspective. One of the goals of such articles is to analyze how entrepreneurs react to legislation or governmental policies. [Castañeda \(1995\)](#) attempts to interpret the economy of Mexico from 1940 to 1988 from a game-theoretic perspective. Loosely using the term “entrepreneur”, the author devises a game involving three players: government, entrepreneurs and workers. While this paper is not strictly related to contemporary entrepreneurship, it is valuable for this review because it represents a meta-organizational application of game theory involving entrepreneurs (business owners) and government policy. The author presents a series of propositions that shed light on the rationale behind political, economic and socio-economic decisions in Mexico. Similarly, [Lu \(2012\)](#) explores ownership arrangements in Chinese Township-Village Enterprises (TVEs). TVEs can be privately owned or jointly owned by entrepreneurs and the government. The article uses a game theory approach to demonstrate that under certain conditions, such as an underdeveloped credit market, entrepreneurs may opt for joint ownership which assumes equilibrium as opposed to private ownership. Lu's model highlights that joint ownership is not always a more efficient solution but emerges as an option under certain contextual conditions. [Eler et al. \(2016\)](#) investigate the case of The Pirate Bay website and analyze evasive entrepreneurship from a game-theoretic perspective. The authors argue that legislation and the government's adoption of technological change lag behind the rapid pace of innovation and digitization in the broader economy. They emphasize the role of evasive entrepreneurship and provide four reasons why policymakers should carefully consider it. First, in a fast-changing market, waiting for government adoption may not be feasible for entrepreneurs. Second, slow government may lead to difficulty in determining if an innovation falls under new legislation. Third, rapid technological development necessitates continuous adjustments to legislation, leading to confusion in interactions between policymakers and entrepreneurs. Fourth, if policy inhibits entrepreneurship, it affects how future entrepreneurs direct their activity. Essentially, the article argues that “*institutions shape entrepreneurship, but the reverse is also true*” ([Eler et al., 2016](#), p. 193).

Perhaps the most relevant article for our analysis is [Dubina et al.'s \(2016\)](#). The authors employ a business simulation game approach to model a sustainable innovation and EE under conditions of uncertain external environments. They begin by formulating a conceptual model of the innovation and EE, which they then integrate with game theory and the business simulation game approach. They also argue that the successful implementation of the system is only possible through systems compromise, given the complexity of the system and the divergence of its constituents' objectives. To the best of our knowledge, this is the only paper in innovation and entrepreneurship literature that attempts to conceptually model the ecosystem and integrate it with a game-theoretic approach. More recently, [Reza-Gharehbagh et al. \(2020\)](#) conduct a meta-organization application of game theory within a specific scope. The authors evaluate different supply chain finance scenarios from the perspective of local supply chains.

Entrepreneurs managing local supply chains and competing with foreign supply chains may require financing due to budget constraints. The authors analyze the government's role in supporting local entrepreneurs by investigating peer-to-peer equity and debt financing under the government's direct and indirect intervention. [Feng \(2021\)](#) uses game theory logic in part of the paper to determine factors that foster innovation and entrepreneurship in China. The article is twofold. The first part uses a game theory model to assess how institutional quality and foreign direct investment spillovers affect entrepreneurship. In the second part, the article provides detailed data analysis related to these variables in the Chinese context. The author's findings reveal that institutional quality has a significantly positive effect on increasing entrepreneurship, while foreign investment does not have a significant effect on entrepreneurship, among other conclusions. Lastly, [Yang et al. \(2021\)](#) use an evolutionary game model to study the promotion and diffusion of green entrepreneurship innovation activities among new ventures. They explore how these activities are influenced by governmental regulation and market mechanisms, with a focus on the Chinese government. The authors draw interesting conclusions, including that market mechanisms alone are not sufficient to foster the 'benign and healthy' evolution of green entrepreneurship in the initial stages of green industries. They emphasize the importance of government support in facilitating this diffusion, among other insights.

