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Using Game Theory for a Schumpeterian analysis of emerging industries: the historical case of the U.S. Steel industry

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Abstract

Purpose – This paper aims to explore the development of the US steel industry from the 19th to the 20th century by applying the Schumpeterian perspective on the concept of creative destruction. It introduces Game Theory as a means to describe patterns of strategic situations and entrepreneurial decision-making in an emerging industry.

Design/methodology/approach – Based on a narrative literature review of Schumpeter's concept of creative destruction, four historical case studies have been designed. These historical case studies build the basis for game-theoretically analysis and evaluation. In doing so, the authors identify games with different payoff matrices that take place while an industry emerges, reflecting different layers of creative destruction.

Findings – Emerging industries, as this paper highlights, go through several stages of development until they reach full maturity. With Schumpeter, these stages can be studied through an entrepreneurial lens, highlighting different patterns of decision-making in each respective stage. This paper adds to a better understanding of emerging industries. Furthermore, this paper provides a methodological repertoire that can also be applied to other cases as well, such as the emergence of contemporary digital industries.

Research limitations/implications – The paper provides a horizontal overview of how Game Theory can be applied to analyze industrial epochs and how the concept of creative destruction works in industry and transforms industry. It introduces Game Theory to management and business history as a sound methodological base to analyze and evaluate strategic situations and entrepreneurial decision-making.

Practical implications – The paper presents a comprehensive method to act in the different stages of an industrial epoch and how to act. The games applied in the particular layers of creative destruction give an insight into the analysis of strategic situations and strategic decision-making in the industry.

Originality/value – This paper provides a horizontal perspective on strategic games that can be used as an analysis methodology in the field of entrepreneurship and applied in contemporary industries. It connects

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historical cases out of the US steel industry with Schumpeter's concept of creative destruction and Game Theory.

Keywords Creative destruction, Game Theory, Business cycles, Industry evolution, Dynamic entrepreneur

Paper type Research paper

1. Introduction

Joseph Alois Schumpeter, a main protagonist of the Austrian school of economic thought, is considered a pioneer of research on innovation- and technology management, and industry evolution (Stephan, 2011). Schumpeter had a gift for combining and moderating between adversarial economic approaches and their representatives (Strathern, 2003), giving an account of society and economy that can inform historical studies in many different ways (Bostaph, 2015).

From today's point of view, Schumpeter's most important contribution to research is the notion of creative destruction (e.g. Aghion *et al.*, 2021), which draws attention to the role of entrepreneurship for industrial development. Entrepreneurship, however, does not always take effect in the same way. This is reflected in the so-called Mark models in Schumpeterian theory that have been discussed extensively since the late 20th century (Breschi *et al.*, 2000; Andersen, 2015). The Mark models distinguish different stages in the lifecycle of an industry, nurturing different types of entrepreneurial activity and intervention.

On the following pages, we use the Mark models to study the history of the US steel industry from an entrepreneurship perspective. Moreover, we introduce Game Theory as a theoretical foundation for our analysis of entrepreneurial activity. The guiding research question of this paper can be phrased as follows:

RQ1. What can we learn from a game-theoretical analysis of the emergence and evolution of the US steel industry by leveraging Schumpeter's concept of creative destruction – thus capturing and conceptualizing the different phases of the industrial evolution and its strategic games to play?

By investigating this research question, the paper can support managers and decision-makers to better estimate strategic decision-making in different economic contexts and the different phases of industrial evolution.

Methodologically, we follow Yin's (2014) recommendations for case study research to elaborate and analyze historical phenomena. Our source material consists of primary data of industrial development and secondary literature. First, we narratively investigate the Schumpeter's Mark models and the Game Theory to summarize, evaluate and define the current state of knowledge as well as to define our analytical rationale. Following Hart (2003), relevant literature from and about Schumpeter's research and Game Theory, especially the taxonomy of 2 × 2 games provided by Rapoport and Guyer (1966) and Rapoport *et al.* (1976), has been searched, scanned, skimmed and – *subsequently* – sorted out or selected for further investigation. The selected literature has been read through carefully and the captured knowledge within was conceptualized. Second, a framework for analyzing the historical studies has been designed and developed as well as an analyzing strategy has been adopted. Third, exemplary cases have been elaborated. In doing so, we make use of the phases of the early industrialization (Mark 0), the high industrialization (Mark I) and the so-called "morganization" (Mark II) of the steel market in the USA as well as the phase of consideration of innovation as a cultural phenomenon (Mark IV). For a more precise analysis of the different stages of the emergence of the US steel industry, we introduce Game Theory as a modeling and analysis tool. Game Theory, which is rather unusual in historical research, proves to be very helpful in the given context. With this approach, we contribute to the ongoing academic discourse not only by giving a new account of an

interesting case of industrial development but also by expanding the methodological repertoire. Furthermore, we would like to show that Schumpeter's theory also opens up new directions for historical research, as it allows us to study industrial development from an entrepreneurship perspective.

The paper at hand is organized into six sections: Section 1 introduces the paper and presents the research motivation and research questions. Section 2 presents the theoretical grounding: the literaturally driven research into Schumpeter's concept of creative destruction and the Game Theory. The concept of creative destruction is divided into four subsections which represent the evolutionary stages of Schumpeter's research: the concepts of adaptation, learning and selection; the concept of creative destruction; the concept of creative accumulation and the concept of social interaction and cocreation. Game Theory is used as a rationale and strategy for analyzing the historical cases. The research design is presented in Section 3 and the historical cases, their evaluation and game-theoretical analysis are presented in Section 4. Section 5 presents the findings and their discussion, captured within the subsection of theoretical implications, practical implications and limitations. Section 6 concludes the paper and provides a brief research outlook.

2. Theoretical grounding: Schumpeter's Mark models and game theory

The objective of this section at hand is to present the review of selected literature about the Schumpeter's approach and its elaboration in the Mark Models 0-III; as well as the introduction of Game Theory as an analytic device.

2.1 Schumpeter's approach to industrial development

Although Schumpeter is considered a liberal-conservative thinker, he was a fervent devotee of Walras (Kurz and Sturn, 2012). Schumpeter considered Walras the greatest of all economists [i.e. (Schumpeter, 1954) and (März, 1983)]. Walras' goal was to transform economic theory into a scientific, natural-law-based discipline – thus to apply mathematics to economic theory in a comprehensive way (Strathern, 2003). The core of Walras' theory is based on general economic equilibrium, including the assumptions of the full employment of resources (i.e. labor and land) and that money has the function of a unit of account and medium of exchange.

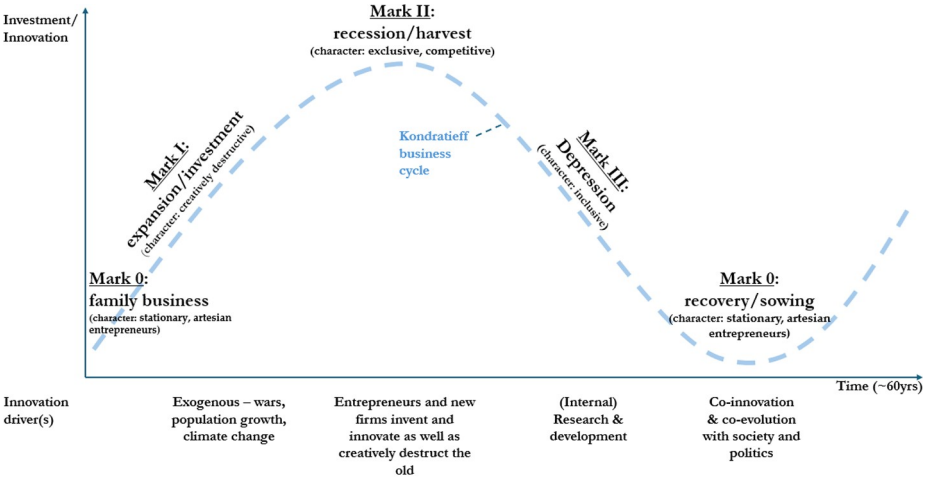
Schumpeter built his theory on the quantitative approach but also addressed very early the need to dynamize economics (März, 1983), thus including creative forces to reorient economic thinking dynamically. In contrast to a static method, which produces boring, mechanistic and equilibrium-oriented people, Schumpeter introduces the concept of the dynamic entrepreneur – a person who is courageous/daredevil, energetic, restless, nonhedonistic, pugnacious, fearless, enterprising, vigorous, determined and tradition-overcoming: a person that initiates "a break from the ordinary, a tectonic shift in the business world" (Bostaph, 2015). Schumpeter's dynamic entrepreneur is not intent on petty advantage-taking, continuously reinventing themselves and revolutionizing the prevailing conditions (Kurz and Sturn, 2012) – it is a person who triggers economic processes: By which innovations continually emerge and render existing technologies obsolete, new firms continually arrive to compete with existing firms, and new jobs and activities arise and replace existing jobs and activities (Aghion *et al.*, 2021).

