A Game Theoretic Real Options Approach to Corporate Acquisitions: Theory and Evidence

Pablo Morán Villar

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ABSTRACT

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The phenomenon of corporate acquisitions has been the subject of extensive research, but despite important advances in our understanding of these corporate events, many issues are still unclear. Our purpose in this thesis is to revisit the M&A subject using the real options paradigm. Even though this literature has been one of the most important recent developments in finance and economics, the application of its lessons to corporate acquisitions is still scarce.

Using a game theoretic real option framework, we develop a model of corporate acquisitions. We incorporate imperfect information about synergy gains, strategic interaction among competing bidders, and between the acquirer and the target firm. Assuming the absence of managerial motives, the model is able to explain some empirical regularities that, thus far, have only been explained under the agency and hubris hypotheses. The undervaluation, asymmetric distribution of gains, and divestiture phenomena are natural results in our model.

In a preliminary empirical test we find support for the prediction relating target gains to the target's undervaluation and volatility. Even though we do not intend to replace other competing theories of corporate acquisitions, we believe our model represents a valid alternative hypothesis that could help to improve our understanding of some stylized facts. The many still unexplored predictions from our model are an interesting area for future research.

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Introduction

The economic role of takeovers has been the subject of extensive research. Different views of the source of takeover activity have along the way shaped different antitrust policies and investors' perceptions. Together with the traditional economic arguments of economies of scale and market power, the current, competing, financial theories of takeover motives appear to be rooted in two different views proposed in the 1960s. Manne (1965) argues that management discipline is the main reason for takeovers. In this view, the control of corporations is a valuable asset, and therefore, takeovers are the result of a successful working of this special market.

In contrast to Manne's view, Gort (1969) argues that merger rates[1] follow patterns among industries and over time. He states: "... *a popular hypothesis is that mergers are consequences of the personal ambitions of managers to manage larger firms. However, unless one is able to explain a particular distribution of ambitious men across industries, or over time, the hypothesis does not offer a sufficient condition for most mergers.*", p.625. This hypothesis has been coined the *economic disturbance theory* as it attributes takeover activity to exogenous shocks.

Whatever the motivation for takeover activity and despite the important contribution of the literature of corporate takeovers, to our understanding, there are still issues

[1]He defines merger rates as the number of acquisitions to the population of business firms in the relevant sector.

that are unclear. For example, diversified firms appear to trade at a discount relative to the market value of individual business segments [for example: Berger and Ofek (1995) and Lins and Servaes (1999)]. If this discount is indeed the result of inefficiencies, then why do some firms remain diversified? If this *inertia* is due to agency problems within diversified firms, a natural question is then why do other competing managers remain passive in the light of a potentially good investment?; Is it a malfunctioning in the market for corporate control? The empirical literature in M&As has consistently documented that acquisition announcements have on average a combined (bidder-target) positive abnormal return, with targets obtaining most of the stock price appreciation [for example: Jensen and Ruback (1983) and Andrade et al. (2001)]. Similar evidence has been found for divestiture announcements [Mulherin and Boone (2000)]. Although it appears that many researchers have taken this evidence as a natural phenomenon, it is interesting to note that, under the Marshallian or Net Present Value (NPV) rule, these abnormal returns are not easy to interpret. For example, under this rule, firms should acquire or divest as soon as the NPV of the action is positive. This implies that we should observe no abnormal return during these events. The fact that the combined abnormal returns are positive on average suggests that firms are making these decisions with delay relative to the Mashallian view. Then, why do firms appear to be waiting more than suggested by the NPV rule?

These are among the issues that motivate our theoretical exploration of corporate acquisitions under the real options paradigm. Considering acquisitions and divestiture as a capital budgeting decision, it is intuitive that lessons from the recent real options literature apply to these economic decisions as well. Perhaps, the most important conclusion from this literature is that the NPV rule is not necessarily optimal when firms face uncertainty, irreversibility and some leeway to time investment. When investment opportunities are seen as options on real assets, optimal decision making is characterized by inertia or *economic hysteresis*. Thus, our claim in this thesis is that the diversification discounts or abnormal returns might be natural and caused by this optimal inertia.

To our final end in this thesis, we organize our work as follows: In the first chapter, we develop the intuition behind the real options approach to investment decisions. Even though we assume that the reader is familiar with the literature of financial options, we expect this chapter to be sufficient to understand the analogy between real and financial options. In this chapter we also develop the building blocks of our model. Chapter 1 concludes with a brief discussion of some recent developments in the real option literature. In chapter 2, we develop our theoretical model. This chapter assumes some basic knowledge of game theory. Our main purpose in this chapter is to obtain the equilibrium strategies for bidder and target firms. From these strategies, the main implications are derived. This chapter ends with a summary of the empirical implications of our model for corporate acquisitions and divestitures. Chapter 3 is devoted to a discussion of the most influential empirical research in takeovers from the perspectives derived in our model. In chapter 4, we perform a preliminary empirical test of our model. Our focus in this chapter will be to test the predictions that relate to target gains. The thesis ends with a brief summary of our empirical and theoretical findings and our main conclusions and suggestions for future research.

Chapter 1

Investment Decisions as Real Options

Since Brennan and Schwartz (1985) and McDonald and Siegel (1985) published their seminal papers, the literature of real options developed dramatically. These authors were the first to formalize the analogy between investment decisions and financial options. They propose that, as in the case of financial options, investment opportunities represent rights but not obligations to undertake a given project. This simple observation has important implications for our understanding of investment decisions.

The development of this literature has been so substantial that it is certainly impossible to summarize all contributions in a reasonably short piece. Consequently, the purpose of this chapter is to summarize the main ideas behind the real options approach that will be the building blocks for our model in the next chapter. This chapter is, thus, by no means an exhaustive discussion of the current state of the art, and readers interested in a more extensive treatment are referred to Dixit and Pindyck (1994) and Trigeorgis (1996). Schwartz and Trigeorgis (2001) present an edited version of the seminal contributions and new development in the area. To our end, the next section presents the intuition for the analogy between financial options and investment opportunities. In section 1.2 the basic ideas are formalized mathematically in a simple model. The last two sections of this chapter are devoted to a discussion of the main implications and some new developments of real options models.

1.1 The Real Options Paradigm

The purpose of capital budgeting decisions is to find investment projects whose value exceeds their cost [Brennan and Schwartz (2001)]. The discounted cash flow (DCF) analysis has gained popularity not only within business schools but also amongst practitioners to appraise or value the assets created by investments. The application of DCF consists of estimating the timing and amount of cash flows as well as the suitable discount rate for these cash flows. Then the present value of these cash flows is compared to the investment cost in order to determine whether or not the project creates wealth. Under this project valuation technique, it is assumed that future cash flows can be represented by their expected value, and therefore, the risk associated with these cash flows is incorporated in the discount rate[1]. The analogy between this project valuation technique and the valuation of fixed income securities is readily apparent. Despite the apparent similarities between these asset classes, it must be recognized that the timing and amount of cash flows are more easily forecasted for bonds than for risky projects. Furthermore, the agent buying a bond has probably no influence on the cash flows, a very unlikely situation for real investments.

These implicit assumptions in DCF analysis have several limitation for real life

[1]Alternatively, the risk can be incorporated in the cash flow in order to obtain certainty equivalent cash flows. In this case, the suitable discount rate is the risk free rate.

situations. For example, by assuming that future cash flows can be represented by the expected cash flows, it is assumed that management is committed to a static or fixed operating strategy (the average scenario) during the economic life of the project. This implies that the ability of management to revise decisions as time passes is not recognized explicitly. For example, the fact that the project might be expanded or abandoned as uncertainty unfolds over time is not explicitly recognized in the NPV approach. In addition, this approach cannot properly capture the strategic value of some projects that might serve as a stepping stone for future projects. Even though simulation techniques and decision tree analyses allow decision makers to recognize the contingency of cash flows, these techniques do not provide a satisfactory solution because it is not entirely clear what discount rate should be used. This problem is not trivial because by affecting the distribution of cash flows, the decision maker is also affecting the project's risk profile. This effect makes it hard to estimate an appropriate discount rate for the project.

The real options paradigm arose as the theoretically correct version of decision tree and simulation analysis. By considering an investment opportunity as a contingent claim, the value of managerial flexibility and the strategic value involved in some projects can be assessed through standard techniques developed for financial options. In this sense, investment opportunities might be studied as an option on strategies and operating options on real assets, or real options. For example, firms can defer investments, expand or contract projects, temporarily close or shut down the firm, etc. Then with this analogy, we recognize that agents are able to affect cash flows by exercising other options in the future. Furthermore, the determination of the appropriate discount rate is addressed theoretically through the use of a replicating portfolio strategy that allows valuing the project by arbitrage[2]. The financial/real option analogy is summarized in table 1.1:

Table 1.1: **Contrast between a Real and Financial Option.**

Call Option on Stock	**Real Option on Project**
Current value of stock	Present value of expected cash flows
Exercise price	Investment Cost
Time to expiration	Time until opportunity disappears
Stock value uncertainty	Project value uncertainty
Risk free rate	Risk free rate

Imagine a simple project that has neither operating options nor additional strategic value for the firm. That is to say, the project is a stand-alone decision. Even in this simple case, the firm can decide to defer the project in order to wait for new information that might affect the desirability of the project. Note that this flexibility to defer investments alters the future distribution of cash flows as it allows the firm to reduce the downside risk while keeping the upside potential. This positive skewness effect is the underlying principle that gives value to financial and real options.

More complex situations are also possible. Imagine now a new project that is otherwise identical to the previous one but that has the option to expand and contract operations after the initial investment if states of nature turn favorable or unfavorable. This operating flexibility has value because at the time of initial investment there will still be uncertainty to be resolved. Therefore, if a firm must choose between the projects, the second project is preferable. Similar options are present, for example, when two facilities have different initial outlays but only one allows for flexibility in

[2]Note that the assumption of market completeness necessary for the construction of a replicating portfolio is also made in traditional DCF analysis. For the application of DCF or Net Present Value analysis, the existence of a traded twin security that allows for the estimation of the discount rate is normally assumed. Thus, it is implicitly assumed that this twin security is able to characterize the risk profile of the project.

switching inputs such as oil or gas. More extreme, imagine a project such as R&D investment that has almost no cash flow during the initial stage. It is almost certain that this project will have a negative NPV. However, this project might generate other growth options for the firm such as the possibility of accessing new markets, or developing new products. In this case, negative NPV projects might be desirable when they have other embedded options. Similarly, in multistage projects the firm might have the option to default at each stage if conditions make the project infeasible at a future date.

The real options approach thus allows for the conceptualization, and in principle the valuation, of several strategic and operating options that the traditional NPV analysis cannot properly capture. The analogy between financial options and investment opportunities is far from perfect however. We shall discuss some of the most important differences in the last section of this chapter, but at this point it is important to sound a note of caution. Dixit and Pindyck (2001) argue that three conditions are necessary for the real options concepts to be applied: First, it is necessary that the project involves some risk. Clearly, in a world of certainty the NPV is a suitable criterion.

Second, investments must be at least partially irreversible. Irreversibility is understood as the existence of costs that once sunk are not retrievable. Under perfect reversibility, the NPV is a suitable criterion because the investment can be undone without any cost if future conditions turn unfavorable. However, most investment decisions involve sunk costs. For example, firm-specific assets are lost if the firm decides to shut down or sell a project. Even when the project involves only tangible assets, informational asymmetries in the second hand market might impose irreversibility. This occurs due to the lemon's problem which implies a low resale value for assets.

The final condition requires that firms have some leeway to postpone investments[3]. In other words, firms must have some degree of discretion in the investment timing. In this sense, the degree of exclusivity affects the value of real options [Kester (2001)]. For example, imagine a situation where the firm has the exclusive or monopolistic right over the investment (i.e. a patent for commercializing a given product). In this case, the firm can wait as long as necessary before committing additional resources. The situation is different when the firm shares the investment option with many firms. In this case, the strategic interaction amongst the firms might affect the value of their investment option. Intuition suggests that firms will not be able to wait long due to potential preemption from other firms. Thus, we would expect shared or common options to be less valuable than proprietary options. This feature is perhaps the most important contrast between financial and real options.

1.2 Canonical Model of Investment under Uncertainty

In this section we develop perhaps the simplest case of an option on real assets. The intention is to formalize, in a simple model, our previous discussion and at the same time introduce some results that will be used in the next chapter. Our discussion in this section follows closely that in Dixit and Pindyck (1994, Chapter 5).

Imagine a firm that is considering an investment in a given project. Consider the simplest situation where the firm has the exclusive right over this investment and this

[3] For tractability, the real options literature normally assumes that investment opportunities have no expiration date. This allows for close form solutions.

right (option) has no expiration date (American-type option with infinite maturity). The project has zero salvage value (investment cost is sunk). This project has a known cost of I, but its market value fluctuates over time following a Geometric Brownian Motion[4]:

$$dV(t) = \mu V(t)dt + \sigma V(t)dW \tag{1.1}$$

Thus the market value will have an expected rate of growth μ per unit of time, but its actual realization will also depend on the noise induced by the standard Brownian Motion dW scaled by σ. In simple terms, the market value of the project will be normally distributed with mean μt and variance $\sigma^2 t$.

The standard NPV criterion advises one to take this project when its value is higher than the investment cost, or $V(t) - I > 0$. The NPV criterion is, to some extent, forcing the decision maker to decide between two alternatives: $Max\{V(t) - I, 0\}$. In other words it assumes a now-or-never situation. As we discussed previously, this simple rule is incomplete as it does not consider that by investing today the firm is killing the value of waiting.

Suppose that the firm can delay the investment without any extra cost. Denote the value of this option as $F(V, t)$. Then the value of this option would now be of the form:

$$F(V, t) = Max\Big\{V(t) - I, (1 + \rho dt)^{-1} E_t\big[F(V + dV, t + dt)\big]\Big\}$$

This expression is known as the Bellman equation. Note that the optimality condition consists of continuously comparing two alternatives: invest today versus wait

[4]It is not difficult to show that when the cash flows follow a GBM with drift and diffusion μ and σ respectively, the market value also follows a GBM with the same drift and diffusion parameters. Furthermore, it can be shown that when the cash flow follows a GBM, the market value of the project is of the form $V(t) = \frac{CashFlow(t)}{\rho - \mu}$, for a given discount rate ρ. Note the similarity of this expression with the constant growth Gordon model.

an instant dt. The main difference with the decision situation described above is that now the decision maker is comparing an infinite number of mutually exclusive projects. That is to say, he is comparing the same project but undertaken at different points in time. Thus the investment decision is analyzed as a timing decision because the decision maker considers not only whether or not the project is profitable but also when it is the most profitable time to undertake it. Formally, this firm faces a dynamic programming problem called the optimal stopping time[5].

Denote the first payoff above $(V(t) - I)$ as the *termination payoff* and the second payoff as the *continuation payoff*. Intuition suggests that there exists a cutoff market value for the project V^* at which the termination payoff is higher than the continuation payoff[6]. This cutoff point, known as the free boundary, will divide the state space in two regions: the *continuation region* and the *stopping region*.

In order to formalize our investment decision, consider the value function, or option to invest, in the continuation region:

$$F(V,t) = (1 + \rho dt)^{-1} E_t\big[F(V + dV, t + dt)\big] \mid V(t) < V^*$$

Noting that $E_t\big[F(V + dV, t + dt)\big] = F(V,t) + E_t[dF]$, the Bellman equation for the option value can be simplified to:

$$\rho F(V,t)dt = E_t[dF] \mid V(t) < V^*$$

The intuitive interpretation is very simple. Taking $F(V,t)$ as an asset, the return on this asset (left hand side) must be equal to the dividend yield plus the expected

[5]The same results can be obtained by using a replicating portfolio argument. We prefer the dynamic programming approach due to its generality and stronger intuition. See Dixit and Pindyck (1994) for a contrast between the two approaches.

[6]For a discussion about the characteristics of this cutoff point, the reader is referred to Dixit and Pindyck (1994)

capital gain. In our particular case, returns come only as capital gains since the option holder does not receive any dividend from holding his option unexercised. This comes from the fact that cash flows are not received until the firm decides to invest. Using Itô's Lemma to represent the term $E_t[dF]$, in the continuation region the investment option must satisfy the following ordinary differential equation[7]:

$$1/2V^2\sigma^2F''(V) + V\mu F'(V) - \rho F(V) = 0 \tag{1.2}$$

Note that this differential equation has only a homogeneous part and its solution is well-known to be of the form:

$$F(V) = CV^\beta \tag{1.3}$$

Where C and β are constants to be determined. Replacing this solution in equation (1.2), we find that the following condition must be met:

$$CV^\beta\big[1/2\sigma^2(\beta-1)\beta + (\rho-\delta)\beta - \rho\big] = 0$$

where we have already used the identity $\mu = \rho - \delta$, which states that the equilibrium return is equal to the expected growth μ plus the dividend yield $\delta = \frac{CashFlow(t)}{V(t)} > 0$. To satisfy this equation, the second factor $\big[(1/2\sigma^2(\beta-1)\beta + (\rho-\delta)\beta - \rho)\big]$ must be equal to zero. This polynomial will be very important in our subsequent analysis, thus following Dixit and Pindyck (1994) we will call it the *fundamental quadratic.*

Some important properties of the fundamental quadratic are of interest at this point. First, this polynomial always has two real roots. Second, one root (β_1) is always greater than one and the other root (β_2) is always less than zero. To see this, set $\beta = 1$ in the fundamental quadratic and check that the polynomial has the value

[7]We must remember that our stochastic process is time homogenous because the drift and variance are assumed constant. This implies that the term $\frac{dV}{dt}$ is dropped from Ito's Lemma.

$-\delta$. If we now set $\beta = 0$, we find that the fundamental quadratic has a value $-\rho$. This polynomial thus has a u-shape form where, for the range of values $]\beta_2, \beta_1[$, its value is negative. From this analysis, we can re-express the option value (1.3) as:

$$F(V) = C_1 V^{\beta_1} + C_2 V^{\beta_2} \tag{1.4}$$

Hence, our task is to find the values of constants C_1 and C_2 together with the free boundary V^*. The boundary conditions that allow us to find these coefficients are as follows:

$$\begin{aligned} F(0) &= 0, \\ F(V^*) &= V^* - I, \\ F'(V^*) &= 1 \end{aligned} \tag{1.5}$$

The first boundary condition recognizes that the absorbing barrier for the GBM is zero; if the process ever gets to zero, it will remain at zero forever. The second and third boundaries are called value matching and smooth pasting conditions, and represent the continuity and optimality conditions respectively. These two boundary conditions determine the moment at which the continuation payoff is less than the termination payoff. From the second equation in (1.5), we see immediately that $NPV > 0$ is not sufficient for an optimal investment decision. The optimal investment point V^* implies $V^* = F(V^*) + I$. Thus, the option value must be taken into account as an additional opportunity cost of investing. From the first boundary condition in (1.5), we know that as the market value of the project goes to zero the option to invest goes to zero as well. This allows us to infer that $C_2 = 0$ in (1.4) because $\beta_2 < 0$. Replacing the option value (1.4) at exercise in (1.5), we obtain:

$$C_1 V^{*\beta_1} = V^* - I,$$

$$\beta_1 C_1 V^{*\beta_1 - 1} = 1$$

We thus have two equations and two unknowns and the solutions for C_1 and V^* are given respectively by:

$$V^* = \left(\frac{\beta_1}{\beta_1 - 1}\right) I$$
$$C_1 = \left(\frac{V^* - I}{V^{*\beta_1}}\right) = (\beta_1 - 1)^{\beta_1 - 1} I^{1-\beta_1} \beta_1^{-\beta_1}$$

Where $\beta_1 > 1$ is the positive solution to the fundamental quadratic:

$$\frac{1}{2}\sigma^2 \beta(\beta - 1) + (\rho - \delta)\beta - \rho = 0 \quad (1.6)$$

The fundamental quadratic equation (1.6) will be extremely important in our model in the next chapter, in particular, the positive solution $\beta_1 > 1$. Therefore, this root will be denoted simply as β from now on. Some additional properties of this positive solution are of interest. First, as the variance in the price process tends to zero, and provided that $\mu > 0$, β tends to ρ/μ. We can obtain an immediate result from this property. Replacing $\beta = \rho/\mu$ in our investment trigger (V^*), we can see that it indeed tends to the Marshallian trigger, $V^* = V_m = \frac{\rho}{\rho - \mu} I$. Thus, the Marshallian trigger (NPV) is still valid, but, only in a world without uncertainty.

The second property is the relation between β and the drift and volatility of our state variable. Let us call Ω the equation (1.6). Differentiating Ω totally with respect to σ and μ we have:

$$\frac{d\Omega}{d\beta}\frac{d\beta}{d\sigma} + \frac{d\Omega}{d\sigma} = 0 \quad (1.7)$$
$$\frac{d\Omega}{d\beta}\frac{d\beta}{d\mu} + \frac{d\Omega}{d\mu} = 0 \quad (1.8)$$

We see from (1.6) that the first and the last term in the left hand of both equations are positive. Therefore $\frac{d\beta}{d\sigma}$ and $\frac{d\beta}{d\mu}$ must be negative for these equations to hold. A direct consequence from this result is that the trigger value V^* will be positively related to μ and σ.

