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Why Do Merger Premiums Vary Across Industries and Through Time?

Explaining merger premiums by time-varying industry factors

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Abstract

To understand how merger premia vary across industries and over time, we analyze 1184 deals involving US public targets and acquirers between 2010 and 2020. The variables and methodology are inspired by Madura, Ngo & Viale (2012) who examined merger premiums on US public targets and acquirers between 1986 and 2007.

We use random effects regressions to study cross-sectional variation in average merger premiums per industry per quarter, and time-series variation among quarters per industry. Therefore, our unit of analysis is industries, rather than individual deals. We also create separate sub-samples and analyze differences between the medium of payment.

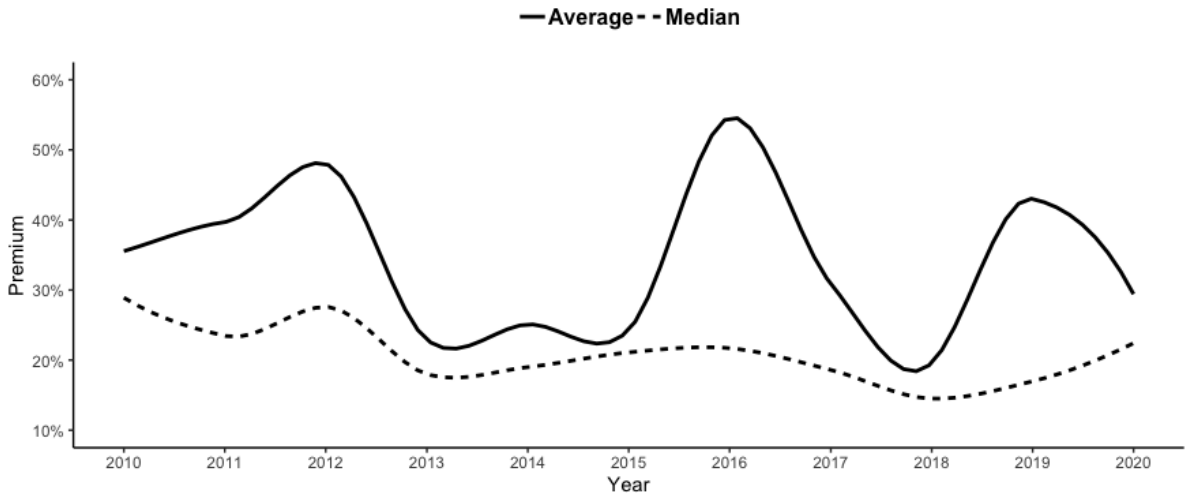
Overall, we are unable to replicate the results of Madura et al. (2012). Specifically, in our total sample and in our sub sample on cash, we identify a positive relationship between premiums and Tobin's Q. We also observe a negative relationship between GDP growth and premiums in our total sample. In contrast and regardless of the medium of payment, Madura et al. (2012) found that premiums were positively related to industries experiencing strong growth, industries with high levels of R&D expenditures, and highly concentrated industries.

However, similar to Madura et al. (2012), we find that there is variation in quarterly average premiums among industries for a given quarter, indicating that the cost of a merger is segmented by industries. This means that acquirers may need to pay higher premiums for targets in certain industries and at certain times.

To test the robustness of the methodology presented by Madura et al. (2012), we conduct disaggregated OLS regressions. As measuring at the industry level yields small variations among the variables, we run regressions on individual takeover premiums. Instead of regressing industry averages, we conduct OLS regressions on individual target-specific factors. We also assign each target with their corresponding industry values for variables that cannot be measured at the individual level.

Our robustness test suggests that not all papers on this subject are replicable, and that the methodology presented by Madura et al. (2012) may have certain challenges in explaining premiums.

Figure 1: Average aggregate takeover premium



Preface

This master thesis concludes our MSc, with specialisation in Finance, at NHH.

Ever since the start of our studies we have been interested in mergers and acquisitions. This interest led us to write our thesis on merger premiums, adding to existing research and expanding our knowledge. Our desire is to reveal new insights and motivate further research.

We would like to express our greatest gratitude to Tommy Stamland, our supervisor this semester. His expertise has been crucial, both for our progress and results. Especially in terms of guidance on econometric methodology, he has been decisive.

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1. Introduction

Acquisitions are considered the quickest route for companies to reach new markets and new capabilities (Rappaport & Sirower, 1999). The market for mergers and acquisitions has seen significant growth since the 2000s and is expected to become an increasingly important part of corporate strategies mowing forward. As consolidation of companies are complex processes that require substantial investments, M&A`s are considered milestones for targets and acquirers involved. Hence, comprehensive research has been done in order to quantify the variety in premiums paid. Most of the research is focused on the characteristics of the bidder, the deal or the target. Some of the most notable publications (e.g., Sirower, 1997) discovered that acquirers are willing to pay more than the market value of a company either because of potential synergies or due to CEO hubris (Hambrick, 1997).

However, there have been few attempts to understand and explain why premiums vary among industries and over time. Given that the M&A market is composed of many partially segmented industries, premiums may be influenced by industry conditions. Madura et al. (2012) attempted to identify these factors in their paper "Why do merger premiums vary across industries and over time?", using merger data from 1986-2007. The study, published in The Quarterly Review of Economics and Finance, sought to identify macroeconomic and time-varying industry factors that explain variations in premiums.

To our knowledge, there have been no similar studies on the US market in recent years that consider both time and cross-sectional variations among industries. Most studies focus on target and market characteristics, but there may also be variations among industries and over time. Therefore, similar to Madura et al. (2012), we attempt to explain premiums by considering macroeconomic and industry factors. Our intention is to complement existing research on how target-specific factors affect premiums by providing an industry perspective.