Dynamic entrepreneurs, in Schumpeter's theory, actively impact industrial evolution from the emergence of an industry through to its maturity and decline. Their activities cause recurring waves of up-and-downswings best expressed in business cycles and highlighted by times of intensive and weak investments. Center to Schumpeter's work is the Kondratieff business cycle representing basic innovation, i.e. the industrial revolution at the beginning of the 19th century, the steam and steel in the middle of the 19th century and electricity, chemistry and motors by the end of the 19th century. Additionally, Schumpeter makes use of

the Juglar business cycle to explain the action and impact of pioneering entrepreneurs on economic upswings and the Kitchin business cycle to explain market behavior. Schumpeter sees a historical as well as statistical relationship between the business cycles. As he argues, six Juglars make to a Kondratieff (60 years) and three Kitchins (less than 40 months) make to a Juglar (10 years) (Schumpeter, 2008).

For the study presented here, we focus on long-term developments, avoiding all conceptual and epistemological problems that Kitching and Juglar cycles might bring about. To distinguish different stages of industrial development, we refer to what has become known Schumpeter's Mark models [1]. The Mark models reflect the varying contexts of entrepreneurial activity. They can also be associated with different phases in Schumpeter's biographical journey, personal life, work and research stages, which contributed to the emergence and evolution of his concept of creative destruction.

As depicted in Figure 1, the Mark 0 model represents Schumpeter's starting point: Walras' economic theory and a static economic equilibrium. Mark I, in the course of this paper, represents Schumpeter's "early views" on industry evolution, the phase wherein he elaborated the concept of creative destruction [i.e. his Habilitation thesis in 1911 and the book "Theory of Economic Development" (Schumpeter, 1934)]. The Mark II model represents Schumpeter's concept of creative accumulation, thus the "advanced Schumpeter" represented in the book capitalism, socialism and democracy (Schumpeter, 2005). While industries in the Mark I model are characterized by family businesses, charismatic entrepreneurship and management (Tapio, 2011), lower levels of market concentration, capital intensity and profitability (Fontana *et al.*, 2012), industries in the Mark II model are characterized by corporate entrepreneurship (Tapio, 2011) and high concentration of innovation activities mainly formed by large and well-established organizations (Castellacci and Zheng, 2008). The Mark III model, as highlighted by Andersen (2015), represents a literately largely ignored model. This model considers industry evolution as part of social interaction and the cocreation of innovation in conjunction with economics (as the focal point), society, academia and politics.



Sources: Own representation; figure by authors

Figure 1. Schumpeter's Mark models in relation to the Kondratieff business cycle

2.1.1 Mark 0 – the concept of adaptation, learning and selection. The Mark 0 model represents a stationary economy wherein, if not disturbed by market forces and/or exogenous change, the same organizational processes take place day in and day out. Organizations display an extreme degree of inflexibility and organizational processes are determined by experiences, traditions, practiced routines and other assigned value systems. These practices are monitored by static and mechanistic managers, who do not carry out organizational innovation (Andersen, 2015). Organizations within Mark 0, therefore, reach a point where adaptive processes among organizations in the market take place: selection – and learning processes forced by price – and/or quantity competitions between the organizations, social and/or environmental events: wars, climate change, etc., until the industry has homogenized. The disappearance of organizations is leading to evolutionary change (Andersen, 2015).

2.1.2 Mark I – the concept of creative destruction. The Mark I model is conceptually based on the Mark 0 model and its adaptive processes but also exogenous innovations (Fontana *et al.*, 2012), introduced by entrepreneurs. Schumpeter's focus in the Mark I model is on the European industrial structure of the late 19th century. This structure was characterized by small firms (Malerba and Orsenigo, 1995) but also by new information technologies, the liberalism of markets and transformation processes that enabled innovation, entrepreneurship and industry evolution. Production and manufacturing processes shifted to mass customization to serve the broad masses of (possible) consumers.

Industrial evolution within the Mark I model happens in two phases – a phase of dense innovation activities (economic upturn) and a phase of economic downturn (adaptation) (Andersen, 2015). An economic upturn is caused by entrepreneurs, who exploit conditions of high technological opportunities, low appropriability and low cumulativeness (Fontana *et al.*, 2012). These entrepreneurs break off stationary cycles through the concept of creative destruction, and cause turbulent economic environments for established organizations (Fontana *et al.*, 2012). As Dekker (2018) highlights, small organizations rather than large ones stimulate innovation and industry evolution. Established organizations, as assumed in the Mark I model, are stuck to routines and do not innovate. It is a state similar to a Nash equilibrium (Andersen, 2015). In contrast, entrepreneurs continuously disrupt the equilibria, thus the current ways of production, organization and distribution (Breschi *et al.*, 2000), i.e. through the launch of product- and process-innovations, the development of new sales markets, the development of new sources of raw materials and semifinished products, the implementation of a new legal (i.e. the creation of a monopoly position or the opposite: the breaking of a monopoly) and technological and organizational change [i.e. Malerba and Orsenigo (1995)]. To survive, established organizations need to efficiently change available techniques and technologies and make efficient use of them as well as the changed market hierarchies (Fontana *et al.*, 2012; Maleki *et al.*, 2016; Castellacci and Zheng, 2008). However, as soon as an economic upturn comes to an end, industry evolution is dependent on another fundamental innovation (Andersen, 2015).

2.1.3 Mark II – the concept of creative accumulation. Like the Mark I model, the Mark II model is based on the Mark 0 model. While the Mark I model is characterized by creative destruction, the Mark II model is characterized by creative accumulation. The accumulated stock of knowledge in specific (technological) areas, as Breschi *et al.* (2000) and Maleki *et al.* (2016) highlight, plays a major role in the Mark II model. Established organizations have institutionalized the innovation processes and maintain departments employed with highly qualified staff (Breschi *et al.*, 2000). Additionally, these organizations have advanced competence in large-scale research and development projects, in production, manufacturing and distribution, and their relevant financial resources [i.e. Andersen (2015) and Maleki *et al.* (2016)]. They continuously and cumulatively push the technological frontier further

(technical progress). Industrial evolution in Mark II is the result of knowledge accumulation, research and development intensity, as well as the cumulativeness of technological change and market concentration (Castellacci and Zheng, 2008): the establishment of oligopolistic or monopolistic structures, oriented to international markets (Andersen, 2015), captured under the roof of corporate entrepreneurship (Tapio, 2011).

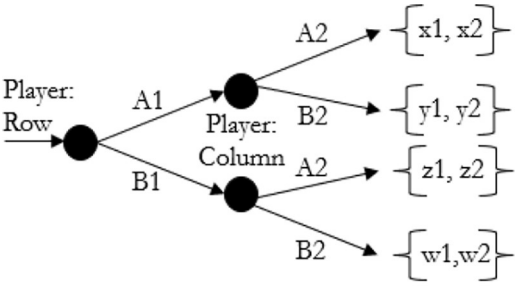
2.1.4 Mark III – the concept of social interaction and cocreation. The basic assumption in the Mark III model is that industries systematize and rationalize human behavior and ideas, thus orchestrating but also restricting industrial evolution (Schumpeter, 2005). In the Mark III model, the socio-economic coevolution shifts into the center. Schumpeter considers industrial evolution as a cultural phenomenon and innovation as an interactional process (Gallouj, 1999). Industrial evolution emerges from a dynamically evolving and progressive process of networks, social interaction [i.e. positive and/or negative incentives from institutions and public society (Aghion *et al.*, 2021)] and cocreation with stakeholders out of economics [the focal entity (Andersen, 2015)], society, science and politics [i.e. dynamic, innovative and creative networks; heteronomous networks; open networks; open source, e.g. Tapio (2011) and Andersen (2015)]. In the center is the critical and constructive engagement with old ideas and concepts across time and space (Plickert, 2012): new knowledge builds on known knowledge, combines it in new ways and thus generates innovations and forces social and cultural changes (Plickert, 2012).

2.2 Game Theory: analytical frameworks and types of games

Game Theory was first introduced by Neumann (1928). In 1944, as highlighted by Selten (2001), Neumann and Morgenstern (1944) established Game Theory as an (*academic*) field and launched a broad stream of research based on their book entitled: "Theory of Games and Economic Behavior." It is the classic book in Game Theory (Osborne and Rubinstein, 1994). Against Walras' mathematical-quantitative approach toward economic equilibrium, Neumann and Morgenstern argue that the economy is a system that is influenced by general conditions (*which can be objective*), people (*players*) and its preferences (*which are subjective, based, for example, on traditions, value systems, etc.*) as well as its strategic interaction (*i.e. player's interests and the constraints on the actions that the players can take; negotiations, competition*). Thus, Game Theory goes, as Crofton (2013) highlights, beyond probability theory and also takes social factors and psychological factors into account – self-interest, bargaining, bluffing and other characteristics of human being.

Game Theory supports strategic decision-making in complex situations (Davis and Riese, 1999) for at least two decision-makers (players). Game Theory proved useful for analyzing situations where two (or more) players are facing each other, involving a few well-informed players trying to outsmart each other in games (Samuelson and Nordhaus, 2005). The aim is to elaborate recommendations for reasonable behavior of players in strategic situations, i.e. to determine an optimal strategy to gain the maximum possible average profit (Wentzel, 1976). The general assumption is, as highlighted by Osborne and Rubinstein (1994), that the players are rational and reason strategically (taking into account their knowledge or expectations of other decision-makers' behavior). The meetings of merchants, as highlighted by Smith (2005, 1776), can be considered as economic games. Based on such (strategic) situations, strategies of cooperation and competition, as well as social dilemmas can arise.

