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Original Article

Game Theory and the Dynamics of Entrepreneurial Decisions in Free Markets

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ABSTRACT

This paper examines the role of game theory in entrepreneurial decision-making within dynamic markets. While classic models like the Nash Equilibrium explain strategic interactions, they often overlook market changes, innovation cycles, and adaptive entrepreneurship. The Austrian School's market process theory focuses on entrepreneurial discovery and continuous adaptation instead of rigid strategies. Case studies of Tesla and Uber compare game theory with Austrian economics. Simulation-based models, such as agent-based modelling (ABM) and evolutionary game theory (EGT), assess competitive adaptability and strategic decision-making under uncertainty. Findings suggest that static equilibrium models fail to capture strategic flexibility and industry transformation. Entrepreneurs succeed by iterating rather than following fixed plans. Simulation-based models better reflect competitive dynamics, showing that organizations embracing agile learning and adaptation maintain an advantage over those relying on traditional optimization. This paper highlights the need to integrate entrepreneurial theories with dynamic game-theoretic approaches. This paper further proposes a dynamic game-theoretic model that integrates entrepreneurial discovery, uncertainty, and adaptive market shaping.

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INTRODUCTION

Game theory provides the framework for analyzing the strategic decision-making of entrepreneurs and market participants in competitive situations (Lu, 2024; Bekius & Gomes, 2023). Game theory allows firms to negotiate cooperation, rivalry and legal barriers to maximise profits by simulating interactions whose outcomes depend on interdependent decisions (Xu, 2024; Schelling, 2010). Entrepreneurs work in an environment characterized by ambiguity and lack of knowledge, which is why strategic decisions are very important (Peng, 2019). Extensive games and Nash equilibrium are two classic game theory models that provide insights into competitive dynamics and ideal strategies (Al Omari, 2023). But these models ignore the non-linear, adaptive nature of entrepreneurial decision-making in dynamic markets and assume rational decision-making under fixed conditions (Haiyan, 2018).

Entrepreneurs aggressively change and redefine existing market conditions through innovation, risk-taking and strategic positioning, thus going beyond their reaction to these conditions. Particularly through the writings of Hayek, Kirzner and Mises (Kirzner, 1987; Andersson & Hudik, 2022), the Austrian School of Economics emphasizes the dynamic nature of market processes, entrepreneurial discovery and competitiveness. In contrast to theories of steady-state equilibrium, Austrian economists claim that markets change through constant entrepreneurial innovation and adaptation. Applying a Schumpeterian perspective to game theory, Maurer and Fritzsche (2024) show how entrepreneurial action causes creative destruction to promote change in markets. Their study of the American steel sector emphasizes how strategic contacts between industrialists such as Andrew Carnegie and J.P. Morgan changed the competitive environment (Harvey et al., 2011). This historical perspective shows how poorly conventional equilibrium-based models capture the function of entrepreneurship in market dynamics.

Strategic contacts in entrepreneurship go beyond rivalry. Trust between entrepreneurs and venture capitalists is very important. Using reinforcement learning integrated into game theory, Haiyan (2018) has modelled trust building and shown how venture capitalists reduce risk by spreading funding across the different stages of the venture. This emphasizes that entrepreneurship is a process of continuous development and not a one-off strategic decision. Interactions between investors, market entry and resource allocation are also guided by game theory (Xu, 2024). Research shows that strategic games improve entrepreneurial capabilities by fostering resilience, innovation and risk tolerance (Kouakou et al., 2019; Sharma et al., 2023), demonstrating the usefulness of game mechanisms for entrepreneurial decision-making. Navigating uncertain business contexts and supporting the argument that game-theoretic methods should consider adaptive learning and strategic flexibility depend on these qualities.

Government intervention influences entrepreneurial decision-making by incentivizing and stabilizing financial markets. While Al Omari (2023) emphasizes the need for legislators to control entrepreneurial activities, Reza-Gharehbagh et al. (2019) have used a game-theoretic model to show how tariffs and subsidies reduce speculation. Beyond rivalry, the game-theoretic design of efficient incentive structures supports sustainable entrepreneurship by unravelling market failures. Using historical industry revolutions under competitive conditions, Maurer and Fritzsche (2024) found that game-theoretic tactics help entrepreneurs anticipate disruption, negotiate alliances, and adapt to regulatory changes, benefiting the digital and technology sectors.

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With a view to corporate decision-making in dynamic markets, this paper will analyze the interfaces between game theory and the Austrian School. The aim of this study is to highlight the synergies and limitations of the two methodologies by analyzing how these two frameworks understand strategic interactions, innovation and competitiveness.

To assess the extent to which they reflect the changing nature of entrepreneurial markets, this paper will undertake a critical review of the static equilibrium notions of game theory. On the other hand, it will examine the process-oriented market idea of the Austrian School, which emphasizes discovery, competition and adaptation, to determine whether it provides a broader justification for entrepreneurial activity. Finally, this paper will develop a game-theoretic model linking strategic choice, market disruption and entrepreneurial creativity. The proposed model attempts to bridge the gap between conventional game theory assumptions and the reality of entrepreneurship in a changing market environment by incorporating dynamic elements such as uncertainty, adaptation and competitive responses.

Research question(s)

The following research questions are answered in this thesis: To what extent can game-theoretical models adequately reflect the strategic behaviour of entrepreneurs in dynamic markets given the complexity of invention, uncertainty and competitive relationships? Are there certain situations in which equilibrium-based game-theoretical models are not sufficient to adequately capture market disruption and entrepreneurial innovation so that other or modified models are required?

THEORETICAL BACKGROUND

Introduction to Game Theory Models (Equilibria, Extensive Games, Dynamic Games)

Game theory provides a mathematical framework for understanding strategic interactions in which the decisions of competitors, legislators and market participants influence the decisions of an entrepreneur. Equilibrium analysis, a basic tenet of game theory, states that rational players search for ideal strategies depending on the expectations of others. Nash equilibrium, the most commonly used equilibrium theory, explains a stable outcome in which none of the participants benefit from unilaterally changing their course of action (Kreps, 1989; Nash, 1950). This structure fits situations such as regulatory compliance, market entry strategies and pricing decisions (Bauso, 2014). However, the ability of the Nash equilibrium to reflect entrepreneurial uncertainty and innovation-driven competition is limited by the assumption of fixed desires and complete rationality.