Given the significant changes in economic growth and macroeconomic factors since the financial crisis, it would be interesting to assess the subject of why merger premiums vary across industries and over time using more recent data. In particular, considering that interest rates have been low since 2007-2008. Therefore, we analyze the period from 2010 to 2020 with the goal of developing a deeper understanding of M&A premiums and providing meaningful insights.

1.1 Structure of the Thesis

In this study, we review relevant literature on M&A, synergies, and premiums, as well as well-known studies on the topic of our thesis in Section 2. In Section 3, we motivate the inclusion of the variables in our analysis and present our hypotheses. We describe the sample collection and methodology used in Section 4 and 5, respectively. In Section 6, we present the descriptive statistics of our data before analyzing the regressions and results in Section 7. We provide robustness checks in Section 8, a conclusion in Section 9, and potential areas for further research in Section 10.

2. Literature Review

In this section, we discuss important aspects of M&A, synergies, and premiums. We then review well-known studies that have investigated the factors influencing variations in merger premiums. Specifically, we summarize studies that examine premiums in relation to characteristics of the deal, bidder, or target, as well as industry factors.

2.1 The M&A market

There are two primary mechanisms by which ownership and control of a public corporation can change: Either another corporation can acquire a target corporation, or the target corporation can merge with another corporation (Berk & DeMarzo, 2020, p. 1001). Either way, the acquiring company must purchase the target`s equity or assets using cash or something of equivalent value (Berk & DeMarzo, 2020, p. 1001).

2.1.1 Types of Mergers

We separate between vertical and horizontal mergers. A horizontal merger is when the target and acquiring entity is in the same industry while a vertical merger is when the target sells to the acquiring industry. Hence, the expansionary effect of the combined entity is either horizontal or vertical. At last, a conglomerate merger, popular in the 1960s, is when the target and acquirer operates in unrelated business (Berk & DeMarzo, 2020, p. 1003).

2.1.2 Methods of Payment

As M&A transactions are substantial investments for the parties involved, one of the most important considerations is how to finance the transaction. Whether the acquirer pays in securities, cash or a combination of securities and cash, can affect the M&A premium.

In a securities payment, the acquirer pays the target company by issuing new shares to the target shareholders. This type of payment is often referred to as a stock-swap transaction. The value of the payment is determined by the exchange ratio, which is the number of acquirer shares received in exchange for each target share, multiplied by the market price of the acquirer's stock (Berk & DeMarzo, 2020, p. 1012).

In stock-based transactions, the risk of achieving synergies is shared between the acquirer and target shareholders. The risk is distributed according to the percentage of the combined company that each party will own (Rappaport & Sirower, 1999). As a result, acquirers often try to convince target shareholders that the synergies resulting from the merger will exceed the premium paid and generate additional profits. To do so, they may present stories or projections demonstrating the potential benefits of the synergies.

In a merger or acquisition, the acquiring company has two options for issuing shares to the target company: a fixed number of shares or a fixed value. In a fixed number of shares deal, the parties agree on the number of shares to be issued, but not the price. This means that the value of the deal can fluctuate between the announcement and the closing date, but the proportional ownership in the combined company remains unchanged (Rappaport & Sirower, 1999). On the other hand, in a fixed value deal, the value of the shares is agreed upon in advance. However, the number of shares issued is not fixed and depends on the price of the shares at the time of the closing (Rappaport & Sirower, 1999).

In a cash deal, the roles of the acquirer and target are clearly defined. The acquirer pays the target a sum of money in exchange for its shares, and the success of the acquisition is determined by whether the expected synergies are realized. As such, the acquirer bears all of the risk associated with the merger. The target, on the other hand, receives a guaranteed payment in the form of cash and is no longer responsible for any potential outcomes of the merger.

When considering the effects of paying in cash, stock, or a combination on the premium in a merger or acquisition, it is important to consider the differences in synergy risks (Rappaport & Sirower, 1999). The method of payment chosen by the acquirer can send a signal to the target shareholders about their confidence in the potential synergies and how they will be realized. An acquirer that is confident in the synergies will typically pay in cash, allowing their shareholders to claim all the potential upside. On the other hand, if the acquirer is uncertain about the synergies, it may be more reasonable to share the risk through a stock offer.

The US economy has experienced a record-breaking period of expansion starting in the 2010s, lasting for 126 consecutive months (Moran, 2020). This trend may have contributed to the popularity of using stocks as a form of payment in business transactions. All-stock deals, in which a company uses its highly valued shares as payment, can dilute the shareholders of the acquiring company by issuing new shares. However, these types of deals also carry less risk of overpayment because they are based on the relative valuation of the two companies involved, rather than the absolute valuation of one company (Hu, 2021).

2.1.3 Types of Acquirers

In general, we divide acquisitions into two categories, strategic and financial. The two categories differ in their business models, both in terms of how they intend to run the business, and their exit strategies.

Strategic buyers are usually operating companies seeking to merge with or acquire a company to create values that exceeds the sum of the two separate entities. This type of value creation is usually referred to as "synergies" by scholars and practitioners. The business strategy of a strategic acquirer is to acquire or merge with companies that will create growth through synergies and strengthen their performance. Most often, target companies are found in the same business area as their acquirers, although some strategic buyers seek to enter new business areas through mergers and acquisitions (Jæger & Ramsnes, 2018). Strategic buyers do not necessarily have an exit strategy, as they usually seek to own the company in perpetuity.