As depicted in Figures 2–4, Game Theory recognizes three forms of graphical representation of games which are the extensive form (c.f. Figure 1, left-hand side), the normal form: payoff matrix (c.f. Figure 2, center) and the characteristic function (c.f. Figure 3, right-hand side). The abstractedness of them allows to study of a broad range of phenomena (Osborne and Rubinstein, 1994). The extensive form, as Selten (2001) highlights, is the most detailed form of representation of a game. It highlights, for example, at which point of a possible game course



Source: Figure by authors – based on Diekmann (2009)

Figure 2. Extensive form

		Player: Column	
	Strategies↓→	A2	B2
Player: Row	A1	x1 x2	y1 y2
	B1	z1 z2	w1 w2

Source: Figure by authors; based on Diekmann (2009)

Figure 3. Normal form: payoff matrix

Row: x1 > y1 > z1 > w1
Column: x2 > y2 > z2 > w2
x1 = x2

Source: Based on Diekmann (2009)

Figure 4. Characteristic function (payoff function)

with which information about the previous game events which decision is to be made (Selten, 2001). The normal form is used to express ideas formally: this form of representation makes it "easy to define concepts precisely, to verify the consistency of ideas, and to explore the implications of assumptions" (Osborne and Rubinstein, 1994). To analyze the historical cases, in this paper, we make use of the normal form – the presentation of the analysis in the so-called payoff matrix. It is the traditional form used in Game Theory to highlight the interaction between two players, and the payoff functions associated with the strategies (Samuelson and Nordhaus, 2005). The payoff matrix provides a way to show the strategies and payoffs of a game. The center of this paper is Pareto strategy and the Nash Equilibrium strategy:

- The Pareto Strategy differs into three states. The Pareto Equilibrium describes the circumstance of a game in that no other payoff exists that would make all players better off at the same time or, in turn: a player's situation cannot be improved without making another player's situation worse. The Pareto Inferior describes a situation in which at least one player can improve, and no other player deteriorates. The non-Pareto Optimum is considered an efficiency problem, and the equilibrium is accordingly an inefficient Nash equilibrium (Diekmann, 2009).
- The natural outcome, as Rapoport (1967) highlights, results if each player chooses the maximin strategy. This strategy minimizes the player's loss if the player should suffer a loss. It is an outcome from which neither player is motivated to switch unilaterally.
- The Nash equilibrium is one of the most basic concepts in Game Theory (Osborne and Rubinstein, 1994). Game Theory is noncooperative and, as Nash (1950) argues diametrically, in the struggle for dominance and optimal profit, each player acts alone and on his own – cooperation arises from pure expediency (Strathern, 2003). As demonstrated in the famous Prisoners Dilemma Game, the Nash equilibrium need not correspond to the Pareto optimum.

For the work presented here, Game Theory acts as an analysis tool of the historical cases. To enable this, we make use of an adapted 2 × 2 Game Taxonomy, first elaborated by Rapoport and Guyer (1966) and Rapoport *et al.* (1976) as a lens to analyze Schumpeter's Mark models. The 2 × 2 Game Taxonomy can act as the basis for the theoretical description of social environments, i.e. unique environments of social interaction (Guyer and Rapoport, 1972).

As depicted in Figure 5, in the Taxonomy, the authors classify 78 games/social environments into three classes (based on the strategy of the game) and categories. In the earlier presented "Taxonomy," Rapoport and Guyer (1966) classified games into ten classes, ranging from I – X (i.e. class I: no conflict games, class II: games with strongly stable equilibria, class III: games with strongly stable deficient equilibria, class IV: games with stable equilibria, V: threat-vulnerable equilibria, VI: force-vulnerable equilibria, VII: unstable equilibria, VIII: two equilibria with equilibrium outcome, IX: two equilibria with the nonequilibrium outcome, X: without equilibrium). In the later presented "Taxonomy," Rapoport *et al.* (1976) defined "genera" in accordance with the pressures acting on a player who gets less than his largest payoff in the natural outcome (i.e. competitive pressures, if a player is motivated to shift unilaterally; the natural outcome is threat and/or force pressure dependent). These genera are genus o: no pressure; genus c: competitive pressure only; genus t: natural outcome only threat-vulnerable; genus f: natural outcome only force-vulnerable; genus ct: threat-vulnerable with competitive pressure; genus cf: force-vulnerable with competitive pressure; genus tf: both threat- and force-vulnerable; and genus ctf: both threat- and force-vulnerable with competitive pressure.

Games - class →	Both players have a dominating strategy (D2)			Exactly one player has a dominating strategy (D1)						Neither player has a dominating strategy (D0)						
Genera in accordance with the singly acting or combined pressures action on a player who gets less than his largest payoff in the natural outcome →										No pressures			Competitive pressure only			
	No pressures	Competitive pressure only	Natural outcome only: threat-vulnerable	No pressures	Competitive pressure only	Natural outcome only: threat-vulnerable	Natural outcome only: force-vulnerable	Both threat- and force-vulnerable	Both threat- and force-vulnerable with competitive	No pressures	No equilibria (●0)	Two equilibria, outline is the natural outcome (●2)	No pressures	No equilibria (●0)	Two equilibria, outline is the natural outcome (●2)	Natural outcome only: force-vulnerable
Phylum N: No conflict games	I No conflict: 1, 2, 3, 4, 5	II Strongly stable equilibria: 6		I No conflict: 23, 25, 28, 29	I No conflict: 22, 24, 26, 27, 30					I No conflict: 59, 60			I No conflict: 58, 61, 62, 63			
Phylum M: Mixed-motive games																
Class E, subclass P (Fig. 2.2): Natural outcome is a Pareto-optimal equilibrium	I No conflict: 7, 8, 9; IV Stable equilibria: 10, 13, 14, 15, 16, 17, 18		V Threat-vulnerable equilibria: 19, 20, 21	IV Stable equilibria: 31, 32, 33, 34, 35, 36; V Threat-vulnerable equilibria: 37, 38; VI Force-vulnerable equilibria: 40, 41, 42, 43		V Threat-vulnerable equilibria: 39	VI Force vulnerable equilibria: 44, 46	VII Unstable equilibria: 50, 52, 54, 55, 56	VII Unstable equilibria: 49, 51, 53							VIII Two equilibria with equilibrium outcome: 64, 65
Class E, subclass p (Fig. 2.3): Natural outcome is Pareto-deficient	III Strongly stable deficient equilibria: 12						VI Force-vulnerable equilibria: 47, 48	VII Unstable equilibria: 57								
Class e (Fig. 2.4): Natural outcome is not an equilibrium											X Without equilibria: 77	IX Two equilibria with non equilibrium outcome: 69		X Without equilibria: 70, 71, 72, 73, 74, 76, 78	IX Two equilibria with non equilibrium outcome: 66, 67, 68	
Phylum Z: Games of complete opposition																
Class E (Fig. 2.5): Natural outcome is an equilibrium (games: 11 & 45); Class e (Fig 2.5): Natural outcome is not an equilibrium (game: 75)	II Strongly stable equilibria: 11			VI Force-vulnerable equilibria: 45									X Without equilibria: 75			

Sources: Figure by authors; based on Rapoport and Guyer (1966) and Rapoport *et al.* (1976)

Figure 5. Adapted 2 × 2 taxonomy

3. Research design

To respond to the set research question as to *what we can learn from a game-theoretical analysis of the emergence and evolution of Schumpeter's concept of creative destruction, thus how to capture and conceptualize the different phases of the industrial evolution and its strategic games to play – in the US steel industry*, we use four historical cases from the US steel economy. The case elaboration is based on a narrative literature review combined with snowball research. The latter allows us to follow-up on citations in literature (i.e. in online library catalogs) to collect additional sources for your research.

We chose historical cases out of the US steel industry, starting from the 19th century, as devices for analysis. The 19th century is an important date for the global business, industry and economy. Shortly before Adam Smith, the grandfather of modern capitalism published his first edition of "The Wealth of Nations." It is a groundbreaking literature for modern economics describing the mechanism of a liberal market economy and has ushered in the industrial age. In addition, America, as MacGregor (2019) exemplifies, has gradually begun its transition from an agricultural-dominated society to an industrialized country. This transition included technological innovation such as the implementation of assembly lines, mega machines and factory farms, (Morris, 2006) as well as new organizational structures: trusts. The steel industry is chosen because we can draw a wholistic storyline in the sense of Schumpeter's Mark models: the transition from static economies, represented by family-owned and family-managed pig iron companies, to dynamic economies, represented by national and international trusts. We can follow-up strategic decisions and resulting business dilemmas out of this transition.

