A work project, presented as part of the requirements for the Award of a Master's degree in Finance from the NOVA School of Business and Economics.

Strategic optimal premium on a Merger and Acquisition processes a game theory approach

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07-09-2021

Abstract:

From a perspective in which mergers and acquisitions can generate value through undervaluation, control, or synergies and taking into consideration that the form of payment, size of the acquirer, and type of target company (public or private) affect the amount of value created on an M&A process. It was possible to use a game theory negotiation model to understand the incentives, interactions, and strategic solutions on an M&A operation to find out the theoretical optimal strategic premium in any M&A process.

From this theoretical model, it was found out that the empiric solution of the acquirer giving up almost all the value created by the transaction upon announcement is not optimal or even strategic. Acquirers theoretically should avoid giving up all the value in the transaction, as it exists an optimal strategic premium to share that is different to give up all value. It was also found that all cash transactions are not strategic and that acquirers should always pay in stock as much as they can in the operation to increase their benefits.

As this is a theoretical model and the solution differs greatly from the empiric solution it has to be established that the model fails to fully explain the situation in hand. The lack of sufficient variables on the model makes it unable to properly assess the situation and generate a believable outcome. Therefore, the empiric solution remains as the optimal premium to be paid.

Keywords: Business and Management, Game Theory, Mergers and Acquisitions, Strategy, Premium, Nash Equilibrium.

1. Introduction

Being part of a Merges and Acquisitions (M&A) process is a very important strategic decision that both target and acquirer companies must make, as the result of the decision might lead to increase returns, new growth opportunities, or even the destruction of a company (killer acquisition). For the target, the decision relies on where to remain independent or give up part or full autonomy over the company´s future. For the acquirer, the decision relies in whether the operation will create value for them on the short and long time, in other words, if it is a growth opportunity.

As one of the main strategic decisions for corporations M&A is also one of the most controversial ones, news and media have demonized this kind of financial operations suggesting that these strategies have a higher failure likelihood than marriages (Voigt 2009) or that between 70% to 90% of mergers fail (Christensen, et al. 2011). Which has fueled the debate whether to be part or not of a merger process and if there are strategic decisions for companies.

Strategic planning is one of the most important operations of any corporation, as it will be the guiding principle for the future development of the company. As corporations decide to invest in new projects, research, and development, and essentially growth opportunities that have a high likelihood of generating value. Then from a strategy point of view, for a corporation an M&A process is only strategic if it´s able to generate value for shareholders, meaning that the most important debate over M&A is whether these can generate value or not. Failure rates affect the likelihood of obtaining value from an M&A process but are not the source of value.

Literature has researched if value is created or not on an M&A process to help corporations in their decision process. Even though there have been many findings and some of them contrary, there is a consensus stating that M&A do create value. Research based on event studies has shown that after the announcement of a merger there is evidence of abnormal returns for the companies involved in the operation (Akben-Selcuk 2015) (Lusyana and Sherif 2016). This means that M&A can generate value for shareholders even on the announcement. There is also evidence that M&A creates value in the long term for the acquirer (Savor and Lu 2009).

Research not only has proven that M&A are operations with the ability to create value, but they also have shown how that value is distributed among the parties in the process. Multiple papers have found that on average target companies are the ones who keep most of the value created upon announcement of an M&A process, meanwhile, acquirers are only able to keep a minimum proportion or no value at all (Eccles, Lanes and Wilson 1999). To understand the magnitude of the difference in the distribution of value Beitel, Schiereck, and Wahrenburg (2001) found that the cumulative abnormal returns (CAR) for target companies is on the magnitude of 12.5% after the announcement, meanwhile, acquirers don't show statistically significant CAR.

Then, if there is such inequality in the distribution of M&A value between the parties involved, why do acquirers are part of this kind of process, if on average they will not be able to keep any of the value created by the transaction. An M&A process is essentially a negotiation agreement, where empirically acquirers will give up all or part of the value created by the transaction to achieve a deal. If M&A does not represent growth opportunities for the acquirer or creation of value upon announcement, then they seem like a really bad strategic decision for any corporation.

On M&A processes the value that the acquirer decides to give up in order to seal the deal or premium can be negotiated as is not a fixed amount, although variable it's bounded by the payment capacity of the acquirer. Then there must be an optimal premium in every M&A process, that ensures the deal to be strategic for both target and acquirer. It seems that the empirical optimal premium is that acquirers have to give up all the value created by the merger, but is this optimal premium strategic for the acquirer.

This research goal is to determine the optimal premium in an M&A transaction that is strategic in terms of value for target and acquirer companies. In this sense, this research seeks to rebate or confirm the empirical findings that the only way to get a deal on an M&A transaction is that the acquirer gives up all the value created by it upon announcement, by determining the theoretical premium that will ensure a deal beneficial to all the players involved in the transaction. In this order of ideas, this paper aims to determine using game theory negotiation model the optimal premium to be paid on an M&A process and if it´s strategic to bid that optimal premium or search for another target company to engage in a merger.

