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Signals during takeovers : A game-theoretic model

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Abstract

The success of a takeover offer hinges on the strategic deployment of signals, emanating from diverse sources including target and bidder management, as well as other stakeholders. The legal and factual frameworks governing the generation of informative signals play a pivotal role in determining which party holds the reins of the offer's success. Precise and widely disseminated signals empower shareholders to coordinate their actions effectively. In this study, I present a takeover offer game characterized by multiple equilibria with conditions of complete information. The adaption of the information structure following the approach of Carlsson & van Damme (1993) engenders a unique threshold equilibrium defined by a specific threshold of a noisy signal concerning the target value. Notably, while opportunistically biased signals may impede efficiency, reliable signals can pave the way for efficiency-enhancing offers, thereby surmounting the free-rider dilemma outlined in Grossman & Hart (1980b). The probability of a signal falling short of this critical value provides a measure of the likelihood of a successful takeover. In the event of a successful acquisition, the financial gains are apportioned between the bidder and target shareholders.

Keywords: takeover offer, signaling, management recommendations, fairness opinions, game theory.
Jel codes: C72, D82, G34

1. Introduction

Takeovers can catalyze efficiency by facilitating the improvement of management in two standard ways. Firstly, the prospect of a hostile takeover offer can compel the current management to align their actions with the maximization of the company's value. Secondly, if the incumbent management lacks the requisite skills to fulfill this obligation, a takeover provides an opportunity to replace them. These lines of reasoning are rooted in economic theory, albeit not immune to objections based on empirical data (Scherer, 1988). Grossman & Hart (1980b) conceptualize proficient management of a company as a public good. This gives rise to the well-known free-rider dilemma, which can diminish the raider's profit and potentially hinder efficient transactions. They identify the dilution of the old shareholders' property rights following a successful bid as a potential solution. The model presented here offers an alternative approach to address the free-rider problem.

Takeovers not only influence economic welfare but also impact the business success of the entities involved. Hence, the driving factors behind takeover procedures hold significance from both a business and economic standpoint. The motivation for the model in this paper is to elucidate the impact of signals from various sources on the outcome of a takeover offer. The modeling approach draws upon the global games method introduced by Carlsson & van Damme (1993). However, it differs in that it aims to be illustrative, thereby reducing the theoretical framework to a simplified complexity. In several real-world decision scenarios, players must adopt a global perspective towards the circumstances, meaning that only broader ranges are known for several features, not precise characteristics (Vives, 2005). This also applies to the model presented here, where players are not aware of the specific game they are engaged in. They understand the game's structure and the underlying distribution functions of the fundamentals, but they only observe the actual realization of the random variable with some noise. Higher-order beliefs play a pivotal role in the process by which players determine their strategies. This enables the determination of a unique equilibrium for games that, under complete information, exhibit multiple equilibria.

Real-world actors can leverage this mechanism to enhance the likelihood of successful and efficient takeover offers, but also to bias the process for their own gain. Regulators, in turn, should take this insight into account if they aim to facilitate efficiency-boosting takeovers. Restricting the signaling options for certain parties enhances the opportunities for other parties to influence the transaction in a specific manner. In a scenario with a reliable signal, bidders with the capacity to enhance the target's value can secure the target by sharing their profit with the target shareholders. Consequently, bidders can generate positive profits without resorting to dilution.

The paper is organized as follows: Chapter 2 outlines the process of takeover offers, introduces the involved agents, and expounds on the effects of takeovers. Chapter 3 encompasses the game theoretical foundations that are pertinent to this paper. In Chapter 4, the model is described and assessed. Chapter 5 offers an interpretation of the model.

2. Real-world (German) takeover offers

2.1. Procedure of a takeover

The process of a takeover offer for a public German company is regulated in the Securities Acquisition and Takeover Act (WpÜG). The bidder must immediately announce their intentions to make an offer and afterwards publish an offer document containing all information that is relevant to make informed decisions. The offer price is an essential element of this information. The offer premium is a relative measure and amounts for the relative difference of the price that is not influenced by an anticipation of the offer and the price offered by the bidder (Eckbo, 2009; Walkling, 1985). It was shown that target shareholders' first reaction to takeover offers depends on their expected offer price (Ang & Ismail, 2015). Also, the final success of offers is driven by the premium. Several studies showed that higher offer premiums allow bidders to win more shares with their offers (Bessler & Schneck, 2015; Betton & Eckbo, 2000; Hirshleifer & Png, 1989; Hirshleifer & Titman, 1990; Officer, 2003; Walkling, 1985). If the bidder aims at surpassing the control threshold with the bid or is obliged to make the offer, the offer price has to surpass the three months volume-weighted average of the domestic stock price of the target shares (§5 (1) WpÜGAngebV). According to Damodaran (2011), the premium covers three aspects of the offer: expected potential for synergies, expected value increases through control changes, and possibly an overpayment.

For the target management, from the publication of the offer document arises the duty to publish a reasoned opinion. In accordance with §27 WpÜG, this statement must contain an assessment of the nature and amount of the consideration offered, as well as the consequences of the offer for the target company, its employees and their representatives, the conditions of employment, and locations of the target company. Further, the target management has to evaluate the pursued objectives of the bidder company. If members of the management board own shares of the target company, they must, additionally, indicate whether they plan to accept the offer. Oftentimes, in the course of takeover offers, the managements commission Fairness Opinions. Independent third

parties compile these documents which contain an objective assessment on whether the offer and, in particular, the offer price is fair; thus are intended to reduce information asymmetries (Cain & Denis, 2013; Kisgen et al., 2009). Measures to hinder takeover offers are prohibited for the target management after the offer was announced. This regulation does not include means that the general assembly explicitly allowed before the offer was announced (§33 WpÜG). Therefore, the management recommendation is supposed to be the main tool for interference for the target management (Hopt, 1993).

The German law defines several thresholds for the stake in a company which determine the extent of control that the owner can exert over the company. A stake of 30% is necessary to control the target company (§29 WpÜG). If a shareholder increases their stake beyond that threshold, they are obligated to make a takeover offer to the remaining shareholders (§35 WpÜG). Higher stakes are required to exercise a majority in the shareholder meetings (50%), to conclude a profit and loss transfer agreement (75%), or to exclude minority shareholders (90% to 95%) (§293 (1) AktG; §62 UmwG (5); §327a AktG). The multiplicity of control thresholds necessitates that bidders can have a range of different initial toeholds. Moreover, this implies that bidders can perceive different outcomes of their bids as successful depending on which level of control over the target company they seek.

2.2. Involved parties

2.2.1. Bidders

Bidders are likely to attempt a takeover if they expect that its completion results in a financial gain for them. For the offer to be successful, the bidder must have a higher valuation of the target shares than their current owners. This can be reflected by a premium that the bidder pays on top of the market valuation of the target. As Damodaran (2011) states, the premium measures the "value of control" over the company. A positive premium thus implies that the bidder assesses their or someone else's skills in managing the company are superior to the current executive's one. Particularly, hostile takeover offers that occur without the consent of the target management should come along with significant control premiums. Bidders will not offer a premium that accounts for the entire value of control, as that would allocate the entire positive surplus to the former target shareholders.

There is a broad range of reasons for companies to intend the acquisition of other companies (Calipha et al., 2010). Whether the bidder pursues purely financial or strategic goals with the acquisition affects the selling mechanism of the transaction and the choice of the target companies. While there is no significant difference in the premium between the two bidder types (Fidrmuc et al., 2012), strategic bidders were found to have higher valuations of companies than financial bidders (Gorbenko & Malenko, 2014). Financial bidders are likely to have higher skills in financial and strategic restructuring of companies; correspondingly, it was shown that firms with low performance and narrow scope for investment are more attractive for financial bidders. Furthermore, the within variation in target valuations is smaller for financial bidders (Gorbenko & Malenko, 2014). Besides having on average higher valuations, strategic bidders seem to outperform financial bidders in identifying undervalued targets (Blomkvist & Korkeamäki, 2017).