As highlighted in the introduction of this paper, we make use of the Kondratieff business cycle. The Kondratieff business cycle represents the long-lasting business cycle in Schumpeter's (2008) research. In this business cycle, basic innovations that impact industrial evolution emerge, i.e. steam, steel, chemistry, electricity, etc. We hypothesize that the Mark models of an emerging until a satisfied industry passes through a Kondratieff business cycle. The hypothesis is underlined with the assumption that the phase of expansion/investment is represented by Mark I, the phase of recession/harvest is represented by Mark II, the phase of

depression is represented by Mark III and the phase of recovery/sowing that is represented by Mark 0. The Mark models additionally represent the maturity level of an industry. Conceptualized among the Mark models, the first two historical cases range from the early industrialization and the high industrialization of the US economy, before and after the US Civil War (1861–1865). We start the first case description from the beginning of the 19th century, which marks a change to industrialism, capitalism and liberalism in economics. While this case is determined by the *family business*, wherein the first processes of cumulative expansion emerged (Aghion *et al.*, 2021), the second case is determined by the emergence of dynamic entrepreneurs and the power of creative destruction. The object of investigation within the second case is Andrew Carnegie, a steel tycoon and (*later*) philanthropist. The third case ranges from the change of the 19th to the 20th century when the so-called *big business* and *big management* era emerged (Porter, 2005): the former entrepreneurs set up monopoly organizations: trusts. This case is determined by the competition between Carnegie and "the biggest and boldest" of the tycoons (Porter, 2005): J. P. Morgan. The case can be understood as the competition between industry purism versus industry community of interest – an organization that exhibited some elements of cartelization (McCraw, 1988). The fourth case builds on the discontent, exploitation and demoralization in society and its impacts on politics, following the inclusion of political and societal innovation into the economy: trade unions and the efforts to political reforms.

Regarding the analysis of games, we focus on the accounts given in literature of entrepreneurial activity that can be interpreted as a two-player interaction. In our account of these games, we adhere to the suggestions made by Rapoport and Guyer (1966):

- If both players have a dominating strategy, both will choose it.
- If only one player has a dominating strategy, the player will choose it, and the other player will choose the strategy that maximizes the player's payoff under the assumption that the first player has chosen his dominating strategy.
- If a game has a single Pareto equilibrium, the players will choose the strategy that contains it.
- If neither player has a dominating strategy, and if the game has either no Pareto equilibrium or more than one, each player will choose the strategy that contains his maximin outcome – the strategy that avoids the smallest of the four payoffs.

4. Analysis: the development of the US steel industry through the lens of Game Theory

The presentation of the cases is as follows: firstly, the general conditions of the cases are presented, including the introduction of the players and preferences. Second, based on the 2 × 2 Game Taxonomy and the analyzing strategy, selected games per case are presented. Assuming the rationality of players, as Rapoport (1967) highlights, games with strongly stable equilibria are determined and offer no theoretical interest. Therefore, to guarantee the greatest possible excitement for the reader, we avoid these games and focus on games that involve the greatest possible dynamics, social dilemmas and tragedies. These games are, for example, the famous Prisoner Dilemma Game, the Chicken Game, the Battle of Sexes Game and the Inspector-Evader Game.

4.1 Mark 0: Early industrialization, family business and diversity

Before the outbreak of the American Civil War, the USA was a rural, agrarian-based civilization (Porter, 2005). Two economic systems prevailed in the USA: the Northern

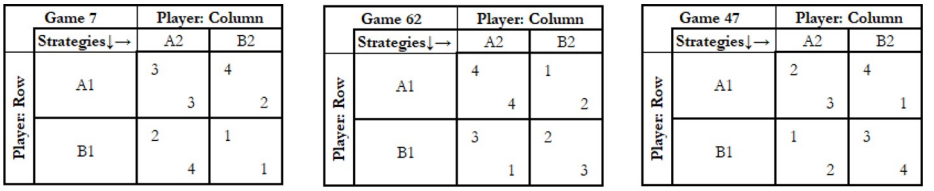
system, which included 110,000 factories and 92% of the factory workers, and the Southern system, including 18,000 factories and 18% of the factory workers (Statista, 2022). Business enterprises operated on a small scale, and specialized in functions and in products (Porter, 2005). Family businesses were in the absolute majority in this era and usually owned by individuals, often bound together by ties of kinship (Porter, 2005). Normally, as Porter (2005) highlights, the owners of a business were also its managers, made all the key decisions, had personal contact with its employees, and mostly, the death of an owner was the end of the family business. Corporations, as Carey (2008) highlights, were nonexistent.

The largest industrial business enterprise in the steel industry employed more than 50 workers – a manager, a few foremen and a group of workers labored in the same building (Porter, 2005). The early factories normally made only pig (cast) iron and did not convert it into finished products (Porter, 2005). Steel could be made only in small and expensive batches that were limited to specialized applications (Gordon, 2017). Financial independence was rare, and the businesses had to rely on loans from merchants (i.e. grants based on the personal character and personal wealth of the borrower).

The early industrialization of the US economy represents a stationary economy. Due to the manager's "ignorance of events and people in distant parts of the country" (Porter, 2005) as well as the diversity of the products, no conflicts or only little competitive pressures arose. Industry evolution was determined and had natural, Pareto-optional outcomes.

Games 7, 62 and 47 (c.f. Figure 6a–c) have been selected to demonstrate the Pareto-optional outcomes in stationary economies. Under the assumption of the rational behavior of the players, game 7 and game 62 lead automatically to a Pareto Equilibrium. For example, in game 7 (c.f. Figure 6a), both players have a dominating strategy, and the game has a stable equilibrium. By its rational behavior, the players are forced to choose strategy A1 (player "Row") and A2 (player "Column"). A unilateral shift from the equilibrium would damage the shifting player. A bilateral shift would damage both players equally. In game 62 (c.f. Figure 6b), no player has a dominating strategy: player "Row" can safely choose strategy A1, and player "Column" can safely choose strategy A2. A unilateral change and/or a bilateral change of the strategy would damage both players and decrease both players' payoffs. The strategy A1/A2 is the Pareto-optimal outcome in game 62: there is no other outcome in which both players get a larger payoff. A change causes the departure from the Pareto-optimal outcome and could happen if, for example, the players (established family businesses) compete among quantitative factors, such as prize, and/or production quantity and cost reductions.

Game 47 presents a game with an efficiency problem that is also entitled the inefficient Nash equilibrium (Diekmann, 2009). It is also known as a partial prisoner's dilemma that ends up in a Pareto-deficient equilibrium. Player "Row" will choose strategy A1 by force.



Source: Rapoport and Guyer (1966)

Figure 6. (a) Game 7; (b) Game 62; (c) Game 47

Player "Column" will choose strategy A2, since this strategy provides the minimum of the maximum to achieve. This output can be caused, for example, through exogenous change such as external effects on markets (i.e. wars). In such environments, only the players' giving (i.e. communication, cooperation, bargaining and negotiations, etc.) leads to an efficient Pareto Equilibrium (strategies: B1/B2). Within game 47, the profession of entrepreneurs rises. To excel in a profession where only a few make it to mediocrity, as Smith (2005, 1776) states, is the very best way to identify genius and superior talent. This genius shift into the focus of the strategic games to be played in Mark I.

4.2 Mark I: High industrialization and the rise of (dynamic) entrepreneurs

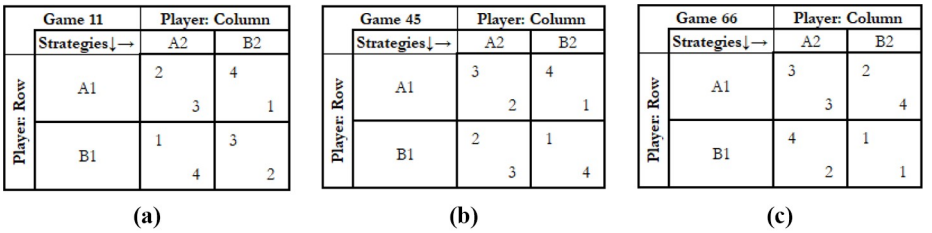
While the Southern economic system remained almost in agriculture, the Northern economic system experienced an economic transition: an industrial miracle and a market revolution. The industries turned from commercial to industrial capitalism and were taking advantage of innovation and technologies of the so-called "first industrial revolution." Entrepreneurs introduced technological advances [i.e. Pak (2013): new and innovative mechanization techniques of production and manufacturing, such as the steam], new infrastructures [i.e. Pak (2013): railroad companies, the first modern big business organizations connected the East with the West], and information and communication technologies [i.e. Pak (2013): telegraph lines, invented in 1844 and consolidated in 1866 to one company: Western Union]. In addition, the USA experienced massive population growth, thus an agricultural evolution [i.e. factory farms (Morris, 2006)] and industrial evolution [i.e. assembly lines, mega machines (Morris, 2006)] to production for scale economies. At the beginning of the high industrialization, from the perspective of the steel industry, the production facilities were small and production was fragmented among many different specialized companies. In the following years, the industry underwent a drastic transformation toward industrialized companies (McCraw, 1988). The corporation became the preferred method by which to finance and organize a business (Carey, 2008).