In section 2 of the paper will be developed the M&A characteristics that affect a deal, to understand the important issues in the negotiation and their impact. Then on section 3 is develop the theoretical model developed to determine the optimal premium to be paid and if it is strategic or not, with all the assumptions that are being made to simplify reality. Next in section 4 will be found the discussion around the solution of the model and the implications of the results on M&A processes. Finally in section 5 will be the conclusions of the paper as well as recommendations when engaging in an M&A negotiation to keep as much value as possible from it.

2. M&A characteristics

Every M&A operation has the potential to generate value through one or a combination of the following 3 channels: undervaluation, control, or synergies. Each one of the sources is independent, which means that there is no need for one happening for another one to occur even though they might happen at the same time. Another important characteristic of the sources of value is that they are affected by the characteristics of the deal, which means that the way of payment, the structure of the merger, or the type of companies involved actively affect the amount of value that the operation can generate. But the intrinsic source of value is not affected by the characteristics of the deal, in other words, the form of payment does not determine whether the operation generates value through undervalue, control or synergies.

The first source of value on an M&A is the simplest one, undervaluation, which is essentially an arbitrage opportunity for the acquirer. This source of value happens when the acquirer evaluates the target company and determines that the intrinsic value of the company is below its market price (Gonzales, Vasconcellos and Kish 1998). Then the arbitrage opportunity is clear, there is an undervalued firm, which can be bought at market price, but its real price is higher, meaning that the profit of the acquirer is the difference between the market price and intrinsic value of the company.

Undervaluation is simple but at the same time it deals with high risks, especially in the valuation process. Valuating a company is not an easy task there is always private information that directly affects the valuation of the firm. Because of the private information and the great information asymmetry on the valuation process, acquirers might overvalue the real value of the company, which lead them to believe that there is an arbitrage opportunity when the intrinsic value of the company is lower or equal that its market value (Gonzales, Vasconcellos and Kish 1998). In other words, if the acquirer because of asymmetry of information overvalues the target it might buy a company which real worth is less than what was paid.

The second source of value on an M&A operation is control, which in simple terms means that the change in the management (control) of the firm will generate value. This source of value arises when the acquirer party finds a target company which because of their characteristics the acquirer believes is being mismanaged, or that is not profiting of growth opportunities such as not investing in positive net present value (NPV) projects (Dyck and Zingales 2004). Therefore, the acquirer believes that by purchasing the target company and doing some changes in the management structure they will be able to profit from those opportunities and investments, which could be transferring wealth from company to company or profit from investment opportunities learned by the interaction between companies (Dyck and Zingales 2004).

The main characteristic of the control value source is that the role of the acquirer is to be the catalyst to do the changes within the company, which means that the target company can profit from the projects or growth opportunities that the acquirer found without the help of the other party (Moreira and Janda 2017). This means that when the value of a company comes from control, the target company is willingly not profiting from all their positive NPV projects, but the acquirer is willing to engage with those projects and by doing so generate value.

Then the main characteristic of control is that the acquirer is not required to be involved in the achievement of profits, as the target company is fully capable of profiting from the projects. By doing some changes in the administration of the firm and engaging with projects the acquirer can generate value and profit from it (Dyck and Zingales 2004). But the acquirer faces risks especially in the assessment of the positive NVP projects that the target firm is not profiting from, as there is asymmetric information the acquirer is not able to fully understand why the target company is not benefiting from the projects, which might lead to a bad assessment of the profitability of them and therefore to overvaluing the control premium and the target company (Moreira and Janda 2017).

The last source of value on an M&A process is synergies, which happen when by merging the resulting company can profit from projects or costs reductions that before neither of the players involved could profit (Garzella and Fiorentino 2014). In other words, if the value of the target company is V_T and the value of the acquirer is V_A then if there are synergies $V_T + V_A < V(Acquirer + Target)$, which means that the value of the resulting firm of the merger is higher than the sum of the value of the individual players involved in the transaction.

The main difference between synergies and control is that there is no way that the individual players profit or generate value if they do not merge, which means that even if the target is willing to change their management, there is no possibility of profiting if they don't merge. Which is contrary to the main characteristic of control as a source of value. This means that by merging the resulting company can be part of new projects, which have positive NPV, or the company can reduce costs of capital, supplies, etc. Another possibility is that by merging the resulting firm can mitigate risk for the operation of the acquirer, target, or both, which leads to better performance and revenue (Garzella and Fiorentino 2014).

One of the most important risks that face any acquirer when the source of value of the M&A operation synergies is the risk of fail integration, for synergies to realize there must be an acceptable or good integration process between the acquirer and the target, which means that the two companies when merged have to become one integrated company which work efficiently and as a unit (Rozen-Bakher 2018). If the integration fails because of lack of communication, loss of human capital, or any other factor then the projects that the combined firm could profit from could not be available, they might not have the capability of profiting due to the low integration.

It is important to consider that in an M&A process not only the sources of value are important, as many other issues directly affect the process outcome. These factors are mainly decisions taken through the bargaining process and considering the characteristics and needs of both the acquirer and the target. These factors are not determinants of the source of value on an M&A process but have an important impact on the result and distribution of value between target and acquirer.