Bidders can further be differentiated by the share of the target company that they own before the offer, the toehold. Larger toeholds are associated with better knowledge on the target firm characteristics. This implies that if the target company wanted to drive the offer price upwards, it could fuel the competition among bidders by providing information to the less informed bidders. Contrarily, theoretically offering exclusive deal negotiations to the best-informed bidder can be the dominant strategy to maximize target shareholder value (Povel & Singh, 2006). Yet, empirically higher bidder toeholds were shown to be detrimental to the target shareholder's expected surplus and to reduce the premiums offered. At the same time, target management was less likely to resist the higher bidder offer (Betton & Eckbo, 2000). As significant toeholds reduce the likelihood for competing bids, higher toeholds can increase the probability of success and can depress the entailed costs for the bidders (Bulow et al., 1999). Another advantage for bidders with initial toeholds is that they can offer prices above their valuation of the target shares as they only have to compensate the remaining shareholders and not factor in the higher costs for the shares they already own (Bessler et al., 2015).

Still, the purchase of a toehold stake prior to the offer can also have an adverse effect for the bidder by causing the market to expect a takeover bid and thereby leading to an upwards trend in the target prices which ultimately increases the final acquisition costs (Ravid & Spiegel, 1999). Also, theoretically, the target management might be more prone to resist the offer if it is made by a bidder with a larger toehold (Betton et al., 2009).

The efficiency of the controlling management is of particular importance insofar as it majorly affects shareholder value. In this sense, the acquisition of control plays an important role in the context of a takeover offer as external control transfer (Choi, 1991). Takeover offers submitted by controlling shareholders are likely to display certain differences compared to other takeover offers. As they already possess the possibility to appoint

the management, their offers are not likely to entail management turnovers. Damodaran (2011) describes the value of control as unrealized potential that lies in the target company but does not materialize due to failure of the current management. Thus, the control premium can be particularly large for poorly managed corporations. The extent to which the acquisition premium contains the control premium depends on how much the market price is already driven by anticipation of financial potential through control shifts. Therefore, if the bidder already possesses a certain decision-making power in the target company, any improvement due to managerial decisions that are in their competence prior the offer dose not drive the control premium upwards unless the market participants, when forming the market price, disregard their potential.

2.2.2. Target shareholders

The target shareholders play a key role in the takeover, as they are the ones who decide on whether to tender their shares and thereby ultimately decide on the success of the offer. This also implies that if the target or the bidder management want to steer the takeover process, their effort will mostly be aimed at the target shareholders. Shareholders can be classified as strategic or financial. In contrast to financial investors, strategic shareholders do not merely care about their financial surplus but rather try to exploit synergistic or strategic potential with their own company (Fidrmuc et al., 2012; Gorbenko & Malenko, 2014). As this implies an additional value of the shares on top of the purely financial value, bidders in takeovers would need to offer higher prices to convince strategic shareholders to sell their shares than financial investors (Dobmeier et al., 2019).

Another distinctive feature of the shareholders is whether their stake in the company allows them to exert a certain degree of control. Overall, majority shareholders can have two antagonistic effects on the agency problem. For one thing, the existence of a controlling shareholder can alleviate the severity of the conflict of interest between shareholders and management, as they possess strong incentives and means to monitor the company executives. Firstly, the majority shareholder as principal can target their monitoring effort at the management's actions and thereby hinder the management as agent from taking actions to the detriment of the principal. Secondly, a majority shareholder when being a principal could have two other advantages compared to shareholders that own smaller fractions of the company. On the one hand, they could afford gathering deeper information on the economic circumstances of the business and, by that, the costs that the agent would have to bear for certain actions, and on the other hand, could afford to make higher expenses to verify the competence of the agent. On the downside, other agency costs arise because minority and majority shareholders of a company are likely to have different interest in the firm. The superiority of majority shareholders to lobby in favor of their interests aggravates this problem (Courteau et al., 2017).

Studying corporations with majority shareholders, Yeh (2005) identifies empirical evidence for the positive effect of larger monitoring incentives by delineating the positive relationship between cash flow rights of the largest shareholder and firm valuation. Similarly, Barka & Hamza (2020) describe that if controlling shareholders also hold a large proportion of the cash flow rights that positively affects market performance. From this, they conclude that cash flow concentration benefits the scope for monitoring of the management. If, on the contrary, they do not possess cash flow rights corresponding to their controlling power that results in a worse development of the share price. Decreasing cash flow rights of the controlling shareholder impairs the alignment of interests between minority and majority shareholders. That indicates that the risk of an opportunistic behavior of the controlling shareholder increases as the gap between their controlling power and ownership rights widens. Further, if controlling shareholders bring forward a bid, the personal influence of target CEOs on the offer is weaker as compared to control seeking bids (Gindele & Rath, 2023a).

Internationally, several regulatory approaches intend to reduce the extent to which majority shareholders can abuse their voting power to the detriment of the minority shareholders. Oftentimes, these regulations ask for a separation of power, for instance between the board and the management, between committees and ordinary board members, and between individual members of the bodies, e.g., by restricting their tenure. Still, it is questionable whether these measures help to restrict the power of the largest shareholder once they have a share in the company that allows them to appoint most of the members of the panels (Courteau et al., 2017).

2.2.3. Target Management

Similarly to the fact that incentives between controlling and minority shareholders can diverge, the aims of the management and the shareholders of the company are not in any case aligned. In the case of controlling shareholders, one would expect this discrepancy to diminish the higher the share and thereby the controlling power of the main shareholder is.

A poor management will decrease the valuation of a company. Examples are underinvestment, overinvestment, flaws in the strategy and suboptimal financing decisions (Damodaran, 2011). In the course of a takeover attempt, the target management is legally obliged to act for the benefit of the shareholders (§3 (3) WpÜG). Thus, the

financial standing of the target company, its shareholder structure, and the type of bidder might also drive the attitude of the management towards the offer. Further, the target management might incorporate the offer premium, additional features of the offer, and the economic surrounding into their decision. With their insider knowledge, target managers might also be better able to assess the future prospects of the company and thereby have an advantage at judging the plans that will most likely help the company draw in its full potential (Kyle, 1985). Knowing that the bidder is not able to prevent the target management from acting against the offer, controlling shareholders have an incentive and the ability to designate a new target management from within their own company or atmosphere (§ 84 (1,2) AktG).

Yan (2015) studies the stance of the managements and its effects on the outcomes of corporate takeovers offers in the United States. His findings indicate that the target management indeed uses a public negative attitude towards the offer as a negotiation tool. For one thing, it decreases the success probability of the takeover attempt, and for another; it is at the same time associated with lower initial offer premiums and an improvement of the premiums in further rounds.

Under the German law, the target management has to act in their shareholders interest during takeover offers (§3 (3) WpÜG). This regulation is a reinforcement of the obligations that the employment contract of CEOs should already contain. It is relevant as various empirical studies traced the conflicts of interest that can prevail between the involved parties in corporate decision making. For example, managers were found to act self-interestedly in corporate transactions. Thereby, they did not maximize the owners' profits (Qiu et al., 2014).

Several characteristics of target CEOs are likely to influence their decision-making during takeovers. The timespan that the CEO has spent in her position prior the offer can affect her power to influence the takeover process (Hill et al., 1991; Jenter & Lewellen, 2015). Also founder CEOs likely have the potential to improve corporate performance. Yet, after a successful takeover, the bidder might be more interested in disposing of the incumbent founder CEO to maintain the structural power balance and prevent the incumbent CEO from attaining outsized influence. Anticipating this action of the successful bidders might, in turn, prompt incumbent CEOs to negotiate for their personal benefits during the takeovers more than for the interests of their shareholders (Adams et al., 2009; Lee et al., 2016; Kumar et al., 2021). The principal agent problem arises whenever the ownership and the management of a project are not incumbent upon the same individuals. This implies, that managerial ownership is a means to reduce this conflict of interest (Duggal & Millar, 1994; Sudarsanam, 1995; Walkling & Long, 1984). Further, a larger stake of the target CEO in their own company makes it more likely that they can stay in office after a successful bid (Iqbal & French, 2007). As our previous research suggest, the age of CEOs as proxy for the career horizon and their potential influence is a determinant of their actions during takeovers (Buchholtz & Ribbens, 1994; Gindele & Rath, 2023a). Older CEOs might experience lower personal losses from takeovers and therefore negotiate lower offer premiums (Jenter & Lewellen, 2015). Another incentive for a CEO to negotiate a lower premium is to get in with the bidder and increase the chances of an employment in the future company (Bargeron et al., 2017; Qiu et al., 2014).