Financial buyers, on the other hand, are typically investment management firms that use funds from investors and debt to acquire companies. They may purchase public companies and delist them or acquire private companies that are already in existence. Their exit strategies often include an Initial Public Offering (IPO) or the sale of the company. Financial buyers typically have an investment portfolio with a duration of five to ten years (Jæger & Ramsnes, 2018).

2.1.4 Types of Acquisitions

In addition to the type of acquirer, the overall atmosphere of the transaction also affects the outcome of a deal process. The general atmosphere can be divided into two types of acquisitions, friendly or hostile.

A friendly acquisition refers to the process in which the management and board of directors of a target company agree to be acquired by an acquiring company (Kenton, Rhinehart & Eichler, 2022). In a friendly takeover, both shareholders and regulators must approve the acquisition for

the deal to proceed. Friendly M&A processes are typically coordinated and cooperative, with both the acquirer and the target working towards a mutually beneficial outcome. The process is usually kept private until the deal is ready to be announced. Friendly takeovers can offer a number of advantages, including a better value deal, all parties working towards a common goal, the target company not being negatively impacted by resistance tactics, and the potential for a more unified company after the takeover (Berk & DeMarzo, 2020). According to Morck, Shleifer, & Vishny (2013), friendly processes are often driven by considerations of synergy.

A hostile takeover is a type of acquisition in which the acquiring company tries to take control of the target company without the consent of the target company's board of directors. The target company's management and board may be unaware of the acquirer's intentions until they are made public. In response, the target company's management and board may attempt to resist the acquisition. To acquire the target company, the acquiring company may make a tender offer to the target company's shareholders, offering to buy their shares. The goal of the acquiring company is to acquire enough shares and stake in the target company to gain control and replace the board of directors.

However, the “free rider” problem might materialize if target shareholders try to keep their shares, hoping others will sell at a low price. Considering none of the shareholders will have an incentive to sell, no shares will be sold. In order to overcome the problem, the bidder can acquire a toehold in the target or attempt a leveraged buyout (Berk & DeMarzo, 2020).

In terms of tender offers, the most effective defence strategy is poison pills. The strategy gives the target shareholders the right to buy discounted shares in either the target or the acquirer (Berk & DeMarzo, 2020). The cost is at the expense of the acquirers’ shareholders, making the merger very expensive.

2.1.4 Merger Waves

Historically, merger activity is cyclical, driven by industry shifts, economies of scale, regulations, and shakeouts in fragmented industries (Hitchcock, Prakash, Negrete, Ramdevkrishna, 2018). The cycle between 1995-2000, or (dotcom) bubble as some will call it, was driven by internet company growth and rapid technological innovation. Thereafter, the bubble burst, and 2000-2003 were characterised by stock market crashes and declining market activity. Increase in overseas exchange reserves, global liquidity and a weak dollar reversed the course and ensured an upward cycle from 2003-2007 (Hitchcock et al., 2018). However, most of it were due to a tightening of regulations that later led to the 2008 crash. The crash resulted

in low activity between 2009-2013 as companies had to rebuild, downsize and concentrate on their core business (Hitchcock et al., 2018). Following that period, 2009-2020 were characterised by the US government providing corporations a helping hand in terms of advantageous funding conditions, quantitative easing and subsidizing, resulting in share price rallies. Many companies took advantage of cheap debt and low interest rates by inorganic growth through the M&A market. In 2021 the merger and acquisitions market hit new hights – exceeding 62 000 deals announced globally (PwC, 2022).

2.1.5 M&A Premiums

Kim & Canina (2013) stipulates M&A premiums as the transaction amount as a percentage of the seller's stock price a day prior to the M&A deal going public.

The risk of paying a high premium stem from the uncertainty regarding potential synergies. For the acquirer, paying too much has consequences as the deal becomes value-destroying for the shareholders (Rappaport, 1999). In cases where the value of the synergies exceeds the premium, the net present value of the project is positive for the acquirer shareholders while the opposite results in a positive net present value for the target's shareholders (Berk & DeMarzo, 2020, p. 1027). In the latter case, as stated in the overinvestment hypothesis (Diaz, Azofra & Gutiérrez, 2009), the premium will have negative consequences for the bidders' returns. Therefore, the premium paid should be in proportion to the expected synergies.

One way to determine if a corporation overpaid for a merger is to examine the stock price reaction of the bidders following the announcement of the merger (Berk & DeMarzo, 2020, p. 1011). During the period from 1980-2005, the stock price of bidders on average increased by 1% after a merger announcement, indicating that the market perceived the premiums paid as being roughly equal to the value of the expected synergies. In contrast, the stock price of the target company typically rose by an average of 15% following a merger announcement (Berk & DeMarzo, 2020, p. 1004).

2.1.6 Synergies and Motives for M&A

Value in M&A derives from the synergistic combination of an acquirer and a target (Feldman & Hernandez, 2022). The possibility to add economic value as a result of the acquisition that the individual entity cannot add alone, is the most common justification bidders give for the premium paid (Berk & DeMarzo, 2020, p. 1004).

Feldman & Hernandez (2022) and their research "*Synergy in Mergers and Acquisitions: Typology, Lifecycles, and Value*" identify typologies based on synergies. The study separates between internal, market power, relational, network and non-market synergies. Internal synergies are considered to have value in terms of efficiency and stems from a combination of resources or capabilities that the targets own directly, resulting in joint increased revenue or lower costs (Feldman & Hernandez, 2022, p. 39). On the other hand, market power synergies are created when assets and industry positions are combined, yielding elimination or weakening of rivals. Other consequences could also be increased buying or pricing power. Relational synergies have value in terms of dyadic relationships and are created by enhancement of assets shared with a third party made possible by the merger (Feldman & Hernandez, 2022, p. 39). Typically, as the third party has a contracted agreement with the merged entity in advance of the deal. Furthermore, networking synergies have value as the combined entity strengthens its structural position and are a consequence of combining the network of the target and acquirer. Typical effects are improved status or centrality of the combined entity. At last, non-market synergies have legitimacy value and stems from combining the targets and acquirers' relationships with non-market stakeholders. This might result in increased legitimacy from stakeholders such as communities or governments (Feldman & Hernandez, 2022, p. 39).