The first of these factors is the form of payment, which means the way in which the acquirer will pay for the transaction. For the acquirer, there are 3 traditional forms of payment which are the most common in M&A processes. The first one is an all-cash transaction which means that the whole payment of the acquisition will be made in cash, but the decision of an all-cash transaction is complicated. The first issue to consider is the liquidity of the acquirer, for the acquirer to engage in an all-cash transaction means to have available enough cash to cover the whole transaction and their operations, which might mean to sell financial products or assets to be able to afford an all-cash operation (Ismail and Krause 2010).

All financial operations transmit information to the market about the expectative of the players involved, an all-cash transaction is one of those cases. This kind of payment informs the market that the acquirer is facing significant competence to buy the target or a bidding war so it might decide to pay in cash to get an advantage. But it might also transmit information about the target firm, on an all-cash operation usually there are no synergies so there is no need to engage the target company with the resulting firm or any project (Ismail and Krause 2010). The payment is straight on cash as there is no need to keep the target company interested and responsible for the integration or successfulness of the operation. Finally, for the target an all-cash payment means immediate taxation, which might be detrimental to their strategic planning.

The second form of payment on an M&A operation is an all-stocks transaction, which means that the acquirer will issue or use the reserves of stock they have to pay the full value of the transaction. This form of payment is delicate withing the acquirer equity structure as in most of the cases it means a major issuance of stock which will mean a dilution of the equity positions of shareholders before the M&A. This means that usually for an all-stock transaction there have to be a previous shareholder meeting where the issuance is allowed, in order to protect all shareholders interests (Sankar and Leepsas 2018). In other words, there is a risk for the target when the offer is an all-stock payment, as there is a probability that the shareholders refuse to be diluted and therefore the operation fails.

Contrary to an all-cash operation an all-stock operation informs the market that the main source of value in the transaction is synergies, as it is important to keep the target company engaged and interested in the outcome of the integration. On an all-stock operation, the target company is exposed to the performance of the resulting company, in other words as the target company shareholders receive as payment stock of the resulting company they are interested and exposed to the performance of the resulting firm (Sankar and Leepsas 2018). This means that the acquirer is interested in keeping the target company engaged with the result of the transaction, which might suggest that there are synergies that can only be archived by the joint effort of both acquirer and target.

On the other side, an all-stock transaction might inform the market about the value of the acquiring company, as usually overvalued companies use all-stock deals. If a firm has overvalued stocks, it means that their cost of equity is lower, and therefore it is possible to engage with an all-stock transaction easily (André and Ben-Amar 2009). This might lead to difficulties in the negotiation of the merger as the target could assume that the acquirer stock is overvalued and ask for a higher payment, due to asymmetric information on the intrinsic value of the acquirer stock. But the target might be benefited from the possibility of postponing taxation that stocks provide.

Finally, the last form of payment is the most common which is a combination of stock and cash, obtaining benefits from both forms of payment and acquiring some of the risks each one brings. It is important to consider that literature has found out that deals financed with stock usually underperform those financed with cash.

The form of payment is an important issue on an M&A operation but there are other such as the type of target firm involved in the transaction. There is evidence that if the target firm is listed or in other words public in most mergers there are negative abnormal returns for the acquirer, but if the target firm is private the scenario changes and there are positive abnormal returns out of the transaction for the acquirer (Farinós, Herrero and Latorre 2017). There are two explanations for this phenomenon, first asymmetric information, there is an important difference between the availability of information for a public and a private company, regulation forces public companies to disclose much more information than privates. Then the information asymmetry is greater for a privately held company because this is a risk for the acquirer they can offer lower payments, by underpaying they are compensating for the risk of asymmetric information and there could be abnormal positive returns (Capron and Shen 2007).

The second reason why there are positive abnormal returns in M&A processes with a private firm is that the market for private firms is usually illiquid and small, which means that there are lesser bidders or competition for the merger (Farinós, Herrero and Latorre 2017). As there are not as many bidders as for a public company, target firms don't have access to many alternatives or white knights, which leads to the possibility of an underpayment and therefore to abnormal positive returns for the acquirer. But it is important to take into account that the lesser the bidders and the higher the asymmetric information there are increasing risks of doing incorrectly the valuation of the company and therefore ending overpaying for the target.

There are also two additional reasons why M&A processes with private firms generate positive abnormal returns and with a public negative returns, but this reasons are situational and not the main drivers of the abnormal returns. In some cases, entrepreneurs or shareholders are seeking to cash out of the target company so they might be willing to receive an undervalue payment to retire from the company by selling to bigger companies (Capron and Shen 2007). The second situational reason is when the target firm managers and owners are naïve about how they want the firm to be managed and future revenues, so they decide to sell even at a lower valuation.

Another important issue in an M&A process is similar to the past discussed issue about the characteristic of the buyer, more exactly the size of the acquirer. This is important as literature has determined that big companies tend to produce negative abnormal returns meanwhile small or medium acquirer are able to generate positive abnormal results (Bradley, et al. 2018). The main reason for this finding is that big companies commonly face competition on their M&A processes, due to the competition on the process acquirers could overpay and therefore generate negative abnormal returns because of the transaction.