2.3. Business effects of takeover

Andrade & Stafford (2004) conclude that the effects of takeovers can serve two functions. If a bidding firm expects positive growth, a merger can be a way to comply with future capital needs. Further, a merger of firms from the same industry can help them rationalize their capacities when needed. In their analysis, buyers in contracting mergers were more likely to show better performance, e.g., through management, which offers potential for efficiency increases.

It was found that stock prices of an industry rose following a merger in that very industry. The reason for this is probably that further corporate transactions were seen more likely. This supports that mergers can be a tool to realize synergies by an optimized distribution of capital (Song & Walkling, 2000). Productivity increases after corporate transactions can be anticipated as buying firms are on average the more productive firms. Following the deal, they are, therefore, able to use their competences to manage a larger fraction of the economy which implies efficiency increases (Maksimovic & Phillips, 2001). If markets were efficient and correspondingly market prices would include the expected value increase of a change in management, bidders that paid a control premium over the market price would overpay (Damodaran, 2011). Further, any change in control of a company could influence market prices of all companies as expectations of the likelihood of control changes would be readjusted (Damodaran, 2011).

A reason for the unexploited potential for efficiency increases regularly lies in mismanagement of the target company. In this case, takeover attempts can be a means to either exchange the incompetent management or to incite capable but unmotivated management to engage in performance increasing measures (Thakor, 1991). The latter is achieved by the threat of an impending loss of the position after the takeover what in fact managers seem to be aware of and seem to take into account during the process of the takeover (Qiu et al., 2014).

Overall, corporate transactions bear potential for welfare-enhancing efficiency increases. Yet, there are possible impediments for takeover offers despite them being efficient. For example, when an offer is made, free-riding of smaller target shareholders can impede the offer (Grossman & Hart, 1980b). Another reason for the target shareholders not to accept an offer is that they might be unaware of the true value of their share and, due to their personal overvaluation, assess the offer price as unfair. Over and above in the model of Grossman & Hart (1980b), bidders would have to offer prices that would not leave any positive profit for themselves. Further, not knowing the chances of success of a contingent offer, the costs of the preparation and execution of the takeover offer can deter possible bidders. The recommendation of the target management to its shareholders, as a means to reduce information asymmetry, is a main determinant of the success of a takeover (Henry, 2004; Wong & O'Sullivan, 2001). Yet, its effectiveness in paving the way for successful takeovers is limited by the condition that the target management must be sufficiently informed and is willing to share all relevant information with its shareholders.

3. Game theory and Finance

3.1. General

Game theory is a younger branch of the economic research discipline. As the name suggests, it deals with the analysis of games that can be delineated in the following manner. From a certain initial point on, agents sequentially take certain actions that they pick from their feasible actions. Also, stochastic incidents can affect the course of the game (Owen, 2013). Here, Γ will be used to describe the game, where $\Gamma = (N, (S_i)_{i\epsilon N}, (u_i)_{i\epsilon N}$. The game Γ consists of the player set N, the strategy set $(S_i)_{i\epsilon N}$, and the set of payoff functions $(u_i)_{i\epsilon N}$. According to Thakor (1991), game theory's first important appearance in finance literature was with Akerlof (1970), who described the phenomenon of adverse selection. He gained an understanding of the consequences that uncertainty about the true value of products had on markets and on the behavior of the agents. If market actors are not able to reliably communicate the value of their products, that can ultimately lead to a welfare reduction through market failure. Before institutional economics gained importance, markets were widely understood as efficient. Consequently, institutions, which deal with differences in information, would be ultimately pointless (Thakor, 1991).

Until then, certain observations on market prices could not be explained, which led finance researchers to consider the distribution of information, e.g., by studying insider trading. To this end, studies increasingly employed game theory when studying money and capital assets. They started to create models in that the involved individuals maximized their own expected utility. Various assumptions on the individuals like initial endowments, preferences, and level of information constrained the feasible solutions. The awareness of the individuals for the interdependence of their decisions and outcomes was an integral part of the analysis. In particular, the study of corporate transactions can benefit significantly from game theory. Corporate transactions are characterized by a clear temporal order, as well as agents make decisions that strongly depend on the information they possess (Thakor, 1991).

3.2. Global Games

In a model setting, agents build expectations on the future value of assets. The dependence of these beliefs on the behavior of other agents and the developments of the market generally yield to uncertainty. Simultaneously, these conditions regularly lead to a multiplicity of feasible outcomes (Cavalcanti, 2010). Whenever models are not suitable for deriving clear projections, that greatly limits the usefulness in real-world decision-making. Also, inside the model, multiple equilibria make it hard for agents to coordinate their actions. As the players are unable to predict the decisions of their counter-players, they might ultimately fail to reach any equilibrium (Vives, 2005). Another source for the multiplicity of equilibria lies in the assumption of complete information games that oftentimes does not allow for an accurate prediction of the agents' actions. At this point, we touch one of the major criticism game theory has to confront (Morris et al., 2016). This is precisely the issue that global games address (Carlsson & van Damme, 1993).

More precisely, Carlsson & van Damme (1993) were able to modify game-theoretic settings with multiple equilibria in a way that allowed for an unambiguous solution. This achievement was reached with the simultaneous analysis of an entire class of games instead of one single game. These classes of games are called global games. In them, for the agents, uncertainty arises as it is unknown which precise game is played. Thus, they are forced to form expectations on the actual conditions. These individual expectations of the agents are likely to be dependent on each other, as they are probably based on similar observations. This implies that each agent will use their own information on the economic conditions to assess the expectations of the other agents. Accordingly, agents choose their actions based on their assessment of the true game being played and on what game they expect other agents are expecting. This means that higher order beliefs are crucial for the outcome of the game. Their consideration results directly from the assumption of purely rational individuals. As an example

from finance literature where a similar approach was used, Goldstein & Pauzner (2005) can be quoted. Their model on bank runs is based on the work of Diamond & Dybvig (1983), where the two equilibria of the game are the beneficial risk-sharing equilibrium and the detrimental bank run equilibrium. Goldstein & Pauzner (2005) modify the informational setting of the model, becoming solvable with a unique equilibrium in that a bank run takes place with a known probability. As in the global game approach, the agents receive an individual signal. In this game of incomplete information, the behavior of the agents is thus not solely determined by the shared public information.

The sequence of a global game can be described as follows. At the outset, all players know the class of games, namely all feasible realizations of games, that they will play. They all share the knowledge on the likelihood of each of the single games. Before the agents decide on their actions, each agent individually receives a private noisy signal on the game that is played. Thereupon, they choose their actions and receive the payoff corresponding to the actual game that is played as well as the decisions made by all agents. As Carlsson & van Damme (1993) explain, the mechanism of their model relies on the factor that in global games agents have to consider all feasible games. These can be numerous, even though the noise might be small. If in this class of games different equilibrium structures exist, agents have to switch between actions, given their observations of the game. The resulting equilibrium corresponds to the risk dominant equilibrium as defined by (Harsanyi & Selten, 2003). The particular solution strategy will be outlined later based on a specific example.

3.3. Former models of takeovers

The overall incentive structures that arise when the owners of companies are not themselves in charge of the management of the firm but rather employ managers are the subject of the principal agent theory. In this theoretical framework, Jensen & Meckling (1976) described how diverging interests between managers, as agents, and owners, as principals, can cause inefficient outcomes. Opportunistic behavior of the agents can not only harm overall efficiency but also lead them to take decisions to the detriment of the principals. During takeover offers, for the shareholders of the target firms, the aim is to increase the value of their shares or sell their shares at the highest price possible, considering the riskiness of each option in accordance with their risk attitude. In contrast, the managers' utility functions might be increasing in their degree of control over the company (Eisfeldt & Rampini, 2008). Consequently, CEOs might oppose takeover offers, even though they might be beneficial for their shareholders, or negotiate less favorable terms for their shareholders, due to the fact that their personal career depends on the outcome of the takeover attempt (Agrawal & Walkling, 1994).