Furthermore, Berk & DeMarzo (2020, p. 1004) separate between cost-reduction synergies and revenue enhancement synergies. However, cost reduction synergies are usually the easiest and most common to achieve due to the overlapping of personnel or operating areas. Some of the most cited justifications by acquirers are economies of scale and scope, vertical integration, expertise, monopoly gains, efficiency gains, tax savings from operating losses, diversification and earnings growth (Berk & DeMarzo, 2020, p. 1005).

Economies of scale and scope are cost savings that result from producing goods in high volume, which small companies are unable to achieve. Vertical integration involves merging companies in the same industry that produce products at different stages of the cycle (Berk & DeMarzo, 2020, p. 1005). In addition, mergers and acquisitions can bring expertise synergies, as the acquiring company may need specialized personnel in certain areas. Monopoly synergies may reduce competition and increase market power, while efficiency gains represent the acquiring company's belief that it can manage the target company more effectively. Synergies related to tax savings from operating losses can occur when conglomerates are able to offset losses in one area with profits in another (Berk & DeMarzo, 2020, p. 1007). Diversification synergies aim to reduce risk and are commonly used by conglomerates. Finally, earnings synergies occur when

the combined earnings per share of two companies is higher than the stand-alone pre-merger earnings per share.

2.2 Research on Why Merger Premiums Vary

In this sub-section, we present studies related to merger premiums and why they vary. First, we assess research that have used bidder, target or deal charactheristics in order to explain premiums. Thereafter, we present studies on how industry conditions might explain premiums.

2.2.1 Bidder, Target or Deal Characteristics Impacting Premium

As previously mentioned, several studies have attempted to explain why premiums vary in mergers. Comment & Schwert (1995) found that poison pills and control share laws were consistently linked to higher premiums, whether or not the takeover was successful. These antitakeover measures increase the bargaining power of selling companies and the costs for acquirers, but do not prevent many transactions. In line with Comment & Swchert (1995), Heron & Lie (2006) also found that poison pills lead to higher bids when using a large sample of unsolicited takeovers.

During the same period, Cotter & Zenner (1994) studied the relationship between managerial wealth and tender offer characteristics. Specifically, they examined how managers react when they receive a tender offer. In situations where managers own a significant portion of the company's shares, their interests are generally aligned with those of the shareholders. However, there may be cases where the interests of the managers and shareholders are in conflict. For example, accepting a tender offer may increase the value of the managers' shares or provide lucrative severance packages, but it could also lead to their displacement. Cotter & Zenner (1994) quantified this trade-off into a ratio of managerial gains to losses. Their results were consistent with those of Jensen & Murphy (1990) and showed that managerial stock ownership has a greater impact on incentives than cash compensation. Additionally, while managerial resistance may reduce the chances of a tender offer being successful, it can also increase the deal premium if it goes through (Cotter & Zenner, 1994).

Several years later, Cotter, Shivdasani, & Zenner (1997) also examined the role of independent outside directors in situations where the interests of managers and shareholders are in conflict. They found that when a target company has an independent board, the initial tender offer premium, the bid premium revision, and the gains for target shareholders are higher.

Additionally, the presence of poison pills and takeover resistance measures tend to lead to higher premiums

More recently, Moeller, Schlingemann & Stulz (2004) investigated the acquirer's size effect in M&As. The studies provided evidence that large companies pay higher premiums after controlling for firm and deal charactheristics. The studies examined over 12 000 acquisitions by public firms from 1980 to 2001. Furthermore, Dong, Hirshleifer, Richardson & Teoh (2006) investigated motivations for takeovers by assessing the empirical relationship between valuations of companies and takeover characteristics. The research discovered how valuations are related to means of payment and premiums paid.

Porrini (2006) took a quite different approach and researched on the role of investment banks in acquisitions. The study investigated transactions-specific attributes under which investment bankers are associated with higher premiums and whether the quality of the bank has any significant impact. By assessing 481 acquisitions between 1988 and 1998, Porrini (2006) discovered that the presence of investment bankers on the acquirers' side have impact on the deal premium.

2.2.2 Industry Conditions Impacting Premium

The aforementioned studies are similar in the way that they all identify how higher expected synergies or increased competition for targets may result in higher premiums. We now present studies that explain the same by industry factors.

Gupta & Gerchak (2002) researched parameters on the production side that might have an effect on the valuation of the target's shares. In specific, if the bidder and target operate in independent markets and the bidder has flexibility in its production facilities, but the target does not, an increase in the product demand for the bidder can make the target less attractive (Gutpta & Gerchak, 2002). Hence, the lack of flexibility reduces the bid that might be offered.

Understanding the clustering of industry mergers through time is an important aspect of M&A research. Harford (2005) suggests that neoclassical theory can be used to explain the occurrence of industry merger waves, which are caused by economic, technological, or regulatory shocks to an industry. However, in order for these shocks to result in a wave of mergers, there must be sufficient capital liquidity. This means that the clustering of merger waves may be influenced by the overall level of capital liquidity, even if the underlying shocks do not change. Mitchell

& Mulherin (1996) also found that patterns in mergers are closely related to economic shocks experienced by industries.