Extensive games incorporate timing and strategic actions into the analysis to make sequential decisions. By examining judgements backwards from the end of a scenario, these models use backward induction to determine the best solutions (Myerson, 1991). For example, when launching competing products, technology companies such as Apple and Samsung use extensive forms of strategic planning. In addition, recurrent games examine how defection and co-operation change over time - a paradigm relevant to price conflict, compliance and strategic alliances (Bauso, 2014).

Dynamic games involve unpredictability, adaptation and learning over time and thus go beyond static models (Rubinstein & Tirole, 1989). These games capture long-term strategic interactions such as changing government regulations, competition between startups and incumbents, and venture capital cycles. An interesting development is reinforcement learning models that replicate adaptive trust between investors and entrepreneurs. Haiyan (2018) has

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developed a multi-stage game model in which venture capitalists change their funding methods depending on the efforts of entrepreneurs, reflecting a non-linear process of trust building. Although they have advantages, dynamic games can rely too much on reasonable assumptions and have difficulty replicating radical upheavals triggered by entrepreneurial ideas.

The Principles of the Austrian School: Entrepreneurship, Market Processes and Spontaneous Order

The Austrian School of Economics, which focuses on entrepreneurial discovery, market dynamics and distributed coordination rather than equilibrium-based modelling, offers a different perspective. In contrast to game theory, which attempts to make ideal strategic decisions within a fixed framework (Hayek, 1945), the Austrian School views markets as changing and inherently uncertain.

A key idea is entrepreneurship as discovery. Entrepreneurial consciousness, first proposed by Kirzner (1973), is the idea that entrepreneurs recognise and seize once-overlooked profit opportunities. In contrast to game-theoretic models in which rational actors maximise within a given framework, Austrian entrepreneurs change markets, create new opportunities and disrupt equilibria (Douhan et al., 2007). This view fits with Schumpeter's idea of creative destruction (Wolfe, 1943), in which new ideas constantly challenge current market systems and render stationary equilibrium models inadequate.

Market process theory is another fundamental concept that challenges the assumption that markets move towards a stable state of equilibrium. Instead, the Austrian school argues that economic coordination does not come about through fixed strategies but through dispersed behaviour (Foss, 2000). In contrast to game theory, which approximates strategic interactions within well-defined boundaries, the Austrian school assumes that market interactions cannot be restricted to a set of rules (Peng, 2019).

Finally, the Austrian School emphasises that the fundamental entrepreneurial skill is to tolerate uncertainty. In an environment of extreme uncertainty, entrepreneurs have to deal with truly uncertain outcomes and not just probabilistic ones (Samuels et al., 2003.). This is in contrast to game theory, which assumes strategic uncertainty and assigns odds to the actions of rivals (Bauso, 2014). Austrian philosophers claim that entrepreneurial success depends not only on strategic optimization but also on judgement, foresight and the ability to anticipate future requirements.

Comparison of the Two Approaches and Possible Areas of Tension

The Austrian school and game theory offer different but complementary perspectives on market competitiveness and entrepreneurial decision-making. While the Austrian school emphasises market dynamics, adaptation and non-equilibrium processes (AlOmari, 2023), game theory offers disciplined methods for assessing strategic interactions. Especially with regard to equilibrium, formalism and political consequences, these differences lead to potential areas of tension in the theory.

The treatment of equilibrium versus process is a key difference. According to game theory, rational actors align themselves with stable strategy profiles such as the Nash equilibrium, which determines behaviour in a competitive environment (Nash, 1950). In contrast, the Austrian school views markets as constantly changing, with companies constantly changing the competitive environment (Kirzner, 1973). For example, Maurer and Fritzsche (2024) examined historical industrial transitions such as the growth of the US steel sector using game theory, but found that equilibrium models overlook disruptive breakthroughs and creative destruction.

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Formalism vs. realism is another important conflict. Although mathematically exact, game-theoretic models can oversimplify entrepreneurial activities by assuming complete rationality and fixed strategies (Peng, 2019). In contrast, Austrian thinkers prioritize real-world complexity, ambiguity and emergent decision-making. They claim that formal mathematical frameworks cannot adequately capture market dynamics (Foss, 2000). This discrepancy is particularly evident in venture capital investment, where the Austrian understanding of confidence building and adaptation (Haiyan, 2018) contrasts with game theory, which focuses on strategic responses and structured incentives.

A third area of conflict is the policy implications. In regulatory economics, game theory has been used extensively to develop policies that influence market behaviour, including antitrust laws, subsidies and price restrictions (Reza-Gharehbagh et al., 2019). In contrast, the Austrian school argues that government intervention distorts natural market processes and thus suppresses entrepreneurial innovation and spontaneous order (Mises, 1949). For example, while game theory favours state-imposed financial market rules to curb speculation (Reza-Gharehbagh et al., 2019), Austrian thinkers would advocate laissez-faire techniques to maintain the adaptability of the market. Notwithstanding these differences, recent studies show possible synergies between the two strategies. Dynamic games that correspond to Austrian concepts of learning, adaptability and reputation building, such as the repeated prisoner's dilemma, fit both models. Moreover, both models recognise asymmetric information as the main driver of market behaviour. Austrian thinkers focus on entrepreneurial innovation and knowledge generation, while game theory analyses the strategic exploitation of asymmetric information (Douhan et al., 2007).

In essence, the Austrian School's focus on entrepreneurial discovery, innovation and market dynamics provides a critical contrast, even as game theory provides disciplined analytical tools. Future studies could look at hybrid models that bridge the gap between formal prediction and actual entrepreneurship by combining organised strategic thinking with dynamic, non-equilibrium market dynamics.

METHODOLOGICAL APPROACH

The method requires empirical analysis, modelling and a thorough review of the literature. To assess its application to dynamic markets, the literature review focuses on the methods of classical game theory, including Nash equilibrium and extensive games (Kreps, 1989; Nash, 1950; Myerson, 1991.). It also looks at the Austrian School's views on market processes, particularly those of Hayek, Kirzner and Mises, to examine their applicability to entrepreneurship and innovation.