A convenient representation of the option value that will be used concurrently in the next chapter is the following:

$$F(V) = \begin{cases} C(V^*)V(t)^\beta = \left[V(t) - I\right]\left(\frac{V(t)}{V^*}\right)^\beta & \text{for } V(t) < V^*; \\ V(t) - I & \text{for } V(t) \geq V^*. \end{cases}$$

Two results are important from this representation. First, Dixit et al. (1999) show that:

$$D(V(t), V^*) = E_t\left(e^{-\rho T}\right) = \left(\frac{V(t)}{V^*}\right)^\beta$$

for the Geometric Brownian Motion, where T corresponds to the random time the process $V(t)$ takes to reach the trigger value V^* given that it started at $V(t)$, and β represents the elasticity of the discount factor with respect to the optimal threshold V^*. These authors also show that this elasticity is independent of the starting value of the process. Thus, the value of the option corresponds to the present value of the payoff at exercise. Second, a higher trigger value implies not only a higher payoff at exercise, but also more discounting[8]. Hence, an alternative way to solve this problem is to directly use differential calculus in order to obtain the trigger price that maximizes the present value of the investment option, $\frac{dF(V)}{dV^*} = 0$. Indeed, this approach will be used in the next chapter. We must remark that both approaches can be shown to be identical.

[8]It should be clear that the process will take longer to hit a higher value of the threshold.

1.3 Main Implications

To this point it should be clear why the standard NPV rule is an incomplete metric for investment decisions when firms face uncertainty, irreversibility and some leeway to postpone investments. The implications of real options are tremendous not only for finance but also for economics.

In the general model presented above, the results indicate that firms should invest when the profitability ratio V/I is at least $\frac{\beta}{\beta-1}$. As β is always greater than one, this profitability ratio (akin to the Tobin's Q) is strictly greater than one. The derivative of $\frac{\beta}{\beta-1}$ with respect to β is negative. In addition, we also know that β is inversely related to σ and μ. Therefore, the optimal profitability ratio varies directly with μ and σ. Then the higher the risk and growth of a project, the higher the profitability ratio must be for optimal investment. The intuition for this result follows closely that of financial options. Projects with higher volatility have more downside risk, and therefore, it pays to wait for new information to arrive. Similarly, high growth projects will have, in equilibrium, a lower dividend yield $\frac{CashFlow(t)}{V(t)} = \delta = \rho - \mu$. Given that the firm does not receive cash flows before exercising, this dividend yield represents the cost of keeping the option unexercised. Thus the lower the dividend, the lower the cost of keeping the option unexercised, and therefore, firms will wait longer before investing.

The intuition from real options also has the potential to explain why some firms normally use a hurdle rate that is higher than the cost of capital. Imagine a situation where the present value of expected cash flows is \$ 1,000,001 and the investment cost is \$ 1,000,000. In this case, based on the NPV criterion, this project should be undertaken because its return is higher than the cost of capital. However, few people would be comfortable with this decision. Given the uncertainty in the cash flows, it appears very likely that a negative future economic event might render this investment a negative NPV project. Hurdle rates above the cost of capital could be considered then as a full return demanded by firms that compensates the loss of the value of waiting. McDonald (2000) examines the rationale of rules of thumbs in investment such as payback and hurdle rates under the real options perspective.

Standard microeconomic theory shows us that competitive firms should enter into an industry when the product price is equal to the long term cost of production. In terms of the model in the previous section, this condition implies that $CashFlows(t) = \rho I$. Nonetheless, the real options results indicate that this condition is not optimal under uncertainty. Indeed, firms will optimally enter at a price above the Marshallian (NPV=0) trigger. Under similar arguments, the real options literature rationalizes that firms stay in business even when they are realizing operating losses. The intuition for this apparently irrational behavior comes from the uncertainty and irreversibility involved in the exit decision. As the exit decision probably involves a complete loss of intangible assets, the firm will decide to shut down only when the operating losses are higher than the value of the option to stay in business. Thus, firms will exit the industry at a price below that indicated by the Marshallian trigger. Then, if we denote the Marshallian trigger by P_m and the entry and exit triggers by P_1 and P_2 respectively, the following condition results from the optimal entry and exit decisions: $P_1 > P_m > P_2$. Thus, there will be a range of product prices between which neither entry nor exit will occur in a given industry. Dixit and Pindyck (1994, Chapter 7) develop a model along these lines.

An interesting phenomenon occurs in this scenario. Imagine a corporate acquisition as any other capital budgeting decision[9]. For simplicity, assume that this decision is akin to an entry/exit decision as described above. Assume that the bidder has to pay a sunk cost which results in having the just acquired firm ready to produce at full capacity. Similarly, assume that divesting this acquisition also involves sunk costs, for example, given by intangible assets that would be lost in case of divestiture. Assume that given the sunk costs, the bidder determines that the optimal product prices that will trigger acquisition and divestiture are P_1 and P_2 respectively. Our previous discussion indicates that $P_1 > P_m > P_2$. Imagine the price process starts at P_m (Marshallian trigger) at time t_0. Note that the acquisition will not take place at this price because the NPV is not enough to cover the opportunity cost of going ahead with the acquisition (option value). At time t_1 the price process hits the acquisition trigger P_1 and the bidder proceeds with the acquisition. By assumption the NPV of this acquisition at time t_1 is equal to the value of the acquisition option, $NPV = F(P)$. Imagine now that at time t_2 the price process returns to its starting point P_m. Note that no divestiture will occur at this price even though the conditions in the economy are identical at t_0 and t_2. Thus, we find that the reversal in economic conditions is not sufficient for a reversal in the economic decision. A necessary condition for divestiture in this situation is that the price process goes down even further until P_2, the price at which, by assumption, the bidder will be realizing operating losses in managing the target firm. This inertia in economic decisions is what in the real options literature has been called *economic hysteresis* [Dixit (1992)].

In fact, the example described in the last paragraph is the basis for our model in the next chapter. Our claim is that acquisition decisions also involve some irreversibi-

[9]Related issues are discussed in Smith and Triantis (2001)

lity. Therefore, bidders will optimally acquire when the NPV is well above zero. For example, in our previous discussion we saw that the optimal investment condition is given by $NPV = V(t) - I = F(V)$. In other words, for optimal investment the acquisition must have a NPV of at least the value of the acquisition option. Therefore, factors affecting the value of this option will also affect the magnitude of the NPV at the optimal acquisition time. This rationale has the potential to explain the timing of acquisition and divestiture decisions, and therefore, the magnitude of abnormal returns (NPV) at the announcements.

1.4 Final Considerations

The fact that financial options are proprietary by definition while some real options might be shared or are common has spurred a great deal of theoretical work. This observation has to some extent divorced the literatures on real and financial options. Traditional financial call options give the holder the legal right to buy the underlying asset at a specified price. In addition, when the holder of this option decides to exercise his right, his decision does not affect other agents holding the same option[10]. When we deal with real options, both conditions might be violated. This implies that the analysis of real option exercises must be carried out in a context where rational agents consider these interactions among option holders.

The literature has dealt with this problem by incorporating game theoretic exercise of real options (option games). Seminal contributions in this area include Grenadier (1996) for games with complete information and Lambrecht and Perraudin (2003) for

[10]We must emphasize that this discussion does not include warrants or other convertible securities. When the writer of the option is the firm itself, there might be some dilution effect at exercise.

games with incomplete information[11]. Both models consider games between two players that share an option to invest[12]. Grenadier finds that strategic interactions indeed erode part of the option value. Under this setting, equilibrium implies rent equalization for both players. Thus, whether or not the option value is totally eliminated in games with complete information depends on the payoff the follower obtains. In the extreme case where the follower obtains zero, the traditional NPV criterion is restored as firms fearing preemption will exercise as soon as the NPV is zero. Lambrecht and Perraudin (2003) find, however, that when players face incomplete information the NPV criterion is not restored. Equilibrium strategies under incomplete information are found between the solution of complete information games and the solution for monopolistic exercise.

One of the strongest assumptions in most real option models is that it is the owner of the option who makes the exercise decision. Thus, it is assumed that there are no agency frictions arising from the delegation of the timing decision. To our knowledge, one of the first contributions that incorporates contract theory in the optimal exercise of real options is Grenadier and Wang (2003). They study the effects of moral hazard and adverse selection for an owner with the proprietary right over a given investment who delegates the timing decision to a manager. They show that the underlying option can be decomposed into two basic options: the owner's option and the manager's option. Interestingly, the model predicts, among other things, that investment decisions will display greater inertia than that found in standard real option models. This

[11]Following the definition in the literature of game theory, games of complete information are those where all players' payoffs are common knowledge. In contrast, games with incomplete information are those for which players know their own payoff but they do not know the payoffs of other players.

[12]Situations such as competitive industry equilibrium with many players are beyond our scope in this chapter. The reader is referred to papers by Leahy (1993) and Grenadier (2002)

effect comes from the fact that the manager does not have a full ownership stake in the option payoff.

The marriage between real options and game theory has proven to be challenging. Similarly, the marriage between real options and agency theory is today showing its initial steps. Perhaps we shall have to wait before we see a model that is able to tractably integrate these three important elements in one framework. As discussed previously, competition has the potential to accelerate investment exercises. Contrary to this, agency frictions have the potential to delay investment exercises. Thus, this integration appears to be necessary in order to study interacting effects and to determine which effect finally dominates. It is reasonable to predict that the integration of real options, game theory and contract theory will be a future direction for real options research.

Chapter 2

Corporate Acquisitions as Option Games

The previous chapter introduced the standard tools used in modelling capital budgeting decisions under the real options paradigm. Perhaps the most important lesson from this literature is that the net present value rule is not necessarily a correct criterion when individuals face uncertainty and irreversibility. Even though the real options theory is well developed for investments in general, applications of its lessons to corporate acquisitions are still scarce and empirical tests are to our knowledge non-existent. In this chapter we elaborate on this paradigm to develop a dynamic model for corporate acquisitions.

The strategy literature recognizes that organizational capabilities or *competencies* can be a source of competitive advantage. As such, these capabilities are valuable and potentially transferable across products and industries. Under this intuition, acquisitions can be considered as a mechanism that allows firms to exploit the aforementioned organizational capabilities. Our model is developed under the premise that acquisitions and divestitures are two sides of the same coin from the capital budgeting perspective.

It follows then that lessons from the real options literature apply to corporate acquisitions with the corresponding considerations that account for the special environment under which these decisions are made.

The first issue we address in our model is the effect of uncertainty on acquisition decisions. Intuition from real options suggests that these decisions should be optimally made with delays in relation to the net present value criterion. We then address the effect of strategic interactions between target and bidder. In other words, we try to uncover what factors determine the distribution of gains derived from corporate transfers of control. Finally, we extend the current theoretical literature dealing with dynamic models of acquisitions [Lambrecht (2001) and Morellec (2002)] in several respects. Smit (2001) emphasizes the importance of strategic interactions in corporate acquisitions as firms rarely have monopoly rights over the acquisition of a given target (shared options). In addition, he highlights the importance of *implementation* uncertainty involved in corporate acquisitions. To incorporate these features, we introduce strategic interaction among bidders as well as imperfect information about the synergy gains derived from the acquisition. This last feature gives rise to another notable feature of our model: the divestiture option.

The chapter proceeds as follows. In the next section we present the assumptions underlying our model setup. Sections 2.2 and 2.3 are devoted to describing the acquisition game and presenting the structure of payoffs for players respectively. The equilibrium strategies for our games are presented in section 2.4. The final section summarizes the empirical implications of our model.

2.1 Underlying Setup

This section describes the basic assumptions in our model. We shall use the same notation as that used in the previous chapter. Thus some previous results will be directly used without further explanation.

For simplicity we first assume that managers always act in the best interest of shareholders. We also assume that the objective function of shareholders is to maximize the market value of their stake in the firm[1]. Firms in our model have neither operating nor fixed costs of production. This assumption allows us to eliminate operating options such as firm exits and temporal suspension of activities. Firms are all equity financed, which eliminates the problem of endogenous bankruptcy and under-investment. As usual in these models, time is continuous and indexed by $t \in [0, \infty)$. All firms are risk neutral and discount their cash flows at the constant risk free rate r. The product price of target firms follows an exogenous process as follows[2]:

$$dP_t = P_t \mu dt + P_t \sigma dW \tag{2.1}$$

With W being a one-dimensional standard Brownian motion defined on a filtered probability space $(\Omega, \mathcal{F}, (\mathcal{F}_t)_{t \geq 0}, \mathbb{P})$. Parameters μ and σ are assumed constant. We need to impose the condition $r > \mu$ with $\delta = r - \mu > 0$ defined as the shortfall rate so as to have a convergency in the market value of our firms.

Following the discussion in the previous chapter and our assumptions in this section,

[1]Even though this last assumption might appear redundant, there is an interesting literature on shareholders' unanimity rooted in the potential conflict between value maximization and portfolio maximization for shareholders. The main lesson from the unanimity literature is that value and portfolio maximization are consistent objectives only when product markets are competitive or financial markets are complete, see for example DeAngelo (1981) and Makowski (1983).

[2]Note that under our assumptions, the product price defines the operating profits of target firms.

the market value of the target firm in our model is:

$$V_t(P) = \frac{P_t}{r - \mu} = \frac{P_t}{\delta}$$

The value $V_t(P)$ will be referred as to the firm value under standard management.

2.2 Description of the Acquisition Game

We model a situation where there are two potential bidders for the target firm. These two bidders have the potential to increase the market value of the target firm due to an exogenously given higher managerial ability or organizational capability. The target firm will not be endowed with this enhanced managerial ability, but this firm will represent a good expected match for bidders' organizational capabilities.

We can think of a firm specific shock as the trigger of this relative ability distortion. This shock might be, for example, a regulatory change or technological breakthrough that alters the relative level of ability of firms. For simplicity, this shock is assumed to arrive exogenously at a deterministic time t_0 when the price process is at a level P_0. After this shock has occurred, bidder firms will find themselves with the potential ability to manage the target firm with positive *expected* efficiency gains in relation to the standard firm value. This expected gain might be, for example, due to economies of scope in operations or simply better management, but in general we shall refer to it as expected synergy gains.

For simplicity we assume that the current business owned by the bidders is unrelated to the target's business. It is assumed that bidders' organizational capabilities are firm-specific or a non-tradable asset. Thus, any generated rent accrues entirely to shareholders. In what follows we shall refer to acquisitions as any transaction that involves the complete transfer of ownership of target assets from the target shareholders to the bidder shareholders[3]. In addition, we assume that the acquisition games are played in a setting with perfectly symmetric information among players. Even though this is not important for our modelling, we will assume that external agents (the market) do not know about the deal until the announcement of the acquisition; the moment when the bidder exercises his option to acquire.

As the synergy gains the bidder derives from acquiring a target represent the consolidation of resources of both bidder and target, we assume that bidders face imperfect information about the true synergy gains. Even though bidders know (prior beliefs) the distribution function of synergy gains, the actual realization of efficiency gains will depend on the ex-post match between bidder and target resources. For example, the strategy literature has linked acquisition failures to employee resistance or cultural clashes. Therefore, along with the economic uncertainty given by the price process, bidders in our model will face this *implementation* uncertainty. We need to emphasize that contrary to the economic uncertainty, which is resolved as time passes, the implementation uncertainty is only resolved when bidders actually acquire the target firm.

We assume that bidders have to incur a fixed sunk cost to carry out the acquisition given by A. This sunk cost involves all post-acquisition integration costs. Bidders also have the option to divest the acquired unit should it result in a failed acquisition. Failed acquisitions[4] in the context of our model are those in which ex-post the bidder's capabilities do not match with the target resources. In our setting, failures are not a

[3] Our model thus can be considered as more representative of cash tender offers and asset sales.

[4] We assume that a failed acquisition does not erode the value of the bidder's pre-existing assets (no externalities between different business units)

consequence of agency problems or managerial hubris. Clearly, the market value of an ex-post failed acquisition will be lower than its potential under *standard* management, and therefore, there is the potential for a mutually beneficial transaction and efficiency improvements. If the acquisition is successful, the acquirer will never divest and will be able to keep the derived rent forever[5].

Given that initially we have two bidders with the potential ability to increase the productivity of the target's resources, we assume that, in case of failure, the first acquirer has the option to sell the failed acquisition to the second bidder. If the second bidder fails, he has the option to divest and sell the business unit to a bidder with *standard* ability, but with certainty about the value of the business unit in his hands. As failure by the first bidder might have a positive informational externality for the second bidder, we assume that there is learning by the second bidder regarding the potential value of the acquisition (negative correlation). This means that the expected synergy gains of the second bidder conditional on the failure of the first bidder is higher than his unconditional expected synergy gains.

The negotiation process for any acquisition is assumed to be a dynamic game where the target sets his reservation premium first and then the successful bidder chooses the timing of the acquisition. As there will be more than one active bidder, we allow bidders to compete (if it is profitable to do so) for the target during any bidding process. The game among bidders is played simultaneously and we allow the successful bidder of a given acquisition to arise endogenously. We have to remark that in our model the probability of both bidders acquiring at the same time is zero. This is not an

[5]The assumption of no divestiture in case of successful acquisition is made for simplicity. Competition or changes in the environment can erode and finally eliminate current synergy gains. In principle, our model can accommodate sudden death (Poisson process) or depreciation (exponential decay) in the synergy gains.

arbitrarily imposed condition. This comes from the fact that a target firm facing two identical bids will choose only one bidder[6].

Even though the identity of bidders is not important in our model, for presentational simplicity we denote the successful bidder in the first acquisition as bidder θ and the successful bidder in the second acquisition as bidder λ. Any management team with *standard* ability will be referred to as bidder n. We assume that there is an infinite number of type-n bidders and that, with certainty, the value of the target under their management is the standard[7] $V_t(P) = \frac{P_t}{r-\mu}$. Without loss of generality, we assume that the beliefs about synergy gains are given exogenously by the joint discrete distribution in table 2.1.

Table 2.1: **Joint Probability Distribution of Synergy Gains.**

		Bidder 2		
		λ_G	λ_B	$\mathbb{P}_\theta$
	θ_G	$\mathbb{P}$(G,G)	$\mathbb{P}$(G,B)	$\mathbb{P}_\theta$(G)
Bidder 1	θ_B	$\mathbb{P}$(B,G)	$\mathbb{P}$(B,B)	$\mathbb{P}_\theta$(B)
	$\mathbb{P}_\lambda$	$\mathbb{P}_\lambda$(G)	$\mathbb{P}_\lambda$(B)	1

In table 2.1, synergy gains for bidders are represented by the factors θ_i and λ_i with $i = [G, B]$ that amplify the current market value of the just acquired business unit, where G and B denote good and bad ex-post acquisitions respectively. We define that $\theta_G > 1, \theta_B < 1, \lambda_G > 1$ and $\lambda_B < 1$. A realization θ_G or λ_G after the acquisition implies a good ex-post match between bidder's capabilities and target's resources. Realizations θ_B and λ_B represent bad ex-post marriages. $\mathbb{P}(x, y)$ denotes the joint probability of events x and y, and $\mathbb{P}_\theta$ and $\mathbb{P}_\lambda$ denote the marginal probability distributions of bidder

[6]This is not an immaterial concern in option games played in continuous time with identical players since the probability of simultaneous exercise is normally positive.

[7]This level of ability of type-n bidders is common knowledge.

θ and bidder λ respectively. This distribution is common knowledge for all players. Both initial bidders are assumed to be identical and have positive expected synergy gains with learning among them. Thus, at time t_0 the following conditions are true:

$$\mathbb{E}_{t_0}(\theta\,|\lambda_B) = \mathbb{E}_{t_0}(\lambda\,|\theta_B) > \mathbb{E}_{t_0}(\theta) = \mathbb{E}_{t_0}(\lambda) > 1$$

As our agents are risk neutral, we impose no restriction on higher order moments of these random variables.

The timing of our acquisition game is as follows. Starting in the first stage, nature moves first and defines the state: good (G) or bad (B) match. The true state of nature is unknown to the players until the actual acquisition. The target plays second and determines his reservation premium (Ψ). Bidders move third and define their acquisitions strategies (P^*) in a simultaneous game. Once the acquisition by the first bidder (bidder θ) is consummated, all players learn the true state of nature. If the acquisition results in a good match, the game ends. If the acquisition fails, we start the second stage. Nature moves again and defines the state. In this stage, bidder θ is willing to divest the just acquired firm, which is undervalued, and therefore he becomes the second stage target who negotiates a deal with bidder λ. If this second acquisition results in a good match, the game ends. If the second acquisition fails we start the third and last stage. In this stage the bidder λ is willing to divest and will negotiate the divestiture with any of the n management teams with standard ability. As bidder n has certainty about the value of the business unit for him, there is no chance for a failed acquisition and therefore the game ends.

2.3 Players' Payoffs

The fundamental value of the bidders and the target when the game begins at time t_0 will be given by:

$$V_f^B(P_0^j) = V^B(P_0^j) + F(P_0^i) \quad \text{for bidders}$$

$$V_f^T(P_0^i) = V^T(P_0^i) + F(\Psi) \quad \text{for target}$$

Where P_0 is the level of the price process at time t_0, Ψ is the reservation premium the target demands, $V^p(P_0)$ for $p = [T = target, B = bidder]$ is the market value of assets in place, $F(P_0)$ denotes a compound option of acquisition/divestiture held by the bidder, and $F(\Psi)$ denotes the present value of the acquisition premium held by the target. We impose the condition, that, at the shock time t_0, the option to acquire the target is worth more alive for the bidder. This implies that the optimal acquisition threshold is higher than the current level of the price process P_0. Thus, acquisitions will be profitable only at a time $t > t_0$. Hereafter, we will use only the option values $F(.)$s as the players' payoff since under our assumptions both components of the market value of firms are additive.

Figure 2.1 shows a simple representation of the game between the target and the acquirer, assuming that the acquirer faces no competition in the contest.