The competition process on an M&A transaction led to overpayment for two reasons involved in the negotiation stage of the merger. First, the acquirers are forced to engage with defensive action in order to obtain a deal with the target firm, actions like getting toehold stakes, termination fees, lockup options, and exit clauses generate costs for the acquirer (Bradley, et al. 2018). These costs might be the cause of the negative abnormal returns for the acquirers, but the second reason is more important to understand the overpayment. The second reason is a bidding war between the competitors for the target company, which leads directly to an increase in the payment offers and therefore to overpaying the transaction. This might also lead to paying on cash, offering to the target certainty of payment but for the acquirer liquidity problems.

Finally, small acquirers usually don't face competition on their M&A transactions, and because of their size are unable to involve in defensive strategies or bidding wars, which lead to underpaying mergers and therefore to positive abnormal returns. For a small firm to acquire other companies is a good strategy if they are able to generate positive abnormal returns as by doing so, they are becoming g a better and stronger target company for a bigger company that might overpay.

3. Model

To determine the optimal premium to be paid on an M&A operation that is strategic both for the acquirer as for the target firm it is necessary to develop a model with the capability to include the most important information on a merger and determine the strategic premium. To do so it will be used the game theory approach of subgames Nash equilibrium, where the players, timing, strategies, and payment functions are properly adjusted for an M&A process.

As discussed previously an M&A process is essentially a cluster of decisions and the interaction that those generate among the target and acquirer, this means that the basic unit of any M&A process is the decisions that the parties are taking to achieve an outcome. Then to create an appropriate model to find the strategic optimal premium, it must be able to adapt to the different decisions that the players can take. As there have to be at least two parties on an M&A process then each decision affects all the parties involved, changing their behavior and conditioning future decisions. Then the model must be able to take into account the interactions between different decisions and their effects on the other party and the overall outcome.

Game theory is the branch of mathematics that study and model the "interacting choices of economic agents" (Ross 2019), this branch of math is commonly applied to social interactions between agents looking to achieve an outcome from each other. The main difference between game theory and an anthropological study of decision making and interactions is that this field of study mathematically model each decision (strategy), each outcome (payment), and the preferences of the parties (utility functions) in order to determine the strategic course of action to fulfill the preference of both players taking into account the effects of the interactions between decisions.

Then game theory offers the appropriate theoretical framework to develop a model able to grasp the most important issues on an M&A process, as game theory can consider decisions of each party and the effect of those in the outcome. But is the Nash equilibrium (NE) concept allows the model to determine the optimal strategic premium on an M&A process. Nash equilibrium is a solution criterion for game theory which states that for a specific set of strategies "no player could improve her payoff, given the strategies of all other players in the game, by changing her strategy" (Ross 2019), therefore NE is all about incentives, if no party in the model have incentives to change their strategy as doing so will represent a decrease on their utility, there is a Nash equilibrium.

Then the framework of game theory and Nash equilibrium can model decision making, the interactions that each decision generates, and determine a set of strategies in which all involved parties are satisfied or unwilling to change. In this sense, this framework allows determining the strategic optimal premium that maximizes the utility of both target and acquirer when engaging in an M&A process.

Another important factor of an M&A transaction is that it is a negotiation process, as both parties are trying to maximize their utility and the optimal outcome for each is the contrary of the optimal outcome for the other player, the only way to reach an agreement is by negotiating. Then the negotiation game theory approach will be used, and subgames perfect Nash equilibrium will be the solution criteria, using backward induction to find the optimal outcome in each subgame.

Extensive form:

Players:

The players involved in the M&A transaction are the acquirer firm (A) and the target firm (T), which can be any type of company engaging in a merger or acquisition:

$$i = \{A, T\}$$

Strategies:

Each player has a specific set of strategies depending on if it´s an acquirer or a target firm. The strategies for each player are the decisions that they can make during the negotiation of the M&A. The acquirer decides over the offer to make to the target firm, the components of this offer are the source of value on the transaction. The acquirer decides to engage or not in a transaction which source of value is undervalue (Uv), control (Ctr) or synergies (Syn), additionally, they can decide the amount of control (δ) or synergies (ρ) to give up to achieve a deal. They might also decide to pay with stock (μ) and the amount to pay with it (ε).

There is an underlying assumption on this set of strategies, the acquirer does not engage in an M&A process if there is no source of value on it, this means that the acquirer is rational and will not engage in a process on which is impossible to extract value.