The research conducted by Adam, Dasgupta, and Titman (2007) explored the relationship between hedging decisions and risk exposure for firms. They found that the decision to hedge is influenced by competition and industry characteristics, including the number of firms in the industry and demand elasticity. In particularly competitive industries, there was a greater variety in the decision to hedge or not (Adam et al., 2007). Therefore, industry conditions, such as the degree of heterogeneity in hedging decisions, may impact the premiums paid in mergers and acquisitions.

Toxvaerd (2008) also studied how increased competition for targets might result in higher premiums. At each point in time, an acquirer has the choice to either engage in a merger immediately or postpone the attempt. The upside of postponing might be more favourable terms and market conditions, while the downside is the risk of rivals acquiring the target. The result in a complete information equilibrium, according to Toxvaerd (2008), is that all acquirers immediately and simultaneously engage in the merger. Thus, the increased competition might lead to higher premiums.

At last, Madura et al. (2012) studied merger premiums by a sample of US public targets and acquirers between 1986 and 2007. By assessing industry and macroeconomic factors, regardless of the medium of payment, the research identified a positive relationship between merger premiums and industries experiencing strong growth, industries with more research and development expenditures and highly concentrated industries.

The variables we present in the subsequent section are inspired by the study of Madura et al. (2012).

3.0 Variables

In this section, we present the independent variables included in our analysis. We explain the reasoning for the specific variables, our interest, and related hypotheses.

3.1 Industry Variables Included in our Thesis

Industry Contribution to GDP Growth

One of the most notable publications regarding growth and M&A premiums are "*When Firms Are Desperate to Grow via Acquisition*" by Kim, Haleblian & Finkelstein (2011). The researchers identify that when a company's organic growth is undesirably low, it either stimulates organic growth or merges with another company. Hence, when a company`s growth stagnates and it becomes dependent on merging, the premiums might be artificially high. This was discovered using a sample from the banking industry between 1994 and 2005.

The studies by Kim et al. (2011) identify that when a company experiences low growth relative to its industry peers, it would be willing to pay high premiums. However, if the industry as a whole is subject to weak growth, there would be no desire to acquire similar companies. Therefore, acquirers would attempt to extract synergies from companies in industries with stronger relative growth.

We hypothesize that merger premiums are higher for industries experiencing strong growth.

Industries with strong historical growth are often expected to continue their growth in the future. Following that argument, acquirers should be more attracted to these companies and thereby willing to pay higher premiums. Gains from cutting redundant operations or increasing market shares should also be higher when the corresponding potential industry growth is high (Madura, et al., 2012). If companies successfully redeploy or recombine assets across industries or markets, they may be able to reinvigorate combined growth (Anand & Singh, 1997; Capron, Dussauge & Mitchell, 1998). However, in case of paying high premiums, managers should be aware of the growth necessary in order to extract enough value to justify the sum paid.

Research and Development

Research and development (R&D) expenses are critical for businesses to grow, innovate, and stay competitive. In certain industries, such as the pharmaceutical industry, developing new products and acquiring patents is essential for success. Bena & Li (2014) found that the likelihood of a merger increases when two companies have overlapping innovation activities. Companies with high levels of R&D spending may be attractive to strategic acquirers, as combining their workforce or technology can drive innovation further. In other cases, a company may have a well-developed and highly competent R&D department that lacks sufficient funding to continue operations. In this case, a merger may be necessary to combine

R&D departments, improve innovation, and take advantage of each other's resources. By eliminating duplicated R&D resources and achieving economies of scale, companies may be able to increase investments in other areas, leading to higher revenues and enhanced growth. In these cases, paying a high premium may be justified.

We hypothesize that merger premiums are higher in industries with higher R&D intensity.

There are several ways of proxying a company's capability for innovation. Cambridge University Dictionary (2022) defines R&D as "*the part of a business that tries to find ways to improve existing products and develop new one*s". However, identifying each company's R&D expenses is not a good measure for comparison as expenses vary with sales and the size of the company. Thus, we use R&D intensity which is the ratio of a firm`s R&D expenditures to net revenue. R&D intensity is suitable for comparisons across industries and serves as a proxy for innovation and resources devoted to science and technology (Eurostat, 2022).

It is important to note that a company's R&D intensity (i.e., the proportion of its revenue or assets invested in R&D) does not necessarily indicate the quality, results, or output of its R&D efforts. Research and development (R&D) expenditures can result in varying levels of efficiency and productivity, even when the same amount of money is invested. Some R&D investments may be effective and successful, while others may be inefficient and unproductive. This uncertainty about the predicted cash flows of the target company's R&D investments can create information asymmetry for acquirers. As acquirers may value R&D resources differently, thorough due diligence is often conducted to reduce this asymmetry (Lamannen, 2007).

In view of the information asymmetry problem, Deng & Lev (1998) also identified the signalling effect from acquirers' valuations. If bidders communicate their valuations of the targets R&D assets transparently to the market, it could signal as a new value and justify the higher premiums paid.

It is also worth noting that R&D expenditures only include expenses related to the research and development of a product or service, intellectual property, copyrights, or patents (Finmark, 2022). Other forms of innovation, such as employee training or investments in fixed assets used for innovation, are not accounted for in R&D expenditures (Jägeroos, 2022). Additionally, some companies may conduct R&D through external companies or conglomerates, which can lead to measurement bias in R&D expenditures.

Industry Concentration

In a competitive market, some companies are successful while others are not, leading to a functioning and dynamic capital market where only the strongest survive. However, as some companies generate large profits and control significant portions of the market, the degree of concentration may increase (Bae, Bailey & Kang, 2021). Market concentration and dynamics tend to change as new technologies, companies, products, services, or management strategies enter the market. Additionally, companies that do not adapt to new market trends or refuse to change may be surpassed by their competitors.