In figure 2.1, letters in the circles refer to players: nature (N), target (T), and bidder (B). Letters on the lines refer to actions by players: good match (G) or bad match (B) for Nature, accept (A) or reject (R) the offer for target, and wait (W) or exercise (E) the acquisition option for bidder[8]. The dotted line connecting intermediate nodes in figure 2.1 indicates that neither bidder nor target know the true state of

[8] In our discussion, 'exercise' is synonymous with 'acquire'.

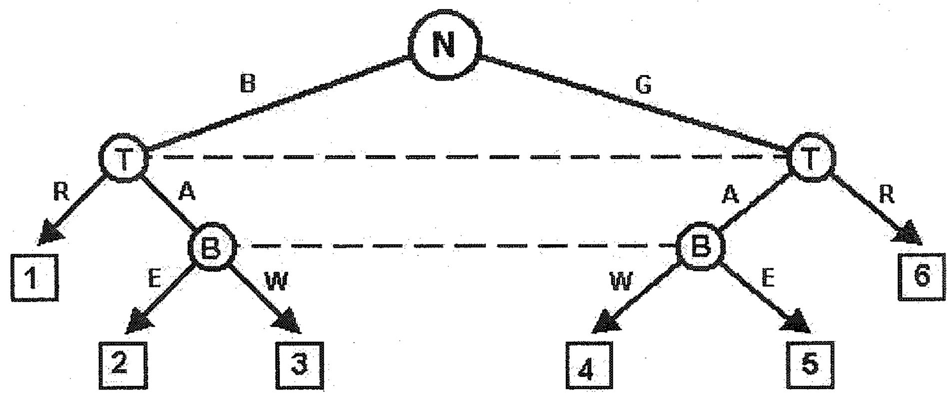

Figure 2.1: Extensive Form of the Game between the Target and the Acquirer.

nature when they move.

As the payoff structure is essentially the same in the three stages of the game, we describe as an example the structure of payoffs for players only in the first stage; the first acquisition. For the first acquisition Nature will chose bad match with probability $\mathbb{P}_\theta(B)$ and good match with probability $\mathbb{P}_\theta(G)$. Assuming that at the optimal acquisition time t^* the price process is P_1, the structure of payoffs for each player at the end of the six nodes for this acquisition will be as shown in table 2.2.

Table 2.2: **Structure of Payoffs for the First Acquisition.**

Node	Description	Target Payoff	Acquirer Payoff
1	Target rejects offer; no transaction	0	0
2	Target accepts offer, bidder acquires	$\Psi_1 V(P_1)$	$V(P_1)[\theta_B - (1+\Psi_1)] - A + F_2(\Psi_2)$
3	Target accepts offer, bidder waits	$F(\Psi_1)$	$F(P_t)$
4	Target accepts offer, bidder waits	$F(\Psi_1)$	$F(P_t)$
5	Target accepts offer, bidder acquires	$\Psi_1 V(P_1)$	$V(P_1)[\theta_G - (1+\Psi_1)] - A$
6	Target rejects offer; no transaction	0	0

The null payoff players receive in nodes 1 and 6 reflects the fact that the transaction will not be realized. In nodes 3 and 4 the bidder's payoff corresponds to option to acquire the target in a future date. Similarly, the payoff for the target in nodes 3 and 4 represents the present value of the premium shareholders will receive in a future transfer of control. The payoffs for the target firm at the acquisition time corresponds to the value of the demanded premium. Bidders will receive a contingent payoff at exercise which depends on the true state of nature. In node 2, the acquisition results in a bad match and the bidder realizes a negative payoff for sure. In node 5, the acquisition results in a good match the bidder realizes a positive payoff.

From table 2.2, it is clear that the target has a dominant strategy, which is to always accept (A) the bidder's offer as long as the bidder is willing to pay a positive premium Ψ_1. The bidder will choose wait (W) as long as the option to acquire is worth more than the intrinsic value of the option, and exercise (E) otherwise. As soon as the bidder decides to exercise the option to acquire, players learn whether they are in nodes 2 or 5.

Thus, assuming that the optimal expected exercise time exists and defining it as $\mathbb{E}_{t_0}(t^*) > t_0$, the expected payoff for both players in the first acquisition at the beginning of the game are given by:

$$\begin{aligned} Bidder &= \mathbb{E}_{t_0}\left[e^{-r(t^*-t_0)}\right]\left[V(P_1)(\mathbb{E}_{t_0}(\theta)-(1+\Psi_1))-A+\mathbb{P}_\theta(B)F_2(\Psi_2)\right] \\ Target &= \mathbb{E}_{t_0}\left[e^{-r(t^*-t_0)}\right]\Psi_1 V(P_1) \end{aligned}$$

We have to remark that the discount factor $\mathbb{E}_{t_0}\left[e^{-r(t^*-t_0)}\right]$ is stochastic since it depends on the time the price process takes to reach the optimal exercise price P_1 when starting at the current level P_0. As the price process is stochastic, the time $t^* - t_0$ is also stochastic. As shown in the previous chapter, for the GBM this discount factor has the form $D(P_0, P_1) = \left(\frac{P_0}{P_1}\right)^\beta$, where β is the elasticity of the discount factor with respect to the optimal price P_1.

Finally, note that the bidder payoff reflects the fact that the divestiture option $F_2(\Psi_2)$ has value for bidder θ conditional on its failure in the acquisition[9]. It is also clear that the target payoff is not conditioned on the true state of nature. This is so because the target's shareholders will not have ownership participation in the firm after the acquisition[10]

2.4 Equilibrium Strategies

Prior to the any acquisition, the action set of targets is $\mathbb{A} = \{Accept, \ Reject\}$. As discussed above, *Accept* will always be a dominant strategy for targets. As targets will not have ownership participation in the firm after the acquisition, their strategy and payoff will not depend on the true state of nature. Given the target's reservation premium, the action set of bidders corresponds to $\mathbb{A} = \{Exercise, \ Wait\}$. If the acquisition is a success, the action set for bidders is $\mathbb{A} = \{Do\, nothing\}$. If the acquisition is a failure, the action set for bidder is $\mathbb{A} = \{Divest, \ Do\, not\, Divest\}$. Given a failure, the dominant strategy for bidders is always *Divest*.

The equilibrium exercise strategies for bidders are derived as the solution to a timing game. We have to notice that the filtration generated by the price process coincides with that of the noise process $W_t\left|_{t\geq 0}\right.$:

$$\mathcal{F}_t^W = \sigma\{W_\tau/\tau \leq t\} = \sigma\{P_\tau/\tau \leq t\} = \mathcal{F}_t^P$$

[9]Notice that Ψ_1 is the premium received by the target in the first acquisition, and that Ψ_2 is the premium the bidder θ will receive in case of divestiture.

[10]It is not difficult to relax the assumption that target shareholders will not have ownership participation after the acquisition. Relaxing this assumption will also make the target's premium contingent on the true state of nature. Intuition suggests that the premium demanded by targets in this case should be smaller as they will be able to participate in the new venture.

Thus, the information structure of the model is based exclusively on observations of the price process (2.1) at time t. Therefore, the exercise strategies for bidders will be Markov strategies corresponding, for player $p \in \{\theta, \lambda, n\}$, to a mapping $S_p : P_t \in [0, \infty) \longrightarrow \mathbb{A}_p$, that indicates when to acquire the target. Given that the strategies are Markov, the proper concept of equilibrium is the Markovian Nash equilibrium.

As is customary in dynamic games, we solve the game by folding back subgames until the beginning of the game.

2.4.1 Third Stage

When arriving at stage three, all players know that bidder θ and λ failed. Given the poor match between bidders' capabilities and the target's resources, all players know that the the target's market value is $\lambda_B \theta_B V(P_t)$ and therefore is *undervalued* in relation to the standard $V(P_t)$. In this stage we have n bidders with standard ability and one target currently owned by firm λ.

The target's problem consists of maximizing the present value of his premium:

$$F_3(\Psi_3) = \sup_{\Psi_3 \in [0,1]} \quad \Psi_3 \lambda_B \theta_B \frac{P_3(\Psi_3)}{\delta} \left(\frac{P_t}{P_3(\Psi_3)} \right)^{\beta} \tag{2.2}$$

Where $P_3(\Psi_3)$ is the bidder n's reaction function, $\left(\frac{P_t}{P_3}\right)^{\beta}$ is the discount factor, and $\beta > 1$ is the positive solution of the fundamental quadratic (1.6).

The bidder's maximization problem is given by the maximization of the value of his acquisition option:

$$F_3(P_3) = \sup_{P_3 \in \mathbb{R}+} C(P_3) P_t^{\beta} \tag{2.3}$$

Where the constant C is chosen so as to maximize the value of the option. As the target is the first player, he will consider in his decision the optimal response of bidder n in deciding the optimal premium. We assume initially that bidder n faces no competition in the contest. Thus, we solve first the bidder's problem, which consists of maximizing:

$$F_3(P_t) = \Big[V(P_3)\big(1 - \lambda_B\theta_B(1+\Psi_3)\big) - A\Big]\left(\frac{P_t}{P_3}\right)^{\beta}$$

With respect to P_3. Taking derivatives and equating to zero, we obtain:

$$\begin{aligned} F_3'(P_t) &= \frac{1-\lambda_B\theta_B(1+\Psi_3)}{\delta}\left(\frac{P_t}{P_3}\right)^{\beta} \\ &\quad - \frac{\beta}{P_3}\left(\frac{P_t}{P_3}\right)^{\beta}\Big[V(P_3)\big(1-\lambda_B\theta_B(1+\Psi_3)\big)-A\Big] = 0 \\ F_3'(P_t) &= \left(\frac{P_t}{P_3}\right)^{\beta}\left[\frac{1-\lambda_B\theta_B(1+\Psi_3)}{\delta} - \frac{\beta}{\delta}\big(1-\lambda_B\theta_B(1+\Psi_3)\big) + \frac{\beta A}{P_3}\right] = 0 \end{aligned}$$

By equating the second factor in the second equation to zero, we can see that optimal response (reaction function) of bidder n assuming no competition and given the target's premium is:

$$P_3^*(\Psi_3) = \left(\frac{\beta}{\beta-1}\right)\frac{A\delta}{1-\lambda_B\theta_B(1+\Psi_3)} \tag{2.4}$$

In this game however we have n bidders with identical (standard) ability. This implies that if any of the n bidders plan to exercise at P_3^*, other bidders might try to exercise a bit earlier and thus preempt other potential bidders. The reason for this is that potential bidders that lose the contest will receive a payoff of zero. Hence any gain greater than zero will be preferred. It is clear thus that P_3^* is not a Nash equilibrium for the bidders' game. The only price consistent with equilibrium is the price at which all n type bidders are indifferent between gaining or losing the contest. In other words, competition will force bidders to exercise when *expected* net present value[11] is exactly zero. This situation is characterized by the condition:

$$F_3(P_t) = \Big[V(P_3)\big(1-\lambda_B\theta_B(1+\Psi_3)\big) - A\Big] = 0$$

[11]Notice that even though bidders in this game have no *implementation* uncertainty, they still face the uncertainty given by the evolution of the price process. This is the reason we talk about expected net present value.

From here, we see that the optimal response of bidder n when facing competition is given by:

$$P_3(\Psi_3) = \frac{A\delta}{1 - \lambda_B\theta_B(1 + \Psi_3)} \tag{2.5}$$

Thus, the option value of bidder n has zero value; there is no value to waiting. This is a direct result of bidder n fearing preemption from any of the other $n - 1$ bidders with equal ability. It is clear from (2.5) that if the target sets a premium too high, he will have to wait longer to realize this premium[12]. Thus the target faces a trade off between a higher premium more heavily discounted and a lower premium which is less discounted.

When the target moves, he will use the reaction function (2.5) in defining his optimal strategy. Thus, his problem is given by the maximization of:

$$F_3(\Psi_3) = [\Psi_3\lambda_B\theta_B V(\Psi_3)]\left(\frac{P_t}{P_3(\Psi_3)}\right)^{\beta}$$

With respect to Ψ_3. To simplify the presentation, we first find some intermediate derivatives:

$$\begin{aligned}
\frac{d}{d\Psi_3}\Big(\Psi_3 V(\Psi_3)\Big) &= V(\Psi_3)\left(\frac{1 - \lambda_B\theta_B}{1 - \lambda_B\theta_B(1 + \Psi_3)}\right) \\
\frac{d}{d\Psi_3}\left(\frac{P_t}{P_3(\Psi_3)}\right)^{\beta} &= \left(\frac{P_t}{P_3}\right)^{\beta}\frac{-\beta\lambda_B\theta_B}{1 - \lambda_B\theta_B(1 + \Psi_3)}
\end{aligned}$$

Using these derivatives to obtain the first order conditions in the target's objective

[12]Observe that $\frac{dP_3}{d\Psi_3} > 0$

function, we obtain:

$$
\begin{aligned}
F_3'(\Psi_3) &= \lambda_B\theta_B V(\Psi_3)\left(\frac{1-\lambda_B\theta_B}{1-\lambda_B\theta_B(1+\Psi_3)}\right)\left(\frac{P_t}{P_3}\right)^{\beta} \\
&\quad - \left(\frac{P_t}{P_3}\right)^{\beta}\frac{\beta\lambda_B\theta_B}{1-\lambda_B\theta_B(1+\Psi_3)}\Psi_3\lambda_B\theta_B V(\Psi_3) = 0 \\
F_3'(\Psi_3) &= \frac{\lambda_B\theta_B V(\Psi_3)\left(\frac{P_t}{P_3}\right)^{\beta}}{1-\lambda_B\theta_B(1+\Psi_3)}\Big[1-\lambda_B\theta_B-\beta\lambda_B\theta_B\Psi_3\Big] = 0
\end{aligned}
$$

By differentiating again, we can see that $F_3''(\Psi_3) < 0$. From this expression, we can deduce that the optimal target's premium is given by:

$$
\Psi_3 = \frac{1}{\beta}\left(\frac{1-\lambda_B\theta_B}{\lambda_B\theta_B}\right) \tag{2.6}
$$

Replacing the optimal premium (2.6) in (2.5) we obtain the exercise price of bidder n:

$$
P_3 = \left(\frac{\beta}{\beta-1}\right)\left(\frac{A\delta}{1-\lambda_B\theta_B}\right) \tag{2.7}
$$

Thus the optimal stopping time for the bidder n is given by:

$$
T_3 = \inf\left[t \geq 0 \;:\; P_t \geq \left(\frac{\beta}{\beta-1}\right)\left(\frac{A\delta}{1-\lambda_B\theta_B}\right)\right] \tag{2.8}
$$

The pair of strategies (2.6) and (2.8) constitutes the Nash Equilibrium for this subgame.

Therefore, the optimal strategy for the firm divesting the business unit is to demand as premium a fraction $\frac{1}{\beta}$ of the relative undervaluation, $\frac{1-\lambda_B\theta_B}{\lambda_B\theta_B}$, of the target firm. As we saw in the previous chapter, $\frac{d\beta}{d\sigma}$ and $\frac{d\beta}{d\mu}$ are negative. It means that, *ceteris paribus*, a higher growth and volatility in the business unit being divested implies a higher seller's reservation premium, Ψ_3. From (2.5) we see that a higher premium means a higher acquisition trigger price. Therefore, divestitures are expected to be faster in industries with low volatility and growth. We see that competition in this scenario with standard-ability bidders forces the bidder to acquire at a time that, although optimal in the context of the game, is earlier than the time that maximizes his payoff. It is clear by comparing the reaction function assuming no competition (2.4) and that assuming competition (2.5). Thus, the n-type bidders bid earlier than they would in the absence of competition by identical firms.

The wealth gains for bidder and target are also easily deduced. For the target, it is simply the premium Ψ_3. It can be obtained by dividing his value function at exercise by the prior acquisition market value of the target, $\lambda_B \theta_B V(P_3)$. We also know that as the equilibrium game for bidder was characterized by preemption and rent equalization, bidder n's expected wealth gain is zero.

Without considering the acquisition cost A, the value gain that the bidder obtains is:

$$\begin{aligned} V(P_3)[1 - \lambda_B \theta_B (1 + \Psi_3)] &= V(P_3) \left[1 - \lambda_B \theta_B - \lambda_B \theta_B \left(\frac{1 - \lambda_B \theta_B}{\beta \lambda_B \theta_B} \right) \right] \\ &= V(P_3) \left[\frac{(1 - \lambda_B \theta_B)(\beta - 1)}{\beta} \right] \end{aligned}$$

It is easily verified that what the bidder obtains in this game is just enough to cover the acquisition cost A. Dividing the last expression by the prior acquisition target's value $\lambda_B \theta_B V(P_3)$, we find that the synergy gain for the bidder as a percentage of target's value conditional on no acquisition is given by:

$$\frac{1 - \lambda_B \theta_B}{\lambda_B \theta_B} \frac{\beta - 1}{\beta}$$

Two deeper issues are worthwhile discussing here. First, it is clear that in this fully competitive scenario for bidders, targets could accelerate divestitures most by choosing a zero premium. The natural question that arises is why are targets willing to induce inertia in the divestiture decision by requiring a positive premium? The simple answer is that this is in the best interest of shareholders. As discussed previously, Dixit et al. (1999) demonstrate that in the case of geometric Brownian motions, the parameter β is the elasticity of the discount factor in relation to the optimal threshold. Thus and even though the acquisition by bidder λ was a failure, he maximizes the value of his divestiture option at the point where an additional dollar of premium is just equal to the marginal cost imposed by the discount factor. In few words, by choosing a *markup* equal to (2.6) the target minimizes the value lost in a failed acquisition.

Second, is there any possibility that the market reacts negatively to this acquisition?; is there a possibility that the bidder gets a negative stock price reaction during the third stage acquisition? Grenadier (2002) analyzes the effects of competition on the likelihood of investment values falling below their initial cost. Through simulation exercises, he shows that this possibility increases dramatically when investors cannot exercise their real options optimally due to competition. It is hardly arguable that the market has better information about the potential gains derived from the acquisition than the insiders, but at the exercise time the market knows that this bidder exercised when the *expected* net present value is zero. In our model, all information about the evolution of the output price is summarized by the current price and no agent can have better information. In reality, however, it is arguable that at the acquisition announcement the market is able to form a better forecast about the future evolution of the industry or the economy in general. Therefore, a sufficient condition for negative stock price reactions for this bidder is that the market forecasts a downturn in output prices, which will render the acquisition a negative net present value investment.

2.4.2 Second Stage

When players arrive at this stage, it is common knowledge that bidder θ failed and is therefore willing to divest the business unit. Bidder λ and bidder n know that the current market value of the firm is lower than what they could achieve. All players know that bidder λ is the one with the highest potential gains. As before, the target and bidder maximization problems are given respectively by:

$$F_2(\Psi_2) = \sup_{\Psi_2 \in [0,1]} \quad \Psi_2 \theta_B \frac{P_2(\Psi_2)}{\delta} \left(\frac{P_t}{P_2(\Psi_2)} \right)^{\beta} \tag{2.9}$$

$$F_2(P_2) = \sup_{P_2 \in \mathbb{R}+} \quad C(P_2) P_t^{\beta} \tag{2.10}$$

As we see, the payoff structure in this game is similar to that in the previous game. Therefore, in our derivations we omit all intermediate steps and present only the final results.

Even though bidder n is already active as a potential bidder, for the moment we will assume that bidder λ faces no preemption threat. Later we will show that bidder n does not participate in this contest. Using similar procedures as those in the previous game, we can show that the reaction function of bidder λ assuming no competition is given by:

$$P_2(\Psi_2) = \left(\frac{\beta}{\beta - 1} \right) \left(\frac{\delta(A - \mathbb{P}(B,B) F_3(\Psi_3))}{\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B(1 + \Psi_2)} \right) \tag{2.11}$$

Using (2.11) and (2.9) we find that the target will demand a premium:

$$\Psi_2 = \frac{1}{\beta} \left(\frac{\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B}{\theta_B} \right) \tag{2.12}$$

Replacing the optimal premium (2.12) in the reaction function of the bidder (2.11), we obtain the acquisition trigger price:

$$P_2 = \left(\frac{\beta}{\beta - 1} \right)^2 \left(\frac{\delta(A - \mathbb{P}(B,B) F_3(\Psi_3))}{\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B} \right) \tag{2.13}$$

So far we have assumed that bidder λ faces no threat of preemption by bidder n. As bidder n obtains zero in the third stage, it is clear that he has the incentive to compete if he can obtain more than zero in this stage. Assuming that the target will set the premium according to the most efficient bidder, a necessary condition for competition is that the bidder n has a positive premium:

$$1 - \theta_B(1 + \Psi_2) > 0 \implies \beta > \frac{\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B}{1 - \theta_B} \tag{2.14}$$

Even though condition (2.14) is a necessary condition for competition, it is not sufficient as the optimal trigger price (2.13) can be lower than that necessary for bidder n to have zero profit. The zero profit price for bidder n is given by:

$$P_2^n = \left(\frac{\delta \beta A}{\beta(1 - \theta_B) - (\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B)} \right) \tag{2.15}$$

For competition in the second stage, the sufficient condition is thus that $P_2^n < P_2$. To examine the behavior of this relation, we compare the ratio of the trigger prices[13] :

$$\frac{P_2}{P_2^n} = \left(\frac{A - \mathbb{P}(B,B)F_3(\Psi_3)}{A} \right) \left(\frac{\beta}{\beta - 1} \right)^2 \left(\frac{1 - \theta_B}{\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B} - \frac{1}{\beta} \right) \tag{2.16}$$

The last term in (2.16) is just the inverse of the necessary condition given in (2.14) and therefore this must be positive for bidder n to compete. The first and second terms are less than one, and greater than one respectively. To prove that P_2 is always less than P_2^n, we will analyze the range of $\beta \in \left(\frac{\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B}{1 - \theta_B}, \infty \right)$, which are the values of β consistent with positive premium for bidder n. It is easy to show that as β tends to the inferior limit of the range, the ratio (2.16) tends to zero. This is because the trigger price (2.15) tends to infinity faster than the trigger price (2.13). The same analysis can be applied to the ratio (2.16) when β tends to infinity. We see that in

[13]In this proof we assume that the sunk cost A is target-specific.

this case the second term tends to one while the other two remains less than one. In conclusion, the ratio (2.16) ranges from zero to a number less than one, and therefore $P_2 < P_2^n$.