For the target the strategies are simple, as the owner of the asset that the acquirer desire (the company) the target has to decide if there is a deal (D) or not (ND) in the negotiation. This means that the target receives an offer from the acquirer for the company ownership and they must decide to accept it or not.

$$S_i = \{S_A, S_T\}$$

$$S_A = \{Offer\} = \{Uv, Ctr, Syn, \delta, \rho, \mu, \varepsilon\}$$

$$Offer = Uv(Mv + \Omega) + Ctr(DCF + \delta Control\ CF + \Omega) + \mathrm{Syn}(\mathrm{DCF} + \rho \mathrm{Synergies\ CF} + \Omega)$$

$$\Omega = \tau - \mu\varepsilon - \alpha$$

$$S_T = \{D, ND\}$$

On the offer that the acquirer proposes the factors $Uv, Ctr\ and\ Syn$ are dummy variables that have a value of 1 if the source of value in the M&A is Undervalue, Control, or Synergies respectively, in any other case their value is 0. These variables are strategies of the acquirer as they can decide the source of value in the operation. For undervalue the offer done depends on the market value (Mv) of the target company, if the value in the operation comes from undervalue then the acquirer will pay the market value willingly as the real value of the company is higher.

Ω is a common factor to every source of value as it contains the parameters that don't generate value in an M&A but are able to affect its value. Therefore, the components are the ones discussed earlier; τ is a parameter that captures the size of the acquirer, as bigger firms usually overpay it has a positive effect on the offer. α is a parameter that contains the risk of asymmetric information for the acquirer, especially the risk caused if the target is private. As a risk for the acquirer the parameter has a negative sign representing that the acquirer will offer less if there is high asymmetry of information risk.

Omega contains a variable in the form of $\mu\varepsilon$ which represents the form of payment of the transaction. This is a strategy for the acquirer as they can decide whether use stock as a form of payment (μ), a dummy which is 1 if there is a payment with stock and 0 if not. But the acquirer can also decide how much are they willing to pay in stock $(\varepsilon) = \#\ shares * share\ value$. It was assumed that for the acquirer the decision of how much to pay with stock is limited as issuing stock will mean dilution for shareholders. Commonly corporations can issue stock if it will not represent a dilution of 20% for shareholders, for issuing more stock they have to get approval from shareholders. Then the decision of how much to pay in stock is limited by this threshold, after it, the decision is not of the acquirer. The mathematical constraint then is $\varepsilon \leq 20\% * \#\ \text{Actual Shares}$.

If the source of value in the transaction is control then the offer will be the value of the company calculated using DCF plus the amount of control cash flows (Control CF) that the acquirer is willing to share (δ), plus the same Omega than in undervalue. For synergies the offer has the same structure, it will be the DCF value plus the amount of synergies cash flows (Synergies CF) to be shared (ρ), plus omega. The amounts to be shared are the product between the cash flows of each source of value and the percentage to be shared (δ, ρ) which means that this decision is a number between 0,1.

Payment functions:

From the different combinations of strategies, the players will receive a payment of the game or M&A process. These payments are described on the following functions:

$$\pi_i = \{\pi_A, \pi_T\}$$

$$\pi_A = Max\ (CA - Offer + TCV)$$

$$\pi_T = Max\ (TCV, Offer + \mu\varepsilon - CO)$$

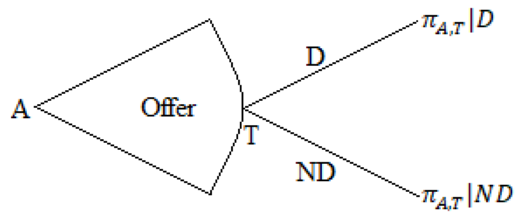
$$CO = Ctr\ (1 - \delta) Control\ CF + Syn\ (1 - \rho) Synergies\ CF$$

For the acquirer, the payment of the transaction will be the cash available (CA) minus the offer if accepted, plus the true value of the company (TVC) which is the discounted cash flows of the company. In other words, the payment will be the cash that they had, minus the amount used to purchase the target firm, plus the value of the firm as they will receive the control of the cash flow of the target firm if the transaction is successful. Because of this payment function, the factor which captures the amount and decision to pay with stock has a negative sign on the offer, as paying in stock will mean that the cash available will decrease less.

On the other side, the payment of the target is a decision between the true value of the company and the payment to be received of the operation, which is consistent with target strategies. If the target decides not to accept the deal their payment will be to keep the firm which means to keep control over the future cash flows of the company (TCV). But if they decide to accept the deal then their payment will be the offer of the acquirer in cash, plus the payment in stock and an additional factor that is the cost of opportunity of the transaction (CO). As this is a game where the information about the deal is complete, the target knows the cash flows that the acquirer will receive because of control or synergies, which means that the cost of opportunity will be the amount of those cash flows that they will not receive, as they know that they could keep searching for acquirers until one offers the full cash flows of control or synergies in the transaction.

Timing:

Finally, it is important to determine that this is a negotiation game, where there could be infinite repetitions of the game, but because of the structure of the strategies, payment functions, and the fact that there is complete information, there will only be one round of negotiations. The acquirer is the first player to act proposing an offer to the target firm, then the target independently will assess the offer and decide whether to accept it or not. After this decision the game ends, as the acquirer has already offered their optimal strategy and deviating form it will mean to engage in a negative strategy for their interests.