Grossman & Hart (1980b) formulated a fundamental model for takeovers that gives reason to doubt the efficiency-enhancing effect of takeovers via control changes. In particular, they elucidate the free-rider problem. It describes that infinitely small shareholders can increase their profits by refusing the takeover offer and benefit from the value increase caused by the acquirer after a successful bid. The analysis is based on the interpretation of the management of the company as public good. The shareholders assume that the company and their shares will increase in value after a successful bid. Because the company is owned by many small shareholders, each one of them has a negligible influence on the success of the offer. Each shareholder will only accept the offer if the bidder offers at least a price as high as the current price plus the value increase by improved management. A price like this would leave the bidder without profit or even lead to a loss if the offer is associated with certain costs for the bidder. The solution Grossman & Hart (1980b) suggest for this problem is an exclusionary device that allows a successful bidder to increase the value of the gained shares. The initial shareholders would have to make provisions for this device in the corporate charter. They have a positive incentive since they, themselves, can benefit from the value increase through the improved management, when the threat of a takeover is not toothless. On the other hand, when they intend to sell their shares during a takeover bid, that regulation would depress their profit. This means that for the overall welfare, the opportunities to dilute the property rights of the old shareholders should be large as it increases efficiency; whereas it only harms the private benefits of shareholders who want to sell their shares.

In another paper, Grossman & Hart (1980a) deal with how information provision by the target affects the takeover. Firstly, they demonstrate how in a world where lying is not an option and without transaction costs, all sellers optimally report on the true quality of their products. If certification causes positive costs, for sellers of high-quality products it will still be worthwhile as long as the price difference between good and bad products outweighs the certification costs. Secondly, according to their model, a forced disclosure can be designed in a way that can impede takeovers. Consequently, the potential of takeover offers to provide incentives for a high-quality management is depressed. In a similar fashion, La Mura et al. (2011) analyze how bidder fairness opinions as independent assessment affect takeover offers and, in particular, shareholder value in different regulatory environments. In their model of asymmetric information, in absence of a fairness opinion, no Nash equilibrium can be reached. While with compulsory fairness opinions there is only one optimal equilibrium, voluntary fairness opinions can result in multiple equilibria including the optimal one.

A multitude of other research projects created models of takeovers, which include the following: Holmstrom & Nalebuff (1992) revisit the Grossman & Hart (1980b), whereby they drop the condition of atomistic shareholders. If shareholders hold larger and possibly differently-sized stakes in the target, bidders can make positive profits. Thus, successful takeover offers are possible without exclusionary devices. Baron (1983) is one example for a model where the target management possesses superior information on the value of the target. If managerial incentives are not fully aligned with the shareholders' interests, resistance of the target management against the offer can be due to an unfavorable offer or opportunistically motivated. This means that to substantiate their stance towards the offer, the target management can publish relevant information on the value of the target after the bidder made the offer. In the streamlined model of Powers (1987) with two large shareholders and an ocean of smaller shareholders, a Nash equilibrium solution can be reached in that one of the larger shareholders is able to gain control over the company. Shleifer & Vishny (1986) showed that even without feasible exclusionary devices, bidders can make successful bids if they, prior to the offer, already purchased a significant share in the target. Bidders can make profits on the purchases prior to the offer, which can offset the transaction costs and losses of the subsequent bid. This takeover mechanism is possible if the market does not expect an offer to happen because the bidder is acquiring shares. Laws that force shareholders to make their holdings public after reaching certain thresholds thus could impede this opportunity. Another way out of the free-rider problem is presented by Bagnoli & Lipman (1988). Their model is built with a finite number of target shareholders. This hinders each shareholder from ignoring her influence on the success of the offer whereby successful offers become possible. In the model of Kyle & Vila (1991), sales by noise traders allow shareholders with formerly insignificant shares to acquire large enough stakes in the target at favorable prices. Successful takeovers are thus possible without dilution and without a shareholder with a large initial stake.

4. Model

4.1. Basic model

The following model describes takeover offers in a streamlined way. In this, it complies with the requirement of Binmore (2007). His claim to fruitful modelling is that exclusively influential aspects of the decision situation should become part of the model while other components should stay beyond the scope of the model. In the first step, the basic model is described to illustrate the issue of multiple equilibria, though later it will be solved by inclusion of a noisy signal to the target shareholders. Figure 1 displays the temporal sequence of the first step.

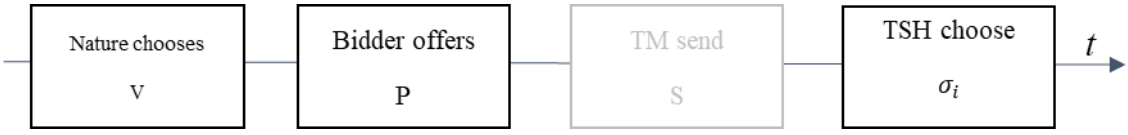

Figure 1. Temporal sequence of basic model

First, nature chooses V, the intrinsic standalone value of the target company. Second, the bidder chooses P, the offer price for the entire target. Third, the two target shareholders (TSH1 and TSH2, or taken together TSH) choose their strategies σ_i. The subscript i denotes the individual shareholder. σ_i is the probability distribution that each shareholder applies over the possible actions. THS can choose between rejecting or accepting the offer of the bidder. The payoffs of the game are depicted in figure 2.

		TSH2	
		Reject	Accept
TSH1	Reject	$(0.5\,V\,,\ 0.5V)$	$((0.5+0.5b)V, 0.5P)$
	Accept	$(0.5\,P\,,\ (0.5+0.5b)V)$	$(0.5\,P\,,\ 0.5P)$

Figure 2. Payoff matrix

For each combination of strategies, TSH1 will receive the payoff values on the left-hand side of the box and TSH2 the payoffs on the right. The offer is assumed to be successful if the bidder gains 50% of the shares. Here, both shareholders equally own 50% of the target prior to the offer. b ($b \in \mathbb{R}^+$) captures the potential value increase following a successful takeover. As it was empirically confirmed, a value increase after successful takeovers can be expected (Bradley et al., 1988). In general, the company value can be positively influenced by increasing the operative cashflow, by improving the growth prospects be it in amount, or in time and by

optimization of the cost associated with the sources of funds (Damodaran, 2011). If a shareholder decides to accept the offer, the payoff is independent of the other shareholder's decision. In accordance with their personal stake in the company, TSH will receive $0.5P$. If both reject the offer, the company value will stay unchanged. So, both shareholders end up with $0.5V$. Finally, if only one shareholder decides to accept the offer, a control shift towards the bidder takes place. The value of the target company will increase by factor b, which leaves the remaining shareholder with $(0.5 + 0.5b)V$.

As a start, the assumption is that all transaction partners share common knowledge about the rules of the game and the payouts. This can be justified by the view that the bidder implicitly reveals all private information concerning the potential value increase following a successful bid (b) by making the bid price public (Hirshleifer & Titman, 1990). Hence, P and b are known to TSH. In this example, TSH each own 50% of the target. Therefore, they can be expected to possess adequate information for an accurate assessment of V. Further, TSH are assumed to exclusively strive for their individual highest financial payoff. Also, this assumption seems plausible as the model abstracts from other circumstances of the offer.

While under some conditions, this game is dominance solvable; there is a region where several Nash equilibria can be reached. For particularly high offer prices in relation to the company value for which $(0.5 + 0.5b)V < 0.5P$ is true, Accept is the dominant action. As players TSH1 and TSH2 are symmetrical, the analysis likewise applies to both. This corresponds to the empirical finding that higher offer prices are suitable to motivate current shareholders to accept the offer (Bessler & Schneck, 2015; Betton & Eckbo, 2000; Officer, 2003). In the other extreme, where $0.5P < 0.5V$, particularly low offer prices in relation to the company value lead to a definite rejection of the offer by rational players. In the area in between, where $0.5V < 0.5P < (0.5 + 0.5b)V$, TSH do not have a dominant strategy. If TSH1 decides to reject the offer, TSH2 optimally accepts it. Yet, if TSH2 can expect the offer to succeed independently of their own action, what in this example is equivalent to TSH1 accepting the offer, TSH2 will reject the offer. Rejecting will allow TSH2 to appropriate the pro rata value growth that results from the successful bid. In this sense, the model replicates the fundamental model of Grossman & Hart (1980b) in that free-riding rules out successful takeover offers. TSH1 and TSH2 both disregarding their effect on offer success and assuming a successful offer could ultimately make them end up at (reject, reject), a strategy pair that is not a Nash equilibrium.