As Bidder n does not participate in this contest, the optimal stopping time for bidder λ is thus given by:

$$T_2 = \inf \left[t \geq 0 \, : \, P_t \geq \left(\frac{\beta}{\beta - 1} \right)^2 \left(\frac{\delta(A - \mathbb{P}(B,B)F_3(\Psi_3))}{\mathbb{E}_t(\lambda \,|\theta_B) - \theta_B} \right) \right] \tag{2.17}$$

The premium set by the target in this scenario without threat of preemption for bidder λ is exactly the same as that demanded by the third stage target (2.6). The target thus asks for a premium *assuming* that the bidder will exercise so as to maximize the value of the acquisition option, and therefore, the characteristics of the bidding process do not affect the target's reservation premium. What should be noted here, however, is that competition, as we saw in the previous game, erodes the bidder's expected gains as he is forced to acquire earlier. Thus competition alters the relative distribution of gains between bidder and target.

From (2.13) we see that the divestiture option, $F_3(\Psi_3)$, held by bidder λ reduces the trigger price as it *reduces* the net sunk cost of acquisition. Clearly, the option to divest makes the acquisition less irreversible and thus the bidder will be less reluctant to acquire. This indicates, *ceteris paribus*, that industries with more liquid or more active markets for corporate assets are more likely to experience acquisitions and divestitures. Furthermore, higher expected activity in the market for corporate control will also enhance the value of this divestiture option, accelerating acquisitions.

The absence of competition induces the bidder to acquire later to maximize the value of the acquisition option. The total hysteresis effect in the present game is composed of the effects induced by both bidder and target. This indicates that the net combined wealth gain should be the highest, *ceteris paribus*, when the bidder faces no competition and when the unit being divested is in a high growth and volatility industry. This is true because under these conditions the bidder will exercise when the option to acquire is deeply in the money, and therefore, the combined expected net present value at exercise will be substantially above zero.

It is interesting to analyze the behavior of the bidder's net gains at this stage since here the bidder is able to maximize the value of his acquisition option. The option value for the bidder is characterized as follows:

$$F_2(P_t) = \begin{cases} \frac{A - \mathbb{P}(B,B)F_3(\Psi_3)}{\beta - 1}\left(\frac{P_t}{P_2}\right)^{\beta}, & \text{for } P_t < P_2; \\ V\left(\mathbb{E}_t(\lambda\,|\theta_B) - \theta_B\right)\frac{\beta-1}{\beta} - A + \mathbb{P}(B,B)F_3(\Psi_3), & \text{for } P_t \geq P_2. \end{cases}$$

Using the equation above and (2.12) we can see that the net gains for target and bidder respectively at the announcement are given by:

$$Net\ Gain_{Target} = \frac{1}{\beta}\left(\frac{\mathbb{E}_t(\lambda\,|\theta_B) - \theta_B}{\theta_B}\right) = \Psi_2 \tag{2.18}$$

$$Net\ Gain_{Bidder} = \frac{\beta - 1}{\beta^2}\left(\frac{\mathbb{E}_t(\lambda\,|\theta_B) - \theta_B}{\theta_B}\right) \tag{2.19}$$

These two net expected gain measures are given as a percentage of the target market value conditional on no acquisition, $\theta_B V(P_t)$. In simple terms, (2.18) and (2.19) represent an index of the form $\frac{\mathbb{E}(NPV)}{Invesment}$ at exercise. Thus, assuming that the market is not able to anticipate the acquisition announcement, these expected net gains have the interpretation of cumulative abnormal returns (CARs) at the announcement dates. We have to note however that the bidder's CAR is given in relation to target's market value. Henceforth, this last interpretation will be given to the net expected gains for players.

We see that the target's cumulative abnormal return is a decreasing function of β as $\frac{dCAR_{target}}{d\beta} < 0$. This implies that target's premiums will be higher for acquisitions in more growing and volatile industries. The derivative of the bidder's CAR indicates that this function has a global maximum at $\beta = 2$, where the bidder obtains 25% of the expected increase in value. At $\beta = 2$, the target's CAR corresponds to 50% of the total expected gains. The remaining 25% is equivalent to the sunk costs of acquisition, A, less the value of the divestiture option. The explanation for the behavior of the bidder's CAR is that for low levels of β, the target demands most of the expected gains as premium. On the other hand, for higher values of β the bidder exercises sooner and even though the premium for the target is lower, the acquisition costs A represents a greater portion of the expected increase in value. Finally it is observed from this game that even though the bidder is able to maximize the value of his acquisition option, he will never obtain more than the target does. The ratio of target's CAR to bidder's CAR corresponds to $\frac{\beta}{\beta-1}$, which starts from $+\infty$ when β tends to 1, and tends to 1 when β tends to $+\infty$. Thus, conditional on the acquisition announcement, acquiring firms will obtain the lowest return relative to the target when the target is a high growth and high volatility firm.

2.4.3 First Stage

At the beginning of the game all bidders are active in the market for corporate control. The target is in hands of an n-type firm, and therefore, the only two bidders with potential efficiency improvements are bidders θ and λ. The target and bidder maximization problem are given respectively by:

$$F_1(\Psi_1) = \sup_{\Psi_1 \in [0,1]} \quad \Psi_1 \frac{P_1(\Psi_1)}{\delta} \left(\frac{P_t}{P_1(\Psi_1)} \right)^{\beta} \tag{2.20}$$

$$F_1(P_1) = \sup_{P_1 \in \mathbb{R}+} \quad C(P_1) P_t^{\beta} \tag{2.21}$$

Assuming for the moment that bidder θ faces no competition, his best response given the target's premium is:

$$P_1^M(\Psi_1) = \left(\frac{\beta}{\beta - 1} \right) \left(\frac{\delta (A - \mathbb{P}_\theta(B) F_2(\Psi_2))}{\mathbb{E}_t(\theta) - (1 + \Psi_1)} \right) \tag{2.22}$$

Where $P_1^M(\Psi)$ denotes reaction function assuming that the bidder has a monopolistic right over the acquisition. Given the bidder's reaction function (2.22), the target maximizes his payoff function (2.20) asking for a premium:

$$\Psi_1 = \frac{1}{\beta} \left(\frac{\mathbb{E}_t(\theta) - 1}{1} \right) \tag{2.23}$$

Again the target asks for a premium corresponding to $\frac{1}{\beta}$ of the total expected synergy gains[14]. Replacing the target's premium in (2.22), we obtain the monopoly trigger price for bidder θ as:

$$P_1^M = \left(\frac{\beta}{\beta - 1} \right)^2 \left(\frac{\delta (A - \mathbb{P}_\theta(B) F_2(\Psi_2))}{\mathbb{E}_t(\theta) - 1} \right) \tag{2.24}$$

We impose $A - \mathbb{P}_i(B) F_2^i(\Psi_2) \geq 0$ to avoid arbitrage, and $A - \mathbb{P}_i(B) F_2^i(\Psi_2) > 0$ to introduce irreversibility. If the leader's role were assigned exogenously, this price would the optimal. At this point we are interested in two results. First, given that we have a learning situation between the two bidders, it might be the case that one or both bidders have the incentive to wait and be the second bidder in case the first bidder fails. In the extreme case when both bidders prefer to wait and see, we would

[14]All the the previous discussion about the optimal inertia induced by the target applies here.

not observe acquisitions unless the target is willing to reduce the probability of failure to one or both bidders. Second, given that the leader arises endogenously, we must determine the equilibrium or the optimal strategy of both players.

For any bidder i with $i = [\theta,\ \lambda]$, it will be optimal to compete in the first stage as long as he can get more now than in the second stage:

$$F_1^i(P_t) \geq \mathbb{P}_j(B)F_2^i(P_t)$$

This expression reflects the fact that the acquisition option for bidder i in the second stage has value conditional on bidder j's failure. Further, the right hand side, $\mathbb{P}_j(B)F_2^i(P_t)$, can be interpreted as an additional opportunity cost of the first stage acquisition for bidder i[15]. Hence, if the right hand side is always greater than the left hand side, bidder i will prefer to be the second mover. Otherwise, he will prefer to compete in the first stage. At the break-even price, denoted by P_1, we must have:

$$V(P_1)\big(\mathbb{E}_t(i) - 1\big)\frac{\beta - 1}{\beta} - A + \mathbb{P}_i(B)F_2^i(\Psi_2) = \mathbb{P}_j(B)F_2^i(P_1) \tag{2.25}$$

The first term in the left hand side of (2.25) represents the gross synergy value for bidder i in the first stage, and results from subtracting the value premium for the target, $\frac{V(P_1)(\mathbb{E}_t(i)-1)}{\beta}$, from the expected synergy value, $V(P_1)(\mathbb{E}_t(i) - 1)$. Given the assumption of symmetry between bidders, we know that $F_2^i(P_1)$ will be exercised at the same price no matter who is the successful bidder, and therefore $F_2^i(\Psi_2)$ and $F_2^i(P_1)$ are perfectly comparable without discounting. Further, the premium set by the target in this first stage will be the same for both bidders.

[15]This additional opportunity cost might be given by a *second chance* as in this case, but it also can be interpreted as positive information spillovers from the first bidder to subsequent bidders in the industry. Clearly, positive externality from *first* movers to second movers such as a better estimate of expected synergy gains might impose an additional opportunity cost to the first bidder, inducing delay.

We have to realize that if P_1 were greater than P_1^M, player i would prefer to acquire in the second stage. For competition in the first stage, we need $P_1 < P_1^M$. In principle as both bidders are identical (symmetrical strategies), the equilibrium must be given by preemption or by a war of attrition depending on the strength of the first or second mover advantage respectively. Rearranging (2.25) and (2.24) conveniently and using our notation, we have for bidder θ:

$$V(P_1)(\mathbb{E}_t(\theta) - 1) = \left(\frac{\beta}{\beta - 1}\right)\left[A - \mathbb{P}_\theta(B)F_2^\theta(\Psi_2) + \mathbb{P}_\lambda(B)F_2^\theta(P_1)\right]$$
$$V(P_1^M)(\mathbb{E}_t(\theta) - 1) = \left(\frac{\beta}{\beta - 1}\right)^2\left[A - \mathbb{P}_\theta(B)F_2^\theta(\Psi_2)\right]$$

From these equations we know that if the first one is greater (smaller) than the second one, then $P_1 > P_1^M (P_1 < P_1^M)$. It is observed that the strategy followed in the previous game of analyzing the limits of the ratio of the two prices for different limits of β is not convenient here. In this case, $F_2^\theta(\Psi_2)$ and $F_2^\theta(P_1)$ are compound options that depend on β through the optimal exercise price P_2. Thus, our strategy to analyze the behavior of the two prices will be done by construction.

Subtracting the second from the first equation and after some manipulation, we obtain:

$$\left(P_1^M - P_1\right)\left(\frac{\mathbb{E}_t(\theta) - 1}{\delta}\right) = \left(\frac{\beta}{\beta - 1}\right)\left[\frac{A - \mathbb{P}_\theta(B)F_2^\theta(\Psi_2)}{\beta - 1} - \mathbb{P}_\lambda(B)F_2^\theta(P_1)\right] \quad (2.26)$$

The first factor on the right hand side of (2.26) is always greater than one by definition, and therefore, the sign of the difference is determined exclusively by the second factor on the right hand side. We also know that $A - \mathbb{P}_\theta(B)F_2^\theta(\Psi_2)$ is greater than zero by assumption[16]. It is easy to see that (2.26) has the unique root at

[16]This assumption was imposed because otherwise we would not have irreversibility in the acquisition.

$\beta = \frac{A - \mathbb{P}_\theta(B) F_2^\theta(\Psi_2)}{\mathbb{P}_\lambda(B) F_2^\theta(P_1)} + 1$. We will call this expression β^U, which will denote the upper limit of β that makes the sign change from positive to negative in (2.26). As we see here, β^U is always greater than 1, and therefore, there will always be a set of parameters consistent with $\beta > \beta^U$ or $\beta < \beta^U$ for a given game.

Interestingly, no matter what the actual value of P_1^M is, both bidders will always want to exercise at P_1, where both are indifferent between being the first or the second mover. However, the strategies for $\beta > \beta^U$ and $\beta < \beta^U$ are different. In the former case, we know that $P_1^M < P_1$ for all parameter values, and therefore, both bidders will want to be the follower (the bidder in the second acquisition). In this interesting case, no acquisition will take place as bidders have the incentive to wait indefinitely. On the other hand, for the case where $\beta < \beta^U$ we know that $P_1^M > P_1$, and thus both bidders will want to exercise *earlier* than they would in the absence of a second bidder. It is clear that if bidder i plans to exercise at P_1^M, bidder j will try to exercise at $t - dt$. As bidder i knows it, he will try to exercise at $t - 2dt$ and so on.

It should be noted that for a given acquisition, β^U will probably be large as $\mathbb{P}_\lambda(B) F_2^\theta(P_1)$ is expected to be small in relation to the numerator of β^U. This in fact makes it very unlikely that $\beta > \beta^U$. This situation would be observed only in acquisitions of targets in industries with very low growth and also low volatility. Thus, competition is the most likely outcome, but it is not the only possible one.

From this argument, we can deduce that the only trigger price consistent with equilibrium is P_1, at which both bidders are indifferent between being the first or the second bidder. As both bidders are identical, they will have symmetrical strategies. This implies that there is always rent equalization in equilibrium. For the former case discussed above, we will have a war of attrition, and for the latter a preemption situation.

Formalizing the strategy for bidder θ, we have:

$$T_1 = \inf \left[t \geq 0 \ : \ P_t \geq \left(\frac{\beta}{\beta - 1} \right) \frac{\delta\big[A - \mathbb{P}_\theta(B) F_2^\theta(\Psi_2) + \mathbb{P}_\lambda(B) F_2^\theta(P_1)\big]}{\mathbb{E}_t(\theta) - 1} \right] \tag{2.27}$$

From this strategy, we see that the divestiture option accelerates acquisition. Contrary to the conventional wisdom and our previous results in game three, the presence of a second bidder might also delay (indefinitely) the acquisition relative to the case with no competition. Our findings in the two previous games indicate that acquisitions will be less likely, ceteris paribus, in industries with high growth and volatility. Given the negative relation between β, and μ and σ, this type of industry is, however, one for which the actual β is more likely to be less than the measure we define as β^U in this game. Thus, competition for high growth and volatility industries will probably accelerate acquisitions. On the other hand, industries with low growth and volatility are more likely to have $\beta > \beta^U$, and therefore, there will be some, potentially infinite, delay in relation to the optimal time in these industries when there is more than one potential bidder for the target.

The acquisition option in this case for bidder θ is represented as:

$$F_1(P_t) = \begin{cases} \mathbb{P}_\lambda(B) F_2^\theta(P_t) \left(\frac{P_t}{P_1} \right)^\beta, & \text{for } P_t < P_1; \\ V\big(\mathbb{E}_t(\theta) - 1\big) \frac{\beta - 1}{\beta} - A + \mathbb{P}_\theta(B) F_2^\theta(\Psi_2), & \text{for } P_t \geq P_1. \end{cases}$$

The cumulative abnormal returns for the players in this stage are given by:

$$CAR_{Target} = \frac{1}{\beta} \left(\mathbb{E}_t(\theta) - 1 \right) = \Psi_1 \tag{2.28}$$

$$CAR_{Bidder} = \frac{\mathbb{P}_\theta(B) F_2^\lambda(P_1)}{V(P_1)} \tag{2.29}$$

Even though learning is not necessarily the only source of the second mover advantage in this game, we see that the higher the learning, the higher $F_2^\lambda(P_1)$, and therefore, the higher the bidder θ's CAR at the announcement. By the same token, a higher unconditional probability of failure of bidder θ implies a higher CAR for bidder θ. This result might appear counterintuitive, but this has a logical explanation. A higher probability of failure for bidder θ increases the ex-ante payoff of the second bidder, and thus, increases the trigger price at which the acquisition option is exercised.

One important parameter that determines whether or not firms strategically over delay their acquisitions is $\beta^U = \frac{A - \mathbb{P}_\theta(B)F_2^\theta(\Psi_2)}{\mathbb{P}_\lambda(B)F_2^\theta(P_1)} + 1$. An action that might actually accelerate acquisitions is an intervention by the target firm that could eventually reduce the probability of failure for one or both bidders. Reducing $\mathbb{P}_\theta(B)$ or $\mathbb{P}_\lambda(B)$ in β^U will increase the value of β^U. This action by the target can turn an attrition situation, where delay is potentially infinite, into a preemptive game. We have to note that the target has a strong incentive to intervene when competition between bidders results in an attrition situation. This is so because if both bidders are willing to wait indefinitely due to a second mover advantage, the transaction will never take place and the target will not receive the acquisition premium. Thus, our model rationalizes target interventions through, for example, better access to its private information. This effort by the target might help bidders to reach better estimation of potential synergies or reduce the probability of failure, making more likely to have a preemptive situation between bidders.

An important finding in this game and in the two previous games is that competition forces firms to exercise the acquisition options at a price different from the one that maximizes the value of the acquisition option. Hence, the model might rationalize *strategic* acquisitions or alliances. Even though there might not be synergy gains if bidder θ and bidder λ merge, but for example, by doing so, they could exercise their acquisition option at its maximum value as they would now face no competition. Thus far we have assumed non-cooperative behavior, but if we assume that bidders can agree on how to split the gains from the acquisition, both would be better off by forming a joint venture, strategic alliances or simply by merging as this would also allow them to improve the timing of exercise[17].

A final remark that emerges from this game is that even though there is competition, an acquirer with higher-than-normal ability should experience positive excess returns during acquisitions. Competition amongst these bidders reduces but does not eliminates gains.

2.5 Empirical Implications

In the proposed model, acquisitions and divestitures are modelled as the same phenomenon seen from two different perspectives. Henceforth, acquisitions and divestitures will be referred to as acquisitions.

Table 2.3 summarizes our previous equilibrium strategies. We have to remark that even though the game was set as a sequential game from acquisition 1 to acquisition 3, the game is generalizable to richer settings. For example, triggers in the first column of table 2.3 might represent the strategies of one bidder facing three potential acquisitions in three different industries.

Thus, our analysis henceforth will treat the three games as independent. An additional reason for treating the three games as independent is that, for modelling purposes, we assumed no time lags between the acquisition and the realization of synergy

[17]It is not difficult to calculate the optimal trigger from the social point of view, but we only concentrate here on private benefits of acquisitions.

Table 2.3: **Summary of Equilibrium Strategies.**

	Trigger Price	Bidder CAR	Target CAR
Game 1	$P_1 = \left(\frac{\beta}{\beta-1}\right)\left[\frac{\delta\left(A-\mathbb{P}_\theta(B)F_2^\theta(\Psi_2)+\mathbb{P}_\lambda(B)F_2^\theta(P_1)\right)}{\mathbb{E}_t(\theta)-1}\right]$	$\frac{\mathbb{P}_\theta(B)F_2^\lambda(P_1)}{V(P_1)}$	$\frac{1}{\beta}\left(\frac{\mathbb{E}_t(\theta)-1}{1}\right)$
Game 2	$P_2 = \left(\frac{\beta}{\beta-1}\right)^2\left[\frac{\delta\left(A-\mathbb{P}(B,B)F_3(\Psi_3)\right)}{\mathbb{E}_t(\lambda\,\|\theta_B)-\theta_B}\right]$	$\frac{\beta-1}{\beta^2}\left(\frac{\mathbb{E}_t(\lambda\,\|\theta_B)-\theta_B}{\theta_B}\right)$	$\frac{1}{\beta}\left(\frac{\mathbb{E}_t(\lambda\,\|\theta_B)-\theta_B}{\theta_B}\right)$
Game 3	$P_3 = \left(\frac{\beta}{\beta-1}\right)\left[\frac{A\delta}{1-\lambda_B\theta_B}\right]$	0	$\frac{1}{\beta}\left(\frac{1-\lambda_B\theta_B}{\lambda_B\theta_B}\right)$

gains. Clearly this assumption is unrealistic, and meaningful inferences about timing between acquisition and divestiture in case of failure is strongly dependent on this time lag. What we will take advantage of, however, is the different conditions under which each game is played.

2.5.1 Timing of Acquisitions

A first implication from the model is that acquisitions should occur when the market value of the target firm undergoes a positive trend. Furthermore, assuming homogeneity among firms within industries, acquisitions will be sequential for a particular industry, from the most profitable to the less profitable one. Acquisition profitability is directly related to bidder ability and target undervaluation, and inversely related to the *indirect* net cost of acquisition[18]. Under rational expectations, the fact that acquisitions occur sequentially in our model implies that after a long quiet period of acquisition activity or an industry shock, the first acquisition might signal to the mar-

[18]In what follows we shall continue referring to this net indirect cost of acquisition. In general, it will be defined as bidder's integration effort (A) - value of divestiture option + any additional acquisition opportunity cost (as in game 1). By definition, this net cost must be positive, otherwise acquisitions would be fully reversible. Thus, net indirect cost of acquisition will be synonymous with net sunk cost.

ket that more acquisitions in the industry are coming. Interestingly, it suggests that there might be a pattern of serial correlation in observed target's CARs for sequential acquisitions within industries.