To explain market entry strategies and disruptive breakthroughs, a dynamic game-theoretic model is presented (H. Zhang, 2021; Truong-Huu & Tham, 2013). Under uncertainty, this model accounts for strategic decision-making and thus enables a thorough analysis of competitive dynamics and entrepreneurial activities in evolving markets.

To demonstrate the useful consequences of the theoretical framework, the empirical analysis combines real-world case studies such as Tesla, start-ups and platform markets (Paldam, 2021; Akushevich & Yashin, 2016). These cases shed light on how companies negotiate regulatory constraints, creativity and competitiveness. To validate the theoretical models, simulations are conducted that allow a quantitative assessment of strategic interactions under different market conditions. The study aims to improve game-theoretical applications in entrepreneurship by combining theoretical insights with empirical observations, thus enhancing knowledge about competitive dynamics, market disruptions and regulatory interventions. Literature review, modelling and simulation together form a strong and all-encompassing methodological foundation.

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Example of a Dynamic Game-theoretical Model for Modelling Entrepreneurial Decisions

In order to bridge the theoretical gap between classical equilibrium models and the process-oriented perspective of the Austrian School, a dynamic game-theoretical model is proposed below that depicts central aspects of entrepreneurial discovery and market transformation. The model is based on a multi-period game with two entrepreneurs who can choose between three strategic options in each period:

Exploration: The search for new business opportunities that are unknown ex-ante and are payoff-structurally modelled by random distributions with high variance. Early exploration can lead to long-term competitive advantages (first mover effect).

Exploitation: The utilisation of existing market opportunities with known but limited returns, based on established market conditions.

Inactivity: Refraining from action to minimize losses in the event of extreme uncertainty or market volatility**.**

The information structure is incomplete and dynamic: findings from earlier periods lead to learning processes that influence strategic decisions in later periods. Payoffs are not deterministic, but endogenous and co-determined by entrepreneurial activities. This creates an iterative, market-shaping process in which market equilibria are not assumed, but emerge through entrepreneurial interaction. This model is in line with the Austrian School's view that markets function as discovery processes (Kirzner, 1973) and that innovation is not understood as a reaction to predetermined incentives, but as a creative act. Dispensing with exogenous equilibrium assumptions allows spontaneous order (Hayek, 1945), creative destruction (Wolfe, 1943) and path dependence (Kerin et al., 1992) to be modelled within a game-theoretical framework.

The proposed model is suitable for further development in agent-based or simulation-supported settings and forms a theoretical bridge between formal strategic analysis and the open, dynamic market processes of the Austrian tradition.

Simulation of a Dynamic Game-theoretical Model for Entrepreneurial Decision-making under Uncertainty

In order to further concretise the conceptual considerations of the model from section 3.1 and at the same time enable empirical simulation-based validation, an exemplary agent-based simulation is presented below. This serves to analyse the effect of dynamic strategic options, exploration, exploitation and inactivity, under conditions of incomplete information, strategic uncertainty and endogenous feedback.

The objective of the Simulation

The simulation aims to test the hypothesis that entrepreneurial success in dynamic markets is based less on static optimisation and more on adaptive behaviour, iterative learning and strategic flexibility. At the same time, it is analysed whether these conditions result in long-term advantages for explorative actors - in particular in the sense of a first-mover advantage, as often described in the innovation literature (Kerin et al., 1992).

Model Structure

The simulation is based on a temporally iterated game between two entrepreneurial agents (A and B) who can choose between the following three strategic options in each period $t \in \{1,...,T\}$:

- Exploration (E): Search for new, ex-ante unknown market opportunities. The payout is based on a random distribution with high variance:

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πEt∼N(μE,σE2)with
μE=1.2,σE=1.0πEt∼N(μE,σE2)with
μE=1.2,σE=1.0

- Exploitation (X): Utilisation of established market opportunities with known, stable but limited returns:

πXt=1.0πXt=1.0

- Inactivity (I): Strategic restraint to minimise losses with extreme uncertainty, payout:

πIt=0πIt=0

In each period, the agents observe the payoffs of the previous period and adjust their choice of strategy using a simple adaptive learning mechanism (reinforcement-based behaviour). The following applies:

- Successful strategies are more likely to be repeated.
- Interactions arise because the payoffs from E can also change due to the behaviour of the other agent (e.g. "crowding out" or "co-creation" of new market opportunities).

Information Structure

The agents do not have complete information about the distribution of payoffs at E, but learn this over time through experience. This endogenous learning curve reflects central assumptions of the Austrian school: ignorance, subjective judgement, and iterative discovery.

The procedure of the Simulation

- Initialisation of the agents with neutral strategy preference (e.g. 1/3 probability distribution).
- Execution of the strategy decisions for T = 50T = 50 periods.
- Adjustment of the probabilities using a reinforcement-like algorithm:

$$p_s^{t+1} = \frac{p_s^t \cdot (1 + \alpha \cdot \pi_s^t)}{\sum_{s' \in \{E,X,I\}} p_{s'}^t \cdot (1 + \alpha \cdot \pi_{s'}^t)}$$

with learning rate $\alpha > 0$

- Observation of strategy development, path dependencies and resulting performance distributions.

Expected Results and Theoretical Relevance

The simulation allows statements to be made about,

- whether explorative strategies bring long-term advantages under certain framework conditions (e.g. high uncertainty),
- how important flexible adaptation mechanisms are over time,
- whether reactive versus creative strategies result in structural competitive differences.

At the same time, this approach concretises the theoretical bridge between game theory and the process-oriented view of the Austrian school. It shows that it is not equilibrium but iteration, learning and spontaneity that are decisive for entrepreneurial success - and thus operationalises central concepts such as "spontaneous order" (Hayek, 1945) and "entrepreneurial discovery" (Kirzner, 1973).