Then the game will go as follows: the acquirer will decide as an strategy the source of value of the transaction and will search for a target company which allow to obtain a certain source of value. Upon finding the target company there has to be a valuation process of the company and the value generated by the M&A which could be the underpricing of the company, control or synergies cash flows in the operation. The acquirer then add up information such as the difference in size between the companies that could lead to defensive strategies, the amount of information asymmetry in the game due to the status of the target firm as public or private and decide if there will be any payment in stock and if so the amount to be paid using this form of payment. With all this information the last action of the acquirer is to decide the amount of value to be shared in the transaction, which will complete the offer proposal for the M&A. The offer then is an open strategy which depend on the set of actions taken by the acquirer gathering information and deciding strategically with it.

After an offer is done by the acquirer, the target firm will review it and determine if it's strategic to accept it or not, which means if the offer generate value for them. With the review of the offer the target company decides which strategy to use, by eliminating all strategies that are not believable. After the strategy of accept the deal or reject it by the target the game ends and both player receive as an outcome the payment associated to the set of strategies used.

4. Discussion

The solution criteria for the model presented is perfect Nash equilibrium in subgames which is done using backward induction. Then the first node to solve is the subgame of the target with its independent decision over the deal on whether to accept or not. For this subgame the solution is made through three possible outcomes: the target will always make a deal if $Offer_t + \mu\varepsilon - CO_t > TCV$, as the income generated by the transaction will be higher than the enterprise value, if they reject the deal they will directly lose utility.

The second solution in the subgame of the target is when there will not be any deal, this equilibrium happens when $Offer_t + \mu\varepsilon - CO_t < TCV$. As the target company is a rational player, they will not accept any deal which offer a payment that is less than the actual true price of the company. Finally, there is an equilibrium in which the target is indifferent between accepting or not the offer made by the acquirer this happens when $Offer_t + \mu\varepsilon - CO_t = TCV$, as the offer is exactly the true company value then there are no incentives to accept or not accept the deal.

After determining the possible solutions to the subgame of the target player the following step is to determine the solution for the acquirer. The acquirer is a player that as stated before will only engage in a negotiation if there is a possibility of generating value of the M&A process which means that they will assess the situation and only engage in a negotiation when there are sources of value but most importantly if they can reach a solution in which the target accepts the offer. Any negotiation and especially M&A processes have transaction costs which means that rational players acquirer will only engage in operations in which their budget constraint allows them to convince the target company to sell. If they engage and don't have the necessary funds, then they will fail in the transaction and face transaction costs which means a loss of utility from the failed transaction.

Therefore, for the solution of the acquirer and as its strategic goal is to get a deal with the target, then the solution criteria of the target that matter the most is the first one in which they will always accept the offer. The other solutions are important but they can be seen as the complement of the first one, which means that if the company doesn't have enough capital to make an offer that is aligned with the first solution, then there will be no offer, as the acquirer knows that the solution will be that the target rejects the deal, but there will be transaction costs.

In this order of ideas, the solution of the acquirer game is subject to a constraint that is obtaining a deal from the transaction or meet the requirement asked by the target to accept a deal, this means that the payment function of the acquirer is subject to $Offer_t + \mu\varepsilon - CO_t > TCV$. But as stated before there is an additional constraint in terms of the payment that can be done through stock, it can only be 20% of the actual stocks, as further dilution will require a shareholders meeting and therefore will not be a decision made by the acquirer, then the constraint will be $\varepsilon \leq 20\% * \#Actual\ Shares$.

From this formulation the solution methodology is Kuhn Tucker as the acquirer will optimize his payment function subject to inequalities. As the offer or strategy of the acquirer depends directly on the source of value in the M&A operation it must be solved in different optimizations, one for each source of value. Then the solution of the model will be the following:

$$Max\ CA - Offer + TVC\ Subject\ to: Offer + \mu\varepsilon - CO > TCV\ \&\ \varepsilon \leq 20\% * \#Actual\ Shares$$

Undervalue scenario (Uv=1)

If the source of value in the transaction is undervalue it means that the dummy variable Uv has a value of one and the other dummies for sources of value are 0. For this scenario the solution found is that there will be no deal whatsoever if the information is complete in the game. The target company will only agree to sell if the payment is over the true company value (TCV), and the acquirer will optimally offer exactly the market value of the company, hoping that the real value of the company is higher than the market value and therefore profit form price difference. Then there will only be a deal if: $DCF > MV = Offer + \mu\varepsilon - CO$ and $Offer + \mu\varepsilon - CO > TCV$. Which means that $DCF > Offer + \mu\varepsilon - CO > TCV$.

This solution means that there is no way that there is a deal if there is complete information in the game, as the acquirer will know that their own valuation of the target is not the true company value then if they pay the market value there will be an overpayment, so they will no transaction.

Then the only way in which is possible to have an undervaluation solution is if there are differences in the valuation of the target firm, which only can happen if there is private information in the game. Under this scenario, it is assumed that the target will be the owner of the private information and will know the true value of the company, which market value is higher or overpriced. If there is a potential acquirer that is willing to pay the market value, then there will be a deal as the target know they are overpriced and will profit from that. For the acquirer, the situation will be that they believe the real value of the company is more than the market value as their information is limited and will buy the firm, but when they receive it they will face the reality that the real value is less than market value, which means that they overpaid and engage on a value destruction M&A.