Carnegie, the main protagonist of this historical case, was a prototype in the sense of Schumpeter's dynamic entrepreneur within the economic context of this time (Bostaph, 2015). When Carnegie saw an opportunity to scale up, as Morris (2006) highlights, Carnegie reorganized, reenergized and recapitalized the organization and emerged as the lead shareholder. Steel, as Morris (2006) continues, was Carnegie's first full-time commitment. For example, Carnegie formed the Carnegie Steel Corporation – a major group vertically integrating all stages of steel and iron production, thus becoming independent from suppliers as well as becoming his best customer at the same time (Gordon, 2017). He represents the American dream: from rags to riches. In doing so, Carnegie challenged established (family) businesses and drove the US steel industry toward monopoly (McCraw, 1988). All his life, Carnegie showed a mixture of virtue and vice and stood open to constant technological innovation and business innovation as well as its early adoption (Gordon, 2017), i.e. before the innovation spread to other companies (McCraw, 1988). In contrast to the family business in Mark 0, Carnegie emphasized strategies of recruitment of top-flight executives, the construction and acquisition of modern plants, backward integration and continuous rationalization of process technology (McCraw, 1988). He recognized knowledge and technology much faster as a driving force for better coordination in the markets in which he competed. But also, Carnegie's relentless pressure, his hounding to reduce costs, his instinct to steal any deal to keep his plant full and his insistence on always plowing back earnings into ever-bigger created, as Morris (2006) states, built his competitive advantage. In his very early business career, Carnegie mastered telegraphy technology and capitalized on this technological advantage. Later, he provided a strong will to gain social power and to introduce new products, new processes and new forms of business organization. The investment into new

and innovative blast furnaces helped to produce more output at ever-decreasing costs and higher quality (McCraw, 1988), provided to those who demanded it. Carnegie showed close alertness to profit-making opportunities and implemented a sophisticated accounting system [incl. to control, manage and reduce operating costs (Gordon, 2017)].

The entry of entrepreneurs caused equilibrium disturbances. Reasons are, for example, technological and organizational changes launched by the entrepreneurs [i.e. Malerba and Orsenigo (1995)], including the release of new products and processes, combined with the introduction of new ways of production, organization and distribution (Breschi *et al.*, 2000), the development of new sales markets, enter new sources of raw materials and semifinished products and implement new legal/organization. Renewal, adaption, and innovation, thus, are the triggers and determine the players' rationale. The games become dynamic, and one player is always satisfied player and the other player is always the disgruntled player – or better: the disappearing player.

As depicted in Figure 7a–c, games 11, 45 and 66 have been chosen to demonstrate the outcomes in dynamic, entrepreneurial economies. In game 11 (c.f. Figure 7a), both players have a dominating strategy. Under the assumption of the players' rational behavior, the disgruntled player (player "Column") will not change the strategy since the change endangers the maximin payoff. In game 45 (c.f. Figure 7b), only player "Row" has a dominating strategy. Player "Column" will choose the strategy that maximizes its payoff. "Column" is dependent on "Row's" decision(s). For example, if "Row" decides to innovate to achieve a higher payoff, player "Column" must inevitably move along. Nevertheless, player "Column" will always be the disgruntled player. The reason for that can lie in market entry barriers that player "Row" set: innovations in product, service and/or process innovations, development of new sales markets as well as the development of new sources of raw materials and semifinished products (Kurz and Sturn, 2012). While the players in games 11 and 45 are determined by low and medium dynamics, the players in game 66 (c.f. Figure 7c) face high dynamics. The players are of equal (economic) power and no player has a dominating strategy. The game, also known as the Chicken Game, provides two Nash equilibria that are also Pareto-optional at the same time. This game does not allow players to revise their decisions if they find that they could improve by making a different strategy decision (Holler and Klose-Ullmann, 2005). The result of this game can not be determined convincingly (Holler and Klose-Ullmann, 2005): it puts the players' rationality to the test (Diekmann, 2009). Nevertheless, if one player switches unilaterally, this player acts – in the words of Rapoport (1967) – as an "Exploiter": the player helps himself and punishes the other. If Carnegie, for example, decides to innovate, thus, moving from a static (strategy A1/A2) to a dynamic (B1/A2) equilibrium, then the opposite player becomes the



Source: Rapoport and Guyer (1966)

Figure 7. (a) Game 11: Disgruntled player I; (b) Game 45: Disgruntled player II; (c) Game 66: Chicken game

disgruntled player. This game provides the high risks of misunderstanding and misinterpretation with every move (Diekmann, 2009) to achieve a common goal.

Entrepreneurs, as Smith (2005) argues, are always interested in expanding the market and limiting competition for their own sake: the foundation of corporate empires and economic dynasties (Kurz and Sturn, 2012). This era, also called big business and big management, is the objective of investigation in the next historical case – a case that is detrimental to the public and social interest.

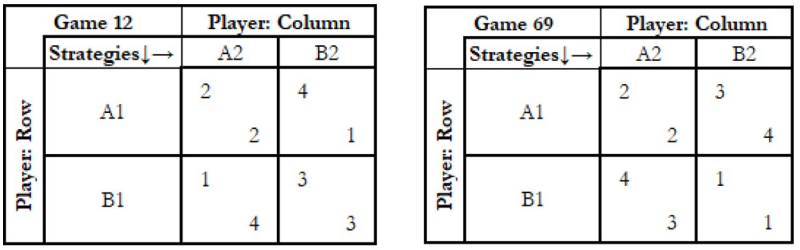
4.3 Mark II: Morganization, the era of big business and big management

This era heralded the rise of big business and big management. Protagonists of this era are, for example, Andrew Carnegie, Jay Gould, John D. Rockefeller and "the biggest and boldest" of the tycoons (Porter, 2005): J. P. Morgan. While the first mentioned tycoon got famous for the "Cleveland Massacre," the elimination and/or merger of 22 of 26 competitors within the oil industry (managed by Rockefeller's South Improvement Company: an alliance of three railroad companies and selected oil refineries), J.P. Morgan got famous for investment banking and the notion of "Morganization" (Van Dormael, 1997). "Morganization" stands synonymously for monopolization techniques (Hayes, 2023) – i.e. taking over a whole industry and stabilizing it through monopoly. The tycoons have triggered a wave of mergers and introduced a new form of organization: trusts. Trusts were a very different economic creation from the family business of the early days. They were structured differently, and – based on (cost) structure, function and the behavior of the businesses – they did different things in new ways (Porter, 2005).

J.P. Morgan represented creditors and business organizations (i.e. railroad corporations) at the same time (McCraw, 1988). Between 1894 and 1914 J. P. Morgan participated in 660 different company deals and managed 352 trusts for a total of approximately US$4.3bn (Pak, 2013). From 1897 to 1904, more than 4.200 businesses were merged into 257 conglomerates (Schröder, 2014). Morgan was responsible for the creation of many organized entities, such as the world's largest bank, America's largest steel production company, and the US's largest railroad (MacGregor, 2019). He was also the driving force in the construction of the Panama Canal (MacGregor, 2019). Compared to Mark 0, trusts such as J. P. Morgan did not compete over prizes and/or quantities. They competed based on performance, reputation and adherence (Pak, 2013).

The focus of this historical case is on the "competition" between Carnegie and Morgan. Carnegie is characterized as an industrial purist, representing the early years of high industrialization, focusing on vertical industry integration and its decentralized management. Morgan, according to Pak (2013), represented a "new" type of entrepreneur. He disliked competition since he believed that competition was too inefficient. His favorite organizational structure is cooperative and hierarchical – with him at the top of the pyramid. In this position, Morgan was able to impose order on chaotic situations and change entire industries (Gross, 1996). His leadership, as Gross (1996) states, was even more impressive than his holdings. In 1899, Morgan formed the second-largest steel empire composed of pipe, wire and bridge construction companies: federal steel. Morgan unleashed an economic war, which Carnegie countered by building a new factory and a rail line between Pittsburgh and the East Coast to attack Morgan's transportation empire ([.e. Albig (2014), Schröder (2014)]. Morgan and Carnegie immediately got into a "delicious" dilemma.

To present and discuss this dilemma, games 12 and 69 have been chosen. Game 12 presents the Prisoners Dilemma Game (c.f. Figure 8a). It is the most famous dilemma in Game Theory [i.e. Crofton (2013)]. Although the natural outcome is an equilibrium, the Prisoners Dilemma Game is different from all the other games. Both players have a



Game 12	Player: Column	
Strategies↓→	A2	B2
Player: Row A1	2, 2	4, 1
Player: Row B1	1, 4	3, 3

(a)

Game 69	Player: Column	
Strategies↓→	A2	B2
Player: Row A1	2, 2	3, 4
Player: Row B1	4, 3	1, 1

(b)

Source: Rapoport and Guyer (1966)

Figure 8. (a) Game 12: Prisoners dilemma; (b) Game 69: Battle of Sexes

dominating strategy (A1/A2), but no player is motivated to switch from the natural outcome. The switch would harm the switching player and reward the opposite (Rapoport, 1967). No player, as Rapoport (1967) highlights, wants to be the "Martyr" for the sake of its competitor. This game is synonymous with the reaction of Carnegie when he realized the emergence of Morgan's Federal Steel company: "only the best will survive" (Carnegie (2011) cites his favorite philosopher [2] Herbert Spencer.