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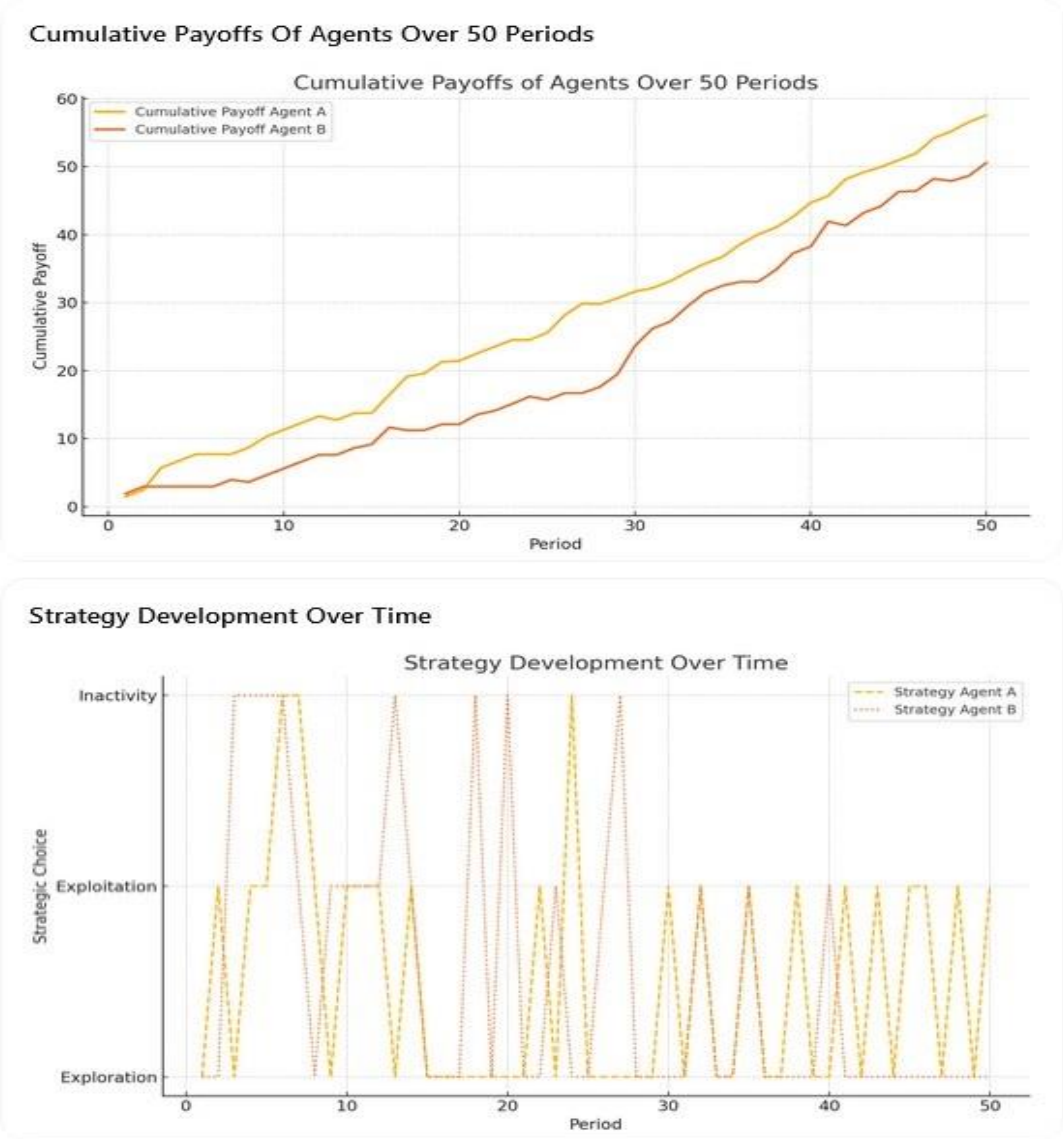
Figure 1: Own Illustration Based on an Agent-based Simulation, Created Using Python and Matplotlib in Collaboration with ChatGPT (OpenAI, 2025).



Simulation Results and Analysis

In order to concretise the theoretical considerations of adaptive strategic decision-making in dynamic markets, an exemplary agent-based simulation was carried out. The aim was to empirically operationalise the model developed in section 3.2 and to investigate the influence of exploration, exploitation and inactivity on entrepreneurial success under uncertainty.

The simulation covered 50 periods with two agents (entrepreneurs A and B) who chose one of three possible strategies in each round: Exploration (searching for unknown opportunities with high variance), Exploitation (exploiting established opportunities with stable returns) and Inactivity (to avoid losses in highly volatile situations). The probabilities for strategy choice were dynamically adjusted by simple reinforcement learning - successful decisions led to a higher probability of repetition with a learning rate of $\alpha = 0.1$.

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Results and Observations

The cumulative evaluation of the simulated payoffs over all periods shows that explorative behaviour was associated with higher total returns in the long term albeit with the acceptance of short-term volatility. In particular, agents who made exploratory decisions at an early stage benefited from first-mover effects and were able to prevail over more risk-averse strategies.

The agents periodically adjusted their strategy preferences based on individual experience with returns from previous decisions. This iterative adaptation leads to path-dependent learning curves, which classical static equilibrium models cannot reproduce. It is also striking that inactivity was rarely chosen permanently, as explorative and exploitative strategies proved to be economically superior despite uncertainty.

Implications for Theory

These results support central assumptions of the Austrian school, in particular the concept of entrepreneurial discovery (Kirzner, 1973) and Hayek's idea of spontaneous order (Hayek, 1945). The model shows that it is not ex-ante known equilibria that structure entrepreneurial behaviour, but rather iterative learning, strategic flexibility and subjective risk assessments. By dispensing with exogenous equilibrium assumptions and including endogenously generated returns, a dynamic understanding of markets as processes continuously shaped by entrepreneurial interaction is operationalised.

This simulation thus not only represents a methodological tool for analysing strategic learning processes, but also provides theoretical evidence for the necessity of linking dynamic game theory with process-oriented market approaches. The results emphasise the importance of adaptive strategies in an entrepreneurial context and provide starting points for further empirical and simulation-based research.

RESULTS

Analysing Game Theory Models in the Context of Dynamic Markets

Entrepreneurial Behavior and Strategic Interaction

Entrepreneurs operate under conditions where their success depends on the behaviour of competitors, regulatory changes and technological developments. By modelling competition, cooperation and adaptive strategies, game theory provides a disciplined framework for studying these strategic interactions (Burguillo, 2017). Nevertheless, static equilibrium models may not be sufficient to adequately capture the volatility and change of dynamic markets. Entrepreneurs, who often rely on game theory principles to anticipate the actions of their competitors, maximise their market position and respond to market disruptions, act strategically to maximise opportunities and reduce risks (Bauso, 2014).