4.2. Model with signal

According to Morris & Shin (2003), the problem of many game-theoretic analysis like this, namely the multiplicity of equilibria, is the result of two general assumptions. Players are generally assumed to be equally informed and to be able to anticipate the choices of the other players correctly. Therefore, in the second step, the basic model is transmuted into a global game. This is achieved by creating the random variable $V \sim U[\underline{V}; \overline{V}]$ with a realization V unknown to TSH1 and TSH2 but known to the target management. The target management sends an information signal on the realization of V. Due to different information processing or knowledge of the economic circumstances, the perceived signals of TSH1 and TSH2 can differ. The individual information signals are $V_i \sim U[V - \varepsilon; V + \varepsilon]$; with $\varepsilon \in \mathbb{R}^+$. V_i is uniformly distributed on $V - \varepsilon; V + \varepsilon$, if it has a distance >ε to the interval limits of V. These individual observations create different player types (Vives, 2005). Figure 3 shows the temporal sequence of the evolved global game; in that, an entire class of games will be analyzed simultaneously.

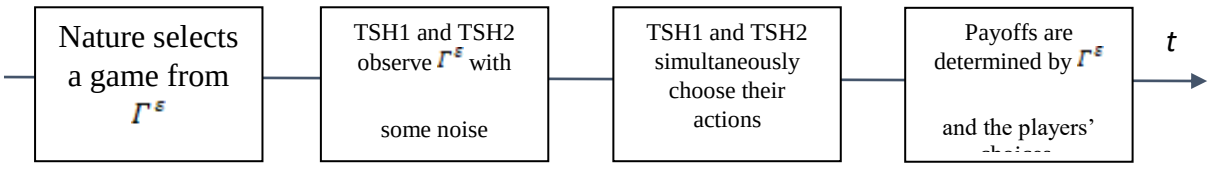

Figure 3. Timeline of the global game

Source: own representation based on Carlsson and van Damme (1993)

In accordance with Carlsson & van Damme (1993), nature begins by selecting a game from Γ^ε that TSH play. Then, TSH1 and TSH2 each make their private noisy observation of the actual game. Based on this, TSH simultaneously choose their actions that, together with the realized game, determine their payoffs. As before, the structure of the game is known to TSH. Further, they know the distribution of their feasible payoffs and of the player types, as defined by the individually obtained signal. The payoffs of this global game correspond to the ones displayed in figure 2. The dominance regions of the different actions are also equal, under the assumption

that TSH are completely informed. This means that the known problem of multiple equilibria exists under the assumption of perfectly informed TSH in the region $0.5V < 0.5P < (0.5 + 0.5b)V$.

The analysis of a global game requires a special awareness for the prevailing information structure, as this is the feature of the game, which makes it definitely solvable. For this purpose, $b_i(V_i) \sim U[V_i - \varepsilon; V_i + \varepsilon]$ is the posterior belief of player i on the distribution of V, after having observed V_i. As long as V_i does not get too close to the interval limits of V distance>ε), the posterior is uniformly distributed on the given interval. Moreover, $b_{-i}(V_i) \in [V_i - 2\varepsilon; V_i + 2\varepsilon]$ captures the posterior belief of player i on the other player's observation. If the private signal stays inside the interval limits of V with a distance >ε to its limits, player i will deduce that the other player's observation lies in the given interval. Player i will expect it to be equally likely that the other player's observation lies below or above V_i. In other words, b_{-i} is symmetric around player i's own observation. This implies that $P(V_{-i} < V_i|V_i) = P(V_{-i} > V_i|V_i) = \frac{1}{2}$: meaning the conditional probabilities that the other player's signal is below or above their own signal, after having received their own signal, are equal. This describes a central aspect of global games. The players experience strategic uncertainty. The blurriness of their observations of the true circumstances does not allow them to make exact predictions on the other player's decision in equilibrium. In addition to the uncertainty of the actual payoffs, the players do not know the range of payoffs that the other players believe to be possible. This describes higher-order beliefs. When solving global games, these necessarily have to be considered, assuming rational individuals (Morris & Shin, 2003). Players of a global game need to consider all possible realizations of the game and the scope of games that the other player believes to be feasible.

An equilibrium of the game is defined by the actions of both players being mutually best responses (Nash, 1951, 1950). At this point, each player chooses the strategy that maximizes the player's expected payoff if the other player chooses the given strategy. σ_i will be used for the probability that player i decides for action reject. Player i's expected payoffs are thus given by,

$$E[U_i(Reject)] = \sigma_{-i}0.5V_i + (1 - \sigma_{-i})(0.5 + 0.5b)V_i = 0.5V_i(1 + b - \sigma_{-i}b)$$

and $E[U_i(Accept)] = 0.5P$

as the conditional expected value of **V** is V_i.

The solution concept for this game is a process of iterated dominance (Carlsson & van Damme, 1993). Starting from values of V_i, for that the dominant strategy is known, the dominance region is gradually expanded. The same is done from the perspective of both players, always considering the other player's current dominance region. As it was shown that for vanishing error terms, a unique Bayesian equilibrium can be found; the following analysis will be a boundary analysis for $\varepsilon \to 0$ (Frankel et al., 2003).

If TSH1 receives a signal for that $0.5P < 0.5V_1$ holds, reject is the dominant strategy. After having made an observation of $0.5P < 0.5V_1$, THS1 deduces that TSH2 will choose reject with a minimum probability of 0.5. At the threshold THS2's signal is higher with probability 0.5 ($P(V_{-i} > V_i|V_i) = \frac{1}{2}$), recall that, reject is the dominant action for all higher or equal observations. Under these conditions, TSH1 can recalculate the expected payoffs as

$$E[U_i(Reject)] = 0.5V_i(1 + b - 0.5b) = 0.5V_i(1 + 0.5b)$$

and $E[U_i(Accept)] = 0.5P$.

These values are maximum values, as TSH2 could still choose reject with a higher probability. That would depress the expected payoff of TSH1 for reject. Yet, reject still is the dominant action as the payoff is still larger than the one for accept.

To pin down the strategy of a player, a function must be defined that provides the optimal action for the player for each feasible observation. So far, the conclusion can be made that the dominance region of reject extends to observations $0.5P < 0.5V_1$. Next, a switching strategy will be formulated: it is defined by a threshold value for V_1 below that the player will optimally switch from action reject to accept. The feature of the model is that rejecting the offer is the riskier action because the payoff for rejecting is plausibly stochastic. Further, agents need to receive comparably better signals that encourage them to take a chance via rejecting what intuitively makes sense. Both players choose their switching strategies based on their privately obtained signals, under the conjecture that the other player will do it likewise.

V_1^* denotes the smallest signal for that reject is still TSH1's optimal strategy. A lowest value for V_1 is known, given by P. V_1 will gradually be decreased until the player is indifferent between the two actions. During the iterative procedure, σ_{-i} can still be assumed to be at least 0.5, as both players apply the same reasoning. This means the switching point is found where $0.5V_i^*(1+0.5b) \geq 0.5P$ holds. This is the case for $V_1^* \geq \frac{P}{1+0.5b}$. An equivalent procedure can be performed for the action accept. Figure 4 depicts the steps graphically.

- ➔ TSH2 plays accept for sure if $V_2 < \frac{P}{(1+b)}$
  - ➔ If TSH1 receives a value in this range as private signal, TSH2 is expected to accept with a probability of at least 0.5
    - ➔ TSH1's expected payoff for accept is $0.5P$ and for reject is $0.5V_i + 0.25V_i b$
      - ➔ As long as the expected payoff for action accept is higher than the payoff for reject, the dominance region is expanded.