Figure 8b (Game 69) represents a game wherein neither player has a dominating strategy. This game is also known as the Battle of Sexes game. The strategy for this game lies in unilateral cooperation: a player gives up their strategy for the benefit of both (i.e. from strategy A1/A2 to A1/B2). The switching player, as Rapoport (1967) highlights, can be considered a "Leader" since this player rewards both players but the opposite more than itself. It is, according to Diekmann (2009), a paradoxical decision, since otherwise both players would lose. It is no longer the original game, and the equilibrium is not Pareto-optimal: a coordination problem occurs when several Pareto-optimal equilibria exist (Diekmann, 2009). Reflecting on the competition between Carnegie and Morgan, this coordination problem was solved by Charles Schwab, Carnegie Steel Corporation's first president and Carnegie's right-hand man. Schwab intermediated between the parties and handed over a company acquisition offer to Carnegie. Carnegie accepted this offer and the payment of US$480–492m [*depending on the source; i.e.* MacGregor (2019) *announces US$480m;* Gordon (2017*) announces US$492m*]. Adjusted for inflation, that offer is about US$16bn today, and was the deal of the century, as financial historians noted 90 years later (Schröder, 2014). The deal made Carnegie the richest person in the world and made him able to pursue his philanthropic interests (Van Dormael, 1997). Morgan merged the Carnegie Steel Corporation with nine other steel companies (Gordon, 2017) and grew to be the economically most powerful man in the US economy in this era (Pak, 2013). Due to the restricting character of market competition of the company merger, J. P. Morgan immediately faced social and political resistance (Pak, 2013). The dispute between monopolists and the public and politics is the objective of the fourth historical case.

4.4 Mark III: Social dilemmas and political resistance

Carnegie (2011) was a fervent admirer of social theorist and philosopher Herbert Spencer. He introduced Spencer's concept of "Survival of the Fittest" to business and economy. In doing so, Carnegie eliminated competitors by the decrease of wages and the increase of working hours of his employees at the same time. The activities of the tycoons did not remain unrecognized and social dilemmas with impacts on public and politics arose. Carnegie

immediately faced worker's revolts (i.e. Homestead in 1892) and got into conflict with trade unions (Morris, 2006). Morgan faced issues with political reformers and the progressive reform movements of that era. Reasons for social dilemmas already can be found in Smith (2005, 1776) "The Wealth of Nations." The more extensive the competition and the freer the market, as Smith (2005) argues, the more benefits the public will derive from each trade. But also, as he continues, in a country where the owners of considerable fortunes enjoy great security, but the owners of small capitals are almost unprotected the capital employed in each trade can never be as large as it can be according to the nature and extent of the business in each case (Smith, 2005). In addition, as Robertson (2021) cites Smith, a fully liberal market as the entrepreneurs' demand, does not and never exist: it is absurd; an Oceana or Utopia (Smith, 2005).

As Pak (2013) highlights, critics found growing support in political institutions, such as the US congress, the House of Representatives, the White House, and the Supreme Court to protect the US American democracy from the evil of big business. Representatives of the political resistance against Morgan are, for example, US President Theodor Roosevelt, who initially differentiated between "good" and "bad" trusts, the Pujo Committee with Woodrow Wilson as chairman (to prove the existence of a monopoly on credit), Louis Brandeis, whose action resulted into the Clayton Antitrust Act and the "beast" Samuel Untermyer, which Morgan partners hated with an underlying passion (Pak, 2013). Untermyer's goal was to show that the practices Morgans' and others regarded as good and necessary put all others at a disadvantage. The tycoons' practices not only caused social dilemmas, as the reformers argued but also led to national and economic catastrophes.

Games identified that represent best the Mark III model are presented in Figure 9a 64) and Figure 9b (game 71). Both games represent conflictual coordination games. Game 64 can easily escalate and harm both players (Hankins and Vanderschraaf, 2021). In this game, also known as Luke and Matthew or Falcon and Dove game, neither player has a dominating strategy but can choose between an aggressive strategy or a cooperative strategy: the aggressive strategy foresees a fight until the victory over the other player, in which the player claims all of the good at stake (Hankins and Vanderschraaf, 2021), or its defeat. An aggressive player always wins over a nonaggressive player (Diekmann, 2009). The more aggressive player receives the correspondingly larger payoff (Bartholomae and Wiens, 2016). The cooperative strategy aims to hold the position. In this strategy, the players agree on an equal distribution. If, for example, two aggressive players or two cooperative players meet, the payoff is shared (Bartholomae and Wiens, 2016).

Game 64	Player: Column	
Strategies↓→	A2	B2
Player: Row A1	3, 4	2, 1
Player: Row B1	1, 2	4, 3

(a)

Game 71	Player: Column	
Strategies↓→	A2	B2
Player: Row A1	3, 3	2, 1
Player: Row B1	4, 2	1, 4

(b)

Source: Rapoport and Guyer (1966)

Figure 9. (a) Game 64: Luke and Mathew; (b) Game 71: Inspector-Evader

Game 71 represents a game entitled Inspector-Evader. An example of this game can already be found in Smith (2005, 1776). Entrepreneurs, as Smith (2005, 1776) argues, complain about the consequences of higher wages, as they lead to an increase in prices. But, as Smith (2005, 1776) also highlights, they do not say a word about the harmful effects of their high profits. They simply keep silent about the consequences of their benefits. The Inspector-Evader Game is a game without equilibrium (Rapoport and Guyer, 1966). It is a conflictual coordination game. An entrepreneur can decide whether to work in the public interest, which is resource- and capital-intensive or to defect. Politics and society can decide to inspect the entrepreneurs, which increases transaction costs, or to trust. This game creates several scenarios. For example, it does not make much sense to inspect if the entrepreneur cooperates. If the politics and society do not inspect, the entrepreneur could defect. If the entrepreneur defects, politics and society should inspect. An inspected entrepreneur cooperates to avoid unnecessary resource expenditures (Ruckle, 1992). A rational player, according to Diekmann (2009), applies the famous Laplace rule – and thus cooperates. The Inspector-Evader Game represents what Schumpeter calls the "march into socialism": the conquest of the private sector by the state (Schumpeter, 2005): if the "socialization" is unsuccessful – the entrepreneurs' defects against the public good. The prescription will be not less but more socialization– which again leads to a stationary economy (Schumpeter, 2005). Entrepreneurs are demanded to reinvent themselves and creatively deconstruct the old.

5. Findings and discussion

Within this paper, we present Schumpeter's research about the concept of creative destruction, represented by the Mark 0-III models. We follow the hypothesis that the Mark models are interrelated with business cycles, especially with the Kondratieff business cycle wherein basis innovation emerges. Furthermore, we hypothesize that the Mark models pass through a business cycle and represent a particular phase out of it, namely: the expansion (Mark I), recession (Mark II), depression (Mark III) and recovery (Mark 0).

The Mark models, as summarized in Table 1, are presented from a theoretical and historical perspective. The theoretical presentation is underlined with historically embedded use cases wherein the particular role of entrepreneurs in the four contexts, i.e. entrepreneurs in a stationary economy, Carnegie and Morgan, as well as public and political influences on entrepreneurship, are presented.

We analyzed the cases by the application of the Game Theory and selected games out of Rappoport's 2 × 2 Game Taxonomy. In doing so, possible and probable strategies for entrepreneurs have been identified. The economy in Mark 0 is stationary, noncompetitive and in a stable equilibrium. It is determined by the coexistence of entrepreneurs (mostly family businesses). Under the assumption of rational behavior and decision-making, the entrepreneurs have nothing to fear in their position. Mark I and II are determined by the rise of dynamic entrepreneurs and monopolists. The cases are determined by the unleashing of the entrepreneur's creativity and exploitation of capital, thus dynamization and the complexation of economic environments. In Mark I, the dynamic entrepreneurs challenge family businesses with new capabilities. These capabilities distinct traditional entrepreneurs from entrepreneurs with superior economic talent which are about, for example, ingenuity, venture, speculation and risk-affinity. Since the entrepreneurs have nothing to lose, they do not fear playing games such as the Chicken Game. The consequences are dynamic equilibrium and the rise of disgruntled entrepreneurs. In Mark II, the (former) dynamic entrepreneurs compete with each other. Over time, these entrepreneurs grew into tycoons and now compete against each other. This circumstance is best represented in the Prisoners Dilemma Game. In contrast to the Chicken Game, which has three equilibria, the Prisoner's

Table 1. Case overview

Case study	Case study I	Case study II	Case study III	Case study IV
Representing	Mark 0	Mark I	Mark II	Mark III
Ranging from	1776–1861 (Early industrialization)	1865–1900 (High industrialization)	∼1880–1901 (Morganization, trusts)	>1901
Economy	Stationary	Creatively destructive	Exclusive, competitive	Inclusive
Players	Family businesses, artesian entrepreneurs	Entrepreneurs, exemplified by A. Carnegie	Big business, exemplified by the takeover of the Carnegie Steel Corporation by J.P. Morgan	Reformers, trade unions, politicians
Market actors	Established firms	Established firms, small- and medium-sized organizations; entry of entrepreneurs and new firms	Established firms and multi-national companies organized in oligopoly or monopoly	Established firms, multi-national companies, entrepreneurs and new firms, collaborating with society and politics
Innovation	Exogenous (i.e. war, population growth, climate change, etc.)	Entrepreneurs and new firms invent and innovate as well as creatively destruct the old	Endogenous (i.e. innovation provided by internal research and development)	Coinnovation and coevolution with society and politics
Driving factors	Price(s), quantity	(Dynamic) entrepreneurs and new firms	Performance, reputation and adherence	Trust, cooperation and reputation

Source: Own representation – table by authors

Dilemma Game provides one dysfunctional equilibrium (Taschner, 2015). Within the fourth case, represented by the Mark III model, politics and society coinnovate with the economy and cocreate the entrepreneur's political, economic, social, technological, environmental and legal boundaries. Games to be played are by nature of conflictual coordination since the interests of the players are diametral. While entrepreneurs pursue their interests, demand economic liberty and consider free markets as an ideal construct (Robertson, 2021), the public and politics demand a say. The right to have a say, as presented in the fourth case, is best expressed in the Luke and Matthew (or Falcon and Dove Game) as well as in the Inspector-Evader Game. In both cases, close cooperation is key.