Market entry strategy is one of the most important applications of game theory in entrepreneurship (Heiets et al., 2023). Game theory helps to assess the reactions of incumbents, which entrepreneurs analyzing entry into a competitive market must do. Price containment and predation games are two examples of entry deterrence models that can be used to predict how existing firms will strategically lower prices, increase capacity or increase marketing budgets to fend off new competitors (Tirole, 1988). The airline sector provides a real-world illustration of game-theoretic first-mover advantage and retaliation strategies; major airlines sometimes lower prices and increase service frequency to challenge new competitors (Dixit et al., 2006; Gruca & Sudharshan, 1995).

Using models such as Bertrand and Cournot's competition, game theory also illustrates the pricing policy of competition. While the Cournot model, which assumes competition through production volume adjustments, shows how companies

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strategically manage their supply in order to maximise their market influence, the Bertrand model (Baye & Kovenock, 2018), in which companies compete by setting prices, predicts that strong price competition reduces profits. These models shed light on price wars in industries such as consumer electronics and e-commerce, where companies use deliberate price undercutting or output restrictions to gain a competitive advantage.

Beyond rivalry, cooperative game theory clarifies interactions such as venture capital, alliances and partnerships (AlSkaif et al., 2015). To pool resources, leverage technologies or increase market reach, entrepreneurs sometimes collaborate with investors, research labs or industry experts. Bargaining games and coalition building are among the game-theoretic models that examine how firms negotiate investment terms, allocate equity and determine profit-sharing arrangements (Haiyan, 2018). Trust building is a fundamental component of these encounters; it is naturally dynamic and changing rather than fixed. Using reinforcement learning to simulate the dynamics of trust in venture capital investments, Haiyan (2018) found that caution in the early stages, followed by a stronger alignment of investments, creates successful alliances in the long term.

Strategic interactions in innovation-driven sectors further emphasize the role played by dynamic game theory models (Sutton, 2001). Entrepreneurs in sectors such as artificial intelligence, biotechnology and green energy must anticipate changes in consumer demand, competitor development and government policy. Real options games and other game theory models simulate situations in which companies decide whether to speed up or slow down investments depending on uncertainty (Grenadier, 2002). This illustrates why some companies choose an aggressive first-mover approach, while others would rather wait for regulatory clarity or technological maturity as part of a conservative approach.

Especially when describing radical innovations, disruptive technologies and the reconfiguration of markets (AlOmari, 2023), standard game-theoretical models have difficulties in adequately reflecting the full complexity of entrepreneurial decision-making, despite these applications.

Limitations of the Static Equilibrium Concept for Explaining Innovations

Static equilibrium models assume that markets inevitably move towards stable states in which all actors maximise their strategies depending on reasonable expectations and fixed preferences. However, entrepreneurial creativity challenges these assumptions, as markets in the real world are characterised by constant change, uncertainty and disequilibrium (Kirzner, 1973).

The Nash equilibrium assumption of fixed strategic contexts, in which participants choose optimal responses depending on the known behaviour of competitors, largely restricts the modelling of innovation. However, entrepreneurs actively change sectors and provide disruptive innovations - they do not just react to market conditions (Maurer & Fritzsche, 2024). Because of this difference, conventional game-theoretical models are unable to reflect the uncertainty and non-linear effects of disruptive ideas (Maurer & Fritzsche, 2024).

An important example is Tesla's disruption of the automotive sector. Traditional static equilibrium models could not predict Tesla's strategic impact, as incumbents assumed that electric cars would remain a niche market due to high costs and limited infrastructure (Xiao, 2024; Olorunfemi, 2024). However, Tesla's approach of increasing battery production, incorporating software advancements and utilizing government incentives turned conventional wisdom on its head and forced competitors to change quickly (Bohnsack et al., 2013). Static models neglected the entrepreneur's ability to redefine market conditions, rather than optimizing only within them, and thus failed to predict this change.

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Understanding entrepreneurial innovation cycles depends on adaptive learning and repetitive feedback loops. Another weakness of static equilibrium models is therefore the absence of these elements (Ahmed et al., 2023; Dagunduro et al., 2024). Assuming known payoff structures, traditional game theory treats interactions as one-shot or finitely repeated games. However, entrepreneurs in the real world are constantly experimenting, pivoting their business models and testing markets (Reza-Gharehbagh et al., 2019).

With an emphasis on rapid prototyping, iterative market feedback and incremental change, the lean startup approach is more akin to dynamic game theory than static equilibrium models (Bortolini et al., 2018). Entrepreneurs change their business models in response to real-time market feedback rather than sticking to predefined strategy paths. Static models are less useful in studying contemporary entrepreneurial behaviour as they lack adaptive flexibility.

Moreover, first-mover advantages and path dependence (Kerin et al., 1992) are difficult to explain with equilibrium-based models. Those who introduce disruptive technologies or new business models often have an early advantage that their rivals find difficult to overcome. For example, early aggressive investments (Challa et al., 2022) led to Amazon's dominance in web services (AWS), which could not be predicted by stationary game theory, as traditional models assumed that retail-focused competitors would adapt quickly and compete effectively (Gawer & Cusumano, 2014; Carreno, 2025).

Furthermore, game theory's reliance on rational choice models ignores the role that intuition, vision and behavioural biases play in entrepreneurship (Peleckis, 2015; S. X. Zhang & Cueto, 2015). Many successful entrepreneurs rely on heuristics, gut instincts and non-linear decision-making techniques that cannot be measured by conventional game theory models. In particular, Kirzner's idea of entrepreneurial vigilance, the Austrian School of Economics, offers a different perspective that emphasizes entrepreneurial discovery, opportunity identification and market adaptation rather than equilibrium optimization (Foss, 2000).

Case Studies, Model Applications and Simulation

Market Entries and Disruptive Innovations

When entrepreneurs enter dynamic markets, they have to manage technological changes, negotiate the regulatory environment and predict competitors' reactions, which entails great strategic uncertainty. Using a framework, game theory helps entrepreneurs make informed decisions by analyzing market entry strategies and the impact of disruptive technologies (AlOmari, 2023).