Higher long term growth prospects and volatility in an industry with potential targets positively affect the level of optimal trigger prices.

Table 2.4: **Numerical Exercise for Timing of Acquisitions.**
This numerical exercise shows the trigger price in game 3 for different values of μ, σ and β. As a contrast, Marshallian trigger is also shown. Base case values: $r = 10\%, A = 1, \theta_B = \lambda_B = 0.8$.

Target σ		0.05			0.15			0.25	
Target μ	0.02	0.05	0.09	0.02	0.05	0.09	0.02	0.05	0.09
Target β	4.17	1.95	1.11	2.62	1.72	1.10	1.98	1.51	1.08
Trigger Price	0.292	0.285	0.282	0.360	0.332	0.312	0.449	0.409	0.372
Marshallian Trigger	0.222	0.139	0.028	0.222	0.139	0.028	0.222	0.139	0.028
Trigger/Mashallian	1.315	2.049	10.139	1.618	2.387	11.235	2.023	2.946	13.377

Table 2.4 shows the trigger prices in game three[19] for different values of μ and σ. These values are computed based on formulas in table 2.3. Clearly, the trigger is higher for higher values of volatility. The influence of μ is less clear as it appears that higher μ decreases the trigger price. This last effect is misleading though. Given a fixed value of r at 10%, an increase in μ will also decrease $\delta = r - \mu$. Thus a change in μ affects both the trigger price and the Mashallian price. Hence, the net effect of an increase in μ must be seen in the ratio of the trigger price to the Marshallian price. This ratio is clearly increasing in μ.

Shocks in industry variables that reduce the net indirect cost of acquisition, might provoke several acquisitions at the same time. In terms of our model, an unexpected

[19] A complete numerical exercise for the games is practically impossible. For example, for game one, it is impossible to estimate the trigger price without knowing the triggers of games two and three. There are several compound options that make a numerical or graphical analysis infeasible.

reduction in A (or an unexpected increase in the value of the divestiture option) might take several bidders to their acquisition regions, and in general, will accelerate remaining acquisitions. As examples of these shocks we can mention, for example, industry deregulation, financial innovations, regulatory changes, etc.

Targets with a good secondary market for its assets will be acquired earlier than targets with a poorer secondary market for its assets. Also, under rational expectations, high expected activity in the market for corporate control in a particular industry will accelerate latent acquisitions in that industry. These two effects can be seen as factors enhancing the value of the divestiture option in our model, which reduces the net sunk cost of acquisition.

2.5.2 CARs and Distribution of Gains

In this section we will maintain our assumption that the market becomes aware of the acquisition only when the acquisition is actually announced. Thus, in our analysis cumulative abnormal returns will be synonymous with expected net wealth gains for target and bidder. Nonetheless empirical implementation of these predictions requires a careful methodological design since if acquisitions are indeed sequential as our model suggests, then the market will probably anticipate most of the expected gains for late acquisitions.

From table 2.3 we see that, according to our model, the premium received by target firms will be positively related to the growth and volatility of their assets' market values. Further, the target's CAR is positively related to its own undervaluation and level of bidder ability. *Perceived* or actual competition in a control contest will accelerate the exercise, and therefore, will reduce bidder CAR at the announcement.

Interestingly, in our model, the target's CAR is not affected by competition as it always asks for a markup equal to a fixed percentage of the total expected synergy gains.

In terms of the the bidder's CAR, the model does not give clear predictions as the net wealth gain for bidders will strongly depend on the level of competition in the contest. Even in game 2, where there is no competition, we saw that the the bidders' CAR strongly depends on the relative importance of the net sunk cost. This last feature induces a nonlinear relation between bidder's CAR, and target's growth and volatility.

In the absence of competition in control contests, the combined CAR is positively related to the target's undervaluation and the bidder's level of ability due to their positive effect in the *total* expected synergy gains. In addition, given a fixed level of total expected synergy, the combined CAR will be positively related to the target's expected growth and volatility. This effect comes from the fact that the bidder will wait longer to exercise in industries with high long term growth and volatility. Thus, as the bidder waits longer, the net sunk cost of acquisition will represent a smaller portion of the value of the expected synergies at exercise[20].

In terms of the relative gains for bidder and targets, the model indicates that the ratio of bidder's to target's CAR will be decreasing in growth and volatility of target's industry when there is no competition in the contest. In other words, the higher μ and σ, the higher the asymmetry in the distribution of gains. Competition induces an even stronger asymmetry in the distribution of gains as it only affects the bidder's CAR. Table 2.5 presents a numerical exercise for game two and three that shows the

[20]It is worth noting at this point that the combined wealth effect will correspond to the net wealth gains for both bidders and target; combined wealth effect=total expected synergies-net indirect cost of acquisition.

CARs for bidders and targets for different values of volatility and growth.

Table 2.5: **Numerical Exercise for Cumulative Abnormal Returns.**
This numerical exercise is based on our equilibrium strategies. Values in the top of the table represent the instantaneous volatility and growth of target assets. β is the solution of the fundamental quadratic (1.6). Base case values are: $r = 10\%, A = 1, \theta_B = \lambda_B = 0.8, \mathbb{E}_t(\lambda \,|\theta_B) = 1.22$.

Target Volatility (σ)			0.05			0.15			0.25	
Target Growth (μ)		0.02	0.05	0.09	0.02	0.05	0.09	0.02	0.05	0.09
Disc. Factor Elast. (β)		4.17	1.95	1.11	2.62	1.72	1.10	1.98	1.51	1.08
	Total Synergy	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
Game 3	Target CAR	0.135	0.288	0.507	0.215	0.327	0.512	0.284	0.372	0.521
	Bidder CAR	0	0	0	0	0	0	0	0	0
	Total Synergy	0.525	0.525	0.525	0.525	0.525	0.525	0.525	0.525	0.525
Game 2	Target CAR	0.126	0.269	0.473	0.201	0.305	0.478	0.265	0.347	0.486
	Bidder CAR	0.096	0.131	0.047	0.124	0.128	0.043	0.131	0.118	0.036

The net sunk cost of acquisition affects the trigger price, but it affects neither the combined wealth effects nor the distribution of gains between bidder and target. The reason for this is that the ratio of the exercise trigger to the Marshallian trigger (zero-NPV price) is not affected by changes in the net sunk cost. Our theoretical model was developed under the assumption that the initial price P_0 is such that $P_0 < P_i$ for $i \in [1, 2, 3]$. The fact that the net indirect cost of acquisition is not related to the combined CAR or its distribution among players implies that shocks in industries will not affect CARs at the announcements[21]. The same analysis indicates that $\delta = r - \mu$ does not affect the wealth effects as long as changes in δ are exogenous (not due to changes in μ).

[21]This effect is more a conjecture than a strong statement since it might be a consequence of the geometry of the model.

2.5.3 Probability and Expected Time for Acquisitions

Two additional issues related to the timing of acquisitions represent natural extensions to the model. The first is related to the likelihood of acquisitions. As the price process in our model is stochastic, more specifically a GBM, the time between today and the time the process hits the trigger price (acquisition point) for the first time is also stochastic. Let us define this time as $\tau = \inf\left[t \geq 0 : P_t \geq P^*, P_{today} = P_0\right]$. Then the probability of acquisition in a period of time t is equivalent to the one-sided first passage time and is defined as $\mathbb{P}(\tau \leq t)$. This conditional density function is developed in Harrison (1985, p.11-14) and Ingersoll (1987, p.353-354) for Aritmetic Brownian motions. With a change in variables for the Geometric Brownian Motion, we obtain[22].:

$$\mathbb{P}(\tau \leq t) = \Phi\left(\frac{-ln\left(\frac{P^*}{P_0}\right) + (\mu - 0.5\sigma^2)t}{\sigma\sqrt{t}}\right) + \left(\frac{P^*}{P_0}\right)^{\frac{2\mu-\sigma^2}{\sigma^2}} \Phi\left(\frac{-ln\left(\frac{P^*}{P_0}\right) - (\mu - 0.5\sigma^2)t}{\sigma\sqrt{t}}\right) \tag{2.30}$$

Where $\Phi(.)$ is the normal cdf. Without much analysis we can see that factors, other than volatility and growth, that increase the trigger price will reduce the likelihood of acquisition. In this sense, we can bring all our previous conclusions about the timing of acquisitions to the analysis of the likelihood of acquisition.

What is different about volatility and growth is that they affect the likelihood of acquisition not only through P^* but also through their explicit appearance in the cumulative distribution function (2.30). At first sight, it is very difficult to argue about the relationship between volatility and growth, and the likelihood of acquisition. Table 2.6 shows estimates for equation (2.30) in game three.

In this table, we see that the likelihood of acquisition is positively related to the

[22]This expression is used in Grenadier (1996) and Sarkar (2000)

Table 2.6: **Probabilities and Expected Times for Acquisitions.**
This table shows two results in the framework of game 3: the probability of acquisition before time t and the expected time until the acquisition. The probability $\mathbb{P}(\tau \leq t)$ is calculated with equation (2.30). The expected time $\mathbb{E}(\tau)$ is calculated using equation (2.31). Base case values: $r = 10\%, A = 1, \theta_B = \lambda_B = 0.8$. The initial price is set at $P_0 = 26.5$.

Target σ		0.05			0.15	
Target μ	0.02	0.05	0.09	0.02	0.05	0.09
Trigger Price	0.292	0.285	0.282	0.360	0.332	0.312
Expected Time in Years	5.22	1.46	0.69	34.88	5.78	2.08
Probability of Acquisition in:						
6 Months	1.1%	14.8%	43%	0.5%	5%	28.8%
1 Year	9.9%	45.9%	81.6%	4.7%	19.5%	45.3%
2 Years	31.7%	78.2%	97.9%	16.9%	41.3%	69.3%

target's growth and negatively related to the target's volatility. The rationale for the negative relationship between volatility and the likelihood of acquisition is that higher volatility increases the value of waiting. In other words, higher volatility implies a higher option value, and therefore, a higher opportunity cost of acquiring, which would make bidders more reluctant to acquire. A similar explanation for the effect of μ on the probability of acquisition can be made. An increase in μ has two opposing effects: first, it reduces the shortfall rate or dividend yield, $\delta = r - \mu$, which reduces the opportunity cost of not exercising the acquisition option. Second, a higher μ will accelerate the process's arrival at a given trigger price. This second effect dominates the first, and thus, bidders are more likely to acquire.

A second natural extension from the model is related to the timing between acquisitions. If acquisitions in a given industry are indeed sequential, then we can use the moments of the first time passage time distribution to define the factors that explain these time lengths. Ingersoll (1987, p.354) presents the formula for the expected time that an Arithmetic Brownian Motion takes to reach the trigger price, P^*, given its current level P_0, with $P_0 < P^*$. With the suitable change in variables for the GBM, and provided that $\mu - 0.5\sigma^2 > 0$, the expected time (equation 41 in Ingersoll) can be expressed as[23]:

$$\mathbb{E}(\tau) = \left(\frac{1}{\mu - 0.5\sigma^2}\right) ln\left(\frac{P^*}{P_0}\right) \tag{2.31}$$

Table 2.6 shows estimates for this expected time in game three. Suppose that after a long quiet period of acquisition activity in a specific industry, we observe $n+1$ acquisitions at times $T_1, T_2, \ldots, T_{n+1}$, with $T_1 < T_2 < \ldots < T_{n+1}$. Suppose for simplicity that targets are relatively homogenous in terms of δ, μ and σ within this industry. From these acquisition exercises, we can infer from our model that $P_1^* < P_2^* < \ldots < P_{n+1}^*$. Let us define the time between acquisitions or *durations* as $\tau_1 = T_2 - T_1, \tau_2 = T_3 - T_2, \ldots, \tau_n = T_{n+1} - T_n$. Applying equation (2.31) to these exercise prices, we can define that the timing between acquisitions is given by:

$$\mathbb{E}(\tau_i) = \left(\frac{1}{\mu - 0.5\sigma^2}\right) ln\left(\frac{P_{i+1}^*}{P_i^*}\right) \tag{2.32}$$

In this setup and under our assumption of homogeneity, we can state that the time between acquisitions is a function of μ, σ and $ln\left(\frac{P_{i+1}^*}{P_i^*}\right)$. Therefore, durations will be positive related to σ and negatively related to μ across industries. In addition, this time interval will be a function of variables affecting the ratio of trigger prices for two consecutive acquisitions. For example, in game 1 the ratio of trigger prices is given by:

$$ln\left(\frac{P_{i+1}^*}{P_i^*}\right) = ln\left[\frac{\left(A_{i+1} - \mathbb{P}_{i+1}(B,B)F_{i+1}(\Psi)\right)}{\left(A_i - \mathbb{P}_i(B,B)F_i(\Psi)\right)} \frac{\mathbb{E}_t(\lambda_i \,|\theta_{B,i}) - \theta_{B,i}}{\mathbb{E}_t(\lambda_{i+1} \,|\theta_{B,i+1}) - \theta_{B,i+1}}\right] \tag{2.33}$$

In (2.33) we have used the assumption that μ, σ and δ are identical for both targets, and the assumption that both consecutive bidder face the same competitive conditions

[23]This expression is used in Mauer and Ott (1995) An aditional treatment of the first time passage time distribution for GBM and its moments is found in Rhys et al. (2002).

in the contest. Clearly these two assumptions can be relaxed in empirical research. Even in this very restrictive setting, we can obtain some interesting predictions. Given two consecutive acquisitions i and $i+1$ (called first and second for simplicity), the timing between them, $\tau_i = T_{i+1} - T_i$ will be:

1. Positively related to the undervaluation of the target in the first acquisition and negatively related to the undervaluation of the target in the second acquisition.
2. Positively related to bidder's ability in the first acquisition and negatively related to the bidder's ability in the second acquisition.
3. Positively related to bidder's integration effort in the second acquisition, A_{i+1}, and negatively related to bidder's integration effort in the first acquisition, A_i.
4. Negatively related to the value of the divestiture option for the bidder in the second acquisition and positively related to the value of the divestiture option for the bidder in the first acquisition.

2.6 Final Remarks

The model presented in this chapter proposes some new insights about how acquisitions and divestitures might be affected by the optimal decision making of individuals under uncertainty, irreversibility and strategic interactions. The model presents a new set of testable hypotheses in relation to likelihood and timing of acquisitions and divestitures, and abnormal returns at the announcement dates.

Even though a model must be scrutinized based on its empirical support, it is perhaps necessary to justify at this point our modelling choice. First, dealing with stock offers necessarily requires the incorporation of asymmetric information and thus the adverse selection problem among bidder, target and outsiders. Thus, our model deals only with cash offers. Second, one important element left out is the free rider problem proposed by Grossman and Hart (1980). We believe that acquirers paying the target's reservation premium mitigates to some extent this limitation and at the same time is a reasonable approximation to reality. For example, findings in La Porta et al. (1999) indicate that most firms around the world can be characterized by the existence of a dominant controlling group of shareholders. When this is the case, it is reasonable to argue that no takeover can take place without the consent of the controlling party. Therefore, the model perhaps reflects a suitable setting for takeovers in most countries.

Finally, most explanations about acquisition findings rest on the agency or managerial hubris theories. What we intended in this chapter is to provide a new perspective for the same problem. Thus, we deliberately left out the potential moral hazard problem between shareholders and managers when the ownership is diffused. In this sense, our model by no mean is a substitute of agency and hubris hypotheses, but it can be considered as an alternative hypothesis.

Chapter 3

Revisiting the Evidence on Takeovers

The literature of takeovers is vast and abundant, and our objective in this chapter is not to discuss this literature in detail rather it is to revisit some stylized facts revealed in the empirical literature from the perspectives derived in our model. Issues such as the source of abnormal returns during acquisition and divestiture announcements, distribution of gains among involved agents, and timing and likelihood of these events will be our major focus.

In the framework of our model, the source of abnormal returns during acquisition announcements is a manifestation of the hysteresis effect induced by agents' optimal decision making under uncertainty. The distribution of gains is the result of strategic interactions between buyer and seller. Potential failed acquisitions might occur as a consequence of imperfect information about the true gains derived from corporate takeovers. In re-examining the empirical evidence, we will mention the authors conclusions and inevitably, we will touch upon issues such as corporate governance in this review. It is important to say at this point that agency is surely an important issue in corporate finance, and our intention is certainly not to diminish its importance. More modestly, we intend to discuss an alternative hypothesis that has not been explored in the empirical literature of corporate takeovers. We expect this discussion not only to connect our model with extant evidence but also to open avenues for future research.

This chapter starts with a review of the evidence on stock price reactions at acquisition and divestiture announcements and how it can be related to our model's predictions. The second and final section is intended to relate our model's predictions in terms of acquisitions timing and the available empirical evidence. In this sense, a substantial part of this section is devoted to a discussion of the diversification discount.

3.1 CARs and Distribution of Gains

Evidence based on stock price reactions at the announcement dates strongly indicates that, on average, acquisitions are expected to create wealth for shareholders. This literature also shows that while bidders earn on average zero or negative abnormal returns during acquisition announcements, targets obtain positive excess returns [Jensen and Ruback (1983); Jarrell et al. (1988); and Andrade et al. (2001)]. On one hand, the managerial hubris hypothesis proposed by Roll (1986) predicts that acquisition announcements should have a zero combined abnormal return, as acquisitions would be only a transfer of wealth from the bidder's shareholders to the target's shareholders. The free cash flow hypothesis proposed by Jensen (1986) predicts, on the other hand, that the combined abnormal return should be negative as managers, instead of paying out the excess cash, use it to invest in negative net present value projects. Perhaps these two hypotheses have a great deal of importance in explaining some corporate failures, but the general evidence finding that transfers of control generate a combined positive abnormal return, on average, suggests that these hypotheses are not a complete explanation of the average corporate transaction.

Asset sales[1] are also events that, on average, have positive combined abnormal returns [Alexander et al. (1984); Jain (1985); Hite et al. (1987); and Mulherin and Boone (2000)]. This finding is interpreted in most of the literature as evidence that acquisitions and especially diversifying ones destroy value. Two hypotheses, which are not inconsistent with our model, have been proposed to explain the combined abnormal returns during divestitures. The fit hypothesis predicts a higher combined stock price reaction when the buyer has a comparative advantage in managing the asset being sold. The focus hypothesis predicts higher returns when the asset being sold is not related to seller's core business. John and Ofek (1995) find evidence supporting both hypotheses. Nevertheless, these hypotheses are silent when it comes to explaining the timing of the divestiture decision, the focus of our model. In other words, these hypotheses do not explain why some firms are willing to wait more, implying larger abnormal returns at the announcement, before divesting a value-destroying unit.

Based on our model rationale, we advance an alternative hypothesis that might help explain the timing, and therefore, the source of abnormal returns during acquisition and divestiture announcements. In considering acquisitions as any other capital budgeting decision, positive combined abnormal returns at announcements implies that these decisions are made with delays relative to the net present value rule. In contrast to the agency view, we interpret this finding as evidence of inertia in takeover decisions, which is induced by agents' optimal decision making under uncertainty and irreversibility.

[1] As we discussed above, our model describes mainly sell-offs. Therefore, we focus our discussion on this type of divestiture.

Andrade et al. (2001) state that a challenge to the value creation hypothesis in mergers is the fact that target's shareholders are able to obtain most of the gains even when there is no competition during the acquisition. A conclusion from our model is that even when the bidder is the owner of the intangible asset, the target is able to extract most of the synergistic gains as a premium. In our model, this phenomenon is not due to overpayment but due to the strategic interaction among agents. The model suggests that the relative distribution of gains between the bidder and the target are a function of fundamental industry or target characteristics, in particular the growth and volatility, and of how the deal is carried out (competition or not competition). Bradley et al. (1988) find that bidder excess returns are higher for the 1960's than those of 1980's. They report that bidders obtain positive CARs in acquisitions with a single bidder and before the passage of the Williams Act. They conclude that competition in the market for corporate control reduces bidder's CARs[2].

Our model is consistent with this explanation, but it also adds another non-exclusive dimension. Acquisitions in the 1960's in comparison to those in subsequent decades were probably more concentrated in lower growth and lower volatility industries. If this is true, then bidders might have optimally exercised their acquisition options when they were deeper in the money, which implies a higher net present value and therefore higher stock price reaction at the acquisition announcement. Thus, we propose that a potential selection bias can help to explain the reduction in bidder's CARs over time. For example, Fuller et al. (2002) report for the period 1990 - 2000 that the three industries with the highest percentage of acquired firms were Business

[2]Similar evidence in relation to the effect of competition on bidder's CAR is reported in De et al. (1996). They find that successful bidders in multiple-bidder contests earn significantly lower returns than successful bidders in single-bidder contests.

Services, Electronic Equipment and Telecommunications. They also report that the industries with the lowest activity for the period were Defense, Nonmetallic Mining and Shipbuilding/Railroad. The contrast between the two group of industries is clear, and even though we do not have evidence reporting industry classification for earlier periods, the three industries with the highest activity were probably not in existence in the 1960s. Similar evidence is reported in Mulherin and Boone (2000) for the period 1990 - 1999, and they state "*Indeed, some of the industries shown in Table 3 to have the highest rate of acquisition activity during the 1990s include Telecommunications, Electrical Equipment, and Electronics that are in high-tech, growing sectors.*", p.124.