Figure 4. Procedure of iterated dominance

After having observed a signal for that $V_1 < \frac{0.5P}{0.5(1+b)} = \frac{P}{(1+b)}$ holds true, TSH1 expects TSH2 to choose accept with at least a probability of 0.5. TSH2's expected payoffs are $0.5P$ for accept and $0.5V_i + 0.25V_i b$ for reject. At the current maximum value for the private signal $\frac{P}{(1+b)}$, accept is the dominant option. The dominance region of accept will gradually be expanded to higher values until the conditional expected values are equal. V_1^{**} denotes the upper-bound of the dominance region for accepting. Setting the conditional expected payoffs to be equal allows the model to determine the threshold to $V_1^{**} \leq \frac{P}{1+0.5b}$. Logically $V_i^* \geq V_i^{**}$. As both players are symmetrical, the same applies to TSH2. The threshold for the switching strategy is determined at $V_i^* = V_i^{**} = \frac{P}{1+0.5b}$. An illustration of the dominance regions can be found in figure 5.

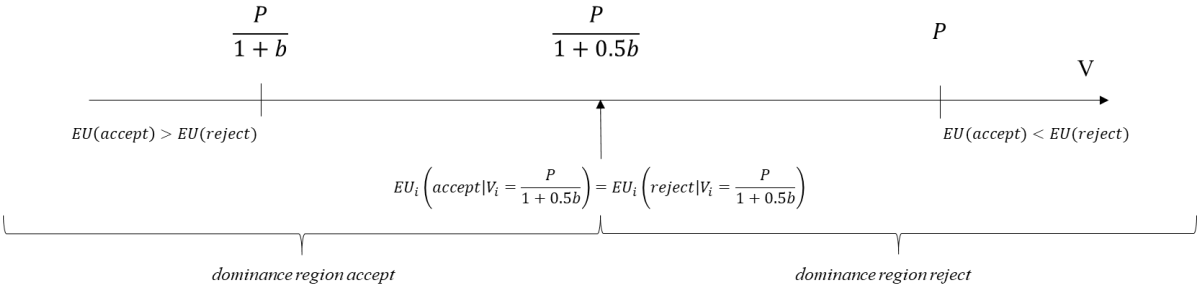

Figure 5. Illustration dominance regions

The equilibrium that is reached via this procedure of iterated dominance corresponds to the risk-dominant equilibrium. Harsanyi & Selten (2003) state that players, when facing uncertainty about the other player's choices, decide upon the riskiness of their own actions. In a game with multiple equilibria, the players evaluate their courses of action by minimizing the opportunity costs that a deviation from the equilibrium would mean for them. Moreover, Morris & Shin (2003) show how the same equilibrium strategy can result with the assumption of Laplacian beliefs. The appealing feature of global games is that sound fundamentals let the players have more positive beliefs, both personal and of higher order (Morris & Shin, 2000). It is also crucial, that in multiplayer games like this with agents with different information status, individual agents are not able to exclude all states of the world that according to their knowledge are not possible. Other agents might not possess the same information and include these states into their reasoning (Morris & Shin, 2000).

Before analyzing the effects of parameter changes on the obtained solutions, some further notes on the baseline scenario should be made. According to the assumptions, bidders possess perfect knowledge and want to maximize their financial benefit with the transaction. This disallows bidders to offer prices in the initial dominance region for accept, as a successful offer in that range would leave the bidders without positive profit. When a switching strategy is determinable under the given assumptions, this allows the compilation of the

success probability of the takeover. The distribution function of the private signals must be used to calculate the probability of a signal surpassing the threshold. This determines the probability of a failure of the offer. Finally, a bid price that allows the bidder to succeed with the offer appropriates half of the value increase that the bidder can achieve in the target company to the target shareholder. As Damodaran (2011) suggest, the target and bidder sides can improve their endowment with the transaction.

4.3. Comparative statics

After having identified the equilibrium of the perturbed game, it seems interesting how adjustments in the input factors of the game change the equilibrium strategies. The partial derivatives of the obtained equilibrium with respect to b and P can be examined. The derivative with respect to the potential value increase is given by $\frac{\partial V_i^*}{\partial b} = \frac{\partial V_i^{**}}{\partial b} = \frac{\partial \frac{P}{1+0.5b}}{\partial b} = \frac{-0.5P}{(1+0.5b)^2} < 0$. Accordingly, higher values of b will shift the threshold value of the switching strategy to lower values for V_i. This enlarges the dominance region of reject and narrows the dominance region of accept. The partial derivative with respect to the offer price is given by $\frac{\partial V_i^*}{\partial P} = \frac{\partial V_i^{**}}{\partial P} = \frac{\partial \frac{P}{1+0.5b}}{\partial P} = \frac{1}{1+0.5b} > 0$. Higher offer prices, thus, have the opposite effect and enlarge the dominance region for accept and narrow the dominance region of reject by shifting the threshold signal to higher values for the privately obtained signal.

Next, we can show that a bidder toehold does not influence the strategies of TSH. Assume that ceteris paribus, the bidder possesses a toehold of 40% prior to the offer and TSH each own a stake of 30%. The expected utilities of both actions will be given by,

$$E[U_i(Reject)] = \sigma_{-i}0.3V_i + (1-\sigma_{-i})(0.3+0.3b)V_i = 0.3V_i(1+b-\sigma_{-i}b)$$

and $E[U_i(Accept)] = 0.3P$.

The threshold signals are consequently at $V_i^* = V_i^{**} = \frac{P}{1+0.5b}$.

In the next analysis, the assumption will be that V and P are both constants, but b is modelled as a random variable. The other features of the game remain unchanged. b is uniformly distributed $\boldsymbol{b} \sim U[\underline{b}; \bar{b}]$ with a realization b unknown to TSH1 and TSH2 but known to the bidder management. The bidder management sends an information signal on the realization of $\boldsymbol{b}$. Due to different information processing, individual information signals are b_i. b_i is uniformly distributed on $b-\varepsilon; b+\varepsilon$ with $\varepsilon \in \mathbb{R}^+$ if it has a distance >ε to the interval limits of $\boldsymbol{b}$. The payoff matrix of figure 2 and the formulas for the expected utilities of each action stay unchanged. After iterated deletion of dominated strategies, the threshold signal for the potential value increase is $b_i^* = b_i^{**} = \frac{0.5P}{V} - 2$. Looking at the partial derivatives with respect to P and V, the model reveals how changes in these figures change the dominance regions. For the offer price, the partial derivative is given by $\frac{\partial b}{\partial P} = 0.5\frac{1}{V} > 0$. This means that higher offer prices make the range of signals for b larger, which will incite THS to accept the offer. In contrast, $\frac{\partial b}{\partial V} = -0.5\frac{P}{V^2} < 0$. Higher intrinsic valuations of the target company will expand the dominance region of reject.

Next, assume that in the model with signal from the target management, the information structure of the game will be changed. Only TSH1 will receive a private signal on the company value, whereas TSH2 does not observe the true circumstances. TSH1 receives the signal V_i and, due to the uniform distribution, infers that this is the expected value for the intrinsic target value. Then, TSH1 assumes that σ_2 follows a uniform distribution on the interval $[0,1]$. The expected payoffs for both actions are

$$E[U_i(Reject)] = 0.5V_i(1+0.5b)$$

and $E[U_i(Accept)] = 0.5P$.

The threshold signal of the switching strategy for that both expected utilities are equal is at $V_1^* = V_1^{**} = \frac{P}{1+0.5b}$ and, by this, equal to one of the model in that both players obtain private signals (Morris & Shin, 2003).

4.4. Limitations

One obvious limitation of the analysis is that shares of the company are assumed to be homogenous. Yet, under some legal schemes, it can be worthwhile for current shareholders to restrict the issuance of new shares to non-voting shares in order to keep control over the company. Further, regulation might be in place that furnish shares with voting rights only after they have been held by the same investor for a certain period of time. For instance, the German law provides the possibility to exclude shares from voting rights that grant a preferential allocation of financial surpluses to their owners (§139 (1) AktG). The different rights that go along with these shares should be reflected in the pricing. While higher payment claims drive the price upwards, lower decision rights depress it (Damodaran, 2011). For takeover attempts, gaining a certain stake in the shares that carry a voting right is pivotal. Nevertheless, cashflow claims held by non-voting shareholders will directly reduce the expected cashflows for the bidder. Non-voting shares can be included in the model presented here without harming the validity of the derivations. In the example with a bidder toehold of 40%, ceteris paribus, the bidder toehold could be reduced to 20% and 20% non-voting shares could be introduced. The bidder would still have to win the shares of at least one TSH, P would denote the price offered for voting shares, and V the intrinsic value of the company reduced by a fixed amount that is granted to the non-voting shareholders.