A clear example of game theory ideas when entering the market is Tesla's revolution in the automotive sector. Assuming a static equilibrium, traditional car manufacturers assumed that electric cars would remain a niche product given the high cost and limited infrastructure. However, Tesla's calculated market launch showed strong advantages for the first step and the long-term will to change the existing quo (Xiao, 2024; Olorunfemi, 2024).

Tesla's Strategic Entry and Disruption

By using an iterative, dynamic market approach, Tesla's market entry strategy differed from conventional Nash equilibrium models, which assume stationary competitor behaviour. To build trust in the brand, Tesla initially focused on the premium market with high-end vehicles such as the Roadster and Model S (Liang, 2022). To reduce costs and solve supply chain issues, Tesla then scaled battery manufacturing and invested in gigabyte facilities (Vizologi, 2024). The company has developed a self-contained ecosystem that strengthens its competitive advantage by combining energy solutions, charging infrastructure and software updates. With this adaptable approach,

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Tesla has been able to outmanoeuvre the established players in a rapidly changing sector and transform the electric vehicle market.

From a game theory perspective, Tesla's approach mirrors real-world option games where companies defer or accelerate investments depending on market volatility (Grenadier, 2002). Tesla used dynamic pricing, network externalities and vertical integration to force competitors to adopt reactive tactics (Xiao, 2024; Olorunfemi, 2024), in contrast to conventional car manufacturers that follow Cournot competition, where companies adjust their production to match the competition.

Tesla's success forced established manufacturers such as Ford and Volkswagen to change their plans. Initially reluctant to invest in e-mobility, they later reversed and demonstrated the prisoner's dilemma of innovation. Companies that delayed the introduction of EVs kept short-term profits, while Tesla's early investments guaranteed long-term benefits. The incumbents had to change their approach as Tesla gained market share, upsetting the balance in the industry.

This scenario shows how static game-theoretical models overlook significant changes in the market and thus emphasize the need for dynamic, iterative strategy models when examining entrepreneurial activities (Xiao, 2024; Olorunfemi, 2024).

The Market Disruption Caused by Uber

Uber's foray into urban mobility is an example of disruptive innovation and market penetration techniques. Uber circumvented traditional taxi laws and price restrictions through app-based real-time pricing algorithms, forcing regulators and rivals to take reactive strategic action (Hakia, 2024; Bolton et al., 2018). Small adjustments to driver incentives or fare increase rules have a large impact on the urban transport ecosystem, as shown by simulation studies that emphasize how dynamic pricing models affect consumer and driver behaviour (Bolton et al., 2018).

Start-ups and Market Entry Games

Start-ups entering existing markets often maximise their competitive position using game theory strategies (Pehrsson, 2009). Using predatory pricing, capacity expansion to lower barriers and advocating for legal restrictions to maintain market dominance and limit competition, pre-entry deterrence games show how incumbents discourage new competitors (Suslow, 2006).

Through niche differentiation such as Airbnb targeting city travellers, aggressive funding to offset early losses such as Uber, and strategic partnerships such as fintech collaborations with banks that allow them to bypass traditional barriers and establish a market presence despite resistance from incumbents, new entrants counteract deterrent strategies (Šepeľová et al., 2021; Zervas et al., 2017). Under these conditions, dynamic game models offer a more realistic representation of entrepreneurial strategy adaptation over time than stationary equilibrium models.

Simulation-based Model Analysis

Simulation-based models provide measurable insights into competitive dynamics, validating game-theoretical applications for market entry and innovation strategies. Agent-based simulations and evolutionary game theory as well as other computer models make it possible to predict how companies interact over time in an unpredictable environment.

Agent-based Models and Start-up Success

Agent-based modelling (ABM) is based on adaptive learning rules and replicates the interactions between individual agents such as entrepreneurs, investors and competitors. Before these models are applied to real company situations, scientists can evaluate various market conditions and strategic reactions.

Keyhani and Lévesque (2015) emphasized the need for flexibility and cooperation in entrepreneurial market entry strategies by using an ABM simulation

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to show that firms can disrupt markets with rapid iteration, that incumbents resist entry when there are regulatory loopholes, and that strategic alliances between small players are effective against monopolistic pricing.

These results show how small firms can challenge incumbents by exploiting uncertainty and iteration rather than maximizing within a constrained equilibrium framework.

Evolutionary Game Theory and Competitive Adaptation

Evolutionary game theory (EGT) considers how tactics change over time according to market pressures, learning effects and competitive survival processes (Izquierdo et al., 2012), in contrast to conventional Nash equilibrium models. As Amazon's approach shows, evolutionary game theory (EGT) models can explain how innovation-driven price wars develop in pharmaceutical patent competitions, why open-source software such as Linux gains traction despite a lack of immediate profitability, and why companies invest in research and development despite short-term losses.

An EGT simulation of renewable energy adoption (Reza-Gharehbagh et al., 2019) emphasizes the strategic importance of sustainability in competitive markets and shows that companies that delay the adoption of green technologies face increasing regulatory penalties, while early adopters benefit from long-term policy incentives and companies that resist innovation lose market share, although they retain pricing power.

This is in line with Schumpeter's theory of creative destruction (Wolfe, 1943), which states that companies that neglect innovation within the changing structures of the game will eventually leave the market.

Monte Carlo Simulations and Strategic Risk Assessment

By incorporating probability distributions into decision-making, Monte Carlo simulations enable organizations to evaluate strategic decisions (Harrison et al., 2010). They assess risk in an uncertain environment, such as venture capital funding, evaluate outcomes for startups negotiating regulatory changes, and project changes in the competitive landscape depending on various strategic decisions, which improves decision-making in a dynamic market environment.

A Monte Carlo study on the probability of crowdfunding success (Norozpour & Safaei, 2020) found that campaigns with incremental stretch goals raised more capital, that entrepreneurs who changed their messaging based on investor response performed better, and that the timing of campaign launch had a large impact on success due to network effects, emphasizing the need for strategic changes in crowdfunding.

These observations indicate that static game-theoretical models based on fixed strategies do not adequately reflect the adaptive risk management strategies of entrepreneurs.