4.2.2 Inter-firm applications. Inter-firm articles differ from entrepreneurship policy articles in that they involve interactions between entrepreneurs and other private organizations. We have identified 12 inter-firm articles, with 6 of them specifically focused on venture capital (VC) firms. [Henkel et al.'s \(2015\)](#) work offers a fresh perspective on the origins of radical innovation. Traditionally, new entrants in a market are believed to possess a higher capacity for innovation than incumbents, owing to their flexibility and the absence of existing products and customer bases. However, the authors propose another reason for entrants having a higher capacity for radical innovation, which is the existence of a technology market. This market, involving interactions between incumbents and new entrants, motivates new entrants to produce radical innovation since incumbents often acquire new entrants and commercialize their innovations. Similarly, [Chou et al. \(2016\)](#) adopt a behavioral game-theoretic perspective to study the interaction between two firms. One is a small firm with an invention, while the second is a larger entrepreneurial firm with more resources. The entrepreneurial firm requires the invention to maintain competitiveness in the market, while the smaller firm needs the larger firm's resources and management skills to commercialize its invention. The asymmetry between the two firms and various contextual factors makes an interesting game. The authors make several observations, with one of the most interesting being that if the larger firm is not sluggish and overly risk-averse, and if the smaller firm is not excessively overconfident in achieving a high payoff without the assistance of the larger firm, then two Nash equilibria exist in the game: collaboration (C, C) and no collaboration (N, N) or what the author refers to as the "valley of death".

[Bade \(2018\)](#) analyzes the multifaceted benefits of crowdfunding among entrepreneurs, crowdfunders and venture capitalists. The author demonstrates, through a multi-stage bargaining model with a double-sided moral hazard, that entrepreneurs having higher bargaining power do not necessarily translate to benefits for the venture. A higher bargaining power for entrepreneurs results in a reduced probability of crowdfunding success. Thus, the trade-off that entrepreneurs face is between venture quality and crowdfunding success. Further, the author concludes that policy should focus on the bargaining power of crowdfunders if it aims to promote crowdfunding processes and platforms. [Fairchild et al. \(2019\)](#) analyze the factors affecting a development bank's choice of a private equity partner when investing in entrepreneurship in emerging markets. The authors present a game-theoretic analysis of how the development bank's decisions are affected by economic factors and behavioral characteristics (such as passion and excitement) of private equity firms and

entrepreneurs, in addition to the bank's own emotional biases. While the article is not a case study, it incorporates the European Bank for Reconstruction and Development (EBRD) as an illustrative example. Archibald and Possani (2021) employ a Markov decision process model to analyze the optimal configuration of the contract between an investor and entrepreneur, where the investor is focused on maximizing net present value, whereas the entrepreneur's main goal is survival. The optimal contract configuration found in this article ideally involves payments that start later and are spread over a long interval, in addition to having a share of the company. It is also found that if the repayments are difficult to meet, entrepreneurs will have a decreased chance of success as they would choose riskier behavior to meet the demands of the repayments. The results of this article are theoretical. Chakraborty and Swinney (2021) investigate challenges related to relaying information about the quality of innovation to a group of uninformed crowdfunders. This article finds that an entrepreneur should convey high quality by setting a higher campaign target. Entrepreneurs with lower-quality innovations will find it difficult to mimic the high-quality target due to its cost. The article concludes that the funding target is a signaling device that conveys information about the product, contrary to its traditional view as a constraint on entrepreneurs. Further, crowdfunders infer information about products based on crowdfunding campaign design.

The remaining inter-firm application articles are related to VC firms. Fairchild (2011) establishes a game where the entrepreneur is the focal point. In contrast to previous research on the matter, Fairchild argues that when entrepreneurs decide between a VC and angel financing, they consider not only economic but also behavioral considerations. A VC has a broader and deeper set of resources than an angel investor. However, entrepreneurs can form stronger personal bonds with angel investors. The trust and empathy between angel investors and entrepreneurs lead to relational rents, which are considered a trade-off due to the double-sided moral hazard in the entrepreneur-VC relationship. The remaining five articles in this subsection discuss VC or VC-entrepreneur issues, such as the positive and negative aspects of VC syndication (Agarwal, 2011), the terms of investment contracts and the nature of VC-entrepreneur bargains considering fund size (Bowden, 1994), optimal decision timings and terms of investments and exits through IPOs (Chen *et al.*, 2021), optimal contract configuration between VCs and entrepreneurs based on a multi-period game that follows the venture from inception until exit (Elitzur and Gavius, 2003) and VC exit strategies (Yuan, 2021).