The assumption of strictly rational individuals does not necessarily match the behavior of real-world actors. In single-actor decision situations, it can be understood as each actor making optimal decisions. Yet, if decision situations involve various agents, the assumption of strict rationality makes strong assumptions about the other players' behavior unavoidable. Oftentimes game-theoretic models deal with this issue by assuming common knowledge and perfect rationality of all agents. The more complex the circumstances of the decision are, the further is the gap between real- and model-world decision behavior (Colman, 2003). Under some circumstances agents in the mean are indeed able to derive very accurate expectations (Muth, 1961). Rational behavior can exclusively be defined with reference to a certain target setting (Hume, 1739). This analysis is governed by the assumption that TSH are risk neutral and only derive utility from their financial payoff. This is a critical feature as some studies did not show a positive relationship between the offer price and the success of the takeover offer (Flanagan et al., 2011; Hoffmeister & Dyl, 1981; Sudarsanam, 1995, 1995). On top of that, several studies identified other factors as determinants of the offer success apart from the offer premium (Flanagan et al., 2011; Hoffmeister & Dyl, 1981; Bessler et al., 2015; Betton & Eckbo, 2000; Of-ficer, 2003; Walkling, 1985).

Another critical feature of the model is the information structure. Not only must the private signals be precise enough but also public information must not allow a conclusion on the true state of the world. If public information was highly precise, that would mimic the model without private signals but common knowledge and thus with multiple equilibria (Jorge & Rocha, 2015). With a comparable information structure, the uniqueness result has been proven for games with diverse features. Carlsson & van Damme (1993) show that symmetry between the players is not required and different distribution functions can be assumed, as long as a subclass of the games can serve as starting point for the procedure iterated dominance. The global games approach could be extended to games with different payoff structures and players structures (Hoffmann & Sabarwal, 2019; Harrison & Jara-Moroni, 2021).

The strong effect that public information can have on equilibrium outcomes is because it is two-fold. First, if there is a public signal that the intrinsic target value increases, for instance the announcement of a new patent, the shareholders will have a higher assessment of the company value, which makes it more attractive for them to reject the offer (for a given offer price) and keep their shares. Secondly, shareholders are aware they share the public information with the remaining shareholders. Based on this, they will adjust their expectations of the other players behavior. A higher assessment of the target value means that they generally expect higher payoffs from rejecting; yet, if each player expects the other player to reject with a higher probability that decreases the expected utility of rejecting (Morris & Shin, 2003).

As Atkeson (2000) notes, a further limitation of the global games approach, in general, is that functioning market price mechanisms should include all information that allows market participants to coordinate on certain actions. Asset prices of targets and bidders could already convey all the information on future value increases, weighed by their specific probability. In the market for corporate control, however, it seems hard to imagine that market prices already fully reflect the effects of potential takeovers, as this would impede financial gains through takeovers. This contradicts that positive or negative target and bidder returns have been found in previous studies (Kang et al., 2000; Aw & Chatterjee, 2004; Servaes, 1991; Draper & Paudyal, 1999).

5. Interpretation of the model

5.1. Signaling by target management

The model that is described in chapter 4.3 involves a noisy signal on the target's intrinsic value that is sent out by the management of that company. Each shareholder individually receives a private signal, whereby the signals are highly interdependent and dependent on the underlying fundamental value of the target. The foundation for this modelling decision lies in the German Securities Acquisition and Takeover Act. It stipulates

that the target management must publish a reasoned opinion on the offer that includes a recommendation to the target shareholders on whether to accept or reject the offer. Besides the legal framework for German takeovers, former empirical studies back the interpretation that the stance of the target management towards takeover offers is viewed as directive signal to the target shareholders (Caiazza & Pozzolo, 2016; Moschieri & Campa, 2014; Schwert, 2000).

The model provides one explanation for the importance of the variable management recommendation for a successful offer. The management recommendation, as a noisy signal, does not exclusively provide additional information on the advantageousness of the offer to each individual shareholder but also enables shareholders to coordinate their actions to a certain equilibrium.

Yet, a possible bias of the target management during the takeover offer could hamper the effect of the management recommendation on the outcome of the offer. During takeover offers for German public companies, the target managements are obliged to act in the interest of their shareholders (§3 (3) WpÜG). Further, the target management is not allowed to take any actions that could be to the detriment of the takeover attempt after the offer's announcement (§ 33 (1) WpÜG). The public stance of the target management towards the offer is therefore the only legal option to influence the offer success. While the target management could make use of this possibility to impede unfavorable offers for their shareholders, studies have reported self-interested behavior of target managers during takeovers (Jenter & Lewellen, 2015; Buchholtz & Ribbens, 1994). When acting opportunistically, target managers could recommend to their shareholders to reject the offer, despite an acceptance being in the shareholders' interest, to assure the managers' own positions in the company. In principle, this would not harm the effect of the signal in steering the transaction's success. Yet, if the target shareholders became aware that the correlation between their private signals and the underlying fundamentals was disturbed that could inhibit the possibility for them to coordinate their actions.

The target management could also oppose offers that could be financially advantageous for their shareholders if it believes that the bidder still has financial leeway and could increase the offer price in another round of negotiation (Schwert, 2000). If this was the case, the target management could send biased signals that imply the offer price is further below the true value of the target. This increases the impact of biased signals as negotiation tool. Additionally, this could make the failure of the offer more likely, which could pave the way for a revised offer with a higher price. This would work by an expansion of the dominance region of reject by declaring especially high intrinsic target values. In this case, biased signals by the target management can be favorable for TSH.

As the management recommendation is a public document and made available via the homepage of the target companies, the question can be raised whether it really is a private signal. With regard to this matter, Angeletos & Pavan (2004) provided a different construct for the informative signal. Instead of referring to privately obtained information, they argue that the private signal can be based on public information that could be perceived differently by different individuals. This model interpretation of the private signal as subjective processing of the information is close to real-world transactions and does not do any harm to the mechanism of action of the presented model. The shareholders might dispose over different competences to assess the information provided to them and might have a different perception of the economic side conditions of the offer.

Bagnoli et al. (1989) provide a model that includes stock repurchases by the target management as a signal during takeover offers. After the offer announcement, the target CEOs choose which outcome of the offer entails the largest financial profit for them. An unsuccessful offer does not change their salaries, and the personal holdings of the CEOs might only be devalued by defensive measures against the offer. However, if the offer succeeds, the former CEOs are left without shares in the target, might receive severance pay, and will not be retained in the company. The CEOs have the possibility to buy target shares during the acceptance period, thereby making their private information on the company value public. This action is only advantageous for the CEOs if they expect that the value of the target under their current management is high. The repurchase goes along with private financial costs for themselves, establishing the signal as trustworthy. For the repurchases to be a valid measure to coordinate the choices of TSH, they must be aware of the underlying distributions of the random variables. If the target CEOs decide to buy shares, that signals a high level of V. Therefore, the dominance region of reject is enlarged and for accept reduced, which consequently reduces the success chances of the bidder. Stock-repurchases were shown to be especially relevant for the public perception of the company value when firms experience takeover pressure (Huang, 2015).