However, highly concentrated industries tend to create an urgency for companies to consolidate or merge, resulting in competitive bidding and increased premiums (Madura et al., 2012). As there are fewer potential targets in the industry, the competition increases even more.

We hypothesize that merger premiums are higher in more concentrated industries.

At last, one should bear in mind that "industry" is not necessarily a good indicator for competitors. Even though it is more unusual than not, a corporation could have significant competitors across industries and segments.

Targets Industry performance

There are several ways of proxying a company's operating performance. ROE and ROA are two commonly used measures (Brown & Caylor, 2004).

Cambridge University Dictionary (2022) defines ROE as "*a company's profit for a particular period compared with the amount of share capital in it".* Considering one of the main reasons for a company to exist is to generate income for common shareholders, ROE measures how effectively the share capital is used to create a profit.

We argue, in conformity of the studies by Madura et al. (2012), that well performing industries have better chances of extracting synergies from mergers. This as previous performance might be considered as a signal of continuous performance. In that case, merger premiums should also be higher.

We hypothesize that merger premiums are higher for industries performing well.

Alternative measure of Targets Industry Performance

In resemblance to Madura et al. (2012), we use Tobin's Q as a measure of industry performance. The ratio is measured as the market value of a company to the replacement cost of its assets and

is widely used to determine the relationship between market valuation and intrinsic value. Thus, it is a proxy to determine whether the company, or industry in our case, is relatively undervalued or overvalued.

The theory was initially introduced by Nicholas Kaldor (1996) In his paper "*Marginal Productivity and the Macro-Economic Theories of Distribution: Comment on Samuelson and Modigliani" but* was later picked up by the well-known Nobel laureate James Tobin (1970). Tobin believed the ratio could be important in a macroeconomic manner, serving in the cross section of the capital markets and the market for goods and services.

Later, several comprehensive studies have been conducted to explore the effects of the Q ratio on various corporate phenomena (Pruitt & Chung, 1994). For example, Lang, Stulz, & Walkling (1989) examined the relationship between Q ratios and managerial performance by studying a sample of successful tender offers. They found that shareholders of high Q bidders tended to gain more than shareholders of low Q bidders. Additionally, shareholders of low Q targets benefited more from takeovers compared to shareholders of high Q targets (Lang et al., 1989). In other words, the greatest gains are typically seen in takeovers of poorly managed targets by well-managed bidders.

More recently, Fu, Singhal & Parkash (2016) hypothesised that if Tobin's Q is to be considered a proxy for investment opportunities, we should observe a positive relationship between the ratio and the operating performance of the company. In order to test the hypothesis, the researchers identified a sample of US publicly traded companies and proved that companies with higher Q ratios perform significantly better in the long run (Fu et al., 2016)

We hypothesize that merger premiums are higher for industries with higher Q ratios.

Volatility of Industry Valuation

Over the past decade, the US economy has experienced a record-long period of expansion, lasting 126 consecutive months (Moran, 2020). This bull market in US stocks was the only one in the past 170 years to go a full decade without a recession (Moran, 2020). During this time, the overall level of equity volatility was lower than the historical average, as evidenced by the Gboe Volatility Index (VIX), also known as the "fear index", which ended the decade at about a third of its average (Ahmed, 2019). However, some industries, such as technology and consumer staples, had higher levels of volatility, with historic volatilities of 16 and 11.3, respectively (Moran, 2020).

When stocks are used as payment in acquisitions, industry valuation uncertainty becomes relevant because it can lead to higher premiums as the risk is shared between the parties. If the potential synergies are not realized, some of the losses may be borne by the target shareholders, which means that the seller is penalized compared to a cash deal. Therefore, we argue that industries with higher valuation uncertainty should command higher premiums.

We hypothesize that merger premiums are higher for industries with higher volatility of valuation.

4. Data

In order to form a sample appropriate for testing our hypotheses, we use four different databases. The process of downloading and structuring such data is time-consuming, but also necessary in order to obtain credible results. In this section, we will describe the process of creating our sample.

4.1 SDC Database

We use the Securities Data Company (SDC Premium) database to identify relevant acquisitions. The database includes global deals and includes information on 150 data elements, sourced from direct submissions from banking and legal contributors as well as research across various sources such as regulatory filings, corporate statements, media outlets, and pricing wires (Wharton wrds, 2016). In addition to identifying deals, we also use the SDC database to collect information on deal characteristics such as the announcement date, transaction value, price per share, and target industry.

4.1.1 SDC Criterion

To ensure that our hypotheses are testable, we create a sample of mergers with a proper mix of industries. The time period is from 1/1/2010 to 31/12/2020, and the sample contains deals with public U.S. acquirors and targets. Tender offers, uncompleted deals and partial acquisitions are excluded. Tender offer processes might disturb our inference of premiums while withdrawn deals are not directly comparable to completed deals. At last, partial acquisitions are not directly comparable to change of control acquisitions, as the premiums arguably are smaller.

After applying appropriate filters, our sample consists of 1184 transactions from the SDC Database. Our steps to the final sample is displayed in table 1, while parts of the sample distribution are displayed in table 2 and 3.