Mitchell and Mulherin (1996) analize takeover activity in the 1980s and find, consistent with Gort's (1969) argument, that takeover and restructuring activity clusters disproportionately in target's industry[3]. For example, they find that 50% of the takeover activity in most industries clusters within a two-year period. In further analysis, they also show that industry shocks such as technology, government policy, and demand and supply conditions during the late 1970s and early 1980s significantly explain the rate of takeover activity during 1980s, suggesting that takeovers and restructuring are driven by common industry shocks. Similar evidence of the importance of industry shocks in observed industry clustering not only in acquisitions but also in divestitures is reported by Mulherin and Boone (2000) for the 1990s[4]. Then, if industry shocks are

[3]They state as their main motivation for the study the inability of past studies to successfully determine the reasons for takeover activity to vary over time. They state "*Whereas hundreds of takeover studies during the past 20 years have shed light on the role of takeovers in redirecting the investments of specific firms, these studies have been less successful in discerning why takeovers happen in waves.*", p.221. Their motivation and Gort's (1969) is clearly the same. Further, most of their tests are very similar to those conducted by Gort for the 1950s.

[4]Andrade and Stafford (2003) in footnote 11 cite evidence indicating that this clustering phenomenon was also reported in Nelson (1959) [Nelson R. 1959. Mergers Movements in American Industry, 1895 - 1956. Princeton Univ. Press/NBER, Priceton, NJ.] for the first half of the century in the US.

the main trigger of acquisition activity, it is arguable that acquired firms in the 1960s are different from those in later decades, supporting our conjecture that a potential selection bias might also explain the reduction the bidder's CARs over time.

The argument often made for the effects of the Williams Act and takeover defenses implemented in the 1980s on bidders returns is that they have made the tender offer process more costly and time-consuming for bidders, and that they have shifted the bargaining balance from bidders to targets [Fuller et al. (2002)]. To some extent, this argument supports the claim in our model that acquisitions involve important sunk costs and the setting forcing bidders to pay target's reservation premium.

The prediction that the distribution of gains depends on the long term growth and volatility of target's assets is very specific to our model. Hence, no empirical evidence has addressed this issue directly, but two papers do report evidence relating growth and volatility to distribution of gains. Morck et al. (1990) find evidence that bidders obtain the lowest returns when buying growth and diversification. They interpret the evidence by arguing that managers buy growth for empire building purposes. Assuming their growth measure is a good proxy of firm's growth prospects[5], our model predicts exactly their evidence but the interpretation is very different. Conditional on acquisition, the target gets most of the synergy gains as a premium and the relative distribution of gains is even more asymmetric when the target is from a more rapidly growing industry.

Datta et al. (2001) in a study of the effects of executive compensation on bidders' CARs[6] find that bidders with managers classified as having high Equity Based Compensation (EBC) earn a significantly positive announcement return, while bidders with

[5]They use the continuously compounded growth of sales during years -6 to -1, where year 0 is the acquisition year, $log\left(\frac{Sales(-1)}{Sales(-6)}\right)$.

[6]Their sample includes 1719 acquisitions for the period 1993 - 1998 in the US.

managers classified as having low EBC earn a significantly negative announcement return. As expected from the theory of managerial compensation, bidders with high EBC are found to acquire riskier firms[7]. Putting together these last two pieces of evidence, our model would predict that bidder with managers in the high EBC range (acquiring riskier targets) should pay a higher premium for targets. In rejecting to this prediction, the authors find that managers in high EBC firms pay a significantly lower premium[8] (35.88%) than their counterparts in the low EBC firms (44.66%).

In relation to asset sales and the sources of gains for sellers, an important element relevant for our model is worth mentioning at this point: a sell-off decision does not eliminate from existence of the parent firm. Hence, considerations other than efficiency might also motivate asset sales. Lang et al. (1995) argue that this restructuring mechanism can also be viewed as a mechanism that allows raising funds without the scrutiny of capital markets, thereby generating the potential agency cost of free cash flow discussed in Jensen (1986). They report evidence indicating that the stock price reaction to asset sales is positive only when the proceeds are paid out to shareholders. Contrary to this finding, Slovin et al. (1995) do not find such a relation in their sample. Jain (1985) argues that one potential reason for sell-offs is the desire of the parent firm to transfer wealth from bondholders by, for example, paying to the common shareholders an important dividend from the proceeds of the asset sale. Findings in Datta and Iskandar-Datta (1996) suggest that, consistent with findings in John and Ofek (1995), the benefits from the asset sale accrue primarily to shareholders when the

[7]This conclusion follows from the fact that bidders in this category suffer a significant increase in stock price variance after the acquisition. They do not analyze potential wealth redistribution from bondholders to stockholder as the source of these gains.

[8]The authors obtain this premium from SDC. This corresponds to PREM4WK, which is computed as the difference between the highest price paid per share and the target share price four weeks prior the announcement date over this last price.

divested unit does not strategically fit with the parent core business (focus increasing sell-offs). However, and consistent with the argument made by Jain (1985), in the case of asset sales motivated by distress, the benefits of asset sales accrue primarily to bondholders. In general, Datta and Iskandar-Datta's (1996) findings indicate that significant wealth transfers might occur among security holders as a consequence of asset sales. Hence whether sellers without investment opportunities use proceeds to pay dividends or to repay debt is an important issue regarding the source of gains from asset sales.

A recent study sheds some new light on the sources of bidders returns. Fuller et al. (2002) argue that bidder's returns at the acquisition announcement might not be a clean effect as it reveals information not only about the potential synergies in the combination but also about a market reassessment of bidder's business, the stand-alone values of bidder and target, and the split in value among firms[9]. Their methodology is very interesting for two reasons. First, they study bidders making five or more successful bids within three years during the 1990s[10]. To some extent, this allows them to control for bidder characteristics, and thus, all potential variation in bidder's CAR can be attributed to target and bid characteristics. Second, they examine bidders making offers for public, private, and subsidiary targets, and using different method of payment combinations. This allows them to introduce substantial variation in the exogenous characteristics as to disentangle the source of bidder's CAR. Their main conclusion is that target and bid characteristics are a key driving factor in bidder's CARs during 1990s. For example, their findings indicate that bidders have significantly negative returns when buying public targets, and significantly positive returns when

[9] Our model sheds some light on the determinants on the distribution of gains.
[10] The sample comprises 539 acquirers making 3135 successful bids.

buying private or subsidiary targets[11]. Furthermore, insignificant returns are found for bidders in public cash offers, but significantly negative returns are found for public stock offers. Bidders for private and subsidiary targets obtain a significantly positive return regardless of the method of payment. The authors advance several potential explanations for the contrast between public and private deals. Two are relevant for our model. First, a liquidity effect that makes private deals less attractive unless the bidder receives a liquidity premium. Second, regulation favors public targets more in the bidding process than private targets[12]. An argument consistent with our model can be made in the sense that liquidity affects the acquisition timing, and that disclosure and delays in public deals create a more competitive bidding processes, forcing bidders to accelerate acquisitions in relation to the optimal time.

Mitchell and Lehn (1990) find evidence that firms making value decreasing acquisitions are more likely to become acquisition targets than those firms making value increasing acquisitions. They conclude that, consistent with the disciplinary role of the market for corporate control, one source of value in takeovers is to recoup some of the value lost in hands of the unsuccessful bidders. Kaplan and Weisbach (1992) in a study of large acquisitions during 1971 - 1982 find that by the end of 1989, acquirers had divested almost 44% of the target firms. From the divested units, they classify between 34% and 50% as unsuccessful or performance related. They also show evidence indicating that the market is able to recognize good deals at the announcement date. A often-made argument in this sense is that managers could observe the market reaction at the acquisition announcement, and if negative, they could redeem themselves

[11]This evidence is consistent with previous research investigating only private deals.

[12]They state that the disclosure and delay requirements of the Williams Act only apply to public targets, not private or subsidiary targets, p.1784.

by divesting immediately. However, our model advances that once the acquisition has been made, managers should wait until the optimal time for the divestiture even if the acquisition is a failure. In contrast to the agency explanation for acquisition failures, our model proposes that managers can make mistakes as a consequence of imperfect information about the actual gains of the acquisition strategy. This feature forces firms to enter into a costly search process.

Even though the finance literature has normally neglected organizational issues, this literature provides some evidence consistent with our conjecture that the post-acquisition integration process might be important in the final realization of expected synergy gains. Chatterjee et al. (1992) study a sample of 30 acquisitions carried out between 1985 and 1987. They hypothesized that the stock price reaction of the acquiring firm at the acquisition announcement will be negatively related to Perceived Cultural Differences (between bidder and target) and positively related to Tolerance to Multiculturalism of the acquirer. Both measures were obtained through structured perception questionnaires administered to the top management of the acquired firm. Consistent with much literature in finance, they find a significant -3% abnormal returns in an event window (-10 , 5) for acquirers during the acquisition announcement. Both Cultural Differences and Tolerance to Multiculturalism explain 38% of the variance in abnormal returns for bidders, both variables are significant at conventional levels and their signs are as hypothesized. The important issue in our model is that even though we can observe mistakes ex-post in corporate acquisitions, ex-ante they are a value maximizing strategy when firms have intangible assets potentially transferable to other products or industries[13]. Thus long term poor post acquisition performance

[13] In this respect, our model borrows insights from Matsusaka (2001), and Bernardo and Chowdhry (2002).

is not necessarily due to managerial motives.

3.2 Timing and Determinants of Takeovers

Our main claim in the model is that acquisition and divestiture decisions are optimally made with delays in relation to the net present value criterion. This optimal inertia is a rational response of firms to an uncertain environment. These optimal delays might be an important determinant of the apparent discount found for diversified firms.

Denis et al. (1997) start with a very simple motivation, "*If, on average, diversification is associated with a reduction in firm value, why do firms remain diversified?*", p.135. Even though most finance literature has blamed agency issues for these delays in divestitures[14], we argue that agency might only be part of the story. For example, if the agency argument were the only motivation for restructuring, then we need a theory to explain why the agency problem, or the market for corporate control discipline, is time varying. Even further, we need to explain why the market for corporate control acts more strongly over some industries at a given point in time.

In our model, acquirers should trade at a discount if target's resources are not a good match for the acquirer's organizational capabilities ex-post. This diversification discount should persist as firms failing to realize the synergies will wait until the optimal time before divesting. Consistent with the evidence presented in Graham et al. (2002), our model predicts this discount for diversifying acquisitions as well as for related acquisitions. Nonetheless, a reasonable conjecture is that the probability of a good match is higher when bidder and target belong to the same industry.

[14] For example, Haynes et al. (2000) argue that poor corporate governance is responsible for firm's low speed of adjustment to external shocks.

In our review of the extant literature, we only found mild mentions to a potential inertia effect in takeovers. Maksimovic and Phillips (2001) in footnote 7 state: "... *A full dynamic model would be necessary to address the question of the optimal timing of transfers (of control)*". Campa and Kedia (2002) in footnote 3 state: "... *In practice, the decision to diversify and refocus involves large amounts of sunk and irreversible costs that lead to a lot of persistence in diversification status... this literature (real options) has emphasized that temporary shocks can have permanent effects due to hysteresis, which is consistent with the observed discount of multiple segment firms prior refocusing.*".

Alexander et al. (1984) and Jain (1985) for the periods 1964 - 1973 and 1976 - 1978 respectively report that voluntary sell-off announcements are made after a period of significantly negative abnormal returns for the parent firm. More recently, Denis et al. (1997) find evidence indicating that parent firms suffer a significant decrease in value for 3 years prior to the divestiture. For the case of takeovers, Asquith (1983) and Malesta (1983) report that targets earn -14% for the window (-480 , -20) in days and -8.5% for the window (-24 , -4) in months respectively. Following a different approach, Kaplan and Weisback (1992) study the extent to which divestitures in the 1980s represent unsuccessful or failed acquisitions in previous years. They follow acquisitions until the time of the divestiture and report that there is a considerable time lag between the acquisition and the divestiture. The median value for this time lag in their sample ranges from 15 years in 1971 to 4.5 years in 1982, showing a decreasing trend and a median for the period of 7 years[15]. Assuming these divestitures are indeed failures as

[15]This decreasing pattern must be interpreted with caution. Kaplan and Weisback (1992) study acquisition carried out until 1982 and close their study in 1989. This implies that some bad acquisition carried out in the early 80s might be divestiture candidates that by the end of 1989 have not been divested yet. This can in part explain the decreasing pattern.

many claim, these time lags appear to be long. Even though this evidence is consistent with the agency and our view of takeovers, more research is needed in order to understand the sources of these delays.

Lang and Stulz (1994), and Berger and Ofek (1995) find that diversified firms trade at a discount relative to the sum of the market values of comparable single-segment firms. Similar evidence is reported for Japan and the UK in Lins and Servaes (1999). Even though there is evidence indicating that announcement returns for diversifying firms in the conglomerate wave are significantly positive [Schipper and Thompson (1983), Matsusaka (1993), and Hubbard and Palia (1999)], Servaes (1996) reports that these diversified firms also traded at a discount relative to single-segment firms at that time (1961 - 1976). Lamont and Polk (2002) argue that diversification is indeed the source of the discount. They find that exogenous changes in investment diversity are negatively related to changes in excess value.

Despite the apparently robust evidence of a diversification discount, current research in the topic would indicate that the evidence might be due to methodological problems. For example, Campa and Kedia (2002) argue that the apparent causality between the discount and diversification is spurious as the diversification decision is endogenous to the firm. They argue that it might be the discount that induces firms to diversify and not the other way around. Controlling for the selection bias induced by firm characteristics, they find that the diversification discount normally drops or sometimes even turns into a premium. Graham et al. (2002) state that previous evidence implicitly assumes that stand alone firms are valid benchmarks for valuing the division of conglomerates. They study a sample of acquiring firms for the period 1980 - 1995 and find that most of the post acquisition discount for the bidder can be explained by the addition of an already discounted target. This reduction in excess value from the acquisition of a discounted target is shown to be independent of: a) whether the acquisition is related or unrelated, b) whether or not the acquisition implies an increase in the number of segments, and c) whether the acquirer ends up being a single or multi-segment firm after the M&A event.

The evidence about the source and existence of the diversification discount is still mixed (see previously cited papers for a great deal of work in progress). Assuming that this discount indeed exists, why do diversified firms appear to be waiting until substantial discounts are realized before refocusing?, more importantly, why do potential bidders wait this long in order to make an offer for undervalued assets?, is it malfunctioning of the market for corporate control?, or as we propose, is it optimal inertia? For example, Berger and Ofek (1996) for the 1980s find that firms that are takeover targets have significantly larger diversification discounts than non-target firms. Further, the diversification discount is positively related to the probability of a takeover attempt. As they state, "*Potential acquirers have an incentive to take over and break up the most value-reducing diversified targets, because empirical evidence indicates that bidders do better when they target poorly managed targets*", p.1179. Nonetheless, their results show that non-target firms trade at an interesting discount of around 20%. Further, only 22% of the diversified firms in the sample are taken over within the four year period of the measurement of the diversification discount. They also report that single line firms are taken over with frequencies of around 15%.

If we put these pieces of evidence together, it appears that the frequency of takeover attempts is too low for the sample of diversified firms, and that bidders need very substantial discounts before committing to a takeover attempt. This evidence indicates that bust-up takeovers are undertaken with substantial delays in relation with the net present value rule unless we are willing to accept that the costs of executing these acquisitions represent over 20% of the market values of diversified firms. Whether these large discounts are observed due to large bust-up costs, due to optimal inertia, or due to agency problems[16] is an important issue that needs to be addressed in future research.

In our model, acquisitions should occur sequentially. We argued earlier that this sequentiality would induce external rational agents to interpret initial acquisitions[17] in a given industry as a signal of potential future activity. This prediction implies that initial takeovers in a given industry should be accompanied by a positive stock price reaction of other industry members. Hence some information spillovers should be observed within industries in anticipation of restructuring activity. Consistent with this contention, Mitchell and Mulherin (1996) find that industry rivals of targets earn a significant 0.5% in the month of the acquisition announcement. This finding is consistent with results reported in Eckbo (1985) and Song and Walkling (2000). Even though Eckbo's motivation is to examine the collusion hypothesis, he reports, for the period 1963 - 1981, statistically significant gains for rivals in 196 horizontal mergers of 1.26% and 0.58% for windows (-20 , 10) and (-3 , 3) respectively.

Song and Walkling (2000) directly address what they call the *acquisition probability hypothesis* as the source of target's rival gains. Under this view, target rivals

[16]Denis et al. (1997) argue that managers will reduce diversification only if pressured to do so by internal or external monitoring mechanisms. Berger and Ofek (1996) state: "*The evidence that diversification represents a suboptimal management strategy suggests that internal control systems do not prevent managers from destroying significant amounts of value.*", p.1175.

[17]We understand initial takeovers as those carried our after a long period of inactivity in the industry. For example a shock that alters the optimal number of industry firms might induce a wave of restructuring activity. Thus the first acquisition might signal that more acquisitions are on the horizon.

earn positive abnormal returns because of the increased probability that they will be targets themselves. They state "*External catalysts, such as regulatory changes, technological innovation, changes in consumer tastes, and changes in an industry's cost structures affect the probability of an acquisition attempt by changing the potential gains to competing managerial teams. An unexpected acquisition within an industry signals the expected gain from bidding exceeds the cost for at least one firm in the industry*", p.146. In a sample of 470 acquisition bids for the period 1982 - 1991, they find a significant abnormal return for rival's portfolios of 0.35% and 0.56% for windows (-1 , 0) and (-5 , 5) respectively[18]. In the longest window, 63% of rivals have a positive stock price reaction. Interestingly, they find that the abnormal return for rivals is positively related to the announcement surprise[19].

In addition, abnormal returns for portfolios of rivals for the first, second, and third initial targets in a given industry declines[20], which is consistent with the acquisition probability hypothesis. Further, they document that 66 and 249 of the 2459 identified rivals are targets in the next 12 months and 2 years of the initial acquisition announcement respectively. The sample of acquired rivals in the next 12 months after the initial industry bid earns a positive 1.36% abnormal return at the initial bid announcement, significantly higher than that of non-targets (0.32%). As additional support for their hypothesis, they find that the abnormal return for rivals at the announcement of the initial bid is positively related to their predicted probability of acquisition[21].

[18]Industry rivals are defined as firms in the same Value Line industry as targets in the quarter preceding the acquisition announcement.

[19]To operationalize the degree of surprise, they define a variable called the dormant period which corresponds to the number of months since a previous acquisition announcement in the same industry.

[20]The first initial acquisition is given by an announcement of acquisition after a 12-month dormant period. In the sample, 141 of the 470 target firms are classified as initial industry targets.

[21]To obtain a predicted probability of acquisition, they use a logistic regression and variables used in previous research to predict acquisition targets.

According to our model, acquisitions and divestitures should occur in a rising market and should, on average, improve efficiency. This is consistent with evidence reported in Haynes et al. (2002) who find for a sample of 132 UK companies involved in restructuring programs in the period 1985 - 1993 that divestitures (1839 disposals in the sample period) enhance performance of the vendor company. Maksimovic and Phillips (2001) for the period 1974 - 1992 find that, on average, 3.9% of the large manufacturing plants in the US change ownership, but they point out that this average has an intra-industry variability and also a pro cyclical time variation with an average of almost 7% during expansions. Even though the rate of transactions is higher during economic expansions, their findings also indicate that capacity utilization does not have a material effect on the rate of reallocation through mergers and acquisitions, and asset sales. In addition, the rate of industry reallocation appear unrelated to industry growth in their sample, but their results indicate that the number of transactions are higher for the fastest growing industries.

Maksimovic and Phillips (2001) conclude that for the manufacturing industry the time series variation in the overall rate of asset reallocations is driven by economy-wide factors[22]. They find that asset sales are more likely when the economy is undergoing positive demand shocks, when the assets are less productive than their industry benchmark, when the selling division is less productive and when the selling firm has more productive divisions in other industries. For mergers and acquisitions, they report that less productive firms tend to sell at times of industry expansions. Further, firms are more likely to be buyers when they are efficient and are more likely to purchase

[22] To some extent this evidence is inconsistent with the evidence about the expansionary and contractionary role of takeover activity discussed in Andrade and Stafford (2003). However, we must emphasize that Maksimovic and Phillips (2001) analyze only the manufacturing industry and that their analysis does not focus on industry shocks as a source of asset reallocation.

additional assets in industries that experience an increase in demand. In general, their findings indicate that transactions in the market for assets result in productivity gains, and thus, facilitate the redeployment of assets from firms with a lower ability to firms with higher ability to exploit those assets.

An issue that has attracted the attention of researchers is the prediction of takeover targets. First, it is well documented that target firms have an important stock appreciation at the announcement. Hence, the prediction of these events might be the basis of a sound investment strategy. Second, the successful prediction of takeover targets certainly would improve our understanding of why takeovers happen in the first place. Hence, it also has managerial and antitrust implications. One of the most influential papers in this area is Palepu (1986). Even though predictor variables are extracted from several hypotheses, we will only discuss variable significance and consistency with our model. Consistent with our model, prior performance and size of the firms are inversely related to the probability of acquisition. Inconsistent with the model, firm's growth and previous takeover activity in target's industry are negatively related to the probability of acquisition.