5.1 Theoretical implications

The evolution of games in business cycles is not only a phenomenon of the historical cases of the US steel industry. Observations in various contemporary industries at the entrepreneurial level (i.e. Zuckerberg versus Musk), on the institutional level (i.e. Meta versus X) and regulatory level (i.e., Meta and X versus the European Union on GDPR and the use of personal data) can be found. With this paper, we add to a better understanding of what we can learn from a game-theoretical analysis of the emergence and evolution of Schumpeter's concept of creative destruction. We provide a methodological repertoire that can also be applied to other cases as well, such as the emergence of contemporary industries. The game theoretical approach applied proved truth to be a perfect tool for the analysis of cases. The applied 2 × 2 Game Taxonomy enabled us to apply different games: no-conflict games, games with strongly stable equilibria, games with strongly stable deficient equilibria, games with stable equilibria and games with threat-vulnerable equilibria with the result to detect strategies per case.

5.2 Practical implications

Considering the US steel industry as a Kondratieff business cycle as well as its segmentation into the Mark 0-III models enables us to consider a whole epoch of industrial evolution in units of economic entrepreneurial expansion, recession, depression and recovery. The application of the Game Theory provides the base for the analysis of rational decision-making within the particular context of the mark. The games presented in the Mark models give an insight into the analysis of strategic situations and strategic decision-making. The paper presents a comprehensive method to act in the different stages of an industrial epoch and how to act. As the analysis shows, entrepreneurs in static economies, such as in the early industrialization of the US steel industry, are embedded in robust economic equilibria. Reason for change and innovation coming from external pressures: exogenous innovation. In the phases of the high industrialization of the US steel industry and its "morganization," entrepreneurs face dynamic economic equilibria. Entrepreneurs are embedded in turbulent contexts, caused by endogenous innovations. Societal demands are considered in Mark model III, where politics, society and industry cocreate and coinnovate. The method is not limited to the US steel industry but is also designed for more contemporary industries, such as the information technology industry and Social Media industry.

5.3 Limitations

The contribution of this paper provides a horizontal overview of how Game Theory can be applied to analyze industrial epochs and the particular phases of entrepreneurship (Mark models). Game Theory has proven to be an adequate method in this context. It provides a sound methodological base to analyze and evaluate strategic situations and decision-making in the set economic contexts. In the study here, it allows us to elaborate on the specificities of

each stage of industrial development. Game Theory moves beyond probability theory and also takes psychological factors of social-human beings into account – self-interest, bargaining, bluffing and other characteristics of human beings, which makes it possible to stay close to business reality. Nevertheless, Game Theory expects the rational behavior of its players. Irrationalities such as ventures, risks, feelings and empathy, which are part of human life, are difficult to depict in Game Theory. A further limitation is located in the 2 × 2 Game Taxonomy. It aligns a positive payoff function to each player. However, entrepreneurial being consists of negative consequences too. The payment of "lesson money," losses in efficiency and effectivity and further transactional costs for failures, and system accidents until organizational doom are not covered by this taxonomy. By extending this taxonomy, games with higher levels of detailization including, for example, probability computation and preference estimations could be played. An example would be the segmentation of the Luke and Mathew game, presented in Mark III, into more specified conflictual coordination games, such as the (extended) Wine Problem Game and the Bargaining Problem Game.

6. Conclusion and future outlook

This paper at hand investigates Schumpeter's approach to industry evolution. Schumpeter is considered a pioneer in innovation management. In his research, Schumpeter established a new type of entrepreneur, considered a "captain of industry": the dynamic entrepreneur. This entrepreneur creatively deconstructs the old and innovates. Centre to this paper are Schumpeter's Mark 0 – III models, applied in the industrial evolution of the US steel industry in the 19th and early 20th century. The Mark 0 model represents a static, mechanistic industry – determined by exogenous innovation. We consider Mark 0 as Schumpeter's starting point in the development of the concept of creative destruction and creative accumulation. Mark I represents an entrepreneurial industry, wherein innovative entrepreneurs and new firms enter the markets and creatively destruct the "old" (i.e. new products, new processes, services, etc.). Mark II represents a research- and development-oriented industry. Established firms (out of Mark 0 and Mark I) have established departments for research and development as well as organizational structures for change, renewal and innovation. Mark III represents a cocreation-oriented industry with society and politics. Industrial evolution in this model is considered a holistic cultural phenomenon and representatives out of these systems coinnovate and coevolute. These stakeholders negotiate the entrepreneur's political, economic, social, technological, environmental and legal boundaries. While games in Mark 0 are determined by stable equilibria, the games in Mark I–III are determined by dynamic environments. Since this paper provides a horizontal perspective on strategic games that can be used as analysis methodology in the field of entrepreneurship and applied in contemporary industries, we see the potential to vertically investigate the presented games.

Notes

1. Note: literature is not clear about the invention of the Mark models. For example, Breschi *et al.* (2000) and Stephan (2011) argue that Nelson and Winter (1982) and Kamien and Schwartz (1982) have been originally introduced the Mark models. Andersen (2015) argue that Freeman (1982) has introduced the Mark models.
2. "Few men have wished to know another man more strongly than i to know Herbert Spencer, for seldom has one been more deeply indebted than i to him and to Darwin". (Carnegie, 2011)

References

Aghion, P., Bunel, S., Antonin, C. and Cohen-Tanugi, J. (2021), *The Power of Creative Destruction: Economic Upheaval and the Wealth of Nations*, Harvard University Press, NJ.

Albig, J.-U. (2014), "Räuberbarone, um 1880: das prinzip rockefeller", *GEO Epoche – Das Magazin Für Geschichte, Nr*, Vol. 69, pp. 74-88.

Andersen, E.S. (2015), *Joseph A. Schumpeter: Eine Theorie Der Gesellschaftlichen Und Wirtschaftlichen Evolution*, Duncker and Humblot, Berlin.

Bartholomae, F. and Wiens, M. (2016), *Spieltheorie: Ein Anwendungsorientieres Lehrbuch (Game Theory: An Application-Oriented Textbook)*, 2 ed. Springer Gabler | Springer Fachmedien Wiesbaden GmbH.

Bostaph, S. (2015), *Andrew Carnegie: An Economic Biography*, Lexington Books, MD.

Breschi, S., Malerba, F. and Orsenigo, L. (2000), "Technological regimes and schumpeterian patterns of innovation", *The Economic Journal*, Vol. 110 No. 463, pp. 388-410.

Carey, C.W. (2008), "Corporations and big business", available at: www.gale.com/intl/essays/charles-w-carey-jr-corporations-big-business

Carnegie, A. (2011), *Autobiography of Andrew*, tredition GmbH, Carnegie.

Castellacci, F. and Zheng, J. (2008), "Technological regimes, schumpeterian patterns of innovation and firm level productivity growth", NUPIWorkingPaper 730, p. 42, Norsk Utenrikspolitisk Institutt |← Norwegian Institute of International Affairs, available at: www.files.ethz.ch/isn/49802/730_Technological_Regimes.pdf

Crofton, I. (2013), *Big Ideas in Brief*, Quercus, Lisbon.

Davis, M.D. and Riese, M. (1999), *Spieltheorie Für Nichtmathematiker: (Game Theory for Non-Mathematicians)*, 3. Auflage Oldenbourg, Muenchen.

Dekker, E. (2018), "Schumpeter: theorist of the avant-garde", *The Review of Austrian Economics*, Vol. 31 No. 2, pp. 177-194, doi: 10.1007/s11138-017-0389-9.

Diekmann, A. (2009), *Spieltheorie: Einführung, Beispiele, Experimente (Game Theory: introduction, Examples, Experiments)*, 4th ed. Rowohlt Taschenbuch, Hamburg.

Fontana, R., Nuvolari, A., Shimitzu, H. and Vezzulli, A. (2012), "Schumpeterian patterns of innovation and the sources of breakthrough inventions: evidence from a Data-Set of R&D awards (working papers WP 24/2012/DE/UECE)", Technical University of Lisbon, School of Economics and Management, available at: https://depeco.iseg.ulisboa.pt/wp/wp242012.pdf

Freeman, C. (1982), *The Economics of Industrial Innovation*, 2nd ed. Taylor and Francis, New York, NY.

Gallouj, F. (1999), "Interactional innovation: a neo-Schumpeterian model. ‚Managing innovation and the external context'", available at: https://shs.hal.science/halshs-01113802

Gordon, J.S. (2017), "Andrew carnegie and the creation of U.S. Steel", Life, Liberty and the Pursuit of Happiness: A History of the American Experiment. Bill of Rights Institute, available at: https://billofrightsinstitute.org/life-liberty-and-the-pursuit-of-happiness

Gross, D. (1996), *Forbes Greatest Business Stories of All Time*, Wiley, NJ.