Table 1: Steps to final sample

Sample Filters	#Of deals
Date Announced: 1.1.2010 to 31.12.2020	
Acquiror Public Status: Public	40136
Target Public Status: Public	9524
Deal Status: Completed	2924
Acquisition Technique: Not Tender Offer	2427
Form of the Deal: Not Partial Acquisition	2260
Target Nation: US	2260
Acquirer Nation: US	2036
Complete Premium Information	1197
Targets within our range of SIC codes	1184

Table 2: Sample distribution by target industry

Industry	Count	Percent
Banks	370	31.20
Finance, Insurance and Real Estate	154	13.00
Manufacturing	305	25.80
Mining	62	5.24
Retail	28	2.36
Services	155	13.10
Transport and Communication	57	4.81
Utilities	53	4.48
Total	1184	100

Table 3: Sample distribution by payment form

Payment Form	Count	Percent
Cash	470	39.70
Stock and mixed	714	60.30
Total	1184	100

In order to calculate our variables, we separate targets by industries. The industries we use are grouped by two-digit SIC codes (1) Banks (code 60); (2) Finance, Insurance, and Real State (codes 61–67); (3) Manufacturing (codes 20–39); (4) Services (codes 70–89); (5) Transportation and Communications (codes 40–48); (6) Mining (codes 10–14); (7) Retail Trade (codes 52–59); and (8) Utilities (code 49).

SDC also provides data on target and acquirer SIC codes, premium one day prior to announcement, deal numbers, price per share, target share price one day prior to announcement and CUSIPs. This allows us to structure our data and create our dependent variable "premium".

Premium

The variable "premium" is calculated by subtracting the stock price one day prior to the deal announcement from the transaction price per share and dividing by the stock price one day prior to the deal announcement. Thereafter, we average all premiums belonging to the same quarter and industry. In other words, we calculate the average quarterly premium for 44 quarters and 8 industries.

As an example, all deals announced in the "Manufacturing" industry in Q1 2011 is used to calculate the average industry premium that quarter: Q1 2011. In order to assign deals to a specific quarter, we make use of deal announcement dates.

$$\frac{Transactions\ price\ per\ share - Stock\ price\ one\ day\ prior\ to\ announcement}{Stock\ price\ one\ day\ prior\ to\ announcement}$$

4.1.2 Compustat and other Databases

Financial information is primarily collected through the Compustat North America Database from S&P 500 Global Market Intelligence. The database includes U.S. and Canadian fundamentals and market information on active and inactive publicly held companies (Wharton wrd, 2022). In addition, we make use of the Bureau of Economic Analyses (BEA) and Kenneth French`s website.

These variables are meant to explain why premiums vary based on industry characteristics. All variables are in the entity of industries and quarters.

R&D

We proxy our independent variable "R&D intensity" by research and development to net sales. In order to extract the necessary data, we make use of Compustat's "Financial Ratios Firm Level by WRDS" subordinated to "Financial Ratios". However as "Financial Ratios Firm Level by WRDS" only produces monthly values, we calculate quarterly values by averaging the monthly values in each quarter.

In other words, we extract monthly R&D values for all targets in all years in our sample. Thereafter, we calculate the average industry R&D value for all quarters.

As an example, the average industry premium for "Manufacturing" in 2011 Q2 is assigned the average industry R&D value the corresponding quarter. Thus, we get R&D data on 44 quarters and 8 industries. Ticker codes for all target companies are used in order to extract data from the Compustat database.

ROE

In similarity with the R&D variable, we make use of Compustat's "Financial Ratios Firm Level by WRDS" subordinated to "Financial Ratios". However, as "Financial Ratios Firm Level by WRDS" only produces monthly values, we calculate quarterly values by averaging the monthly values in each quarter.

In other words, we extract monthly ROE values for all targets in all years in our sample. Thereafter, we calculate the average industry ROE value for all quarters.

As an example, the average industry premium for "Manufacturing" in 2011 Q2 is assigned the average industry ROE value the corresponding quarter. We get ROE data on 44 quarters and 8 industries.

Ticker codes for all target companies are used in order to extract data from the Compustat database.

Tobin's Q

In order to get to the Q ratio, we identify each targets outstanding shares per month, end of the month share price, book value of equity per quarter and assets total per quarter. However, as outstanding shares and end of the month share price were extracted in monthly values, we proxy quarterly values as the last day of the month in March, June, September and December.

In other words, we calculate the Tobin's Q value for all targets in all quarters. Subsequently, we average all Tobin Q values belonging to the same industry and quarter. As an example, the average industry premium for "Manufacturing" in 2011 Q2 is assigned the average industry Tobin's Q value the corresponding quarter.

Ticker codes for all target companies are used in order to extract data from the Compustat database and match average quarterly industry premiums with average quarterly industry Tobin's Q values.

In specific, we make use of Compustat's "Security Monthly" and "Fundamentals Quarterly". We get Tobin's Q data on 44 quarters and 8 industries.

Formula used to calculate Tobin`s Q:

$$\frac{(\#OutsShares \cdot End\ of\ the\ month\ Shareprice - Book\ value\ of\ Equity + Assets\ Total)}{(Assets\ Total)}$$

HHI

Herfindahl's Index (HHI) is calculated by dividing the market share of each company in an industry by the total market share in the industry, squaring each of the values and adding the numbers together. We calculate HHI for all companies in the same industry based on their revenues for each quarter.

As an example, the average industry premium for "Manufacturing" in 2011 Q2 is assigned the industry HHI value for the corresponding quarter.

To measure market share, we use sales as a proxy. For instance, we calculate the market share of company X by its sales divided by the total sales of all companies in the respective industry and quarter.