4.2.3 Entrepreneurship theory applications. The last group in our analysis encompasses articles on entrepreneurship theory. These articles utilize game theory within entrepreneurship literature to contribute to theories concerning entrepreneurial behavior and mechanisms within the market. This group might appear less directly relevant from a policymaker's perspective when it comes to EEs. Nonetheless, these articles offer insightful contributions to the entrepreneurship literature. Haase Svendsen (2010) investigated how entrepreneurs transform social capital (intangible capital that exists in social structure between humans, accessible to everyone, can be increased, not taxed . . . etc.) into economic capital (tangible capital such as monetary income). Through in-depth interviews with four Danish entrepreneurs, they identify a correlation between their strategies and game theory's prisoner's dilemma, with only one of the four entrepreneurs successfully appropriating social capital. The study also highlights that investing resources in social capital is risky for entrepreneurs. The entrepreneur who transformed social capital into economic capital did it by successfully creating systems that compel other participants in the game to actively contribute to achieving gains for all participants. Kuechle (2011, 2013) explores stable levels of entrepreneurial activity across countries, using an evolutionary game theory approach. They conclude that, at least theoretically, super-people with special attributes are not a prerequisite for higher levels of entrepreneurial activity. Further, entrepreneurial and non-entrepreneurial activities cannot displace each other as they are strategic substitutes. Along

the same lines, [Kuechle \(2014\)](#) uses a cultural evolutionary game-theoretic model to investigate how two economically similar regions can end up having varying rates of entrepreneurial activity. This article complements agglomeration literature. In the game model, individuals, who are matched pairwise, choose between becoming employed and entrepreneurs. Migrating from one region to the other, as well as imitating successful individuals, is assumed. Among several interesting observations, the model has two agglomeration equilibria, which occur in the case of early events determining region specialization (each region presents a different level of entrepreneurship) and one non-agglomeration equilibrium.

[Keyhani and Lévesque \(2015\)](#) use game theory models and computer simulations to investigate creation as entrepreneurial mechanisms in the market to advance the theory on disequilibrium and entrepreneurial rents. The authors add two reasons to the existing argument of why entrepreneurs start firms and take their product to the market themselves, as opposed to convincing others about the value of their product: (1) a small level of discovery capability is more than enough for an entrepreneur to profit considerably and (2) after starting a firm and establishing the product, the entrepreneur is in a much better position to negotiate with potential partners. The article also makes contributions to entrepreneurship strategy vis-à-vis resource allocation in the form of creation and discovery over time. [Keyhani and Lévesque \(2015\)](#) explore the equilibrating and disequilibrating dynamics of the entrepreneur in the market. They used a game-theoretical model and sophisticated computer simulations and arrived at intriguing conclusions that support and add to existing entrepreneurship market process theories.

[Arend \(2015\)](#) investigates entrepreneurship, rule-breaking and realized advantage. The author conducts a lab experiment on a group of businesspeople that includes entrepreneurs. The group competes in a simple game of rock-paper-scissors but with modifications to the game that enable strategy instead of chance, as well as rule-breaking. The article finds that entrepreneurs will break rules more often than non-entrepreneurs. Further, entrepreneurs will benefit from breaking the rules more than non-entrepreneurs because they do it “in a smarter way”. The article attempts to explain the relationship between entrepreneurs, rule-breaking and inter-firm competitiveness. [Pineiro-Chousa et al. \(2016\)](#) examine how entrepreneurs manage their reputation, a driver of entrepreneurial sustainability, from a game-theoretic perspective. The authors demonstrate how the entrepreneur frames and subsequently manages reputation in three directions: risk source, competitive advantage and core value. Perceiving reputation as a risk results in a prisoner’s dilemma game. Perceiving reputation as a competitive advantage results in an innovator’s dilemma game. Perceiving reputation as a core value results in a novel game where entrepreneurs adopt reputational thinking in their business philosophy, affecting all actions and decisions. [Huang et al. \(2018\)](#) utilize game theory to investigate how entrepreneurs should allocate their time to potential buyers when entering an existing market with a superior technological product. The article highlights two important aspects of the market in this scenario: the impact of influential customers on target customers and how incumbents will react. Entrepreneurs manage both these aspects while recognizing/managing a scarcity of resources and reputation, among others. [Bi et al. \(2021\)](#) study the trust behaviors of entrepreneurs in a dynamic environment compared to managers and professionals. Using a behavioral game theory trust game, the authors study the differences in trust building, trust violation and trust recovery between the entrepreneurs and the two groups of non-entrepreneurs. The results of the article demonstrate that there are significant differences between entrepreneurs and non-entrepreneurs. The entrepreneurs in the study built and lost trust quicker and they were faster in recovering from trust violations than non-entrepreneurs. Thus, the authors speculate that it is perhaps due to the volatile and risky environments of entrepreneurs, to which they must adapt.