Guyer, M.J. and Rapoport, A. (1972), "2× 2 Games played once", *Journal of Conflict Resolution*, Vol. 16 No. 3, pp. 409-431.

Hankins, K. and Vanderschraaf, P. (2021), "Game theory and ethics", in Zalta, E.N. (Ed.), *The Stanford Encyclopedia of Philosophy*, 2021st ed. Metaphysics Research Lab, Stanford University, CA, available at: https://plato.stanford.edu/archives/win2021/entries/game-ethics/

Hart, C. (2003), *Doing a Literature Review: Releasing the Social Science Research Imagination*, Sage, London.

Hayes, A. (2023), "Morganization: what it is, how it works", in Roosevelt, T. and Brown, J.R. (Eds), Investopedia, available at: www.investopedia.com/terms/m/morganization.asp

Holler, M. and Klose-Ullmann, B. (2005), "Spieltheorie für manager (game theory for managers)", Accedo Verlagsgesellschaft.

Kamien, M.I. and Schwartz, N.L. (1982), *Market Structure and Innovation*, Cambridge University Press, MA.

Kurz, H.D. and Sturn, R. (2012), "Schumpeter für jedermann", *Frankfurter Allgemeine Buch*, available at: www.facultas.at/item/Schumpeter_fuer_jedermann/Heinz_D_Kurz/Richard_Sturn/5958166

McCraw, T.K. (1988), "Thinking about competition", *Business and Economic History*, Vol. 17, pp. 9-29.

MacGregor, J. (2019), "J.P. Morgan: the life and deals of Americás banker: Insight and analysis into the founder of modern finance an the American banking system", CAC Publishing LLC.

Maleki, A., Rosiello, A. and Wield, D. (2016), "The effect of the dynamics of knowledge base complexity on schumpeterian patterns of innovation: the upstream petroleum industry", Innogen Working Paper 116, University of Edinburgh, available at: www.innogen.ac.uk/sites/default/files/2019-08/Innogen-Working-Paper-116_v2.pdf

Malerba, F. and Orsenigo, L. (1995), "Schumpeterian patterns of innovation", *Cambridge Journal of Economics*, Vol. 19 No. 1, pp. 47-65.

März, E. (1983), "Persönliche Erinnerungen an Joseph A. Schumpeter als akademischen lehrer (personal recollections of joseph a. Schumpeter as an academic teacher)", Joseph Alois Schumpeter—Forscher, Lehrer und Politiker (Joseph Alois Schumpeter—Researcher, teacher and politician). Verlag für Geschichte und Politik.

Morris, C.R. (2006), *The Tycoons: How Andrew Carnegie, John D. Rockefeller, Jay Gould, and J. P. Morgan Invented the American Supereconomy*, First Holt Paperpacks edition Times Books/Henry Holt and Company, New York, NY.

Nash, J.F. (1950), "Equilibrium points in n-person games", *Proceedings of the National Academy of Sciences*, Vol. 36 No. 1, pp. 48-49, doi: 10.1073/pnas.36.1.48.

Nelson, R. and Winter, S.G. (1982), *An Evolutionary Theory of Economic Change*, Harvard University Press, MA, available at: https://inctpped.ie.ufrj.br/spiderweb/pdf_2/Dosi_1_An_evolutionary-theory-of_economic_change.pdf

Neumann, J. (1928), "Zur theorie der gesellschaftsspiele", *Mathematische Annalen*, Vol. 100 No. 1, pp. 295-320, doi: 10.1007/BF01448847.

Neumann, J. and Morgenstern, O. (1944), *Theory of Games and Economic Behavior*, Princeton University Press, NJ, available at: www.jstor.org/stable/j.ctt1r2gkx

Osborne, M.J. and Rubinstein, A. (1994), *A Course in Game Theory*, 1st ed. The MIT Press, PA.

Pak, S.J. (2013), *Gentlemen Bankers: The World of J. P. Morgan*, Harvard University Press, MA, available at: http://ebookcentral.proquest.com/lib/vorarlberg/detail.action?docID=3301314

Plickert, P. (2012), "Alte meister (2): zum 100. Geburtstag von joseph schumpeters „theorie der wirtschaftlichen entwicklung "(old masters (2): on the 100th birthday of joseph schumpeter's "theory of economic development). Fazit - Das wirtschaftsblog", available at: https://blogs.faz.net/fazit/2012/02/24/alte-meister-2-von-der-rastlosigkeit-des-kapitalismus-zum-100-geburtstag-von-joseph-schumpeters-theorie-der-wirtschaftlichen-entwicklung-266/

Porter, G. (2005), *The Rise of Big Business, 1860-1920*, 3rd ed Wiley-Blackwell, NJ.

Rapoport, A. (1967), "Exploiter, leader, hero, and martyr: the four archetypes of the 2 × 2 game", *Behavioral Science*, Vol. 12 No. 2, pp. 81-84, doi: 10.1002/bs.3830120202.

Rapoport, A. and Guyer, M. (1966), "A taxonomy of 2×2 games", *General Systems*, Vol. 11, pp. 203-214.

Rapoport, A., Guyer, M. and Gordon, D. (1976), *The 2x2 Game*, The University of MI Press, MI.

Robertson, R. (2021), *The Enlightenment: The Pursuit of Happiness, 1680-1790*, Harper, New York, NY.

Ruckle, W.H. (1992), "The upper risk of an inspection agreement", *Operations Research*, Vol. 40 No. 5, pp. 877-884.

Samuelson, P.A. and Nordhaus, W.D. (2005), "Volkswirtschaftslehre: das internationale standardwerk der makro- und mikroökonomie (economics: the international standard work on macroeconomics and microeconomics) (3., aktualisierte auflage)", *mi-Fachverlag, Redline GmbH*, (McGraw-Hill/Irwin, New York, NY).

Schröder, J. (2014), "Räuberbarone", *GEO Epoche - Das Magazin Für Geschichte, Nr*, Vol. 69, pp. 132-141.

Schumpeter, J.A. (1934), *Theorie Der Wirtschaftlichen Entwicklung: Eine Untersuchung Über Unternehmergewinn, Kapital, Kredit, Zins Und Den Konjunkturzyklus (Theory of Economic Development)*, 7th ed. unmodified reprint of the 1934 published 4th edition Duncker and Humblot, Berlin.

Schumpeter, J.A. (1954), *History of Economic Analysis*, in Boody, E. (Ed.), Oxford University Press, Oxford.

Schumpeter, J.A. (2005), *Kapitalismus, Sozialismus Und Demokratie (Capitalism, Socialism and Democracy)*, 8th ed. A. Francke Verlag, Wuerttemberg.

Schumpeter, J.A. (2008), "Konjunkturzyklen (business cycles. A theoretical, historical, and statistical analysis of the capitalist process) (neuausgabe 2008 (1961))", Vandenhoeck and Ruprecht GmbH and Co. KG.

Selten, R. (2001), "Die konzeptionellen grundlagen der spieltheorie einst und jetzt (the conceptual foundations of game theory once and now)", *Bonn Econ Discussion Papers*, Vol. 2, available at: www.econstor.eu/bitstream/10419/78400/1/bgse2_2001.pdf

Smith, A. (2005), *Der Wohlstand Der Nationen (the Wealth of Nations)*, H. C. Recktenwald, Trans. Deutscher Taschenbuch Verlag, Munich.

Statista (2022), "Amerikanischer bürgerkrieg: Wirtschaftsdaten (American civil war: Economic data)", Statista, available at: https://de.statista.com/statistik/daten/studie/1134329/umfrage/wirtschaftsdaten-der-nordstaaten-und-der-suedstaaten/

Stephan, M. (2011), "Der einfluss der deutschen und österreichischen nationalökonomie auf die betriebswirtschaftslehre am beispiel J.A. Schumpeter (the influence of german and Austrian national economics on business administration using the example of J.A. Schumpeter)", Department of Technology and Innovation Management, Philipps-Univ, available at: www.econstor.eu/handle/10419/77070

Strathern, H.H. (2003), *Schumpeters Reiterhosen (Dr. Strangelove's Game. A Brief History of Economic Genius)*, Campus Verlag GmbH.

Tapio, K. (2011), "Uusi innovaatioregiimi schumpeter mark III (the new schumpeter mark III innovation programme)", in Tapio, K., Mikkonen, T., Vadén, T., Valkokari, K., Ahonen, M. and Vainio, N. (Eds), *Rajoja Ylittävä Innovoint (Cross-Border Innovation)*, Tampere University Press, Tampere, pp. 152-191, available at: https://trepo.tuni.fi/bitstream/handle/10024/102996/978-951-44-8561-9.pdf?sequence=1&isAllowed=y

Taschner, R. (2015), *Die Mathematik Des Daseins: Eine Kurze Geschichte Der Spieltheorie*, Hanser, Munich.

Van Dormael, A. (1997), "The morganization of america", in Van Dormael, A. (Ed.), *The Power of Money*, Palgrave Macmillan, UK, pp. 10-20, doi: 10.1007/978-1-349-14301-6_2.

Wentzel, J.S. (1976), *Elemente Der Spieltheorie (Elements of Game Theory)*, Deutsch.

Yin, R.K. (2014), *Case Study Research: Design and Methods*, 5th ed. SAGE Publications, London.

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