5.2. Signaling by financial advisor

The interpretation of the informative signal in subchapter 5.1 is based on conjecture that the target management has an information advantage towards the target shareholders concerning the intrinsic valuation of the target company. As the management deals with the business concerns of the target daily, it can likely assess the financial and economic risks and chances properly. Nevertheless, takeovers marked by a high complexity can

cause difficulties for an adequate valuation of all current and feasible financial circumstances. Due to this, target managements frequently commission fairness opinions in the context of corporate transaction. These documents report on the financial adequacy of the transaction offers from a third-party perspective. They can be compiled by an investment bank or a financial advisor (Kisgen et al., 2009). Therefore, they offer the advantage that the authors are experts in corporate valuation and likely have a less biased perspective towards the financial standing of the target. Therefore, target fairness opinions were shown to be a valid information source for the market (Cain & Denis, 2013; Shaffer, 2020). This view is consistent with the finding that fairness opinions have been commissioned more frequently if the transaction is more complex (Kisgen et al., 2009). Not only could the view of the target management be biased by overconfidence or other behavioral phenomena, but they could also pursue personal objectives with their public stance towards the offer. The second purpose of fairness opinions is based on this intentional bias in the management's assessment. The management can commission an independent assessment to prove that it has fulfilled its duties towards the target shareholders (Kisgen et al., 2009).

According to the German standards for fairness opinions the target readership of these documents are the corporate organs of the mandating company (Guidelines for the Preparation of Fairness Opinions, in the version released March 2023). As we have shown in an earlier study, if it was the case that the fairness opinion is exclusively considered by the management of the company, nevertheless, it would influence the model presented here (Gindele & Rath, 2023b). We showed that target managements were more likely to arrive at an unambiguous recommendation if they had commissioned a fairness opinion. In addition to making a definite positive or negative statement of the management more likely, the management followed the judgement of the fairness opinions. Positive management recommendations were more frequent after positive fairness opinions, whereas negative fairness opinions likely led to a negative judgement of the target management. As a relatively precise signal is crucial for the achievement of an equilibrium in the model presented here, a fairness opinion has beneficial consequences on the takeover process when being considered by the target management.

Further, when being authored by an assumedly independent assessor, fairness opinions were directly considered by the target company's shareholders (Gindele & Rath, 2023b). In that case, the signal of the model presented here can capture a fairness opinion. Analogously to our empirical analysis, the model predicts better chances for a successful offer following a positive fairness opinion and worse chances after a negative third-party assessment. A positive fairness opinion states that the offer price is relatively higher in comparison to the intrinsic value of the target company and thereby expands the dominance region for the action accept. A negative assessment of the fairness opinion contrarily enlarges the dominance region for reject.

5.3. Opportunistic signaling by bidder

Being aware of the impact that signals can have on the offer's success, not only could the target management opportunistically exploit this opportunity but also the bidder management could try to make use of it. It was shown that transactions with bidder fairness opinions go along with lower offer premiums; furthermore, these transactions are also more likely to be completed (Kisgen et al., 2009). If a fairness opinion is published from the bidder side, it will most likely testify the adequacy of the offer. In this case, it will state that the offer price is high or certainly above the intrinsic valuation of the target. Under certain conditions, a signal of this type is apt to shape the outcome of the transaction in the present model.

The target shareholders must rely on the trustworthiness of the signal based on the bidder fairness opinion. Whether this condition is generally fulfilled is questionable. Bidder fairness opinions have been shown to include higher valuation errors as compared to target fairness opinions (Cain & Denis, 2013). Additionally, the potential for biased publications by bidders is even higher than for targets. For the signal to be able to coordinate the behavior of TSH in the model, the signals should be centered around the true intrinsic target value. Also, the players need to be aware of the distributions of the fundamental value and the signal on it.

In contrast to the target management, the bidder management is legally allowed to take actions to increase the success probability of its offer. Publications of target valuation that support the adequacy of the offer could be one measure to increase the success probability. Nevertheless, bidder managements will experience difficulties in producing signals that comply with all conditions for their effectiveness. Bidders have to be aware of the fact that signaling a relatively low value of the target can have detrimental effects on their own financing conditions by depressing the issuance price of their own shares. Also, myopic managers might find it advantageous to signal high values for their acquired assets (Liu, 2012).

5.4. Implications from the model

Corporate transactions involve various interest groups, and the implications of the presented model can be analyzed from multiple perspectives. Firstly, the German legislation appears cognizant of the impact of disclosures containing information crucial for assessing the target's value. This is evident in the provision requiring target managements to refrain from actions that may negatively affect the likelihood of offer success

after its announcement (§33 WpÜG). This safeguards investor interests by addressing potential opportunistic behavior by the target management, which might prioritize personal future prospects over the financial benefit of shareholders.

However, a drawback of this regulation is that, as legally mandated, target management typically advocates for the interests of the target shareholders (§3 (3) WpÜG). At a minimum, it can be assumed that the target management is more aligned with the interests of target shareholders than the bidder management. Given that bidder management is not prohibited from interfering with offers during the acceptance period, there exists a risk that they may exploit this opportunity to the detriment of shareholders.

Other groups with a potential interest in influencing shareholders' decisions regarding the acceptance of an offer include employee representatives, possibly representing fractions of employees or groups of target shareholders. The further removed a group is from the target's business and valuation-relevant data, the more challenging it becomes to generate a reliable signal for the target shareholders to coordinate their actions. In the presence of multiple signals regarding company value, the precision and dissemination of the signal are crucial in determining which signal exerts the highest impact on shareholders' decisions. The more players are believed to have received the signal and the more precise it is; the higher capability it has to coordinate the agents' choices. Consequently, if, for instance, target managements only meet the minimum requirements in their reasoned opinions and do not commission fairness opinions, while bidders engage in extensive publication of valuation results, the bidders may partially or completely compensate for their deficit in trustworthiness.

From an efficiency perspective, any offers by bidders capable of implementing a positive value increase could be advantageous if successful. However, the pricing power after the offer could potentially hinder overall welfare. Other potential takeovers with even greater potential for value increases could be impeded. If a concern arises regarding monopoly power, German or European merger control authorities may be compelled to intervene and potentially prohibit the takeover. Setting aside market power, any takeover by a bidder resulting in a positive value increase signifies an enhancement of the current ownership structure. Therefore, in the optimal scenario, these offers should always succeed. Nevertheless, as derived from the solution in chapter 4.3, offers are only successful if the bidder is willing to share the value increase with the shareholders that accept the offer equally. From a distributional standpoint, opinions on this may vary, but this insight could empower bidders with potential for value increases to enhance the likelihood of their offer's success.

Social costs are likely to arise whenever an agent decides to send misleading signals out of self-interest. Any biased signal complicates the impact of trustworthy signals on the transaction. This can lead to higher costs by necessitating more detailed internal and external analyses. The costs of the misleading signal exacerbate the efficiency loss. As a consequence of the misleading signal, even favorable offers, in which bidders are willing to share half of the financial gains with target shareholders, can be unsuccessful.

In general, the effect of the signal – whether an offer succeeds or fails – must be proportionate to compensate the sending party for the costs it incurs. Due to their insider knowledge, the target management's costs in this regard should be relatively low. Balancing this, there is the personal value of control for the target management, and the utility derived from fulfilling its legal and contractual obligations. On the other hand, the bidder would likely have to bear higher costs, as data collection can be more expensive, and proving the trustworthiness of the signal may necessitate deeper analysis, possibly from third-party sources. The bidder's benefits may include the personal value of control over the target and the increase in the value of their own shares. However, it's crucial to remember that the bidder already has to share the financial profit with the target shareholders to succeed with the offer in the model presented here.

In the model presented, shareholders are assumed to have equal capabilities in deriving information on payoffs and the behavior of their counterparts from the informative signal. However, in reality, shareholders might lack the necessary skills and may not be uniform in their ability to assess the offer. Consequently, shareholders may not always make the optimal decision for themselves, and other shareholders may be unable to anticipate their choices. This hinders the coordination of shareholders toward a unique equilibrium outcome. Therefore, the significance of clear and comprehensible financial communication is emphasized. Unbiased platforms providing investor education could facilitate coordination among market participants, resulting in higher success probabilities for fair and efficient takeovers, and deterring other takeover offers.

In conclusion, the presented analysis is related to traditional applications of game theory in finance. Similar to Akerlof (1970), asymmetric information and trust are pivotal elements of the model. Furthermore, the free-rider problem, as elucidated in Grossman & Hart (1980b), is resolved, allowing for efficient takeovers without dilution. Trustworthy private signals are a necessary condition for this. If the government or groups of target shareholders were to commission genuinely independent third-party assessments of offers, this would streamline the process for efficient takeovers and enable the calculation of the offer's success probability.

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