Ambrose and Megginson (1992) extends Palepu's work in two directions by including asset and ownership structure as an important determinant of takeovers. Consistent with our model they find that the proportion of tangible assets in target's asset structure is positively related to the probability of acquisition. The arguments they state for the inclusion of the proportion of tangible assets rest on the contention that more tangible assets increase the debt capacity of the firm, or alternatively, that tangible assets are a proxy for production capacity. Additional analysis shows that the first explanation is not consistent with their evidence[23]. In our model, the proportion of tangible assets proxy for the liquidation value of assets, which enhances the value of the divestiture option, accelerating acquisitions. Powell (1997) also finds a positive relation between target's tangible assets and the probability of acquisition, but they remark that, in general, the importance of variables they use as predictors is time-varying and that hostile and friendly takeovers have different determinants. Finally, Espahbodi and Espahbodi (2003) show with different methodologies that the out of sample accuracy of prediction models is very poor. We interpret this evidence as consistent with unexpected and unpredictable economic shocks as the main trigger of takeover activity at the industry level. Consistent with our view that liquidity of corporate assets plays a role in takeovers, Schlingerann et al. (2002) find that conditional on the need to divest, the liquidity of the market for corporate assets is an important determinant in the choice of which assets to divest.

[23]Interestingly, they are unable to replicate Palepu's findings in their sample period (1981 - 1986).

Chapter 4

Empirical Test

In chapter 2 we saw that corporate acquisitions and divestitures can, in principle, be modelled as a real option game. Several predictions emerged from our model. The timing of acquisitions can be seen as the optimal exercise of an American-type option by the bidder. Early exercise might be expected when bidders face potential competition in the control contest. In terms of the gains for the target and bidder, our predictions indicate that targets will be able to extract most of the expected gain as a premium. The degree of asymmetry between bidder and target gains is mainly driven by the expected growth of and the uncertainty about the target's business. The analysis of the empirical evidence in the previous chapter indicates that several of these predictions might indeed explain what we observe in actual acquisitions.

Despite the richness of our predictions, our model shares the same empirical limitations of theoretical work in real options in general. At least three limitations are important to note: first, key inputs in these models are normally unobserved variables[1]. Second, it is customary to assume that uncertainty has a specific form, which

[1]Davis (1998) presents an interesting discussion about the limitations and challenges in the estimation of two of the most important inputs: volatility and dividend yield.

is probably rejected in reality. Finally, empirical tests demand the availability of discrete, observable and economically material events. Hence the few empirical works that have tried to test these models have taken the qualitative implications as testable hypotheses. Examples of empirical work in the area are papers by Quigg (1993), Leahy and Whited (1996), and Moel and Tufano (2002). Nonetheless, the nature of our model allows us to overcome at least one of these limitations: acquisitions and divestitures are discrete, observable and economically important events for corporations. Furthermore, when the target is publicly traded, some of the inputs can be estimated from market or publicly available data.

The main objective in this chapter is to provide a preliminary empirical test of our model's predictions. As such our empirical approach will focus on the simplest and cleanest predictions. That is to say, we will limit our analysis to the predictions that refer to target gains only. In this sense, the results must be interpreted as exploratory evidence about the validity of our model, and empirical tests concerning bidder's gains, combined gains and timing of acquisitions are left for future research. This chapter proceeds as follows: In the next section, we state our empirical hypotheses. Our methodology and sample selection criteria are presented in sections 4.2 and 4.3 respectively. In section 4.4 the results of our empirical tests are presented and discussed.

4.1 Research Hypotheses

In our acquisition game, the bidder chooses the timing of the acquisition. This timing decision depends, among other factors, on the target reservation premium. In general we saw that the optimal target's premium is the one that maximizes the present value of its payoff. Thus, as the target knows that a large premium will delay the acquisition, it demands a premium that will balance the benefit of an additional dollar premium with the cost imposed by discounting. Furthermore, in our model the target has no ownership participation after the acquisition, and its reservation premium was shown to be independent of the level of competition in the contest and the level of *implementation* uncertainty in the acquisition. For completeness and ease of reference, table 4.1 summarizes our previous equilibrium strategies for targets.

Table 4.1: **Summary of Theoretical Target Reservation Premiums**

	Game 1	Game 2	Game 3
Reservation Premium	$\frac{1}{\beta}\left(\frac{\mathbb{E}_t(\theta)-1}{1}\right)$	$\frac{1}{\beta}\left(\frac{\mathbb{E}_t(\lambda\,\vert\theta_B)-\theta_B}{\theta_B}\right)$	$\frac{1}{\beta}\left(\frac{1-\lambda_B\theta_B}{\lambda_B\theta_B}\right)$

The last three columns show target gains as a proportion of the target market value conditional on no acquisition. Even though the three games were played in different settings, we see that the reservation premium the target demands is indeed independent of the degree of competition in the control contest and the value of the divestiture option. Thus, according to our model, the premium for targets is inversely related to β and directly related to the total expected wealth creation in the acquisition. These predictions form the base for our hypotheses. On one hand the total wealth creation is a positive function of bidder's ability and the target's level of undervaluation. On the other hand, the parameter β is inversely related to the expected growth and uncertainty of target's assets. In simple terms our model predicts the following four hypotheses in relation to target's reservation premium:

- Hypothesis 1: The higher the expected growth in target assets, the higher the premium demanded.

- Hypothesis 2: The premium for the target will be higher when the target's assets are riskier.

- Hypothesis 3: The premium for the target will be positively related to bidder's level of ability in managing target's assets.

- Hypothesis 4: The target's reservation premium is positively related to the target undervaluation under current management.

As undervaluation is difficult to measure, hypothesis 3 and 4 might be considered as complementary. These two hypotheses are presented separately because bidder's ability and target's undervaluation are two different concepts in our model[2]. Despite this, we are interested in the expected wealth creation, which depends on both the bidder's ability and the target's undervaluation, because this is the factor affecting the target's reservation premium.

4.2 Methodology

In order to test our hypotheses, we need measures of target premium, of bidder ability and target undervaluation, and finally of uncertainty and expected growth for target assets.

It is reasonable to argue that the level of managerial ability is captured by the gap between the market value and the replacement value of bidder assets. Under

[2]It is important to bear in mind that we do not need both undervaluation and ability for an acquisition to be profitable. It is sufficient the presence of one only. Thus we can have acquisitions motivated by undervaluation (or discipline) only as in our game 3, or acquisitions motivated entirely by ability as in our game 1. Game 2 is an acquisition where both elements are present.

the same rationale, this gap can also be considered an indicator of the target current management quality. Ideally, this gap should be measured by the marginal Tobin's Q. However, this measure is probably impossible to obtain in practice. Following much of the empirical research in finance, we will proxy this metric with the following market to book (MTB) ratio[3]:

$$MTB = \frac{BVA + MVCE - BVCE}{BVA}$$

Where BVA is the book value of total assets, $MVCE$ is the market value of common equity (market value of shares times number of shares outstanding), and $BVCE$ is the book value of common equity. Under our specification, the target's MTB will proxy for undervaluation, and the bidder's MTB will proxy for managerial ability. We have to note that we are assuming that MTB is a reasonable proxy for the expected wealth creation in a particular acquisition. However, it is entirely possible that, for example, bidders with high MTB are not systematically making good acquisitions. This limitation must be kept in mind in the interpretation of our results.

Measures of growth and volatility for the market values of target's asset are difficult to obtain in practice. For example, many of the firms that are taken over have only a few years of data in COMPUSTAT, making it impossible to obtain a reasonably long time series that would allow for the estimation of growth and volatility of the target's market value of assets. Even having a long time series, accounting numbers are perhaps not the best proxies for market values. Our approach, which is not free of problems, will favor simplicity in order to obtain proxies for these unobserved variables. To proxy for expected growth, we will use the target's total payout ratio defined as

[3]Despite the common usage in finance, this measure suffers from serious drawbacks. For example, it assumes that the replacement value of assets and market value of debt are well approximated by their respective book values. Further, it assumes that the average and marginal ratios are the same.

follows:

$$Payout = \frac{IE + CED + PD}{BVA}$$

Where IE is the annual interest expense, CED is the annual cash dividends for common shareholders, PD is the annual cash payments for preferred shareholders, and BVA is the book value of total assets[4]. The rationale for the use of this payout as an inverse proxy for growth is that firms paying out more cash today are probably firms with less expected growth[5].

In general, for the estimation of market to book ratios for bidder and target, and payout for targets we followed the following approach. First, we identify the tender offer **announcement date**. Second, we subtract 120 calendar days to the announcement date and obtain a **reference date**. **The measurement date** for our proxies is the first fiscal year end that precedes the reference date.

As a proxy for volatility of target's assets, we use the target's stock price volatility after subtracting market induced variability. To this end, we estimate a market model as follows:

$$R_{TargetStocks} = \alpha + \beta R_{StockIndex} + \epsilon$$

The stock index corresponds to a CRSP equally weighted market index as used by Eventus ®. Our measure of volatility is thus the standard deviation of the market model residuals, $\sigma(\epsilon)$. In order to avoid potential effects on variance induced by the BID/ASK spread, we used weekly returns in this estimation. The market model was estimated with 60 weeks of returns, from week -70 to week -10 relative to the acquisition

[4]Even though tax payment might also be considered as cash paid out to society, this item is perhaps better classified as a cost of operating in a given legal environment. Further, the amount of taxes does not represent a voluntary decision by firms.

[5]A limitation of this inverse proxy for growth is that it assumes that all firms are able to invest the cash retention in projects with similar rates of return.

announcement week (week 0)[6]. Our argument for using this measure of volatility is that a more sophisticated approach might induce more noise in our estimates. For example, assume that the market value of target's assets (V) follows as Geometric Brownian Motion with drift and diffusion parameters given by a and σ_V^2 respectively. Acknowledging that target's stocks (S) are derivative securities with the underlying being the market value of assets and using Ito's lemma, we can express the process followed by the stock price as follows:

$$dS = \left[a\frac{V}{S}\frac{dS}{dV} + \frac{V^2\sigma_V^2}{2S}\frac{d^2S}{dV^2}\right]Sdt + \left[\sigma_V\frac{V}{S}\frac{dS}{dV}\right]SdW$$

It is clear from this process that the volatility of assets and stocks are related by the relation:

$$\sigma_{stock} = \sigma_V\frac{V}{S}\frac{dS}{dV} \quad \Rightarrow \quad \sigma_V = \sigma_{stock}\frac{S}{V}\frac{dV}{dS}$$

Thus with a measure of stock volatility and a measure of the elasticity of the stock price with respect to asset's market value, we could, in principle, obtain a measure of asset volatility. However, this elasticity is difficult to obtain. Even though we could estimate the ratio $\frac{V}{S}$ with the target's financial structure, we need an estimate of $\frac{dS}{dV}$. This last measure, known as delta in the literature of financial options, will be a function of how close the firm is to bankruptcy, condition that is hard to observe. As $\frac{V}{S}$ is greater than 1 for a leveraged firm, and $\frac{dS}{dV}$ is less than 1 by the definition of delta, it is almost impossible to conclude whether this elasticity is greater or less than 1. Thus, instead of introducing more noise in our volatility estimate, we feel that a cleaner proxy for volatility of target's assets is simply the volatility of target's stock price. As long as the elasticity of the stock price with respect to market value of assets

[6]We also tried to obtain a measure of volatility based on monthly returns, but many targets did not have enough history in CRSP to estimate the market model.

does not vary substantially among firms, the volatility of stock returns will be highly correlated with the volatility of assets market value.

For the estimation of the target's premium, our main measure will be the cumulative abnormal return for the target during the takeover announcement[7]. As it is well documented that targets start showing abnormal returns long before the acquisition announcement, we will use an event window from day -49 to day 5 relative to the event announcement day (day 0). We divide this period into two windows: the runup period (-49 , -5) and the markup period (-5 , 5). This separation derives from the fact that the literature is unclear about the source of the observed runup in target's stock prices (see Schwert (1996) for a discussion about competing theories and empirical evidence on this issue).

Thus, our tests will be carried out using the three series of cumulative abnormal returns: the runup (-49 , -5), the markup (-5 , 5), and the full period (-49 , 5). Abnormal returns are obtained by estimating:

$$A_{jt} = R_{jt} - (\hat{\alpha}_j + \hat{\beta}_j R_{mt})$$

Where R_{jt} and R_{mt} are the returns of the stock j and the market index respectively for day t, with $t \in [-49, 5]$. $\hat{\alpha}_j$ and $\hat{\beta}_j$ are estimated using OLS and 255 daily returns ending 51 days before the announcement date, $t \in [-305, -51]$. Thus, our premium

[7]In addition to this premium measure, we shall also use the premium PREM4WK reported in SDC. This premium is the difference between the highest price paid per share and the target share price four weeks prior to the announcement date as a percentage of the target share price four weeks prior to the announcement date.

measures for target j will be:

$$CAR_{Runup} = \sum_{t=-49}^{-5} A_{jt} \,,$$

$$CAR_{Markup} = \sum_{t=-5}^{5} A_{jt} \,,$$

$$CAR_{Full} = \sum_{t=-49}^{5} A_{jt} \,.$$

Statistical significance of abnormal returns is verified with the standardized cross-sectional test proposed by Boehmer et al. (1991). The estimation of abnormal returns and test statistics are carried out in Eventus ®.

In summary, our empirical test will consist of testing the following relation between the premium and the explanatory variables:

$$CAR_{target} = f\left(\underbrace{Sigma_{target}}_{+}, \underbrace{Payout_{target}}_{-}, \underbrace{MTB_{target}}_{-}, \underbrace{MTB_{bidder}}_{+}\right)$$

In addition to the explanatory variables defined by our model, we also include in our estimation a measure to control for target's and bidder's size. Firm size has been used in the literature as a proxy for the degree of asymmetric information between the firm and the market, which might affect the CAR we observe in the period surrounding the acquisition announcement. We proxy size by the targets and bidders book value of total assets. In our estimation, we shall use the natural log of total assets to control for size.

4.3 Sample Selection

At this point, it should be clear that our empirical test places very stringent requirements on our sample of acquisitions. For example, strictly following our model, we need takeovers that imply a full transfer of ownership or at least the transfer of control. If takeovers are an industry phenomenon, as opposed to managerial discipline only, then takeovers in one industry might have an informational effect on subsequent potential targets[8]. Thus, our selection criteria will try to select transactions that are consistent with the type of acquisitions in our model. Whether or not our model explains the patterns of abnormal returns for the universe of all acquisitions is an issue left for future research.

4.3.1 Selection Criteria

We start with a universe of 3337 tender offers as reported in SDC for the period 1977 - 2001. We eliminate transactions that by the end of 2001 are not completed. Further, we eliminate all transactions for which there was not a transfer of control. In this sense, for a transaction to be in our sample, it must be completed, and the bidder must have had less than 50% ownership before the tender offer and more that 50% after the transaction. These requirements result in a total of 2264 transactions for our initial sample.

In order to avoid the problem of legal differences across countries and their effects on measured abnormal returns, we restrict our sample to acquisitions where the target is a U.S. firm. To avoid potential backfilling errors in SDC, we restrict our sample to tender offers that occurred between 1982 - 2001. As early acquisition announcements might signal that more acquisitions are coming in the same industry, this signaling effect will cause problems in our measured cumulative abnormal returns. In order to

[8]This presumption is supported by empirical findings in Song and Walkling (2000). They find that rivals of acquisition targets also experience a significantly positive abnormal return. This result is interpreted as evidence that acquisitions in a given industry signal that more acquisitions are likely in the same industry.

reduce this potential effect, we impose an additional selection criterion. All tender offers that fulfill our previous selection criteria were sorted by target 3-digit SIC code. Then within each 3-digit SIC code, transactions were sorted by announcement date, from the earliest to the latest. We define the dormancy period for a transaction as the number of calendar days between its own acquisition announcement and the acquisition announcement of the previous acquisition within the SIC group. We select for inclusion in our sample only the transactions for which this dormancy period is greater than 250 calendar days. These three additional selection criteria leave us with 820 transactions.

Finally, for a transaction to be included in our sample, we require it to fulfill three additional requirements. First, we require both bidder and target to have the permanent number available in CRSP files. This reduces our sample to 411 transactions. Second, as some of our estimates will be based on accounting numbers, we delete transactions for which the bidder or the target is a financial or utility firm. With this criterion, 331 transactions remain in our sample. Finally, we require bidder and target to have the information needed for our estimates available in COMPUSTAT. After imposing this criterion, 230 transactions remain in our final sample[9]

4.3.2 Descriptive Statistics

Table 4.2 presents a contrast between our final sample and the universe of tender offers available in SDC.

In terms of average deal value, we do not observe any persistent bias toward smaller or larger deals in our sample over time. The same figure is observed when we analyze

[9]Even though the method of payment has been the subject of extensive research, we do not impose any restriction based on the way acquisitions are financed.

Table 4.2: **Contrast Between the Sample and the Universe of Tender Offers.**
The universe in this table comprises all US-target completed tender offers with available deal value for period 1983 - 2001. The second and third columns show the average deal value for a given year in Millions of US$ for the universe of tender offers and our sample. The fourth and fifth columns show the number of deals completed in a given year. The last two columns show (in percentage) the number of deals completed in a given year over the total number of deals for the period 1983 - 2001.

	Mean Deal Value (US$M)		Number of Deals		Percentage of Deals per Year	
Year	Universe	Sample	Universe	Sample	Universe	Sample
1983	112.76	294.00	68	1	4.1	0.4
1984	543.88	605.23	106	10	6.4	4.3
1985	782.65	381.77	69	15	4.1	6.5
1986	490.73	381.21	118	21	7.1	9.1
1987	442.77	449.27	107	9	6.4	3.9
1988	812.95	277.78	161	18	9.7	7.8
1989	618.93	682.28	104	6	6.2	2.6
1990	515.00	67.57	40	6	2.4	2.6
1991	306.37	223.00	18	4	1.1	1.7
1992	164.30	303.92	14	5	0.8	2.2
1993	226.38	195.98	61	8	3.7	3.5
1994	785.57	479.36	57	12	3.4	5.2
1995	516.07	365.00	78	14	4.7	6.1
1996	639.84	741.77	67	18	4.0	7.8
1997	400.69	370.92	111	21	6.7	9.1
1998	543.73	1255.73	111	13	6.7	5.7
1999	559.54	540.22	154	20	9.2	8.7
2000	1057.30	1845.61	141	20	8.5	8.7
2001	522.35	964.96	80	9	4.8	3.9
Agregate	528.52	548.71	1665	230	5.26	5.26

the proportion of deals carried out in a given year. It implies that all years are reasonably well represented in our sample. Further, the average proportion for the 19 years is the same in the universe and our sample. Even though we can not claim that our sample is free of selection bias based on this analysis, we can argue that our sample does not differ substantially from the universe in terms of macro numbers.

Table 4.3 provides descriptive statistics for the exogenous variables used in our estimation. A first interesting observation is that bidders show significantly higher mean and median than targets in terms of MTB ratios, total assets and market capitalization of common equity. The t-tests for differences in means and the Kruskal - Wallis

Table 4.3: **Descriptive Statistics of Explanatory Variables.**
Target sigma is measured as the volatility of the residuals in a market model estimated with weekly returns, from week -70 to -10 relative to the announcement week. BVA and MTB denote the book value of total assets and the market to book ratio respectively. MarCap denotes the market value of common equity. Target Payout is measured as the total proceeds paid to stakeholders over the book value of total assets. Variables based on accounting information is measured at the first fiscal year end that is at least 120 calendar days before the acquisition announcement date.

	Obs.	Mean	Median	Min	Max	St. Dev.
Target Sigma	228	3.438%	2.945%	0.507%	12.867%	1.871%
Target Payout	230	3.544%	3.235%	0.000%	21.624%	29.726%
Target MTB	230	1.417	1.256	0.527	5.520	0.616
Bidder MTB	230	1.729	1.390	0.674	7.820	0.988
Target BVA	230	494.6	145.2	8.0	8318.0	997.9
Bidder BVA	230	5947.7	1600.2	15.1	237545.0	20616.8
Target MarCap	230	354.92	112.86	5.14	5967.10	759.90
Bidder MarCap	230	5886.19	1466.01	23.10	174083.00	18134.90

and Wilcoxon/Mann - Whitney tests for differences in medians are significant at less than 1% level in the three pairs of variables[10]. This implies that bidders are on average larger than targets. This is consistent with findings reported by Mulherin and Boone (2000) for the 1990s. They also find that acquired firms are generally smaller than their industry peers. If we interpret the MTB ratio as an indicator of managerial quality, then our evidence indicates that bidders show, as a group, a higher level of ability. In terms of our four basic variables, it is interesting to note the relatively high dispersion of the payout ratio. If we compare the relative dispersion of sigma and the MTB ratios with that of total assets and market capitalization for bidders and targets, we see that these three measures show a relatively low relative dispersion (relative to their means).

[10]In the case of differences in means, the p-values for the t-tests are: 0.0001 for the MTB ratios, 0 for the market capitalizations, and 0.0001 for total assets. All p-values for tests in differences in median show a p-value of 0.

4.4 Empirical Findings

Section 4.4.1 and section 4.4.2 are dedicated to a preliminary analysis. After reviewing our findings in terms of cumulative abnormal returns in the next subsection, we proceed to analyze our hypotheses in a univariate framework in section 4.4.2. In the last part of this section, we study the validity of our hypotheses in a multivariate framework.

4.4.1 Announcement Abnormal Returns

Table 4.4 presents the cumulative average abnormal returns for our sample.