5. Discussion and conclusions

The primary objective of this paper was to review articles in entrepreneurship literature that utilize game theory while highlighting the significance of such approaches. Through our analysis, we identified three primary categories of articles based on their application of game theory: entrepreneurship policy applications, inter-firm applications and entrepreneurship theory applications. Entrepreneurship policy and inter-firm applications offer direct insights for shaping policy within EEs. In entrepreneurship literature, game theory has been integrated into entrepreneurship policy papers that investigate how entrepreneurs respond to relevant policies, exploring economic and political strategies and their outcomes (Castañeda, 1995), optimal economic configurations (Lu, 2012), incentives (Reza-Gharehbagh *et al.*, 2020), evasive entrepreneurship, governmental response to technological change (Elert *et al.*, 2016), methods to stimulate entrepreneurship (Feng, 2021) and specific forms of entrepreneurial activity like green innovation (Yang *et al.*, 2021). Most importantly, game theory can also simulate an EE and address issues of sustainability in the system (Dubina *et al.*, 2016). This underscores game theory as a potential solution to address the challenges of the EE literature discussed in this article.

Inter-firm applications also offer valuable insights for policymakers, elucidating how entrepreneurial firms engage with and react to others in the system. The inter-firm articles primarily focus on finance and VC firms (Agarwal, 2011; Bowden, 1994; Chen *et al.*, 2021; Elitzur and Gavious, 2003; Fairchild, 2011; Yuan, 2021). However, game-theoretic approaches can simulate games between organizations involving strategy (Chou *et al.*, 2016), innovation capability (Henkel *et al.*, 2015), crowdfunding considerations (Bade, 2018; Chakraborty and Swinney, 2021), entrepreneur and investor contracts (Archibald and Possani, 2021) and other pertinent issues. Thus, using game theory solely for finance-related matters is limiting. Our review suggests that game theory's scope in entrepreneurship and EE literature can be expanded to encompass a wider range of interactions (e.g. entrepreneurs – universities, entrepreneurs – support organizations ... etc. ...)

Finally, entrepreneurship theory articles leverage game theory to contribute to the theory and mechanisms of entrepreneurial behavior and decision-making. This group of articles touches on critical areas ranging from entrepreneurial processes within economics theories (Keyhani and Lévesque, 2015; Keyhani *et al.*, 2014; Haase Svendsen *et al.*, 2010; Kuechle, 2011, 2013, 2014) to entrepreneurship behavior and action (Arend, 2015; Bi *et al.*, 2021; Huang *et al.*, 2018; Pineiro-Chousa *et al.*, 2016). Some of the issues raised in entrepreneurship theory articles have practical value in informing policy and entrepreneurship literature.

Overall, our analysis reveals several benefits of applying game theory in entrepreneurship. Firstly, game theory models aid entrepreneurs and policymakers in understanding strategic interactions among various actors within an EE, such as entrepreneurs, investors and government agencies. By analyzing these interactions, game theory provides insights into optimal decisions for achieving individual goals. Secondly, it identifies interactions between entrepreneurs and incumbents. Thirdly, game theory can help analyze the role of regulations and policies in shaping the behavior of actors within an EE. By modeling interactions between institutions and entrepreneurs, game theory provides insights into the effectiveness of different policy interventions. Lastly, game theory predicts outcomes in different EE scenarios, facilitating the design of incentive mechanisms aligning the interests of different actors in an EE.

This article has certain limitations. Firstly, it is a qualitative review paper that examines prior applications of game theory in entrepreneurship. Technical considerations regarding the applicability of game theory in entrepreneurship and EEs may not be addressed here. Secondly, the scope of this paper was restricted to summarizing the main concepts of the reviewed articles. However, some articles possess nuances and contributions not highlighted due to their intricacies. Thirdly, articles oriented toward pedagogy and entrepreneurial education were excluded, as they lie beyond the scope and aims of this article.

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