DISCUSSION

The results of this study show the important role that game theory plays in entrepreneurial decisions, especially in dynamic and uncertain markets. While traditional static equilibrium models are useful in controlled competitive contexts, they struggle to adequately represent the complexity of inventions, disruptions and market developments. This paper emphasizes the strategic behaviour of entrepreneurs, the limitations of static equilibrium and the role that simulation models play in improving knowledge of entrepreneurial market interactions.

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Entrepreneurial Behavior and Strategic Interaction

The study confirms that entrepreneurs work in a volatile environment in which success depends on the behaviour of competitors, changes in legislation and technological developments (Burguillo, 2017). Entrepreneurs actively shape sectors and thus question the predictive accuracy of static equilibrium models, as they do not only react to the state of the market. Game theory provides a disciplined framework for analyzing strategic interactions, particularly in terms of market entry conditions, pricing policy and cooperation (Heiets et al., 2023).

The findings on market entry tactics underpin the relevance of entry deterrence models, such as limit pricing and predictive pricing (Tirole, 1988), which predict how incumbents change prices and capacity to discourage new competitors. Case studies from the airline sector show how large airlines use service growth and price manipulation to maintain market control (Dixit et al., 2006). However, while entrepreneurs often react and adapt to market signals, these models assume rational behaviour under fixed conditions, highlighting the need for dynamic game models.

Models of price competition such as Bertrand and Cournot's competition also provide an insightful analysis of price conflicts in e-commerce and consumer electronics (Baye & Kovenock, 2018.). They are therefore unsuitable for describing innovation-driven competition, as they ignore aggressive discount policies, innovative business models or first-mover advantages.

Additionally, important for alliances, venture capital negotiations and partnerships is the function of co-operative game theory (AlSkaif et al., 2015). Inspired by reinforcement learning, trust building in venture capital arrangements shows that early-stage caution and strategic alignment lead to closer long-term alliances (Haiyan, 2018). This implies that entrepreneurs do not make fixed agreements but continuously make strategic changes, which highlights the limitations of static models in modelling actual business interactions.

The Limits of Static Equilibrium in Explaining Innovation

A major drawback of static equilibrium models is their inability to explain industry change and radical innovation. These theories assume that markets often reach stable states in which actors maximise their strategies depending on reasonable expectations (Kirzner, 1973). However, the results of Tesla's upheaval of the automotive sector show that entrepreneurs are reshaping entire sectors rather than just maximizing within a particular market structure (Xiao, 2024; Olorunfemi, 2024).

Conventional manufacturers could not foresee Tesla's vertical integration, scaling of battery production and software-driven innovations and therefore assumed that electric cars would remain a niche industry. This upset assumptions about equilibrium and forced competitors to take reactive action (Bohnsack, et al., 2013). Such situations show that static models cannot adequately capture the uncertainty, adaptation and non-linear effects of breakthrough ideas (Maurer & Fritzsche, 2024).

The inability of static equilibrium to account for adaptive learning and feedback loops (Ahmed et al., 2023; Dagunduro et al., 2024) is another major drawback. Real-world entrepreneurship is more in line with dynamic game-theoretic models and involves constant experimentation, market testing and business model switching (Reza-Gharehbagh et al., 2019). The lean startup approach, which emphasizes iterative feedback and rapid prototyping, helps to support the need for dynamic strategy models over fixed predictions (Bortolini et al., 2018).

In addition, path dependency and first-mover advantages are a problem for steady-state equilibrium models. Early entrants, especially Amazon's cloud computing division (AWS),

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secured a dominant position by aggressively investing and building an ecosystem, making it difficult for competitors to catch up (Challa et al., 2022). Assuming rapid competitive changes, static models, which revealed their limitations in assessing market asymmetries, could not predict Amazon's continued dominance (Gawer & Cusumano, 2014).

Moreover, intuition, vision and behavioural biases in entrepreneurship are ignored by game theory, which relies on the assumptions of rational choice (Peleckis, 2015; Zhang & Cueto, 2015). Many entrepreneurs rely on heuristic decisions, gut feelings and trial-and-error methods - qualities that are not quantifiable in equilibrium models. The Austrian School approach, which emphasizes opportunity perception and market discovery, provides a more flexible framework for understanding dynamic entrepreneurship (Foss, 2000).

Simulation-based Modelling Applications and Market Distortions

Case studies and simulation results show that dynamic modelling techniques provide a more realistic representation of entrepreneurial decision-making than stationary models. Agent-based models (ABM) provide insights into market dynamics and adaptive strategies and replicate the interactions between entrepreneurs, investors and competitors (Keyhani & Lévesque, 2015). Through rapid iteration and intelligent flexibility, simulations show that even companies with low initial resources can cause disruption in sectors.

By simulating how firms change their strategies depending on learning effects and market constraints, evolutionary game theory (EGT) further supports the dynamic nature of competition (Reza-Gharehbagh et al., 2019). The results of renewable energy adoption models show that companies that adopt these technologies early realize long-term economic benefits, while companies that delay the adoption of sustainable technologies suffer additional negative impacts. These observations support Schumpeter's theory of creative destruction (Wolfe, 1943), which states that companies that neglect innovation eventually lose their market relevance.

In addition, Monte Carlo simulations support the need for risk assessment when making strategic decisions (Norozpour & Safaei, 2020). The results of crowdsourcing simulations show that well-timed campaign launches, real-time strategic changes and small financial targets significantly increase success rates. These results are in contrast to static models that assume fixed strategic interactions instead of adaptive risk management.

LIMITATIONS OF THE STUDY

This study has several limitations. First, while game theory provides an insightful analysis of entrepreneurial decision-making, it is difficult for conventional equilibrium-based models to adequately represent dynamic, innovative market activities (AlOmari, 2023). Second, the study mostly relies on simulations and case studies, which limits the empirical validation of actual entrepreneurial methods over long time horizons. Third, the models used assume rational decision-making and therefore exclude non-linear strategic thinking, intuition and behavioural errors (Vance et al., 2007). Even though the study mainly refers to technology and innovation-driven sectors, its relevance for conventional sectors such as industry and agriculture has not yet been sufficiently investigated. With the help of longitudinal studies and behavioural insights (Hsu et al., 2006), future research should resolve these limitations. In addition, the model developed in section 3.1 has methodological limitations. Although it translates the central principles of the Austrian School into a game-theoretical framework, it remains on a conceptual level. The lack of an analytical solution, for example in the form of an equilibrium or stable strategy profile, makes exact mathematical verification difficult. In addition, the evaluation of

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long-term dynamics requires further simulation approaches, such as agent-based modelling. These limitations highlight possible starting points for future empirical and computer-aided research.