Table 4.4: **Cumulative Abnormal Returns for the Sample.**
Abnormal returns are estimated using the market model. The estimation window covers 255 daily returns ending 51 days before the announcement date. For the estimation of the combined abnormal return, we formed a portfolio with the bidder and target in each transaction. The portfolio weights correspond to the relative market capitalization of common equity of each firm as measured at the measurement date. The measurement date corresponds to the first fiscal year end that is at least 120 calendar days before the announcement date. The event study was then conducted for each of these portfolios following the procedure described previously. *, ** and *** denotes significance at 10%, 5% and 1% respectively for the standardized cross-sectional test.

Windows	Targets (n=228)	Bidders (n=226)	Combined (n=226)
(-49, -40)	-0.21	-1.00*	-0.66
(-40, -30)	1.36*	-0.41	-0.30
(-30, -15)	4.81***	0.18	0.95**
(-15, -5)	5.41***	0.24	0.64**
(-1, 1)	28.06***	0.73*	5.22***
(-5, 5)	32.82***	1.19*	6.19***
(5, 15)	0.73	-0.35	-0.24
(15, 40)	-0.35*	1.74**	1.32

A first interesting finding is that bidders have a marginally significantly positive abnormal return in our sample. Considering that we cover the period 1983 - 2001, this finding is interesting because studies in general find significantly negative or insignificant returns for bidders with a decreasing pattern over time. Bradley et al. (1988) find returns for bidders of 4%, 1.3% and -3% for the 1960s, 1970s and 1980s respectively. They argue that the passage of the Williams Act is an important determinant of the lower abnormal return for bidders. In a recent study, Fuller et al. (2002) find significantly negative abnormal returns for bidders in the order of -1% when the target is a public firm for the decade 1990 - 2000. Based on this previous evidence and our findings, it is reasonable to speculate that our selection criteria biases our sample toward the most profitable acquisitions for bidders. As described above, we selected transactions in each industry (as measured by target 3-digit SIC code) with a dormancy period longer than 250 days. Thus, an argument can be made that the most skilled bidders are the first movers when a given industry shows potentially good acquisitions. As our focus is the study of targets abnormal returns, we leave this conjecture for future research.

As shown by the combined abnormal returns, transactions in our sample have a significantly positive abnormal returns of around 6% as measured in the window (-5 , 5). It is important to consider that this expected wealth creation is free of potential problems induced by the relative size of bidder and target in the transaction. This finding is in line with that reported in Bradley et al. (1988). They study a sample of 236 transactions in the period 1963 - 1984 and find a significantly positive combined abnormal return of 7.43%. Kaplan and Weisbach (1992) and Servaes (2000) also find significantly positive combined abnormal returns in acquisitions carried out in 1971 - 1982 and 1972 - 1987 respectively. However, their findings indicates that the combined abnormal returns would be slightly over 3.5%. Similar evidence is found by Mulherin and Boone (2000) for acquisitions between 1990 - 1999. They report an average (median) combined abnormal return of 3.56% (1.99%). The fact that in our sample the combined abnormal return is higher than those reported in these two previous studies supports our conjecture that the first acquisitions in a given industry are those more profitable not only for bidder's but also for target's shareholders[11].

Consistent with previous evidence, targets in our sample obtain abnormal returns of around 30% at the acquisition announcement. Schwert (2000) finds abnormal returns of 22% for a sample of over 2000 targets in the period 1975 - 1996. Jarrell and Poulsen (1989) find abnormal returns of 29% in a sample of 526 targets in the period 1963 - 1986. Also consistent with the evidence reported in Schwert (1996), we observe significantly positive abnormal returns for targets starting around 40 days prior the public announcement of the acquisition.

Figure 4.1 shows a kernel density estimation of our two premium measures for target firms: $CAR(-49\ ,\ 5)$ and $PREM4WK$ as reported in SDC[12]. The kernel density estimation consists of estimating:

$$\hat{f}_h(x) = \frac{1}{n}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right)$$

Where n is the number of observations, $K(.)$ is the kernel (smoothing) function, and h is the optimal bandwidth. In the estimation we used the Epanechnikov kernel, with bandwidth $h = 0.1810$ and $h = 0.2183$ for CAR and PREM4WK respectively. In simple terms, this estimation allows us to obtain a smoothed histogram of frequency.

The figures show some differences between the two measures of premium. First the premiums reported in SDC appear to be more skewed to the right than those

[11]Another interpretation of our findings is that we are able to capture unexpected acquisitions in a given industry. This is precisely our purpose with our selection criteria.

[12]This premium is measured as the difference between the highest price paid per share and the target share price four weeks prior to the announcement date as a percentage of the target share price four weeks prior to the announcement date.

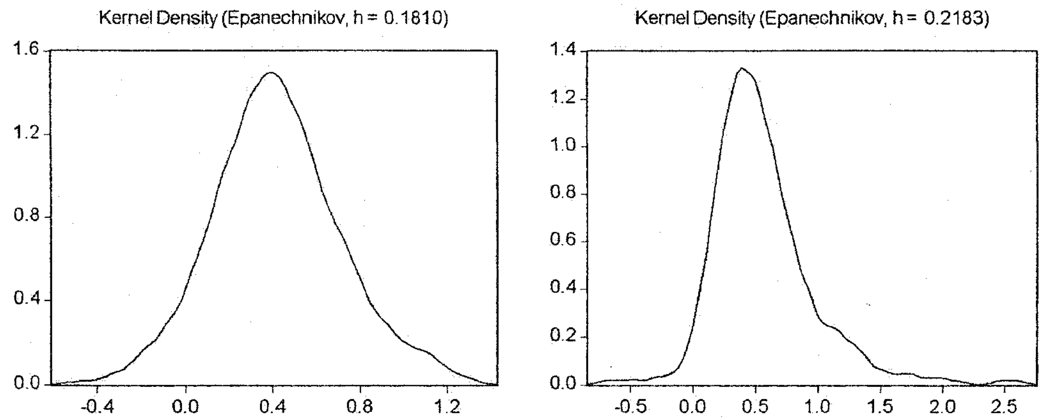

Figure 4.1: Kernel Density Estimation for Premiums

estimated with abnormal returns. The distribution of paid premiums (SDC) has some important mass allocated in the range 140 - 200%. This situation is not observed in the kernel for CARs, but the kernel for CARs is allocating relatively more mass in the range below 0%. Nonetheless, both distributions concentrate most of their masses in the range 0 - 80%, with a similar mode around 40%. Apparently both measures have some important similarities, but the Pearson correlation between the two measures is only 0.54. This implies that the stock price reaction for target firms might not be necessarily related to the final price offered in the tender offer only. This last observation makes interesting the analysis of both measure of premium in our final empirical test.

4.4.2 Univariate Analysis

The purpose of this section is to conduct a preliminary analysis of the explanatory power of the hypothesized determinants of targets' premiums.

Table 4.5 presents the average and median CAR for targets classified as above

Table 4.5: **Univariate Tests for Premium Measures.**
Target sigma is measured as the volatility of the residuals in a market model estimated with weekly returns, from week -70 to -10 relative to the announcement week. MTB denotes the market to book ratio. Target Payout is measured as the total proceeds paid to stakeholders over the book value of total assets. Variables based on accounting information is measured at the first fiscal year end that is at least 120 calendar days before the acquisition announcement date.

	Runup Period (-49, -5), n=228					
	Above Median Variable		Below Median Variable		p-value	p-value
Variable	Mean CAR	Median CAR	Mean CAR	Median CAR	t-test	Kruskal-Wallis
Target Payout	10.58	6.41	9.04	7.79	0.5654	0.9049
Target Sigma	12.54	11.66	7.06	3.82	0.0404	0.0093
Target MTB	8.44	5.84	11.13	9.35	0.3154	0.1277
Bidder MTB	8.93	5.88	10.67	8.16	0.5158	0.2936
	Markup Period (-5, 5), n=228					
	Above Median Variable		Below Median Variable		p-value	p-value
Variable	Mean CAR	Median CAR	Mean CAR	Median CAR	t-test	Kruskal-Wallis
Target Payout	30.31	24.09	35.27	32.59	0.1342	0.0454
Target Sigma	36.29	32.11	29.34	24.52	0.0349	0.0375
Target MTB	33.09	29.78	32.55	28.37	0.8718	0.5095
Bidder MTB	36.51	31.20	29.13	24.52	0.0253	0.0215
	Full Period (-49, 5), n=228					
	Above Median Variable		Below Median Variable		p-value	p-value
Variable	Mean CAR	Median CAR	Mean CAR	Median CAR	t-test	Kruskal-Wallis
Target Payout	39.72	40.88	43.67	42.37	0.2995	0.2987
Target Sigma	48.03	47.73	35.40	32.94	0.0008	0.0001
Target MTB	39.85	38.58	43.54	43.87	0.3337	0.2760
Bidder MTB	44.19	41.53	39.24	40.48	0.1931	0.2782

and below the sample median for our four main variables. The analysis is conducted for the three measures of cumulative abnormal returns: the runup, the markup, and the full period. In the first panel, we can see that the only statistically significant difference is given for our measure of uncertainty. Some very marginal significance is also observed for the target's MTB ratio. Targets with a higher variance appear to have a statistically higher runup return as measured by the mean and median CAR. For the markup period presented in the second panel, we see that three of the four variables show statistically significant differences in means and medians. Consistent with our predictions, targets with lower payout ratio and higher variance appear to have a significantly higher stock price reaction at the acquisition announcement. Also consistent with our predictions, targets experience a significantly higher stock price reaction when the bidder is classified as a high MTB firm.

In the last panel of table 4.5, however, we see that when we consider the full period, only our measure of target volatility remains significant. Even though the other three variables show results consistent with our hypotheses, the differences between groups are not statistically significant at conventional levels. The contrast in significance between the second and third panels is difficult to explain because most of the total cumulative abnormal return is realized during the markup period. Based on this observation, we would expect a reasonable degree of consistency between the last two panels. This is clearly not the case, suggesting that noise in our premium measures might be causing this inconsistency.

Even though our univariate analysis is informative and indicates some support for our predictions specially for the markup period, this analysis must be interpreted with caution. First, it considers one variable at a time, which might obscure potential interactions among explanatory variables. Second, this analysis does not take into account the fact that cumulative abnormal returns have different variances across firms in the sample. These two limitations are addressed in the next section.

4.4.3 Multivariate Analysis

Table 4.6 presents the regressions of four measures of target premium on the same set of explanatory variables. The three CAR-based measures consider 228 transactions for which the CAR was available for the target. The cross-sectional estimation was carried out with WLS and the weights reported by Eventus ®. The final column is estimated with OLS and the 173 observations with the premium PREM4WK available in SDC.

Table 4.6: **Multivariate Test for Target Premiums.**
The hypothesized sign for each variable is given in parenthesis next to the corresponding variable. Log of book value of total assets for bidder and targets is used as a proxy for size. The first three regressions are estimated using WLS and the weights reported by Eventus. Our measures of premium correspond to the target CAR for the windows (-49 , -5), (-5 , 5) and (-49 , 5). The last regression is estimated with OLS and the premium reported in SDC. Target sigma is measured as the volatility of the residuals in a market model estimated with weekly returns, from week -70 to -10 relative to the announcement week. BVA and MTB denote the book value of total assets and the market to book ratio respectively. Target Payout is measured as the total proceeds paid to stakeholders over the book value of total assets. Variables based on accounting information is measured at the first fiscal year end that is at least 120 calendar days before the acquisition announcement date.

	Runup (-49, -5)		Markup (-5, 5)		Both (-49, 5)		Premium	
Variable	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Intercept	-0.4212	0.0156	0.0589	0.7882	-0.3277	0.1660	-0.0231	0.9472
Target Sigma (+)	4.6430	0.0000	0.9267	0.3641	5.5605	0.0000	4.6043	0.0064
Target Payout (-)	0.2687	0.5735	-0.7122	0.2399	-0.5503	0.3982	-0.5320	0.5749
Target MTB (-)	-0.0503	0.0514	-0.0135	0.6788	-0.0621	0.0779	-0.0949	0.0586
Bidder MTB (+)	-0.0159	0.3633	0.0134	0.5464	-0.0053	0.8258	-0.0064	0.8283
Ln Bidder BVA (?)	0.0159	0.0740	0.0173	0.1259	0.0302	0.0130	0.0317	0.1255
Ln Target BVA (?)	0.1419	0.0119	0.0550	0.4388	0.1867	0.0152	0.1600	0.1979
(Ln T. BVA)^2 (?)	-0.0126	0.0096	-0.0062	0.3140	-0.0175	0.0083	-0.0168	0.1337
Sample Size	228		228		228		173	
Adjusted R^2	0.1668		0.0098		0.1689		0.0616	
p-value Global F	0.0000		0.2408		0.0000		0.0138	

The first interesting result that emerges from the table is that even though the signs are as predicted for all variables in the markup regression, none of these regressors is significant at conventional levels. The test of global significance for this regression also rejects the model at conventional levels, indicating that multicollinearity is not the reason for the lack of significance of the individual parameters. This result is in strong contrast with our previous findings in table 4.5 where our variables were fairly successful in explaining CAR differences for the same period. As suggested earlier, a potential problem that might explain this contradiction between table 4.5 and table 4.6 is that noise during the markup period is responsible for most of the significant differences found in the univariate tests. Thus, after correcting the CAR during the markup period for its individual variance, or measurement error, in the WLS estimation, the differences are not statistically significant.

Consistent with our hypotheses and the results from the univariate analysis, targets with higher variance and lower MTB ratio show a significantly higher CAR in the runup period. This result holds even after controlling for the sizes of bidders and targets. As we discussed previously, size has been used in empirical research as an inverse proxy for the degree of asymmetric information between insiders and the market. This interpretation for size is consistent with the signs for target's and bidder's size in the runup regression. Our regression estimates for the log of book value of total assets indicate that the larger the bidder the higher is the target's runup CAR. A similar pattern is found for target's size although this relationship is non-linear with a inverted u-shaped form.

If we are willing to accept that our measure of size (book value of total assets) is a reasonable inverse proxy for the degree of asymmetric information between firms and the market, our results for the runup period can be interpreted as evidence that abnormal returns during this period are part of the premium the target's shareholders receive in the tender offer. This explanation would indicate that the runup return derives mainly from anticipated trading by informed investors as opposed to insider trading only. We should remark however that the magnitude of the CARs during the runup and the markup period are very different. In general, most of the total effect is seen in the window (-5 , 5), see table 4.5.

When we consider the CAR for the window that includes both runup and markup, we observe that our measure of uncertainty is strongly significant and its sign is as hypothesized. With the exception of the coefficient for bidder's MTB, which is not significant, all remaining variables show signs that are consistent with our predictions. Nevertheless, only the target's MTB ratio is marginally significant. It is interesting to note that in this regression we also find a direct relation between our measure of bidder size and target CAR (-49 , 5). Note that the same u-shape relation for the target CAR (-49 , 5) and target size is also found in this regression. This last result is interesting because we are not aware of any empirical study documenting such a finding.

In comparing the last two columns, which use two different measures of target's total premium, we see very consistent results for our main variables. This result is to some extent surprising because these two premium measures were previously found to have a low correlation (0.54). Interestingly, in the last regression our measures of size are not significant at conventional levels. This interesting contrast between these two premium measures may reflect that they do not measure exactly the same things. For example, the premium reported in SDC reflects the final price *paid*. In contrast, the CAR reflects the first price *offered* and the market expectations of future increases in offer price, rival bidders, success of the bid, etc. Nonetheless, results in the last model support our previous conclusions that sigma and target's MTB are two important determinants of the premium received by target's shareholders.

Finally, the regressions in table 4.6 were also estimated using dummy variables to characterize observations above and below the median for each of our variables. For these estimations, we kept the proxies for size as continuous variables. The results remain qualitatively the same as those just discussed, and therefore they are not reported. However, these results indicate that some of the inconsistencies we found between the univariate and multivariate tests for the markup period are not due to data problems in our explanatory variables, but rather in our measure of premium for the markup period. This observation supports, to some extent, the conjecture that the markup period is characterized by a great deal of noise in abnormal returns. Alternatively, it might be the case that abnormal returns during the markup period are driven by factors other than those derived from our model.

4.5 Conclusion

Our evidence in this chapter indicates support for two of our hypothesis. We find reasonable support for the hypothesis that relates inversely the target's premium and the target's undervaluation as measured by the target's MTB. This result complements findings in previous research indicating that bidders earn higher returns when their targets have lower Tobin's Q [Lang et al. (1989) and Servaes (1991)]. Thus, it appears that, as suggested by our model, targets are able to share part of the potential gains bidders expect to realize.

Even though the bidder's MTB is found to be insignificant in explaining the cross-section of target's premiums, previously we pointed out that bidder and target MTB are a joint measure of the potential gain achievable by the bidder firm. Thus, it might be the case that most of the acquisitions in the period we consider are motivated by target undervaluation. Alternatively, it can also be the case that, contrary to our methodological assumption, the bidder MTB ratio is a poor proxy for bidder ability.

Our inverse measure of target growth (payout ratio) is found to be insignificant in most of our tests. It is entirely possible that the payout ratio alone is a poor measure of growth. As mentioned previously, in using the payout ratio as our measure of expected growth, we assume that firms will invest their retentions in projects with a similar return profile, a situation that might not be true. In addition, in our descriptive analysis we found that our measure of target payout has a relatively high dispersion relative to the other explanatory variables. Thus, it might also be the case that the noise in our payout ratio obscures any potential effect of this variable on the premium targets obtain during acquisitions.

One result that appears consistently across most of our tests is that the target's volatility is strongly significant and its effect is the one predicted by our model. This is not a minor finding because we are not aware of any theory predicting a relation between target premium and target volatility. Perhaps the most surprising result in our empirical test is that our model is not able to explain the cross-section of CAR during the markup period. This is surprising because two of our four variables were consistently found significant for regressions with the runup and full premium. Even though we are not able to articulate a theoretical reason for this finding, we can argue that abnormal returns during the markup period might be driven by different factors. This conjecture is consistent with findings reported by Schwert (1996). Even though he does not present results for the full premium, he finds that the pre-bid runup and the post-announcement stock price appreciation (markup) are generally uncorrelated.

Conclusions

The literature of real options has brought many lessons and new insights about how rational investment are carried out. Acquisitions and divestitures are important corporate events and one of the major corporate capital investments. In this thesis we start with a very simple motivation, why do we observe abnormal returns during these events? Understanding that acquisitions are latent investments, firms should, according to the Marshallian view, invest as soon as the NPV is zero. By the same token, firms should divest as soon as the NPV of the disinvestment is zero. Under these circumstances, we should observe no abnormal returns during announcements. This is clearly against the findings in the bulk of empirical literature. One potential answer is that firms unexpectedly find potentially profitable acquisitions. What we argue here is that firms rationally wait until the optimal time to exercise their acquisition or divestiture options. This last feature would induce optimal inertia in takeovers and would be the cause of observed abnormal returns.

The model developed in chapter 2 presents a new set of testable hypotheses in relation to likelihood and timing of acquisitions and divestitures, and abnormal returns at the announcement dates. In terms of industry-wide implications, our model predicts that acquisitions should occur sequentially in a given industry, from the most profitable to the least profitable. It implies that early acquisitions in a given industry might signal to the market that more acquisitions are likely in the same industry. In addition, the model predicts that, *ceteris paribus*, industries with higher long term growth, lower volatility, an active or more liquid market for corporate assets, and with higher expected activity in the market for corporate control are more likely to experience acquisitions and divestitures. The model suggests, thus, that controlling for industry characteristics in empirical research is important.

Absent managerial motives, our model predicts that the distribution of gains is asymmetric between bidder and target. Even when the bidder has a comparative advantage in managing the target's resources, the target is able to extract most of this gain as a premium. This asymmetry is more pronounced when firms acquire rapidly growing and volatile firms. Competition among bidders force them to acquire earlier than they would in the absence of competition. This effect reduces bidders CARs at the announcement date. Interestingly, competition does not erode the target's premium and thus it increases the asymmetry of the distribution of gains. The combined wealth effect depends on the timing of the acquisition, and this timing depends on the inertia induced by agents' optimal decisions. In our model, the highest combined excess return during acquisition or divestiture announcements should be observed in industries with high growth and high volatility, and when the buyer faces no competition in the contest.

In our review of the empirical literature in chapter 3, we saw that some empirical regularities found in the extant finance literature are natural outputs in our model. This consistency is interesting because most of these empirical regularities have only been interpreted through the eye of agency theory. Even though our model might be consistent with some empirical regularities, it does not imply its automatic validation. However, we are not aware of any empirical study testing predictions similar to those in our model.

As a preliminary empirical validation, in chapter 4 we tested the simplest prediction in our model: the determinants of targets premiums. Using a sample of 228 completed acquisitions of US targets for the period 1983 - 2001, we find that two of the four hypothesis derived from our model receive empirical support. Consistent with our hypothesis, we find that the target premiums are directly related to our measure of target assets volatility and inversely related to our measure of target undervaluation. Perhaps a unique finding in our empirical test is the relation found between target gains and target volatility. Furthermore, we are not aware of any theory, other than our model, predicting such a relation. Even though there is previous empirical evidence indicating a relation between target undervaluation and bidders gains, the relation between target undervaluation and target gains has to our knowledge not been reported previously. This finding thus indicates that targets are able to share part of the value the bidder expects to realize in corporate acquisitions.

Based on our findings in chapter 4 and our discussion in chapter 3, it would be exaggerated to jump to the conclusion that our model is able to explain what we observe in corporate acquisitions. However, we believe that our theoretical and empirical findings are worth further exploration in future research. It is important to bear in mind that the impossibility of perfect contracting makes agency theory surely an important aspect in corporate finance. In this sense, what we propose in our model should be considered as an alternative hypothesis that, in conjunction with agency, might help improve our understanding of corporate acquisitions.

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