Control Scenario (Ctr=1)

In contrast with undervalue, the control scenario does have an equilibrium in which there is a deal from which both parties can profit. Performing the optimization using Kuhn Tucker it is found that there is an optimal value of control cash flows to share to obtain a deal from an offer made by the target. The solution is the following:

$$\delta^* = \left(\frac{DCF - \tau + \alpha}{2}\right) * \frac{1}{Control\ CF} - \frac{1}{2}$$

Which normalized to get a result bounded between 0 and 1 is:

$$\delta^* = \frac{DCF - \mu\varepsilon}{DCF}$$

As the optimization has constraints there is also a solution to the amount to be paid with stock in the transactions which is: $\varepsilon^* = 0.2 * \#Actual\ Shares$ and $\mu = 1$. This result means that in the optimal transaction the acquirer will always make an offer that involves stock as a form of payment as by doing so the cash available will decrease less and utility rise. Therefore, any all-cash transaction is not optimal and there is money that is left on the table in the negotiation. But the result goes beyond as it states that it is strategic to pay as much as possible with stock without triggering a shareholders meeting, meaning a dilution of 20% for actual shareholders.

From the solution, it can be determined that there is an actual optimal strategic amount of value to be shared by the acquirer to obtain a deal that is different from giving up all the value. Empiric research has shown that usually, acquirers give up all the value, but the model showed that that is no the case, as for that to happen the amount to be paid in stock should be 0 and as discussed before there should always be payment with stock, to the point of reaching a dilution of actual shareholders of 20%.

Then it has been proved that the empirical premium is a suboptimal not efficient solution in an M&A process, as this theoretical model has shown that for acquirers the strategic decision is not to share the full amount of the value created in the operation ($\delta^* \neq 1$). The empiric solution can only be reached on the model by having an all-cash transaction, and it's because of this that the empirical solution is not efficient or even possible. For the model an all-cash transaction is not optimal in any case as it will directly affect the cash of the acquirer company, meanwhile financing the operation with stock will not have this detrimental effect, and as the model is based on cash flows changes in cash are negative for the players, but stock changes are neutral.

It is important to take into account that in this research players are companies and not their stakeholders, this means that there are no agency problems between management and shareholders. But this problem could be the reason why empiric research have found that acquirers share almost all the value of the transaction, as managers can engage in transactions for empire building which will be damaging for shareholder's interests, or overconfidence of the management team can easily lead to overpayment.

It is also important to consider a limitation of the model which can explain the difference between the theoretical model and the empiric findings. As the players are companies the dilution generated by issuing stock is not taken into account, this means that for the model financing an M&A transaction with stock is essentially generating free money. The stock financing is indeed capped in the model by the shareholder meeting which is triggered with a dilution over 20%, but the actual effect of dilution is not in consideration in the model. This is one of the main limitations of the model and also the reason why it has a direct tendency to always have stock payments and as big as possible.

The actual effect of each of the parameters on the optimal offer or shared value can be determined from the solution, for doing so there were found the derivatives and their sign are analyzed considering that the solution is an injective equation, so the analysis of concavity tells the direct effect of the variables over the optimal shared value. The results are that the valuation of the target firm has a positive effect on the amount to be shared, if the acquirer is committing to buy more cash flows in the future, they are also willing to give up more money today in order to secure those future cash flows. The size of the acquirer has also a positive effect, meaning that if the acquirer is way bigger than the target company there will be more competition and defensive strategies could be used in the operation, so to avoid all these transaction costs acquirers are willing to give up value to get the deal.

On the contrary, the actual valuation of the control cash flows has a negative effect on the optimal shared value, which means that if the value created by control increases the acquirer will try to share less of it. This can be explained by the fact that acquirers are utility maximizers and control cash flows are sources of utility, therefore if they increase the acquirer will try to capture more value from it. Finally, the effect of asymmetric information is expected to be negative, the model proves this as the risk increases the acquirer will protect from it by giving up less value in the negotiation.

Synergies Scenario (Syn=1)

The solution of control is exactly the same that the one for control but with synergies cash flows, then the discussion and effects of the variables are the same that for control.

$$\rho^* = \left(\frac{DCF-\tau+\alpha}{2}\right) * \frac{1}{Synergies\ CF} - \frac{1}{2} \text{ normalized between 0 and 1 } \rho^* = \frac{DCF-\mu\varepsilon}{DCF}$$

5. Conclusion

This research was able to determine the existence of a theoretical optimal premium in merges and acquisitions processes that is different from the empiric. It was found that if the source of value in the transaction is undervaluation there is no possible strategic solution that led to a deal if there is complete information. Therefore, it has been shown that the undervalue as a source of value in a transaction is only possible in a situation with high levels of asymmetric information that lead to different valuations between players.

It was also found that the empiric solution of the acquirer giving up all the value from the operation is suboptimal in terms of the theoretical model. Game theory model has the property of eliminating all not believable or not viable solutions in the game, the empiric solution is eliminated both in control and synergies as value sources. The only way for the model to replicate the empiric solution is to perform an all-cash transaction, but this is not possible as it was proven that the optimal strategy is to perform a combined cash and stock payment in the operation.