CONCLUSION AND IMPLICATIONS

The result of this study shows how poorly stationary equilibrium theories explain entrepreneurial decisions in dynamic markets. Game theory provides a valuable framework for analyzing strategic interactions, even though traditional models ignore the adaptability, innovation and non-equilibrium dynamics that characterize entrepreneurship. By combining dynamic game-theoretic models, agent-based simulations and evolutionary approaches, this work provides a more comprehensive picture of market entry, competition and invention.

Theoretical and Practical Consequences

From a theoretical perspective, this work emphasizes the need to move from static to dynamic, game-theoretical models in business research. While companies in the real world operate in an uncertain and changing environment, traditional strategies based on a Nash equilibrium assume rational decisions under fixed parameters. Dynamic models such as evolutionary game theory (EGT) and real options games show how entrepreneurs react to constantly changing strategies in response to market fluctuations, competitor behaviour and regulatory changes (Reza-Gharehbagh et al., 2019). An important theoretical implication is that game theory, particularly that of the Austrian school, needs to be merged with process-orientated market theories. The Austrian idea of entrepreneurial vigilance, which emphasizes opportunity discovery and distributed decision-making, fits better with adaptive, learning-based models than with static optimization systems (Kirzner, 1973; Foss, 2000). Future theoretical models should capture the actual complexity of entrepreneurial activity by incorporating uncertainty, iterative feedback loops and strategic learning mechanisms. In practice, this study provides information for investors, legislators and business owners. Dynamic strategic models help entrepreneurs predict consumer reactions, overcome barriers to entry, and maximise long-term innovation plans (Chan & Ip, 2011). The case studies of Tesla and Uber show that maintaining competitive positions depends crucially on early warning advantages, market disruption and strategic flexibility.

These findings imply to legislators that the non-equilibrium nature of entrepreneurial markets should be taken into account when designing regulations (Lucas, 2022). In industries such as technology, green energy and artificial intelligence, which are rapidly evolving, static measures such as fixed tax incentives, compliance with standardized regulations or strict enforcement of antitrust law may not be beneficial. Rather, adaptive control systems that encourage creativity while eliminating market failures can promote economic dynamism. The work emphasizes for investors and venture capitalists the need for smart funding cycles and building trust in dynamic alliances. Models for building confidence through reinforcement learning in venture capital (Haiyan, 2018) assume that long-term stability and innovation growth follow early restraint followed by strategic alignment of funding. This has a direct impact on investment decisions in uncertain, high-risk markets.

Further Research Perspectives

Dynamic game theory models should be improved in future studies through entrepreneurial theories, empirical validation and extended computational simulations (Keskin & Ucal, 2020). Combining game theory with Austrian market process theories would help hybrid models to better represent entrepreneurial discovery, flexible decision making and market change. These models, unlike static equilibrium methods, should incorporate real-time learning and distributed strategy development. Especially in the fields of financial technology,

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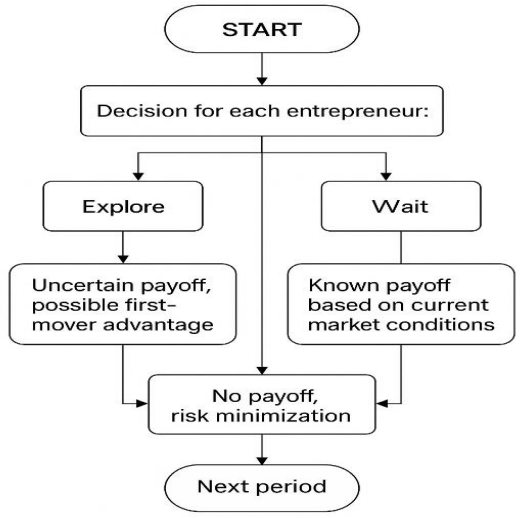
green energy and biotechnology, empirical longitudinal studies are needed to track how start-ups, scale-ups and established companies evolve over time (Bendig et al., 2022). In addition, agent-based and evolutionary game simulations should be conducted to assess how external shocks such as regulatory changes and economic crises affect market dynamics. The combination of behavioural economics and cognitive psychology could also help to clarify how risk tolerance, cognitive biases and intuition influence entrepreneurial decisions (Barbosa et al., 2007). Finally, sector-specific applications should investigate game-theoretic strategy adaptation in creative sectors, supply networks and healthcare, where uncertainty and competition influence strategic decision-making.

Implications of the Model for Theory and Practice

The dynamic game model of entrepreneurial discovery developed in section 3.1 provides a theoretical bridge between the formal game-theoretical structure and the dynamic, process-orientated market concepts of the Austrian School. It deliberately dispenses with exogenous equilibrium assumptions and instead models entrepreneurial action as a continuous decision-making process under uncertainty, in which market structures develop endogenously.



Dynamic game over *T* periods

Figure 2: (created by the author with ChatGPT)

illustrates this process graphically. The decision model shows how entrepreneurs choose between exploration, exploitation and inactivity in repeated periods and thus actively contribute to the design and transformation of markets. In contrast to classic game theory approaches, the payoff structures in this model are not static or completely known, but arise iteratively from the actions of the actors themselves. Markets are therefore not understood as given framework conditions, but as the result of entrepreneurial discoveries, adaptations and learning processes. This perspective reflects central elements of the Austrian School, in particular the role of uncertainty, subjective knowledge and spontaneous order. Entrepreneurial action is not modelled here as mere optimisation within given constraints, but as a creative, knowledge-generating and structure-shaping force. The abandonment of static equilibria and the integration of path dependencies and feedback loops open up new avenues for the game-theoretical modelling of dynamic markets.

Relevant conclusions can also be drawn from a practical perspective. The logic of the model suggests that successful entrepreneurial strategies are based less on long-term planning and more on adaptive behaviour, a willingness to experiment and an early start. In volatile markets, for example in technology-intensive or regulation-driven sectors, the ability to explore opportunities appears to be just as crucial as dealing with ignorance and iterative learning processes.

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