The theoretical model not only determines the need for stock payment in every M&A transaction, but it determined that the amount to be paid with stock should be the highest possible. This means that if acquirers must finance as much as possible of the transaction with stock before losing independence over this decision. This means that the acquirer must issue stock to the point before triggering a shareholder meeting because of dilution and pay with this issued stock.

From this result it can be concluded that the model is not capable of explaining the empiric solution as the results differ. Then this model lacks sufficient variables to determine the real optimal premium to be paid. Assumptions such as rational players or not taking into consideration sentimental value, could have led to the model to be an inaccurate predictor of the optimal premium, as the empiric solution has to be seen as the optimal solution.

For future research is important to go beyond the limitations of this model to fully understand the effects of the variables in the game. The most important aspect to be expanded in future research is to include more players, such as the manager and shareholders, by doing so the effect of dilution will be taken into consideration in the game as a detrimental effect for one of the players and agency problems could be considered directly affecting the optimal solution.

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7. Supplemental Material

- **Algebra:**

Kuhn Tucker maximization model

$$Max\ CA - Offer + TVC\ Subject\ to: Offer + \mu\varepsilon - CO > TCV\ \&\ \varepsilon \leq 20\% * \#Actual\ Shares$$

$$Max\ CA - Uv(Mv + \tau - \mu\varepsilon - \alpha) + Ctr(DCF + \delta Ctr\ CF + \tau - \mu\varepsilon - \alpha)$$
$$+ Syn(DCF + \rho Syn\ CF + \tau - \mu\varepsilon - \alpha) + TVC$$

Subject to

$$Uv(Mv + \tau - \mu\varepsilon - \alpha) + Ctr(DCF + \delta Ctr\ CF + \tau - \mu\varepsilon - \alpha)$$
$$+ Syn(DCF + \rho Syn\ CF + \tau - \mu\varepsilon - \alpha) + \mu\varepsilon - Ctr(1 - \delta)Ctr\ CF$$
$$- Syn(1 - \rho)Syn\ CF > TCV$$

$$\varepsilon \leq 20\% * \#AS$$

Control Lagrange (Ctr=1)

$$\mathcal{L}_{Ctr} = CA - DCF - \delta Ctr\ CF - \tau + \mu\varepsilon + \alpha + TCV$$
$$+ \lambda(DCF + \delta Ctr\ CF + \tau - \mu\varepsilon - \alpha - (1-\delta)Ctr\ CF - TCV)$$
$$+ \chi(0.2 * \#AS - \varepsilon)$$

Kuhn Tucker conditions

$$\frac{\partial\ \mathcal{L}_{Ctr}}{\partial\ \delta} = -Ctr\ CF + 2\lambda Ctr\ CF = 0$$

$$\lambda \geq 0 \qquad \chi \geq 0$$

$$\lambda(DCF + 2\delta Ctr\ CF + \tau - \mu\varepsilon - \alpha - Ctr\ CF) = 0$$

$$\chi(0.2 * \#AS) = 0$$

$$DCF + 2\delta Ctr\ CF + \tau - \mu\varepsilon - \alpha - Ctr\ CF > 0$$

$$0.2 * \#AS > \varepsilon$$

Solution

$$\delta^* = \left(\frac{DCF - \tau + \alpha}{2}\right) * \frac{1}{Control\ CF} - \frac{1}{2}$$

$$\varepsilon^* = 0.2 * \#AS$$

Normalized

$$\delta^* = \frac{DCF - \mu\varepsilon}{DCF}$$

Synergies Lagrange

$$\mathcal{L}_{Syn} = CA - \ DCF - \rho Syn\ CF - \tau + \mu\varepsilon + \alpha + TCV$$

$$+ \lambda(DCF + \rho Syn\ CF + \tau - \mu\varepsilon - \alpha - (1-\rho)Syn\ CF - TCV)$$

$$+ \chi(0.2 * \#AS - \varepsilon)$$

$$\mathcal{L}_{Syn}^{'} = -Ctr\ CF + 2\lambda Ctr\ CF = 0$$

Kuhn Tucker conditions

$$\frac{\partial\ \mathcal{L}_{Syn}}{\partial\ \rho} = -Syn\ CF + 2\lambda Syn\ CF = 0$$

$$\lambda \geq 0 \qquad \chi \geq 0$$

$$\lambda(DCF + 2\rho Syn\ CF + \tau - \mu\varepsilon - \alpha - Syn\ CF) = 0$$

$$\chi(0.2 * \#AS) = 0$$

$$DCF + 2\rho Syn\ CF + \tau - \mu\varepsilon - \alpha - Syn\ CF > 0$$

$$0.2 * \#AS > \varepsilon$$

Solution

$$\delta^* = \left(\frac{DCF - \tau + \alpha}{2}\right) * \frac{1}{Synergies\ CF} - \frac{1}{2}$$

$$\varepsilon^* = 0.2 * \#AS$$

Normalized

$$\delta^* = \frac{DCF - \mu\varepsilon}{DCF}$$