We extract sales for all companies in the Compustat database. Thereafter, we sort the companies based on our two-digit SIC code classification. In specific, we make use of Compustat's "Fundamentals Quarterly". We get HHI data on 44 quarters and 8 industries.

$$Herfindahl\ Sales\ Index\ =\ \sum_{i=1}^{n} Sn^2 = Sn^2 + Sn^2 + \cdots + Sn^2$$

$$S_n = the\ market\ share\ percentage\ of\ firm\ n$$

GDP Growth

Industry growth is measured by extracting real value added per industry per quarter. We use real value to capture real growth and not inflationary effects. Thus, by calculating the growth rate each quarter, we separate the growth each industry adds to GDP. The base year of the inflation adjustment (chained dollars) is 2012. The formula used to calculate growth rate per industry is the percentage change in billions of 2012 chained dollars added to GDP per quarter.

The variable "GDP Growth" is extracted from the Bureau of Economic Analysis (U.S Department of Commerce, 2022). BEA is an independent federal statistical agency that offers a better understanding of the US economy through objective and accurate economic data. The BEA is, among other measures, well known for the closely watched gross domestic product (GDP) and trade balance. These indicators, as well as our statistical measure of interest "GDP per industry", are important in decisions made by policymakers and the public.

For instance, we look at how many billions of 2012 chained dollars the service or manufacturing industry has contributed to GDP for a certain quarter and calculate the percentage growth from the previous quarter.

As an example, the average industry premium for "Manufacturing" in 2011 Q2 is assigned the industry growth for the corresponding quarter. Hence, we get quarterly growth rates on 44 quarters and 8 industries.

Example:

$$\frac{Growth\ 2011Q3 = (Real\ Value\ added\ 2011Q3 - Real\ value\ added\ 2011Q2)}{(Real\ value\ added\ 2011Q2)}$$

Volatility of Valuation

We extract our independent variable "Volatility of Valuation" from Kenneth French`s Website. We sort on "Industry Portfolios", more precisely "Average Equally Weighted Monthly Returns" subordinated to "Fama French 48 Industries". Subsequently, we restructure the data by industry groups using two-digit SIC codes. For example, the SIC codes "Manufacturing" (20-39) are equivalent to the groupings Food, Soda, Beer, Smoke, Toys, Books, Household, Clothes, Medex, Drugs, Chemichals, Rubber, Textiles, BldMt, Steel, FabPr, Mach, ElEc, Auto, Aero, Ships, Guns, Comps, Chips, LabEq, Paper and Boxes.

We calculate the volatility for each quarter, per grouping, by the standard deviation of the monthly returns. To get the volatility for "Manufacturing" we add all volatility values belonging to the same quarter and divide by the number of groupings. In other words, we average the volatilities for all groupings subordinated to "Manufacturing". However, industries such as "Utilities" only have one grouping, meaning we can calculate the volatility of returns directly from Fama French 48.

As an example, the average industry premium for "Manufacturing" in 2011 Q2 is assigned the volatility value for the corresponding quarter. Hence, we get volatility values on 44 quarters and 8 industries.

5. Econometric Methodology

In this section, we present the econometric methodology used to quantify our hypotheses. We make use of a static panel to assess the mean quarterly premium per industry, as we have data containing both cross-sectional and time-series dimensions. Hence, we capture cross-sectional variation among industries per quarter, and time-series variation among quarters for a particular industry.

Our independent variables are all continuous and serve with the purpose of explaining premiums. First, we assess the regression model used to explain premiums regardless of medium of payment. Thereafter, we describe the regressions models separated into payment by cash and payment by stock.

5.1 Random Effects

Datasets that have both cross-sectional and time-series dimensions are being more and more used in empirical research (Wooldridge, 2019, p. 426).

When assessing a time series dimension and a cross-sectional dimension, Wooldridge (2019, p. 426) separate between independently pooled cross section data and panel data. Independently pooled crossed section data is obtained by sampling randomly from a population at various points in time, while panel data attempt to observe the same individuals through time.

In terms of panel data, both the fixed effects and the first difference estimators transforms the unobserved effects (a) ahead of estimation. These methods subtract the time averages from the corresponding variables, ensuring that time-constant factors are removed, while random effects only extract part of the time averages (Wooldridge (2019, p. 426).

$$Cov(Xitj, ai) = 0,\ t = 1{,}2 \ldots\ldots, T; j = 1{,}2, \ldots., k$$

In resemblance with Madura et al. (2012), we make use of random effects as this is the most suited model when the sample is a random drawing of a population viewed as a large set of

individuals (Nerlove & Balestra, 1996). Our model is consistent with the methods of Madura et al. (2012) as it consists of a population of transactions.

However, in order to use random effects, we must assume that the unobserved effects are uncorrelated with the explanatory variables (Wooldridge, 2019, p. 462). Furthermore, we must believe any remaining neglected heterogeneity only causes serial correlation in the error term and not correlation between the errors and explanatory variables.

5.2 Random Effects Regressions

As some variables might be more relevant than others in explaining premiums, we are cautious when building up our regression model. This as including too many variables might cause overspecification in the model. Hence, in in order to capture the most accurately specified model, we run regressions with different numbers of variables. In addition, we use techniques such as backward and forward selection.

Furthermore, we run various diagnostic tests to control for heteroskedasticity, multicollinearity and potential model misspecifications (see section 8 for detailed robustness analysis).

To test whether our variables on industry characteristics are significantly able to explain variation in premiums, we make use of random effects regressions with "premium" as a dependent variable. Furthermore, by creating subsamples separated by means of payment we can assess the relevance of our variables controlling for choice of payment. Thus, we create regression 2 (stock and mixed) and regression 3 (all cash).

Random Effects Regression 1: (Definitions in table 4) - Total sample

This includes all deals in our sample.

$$premium\ i,t = \beta 1 TobinsQ\ i,t + \beta 2 HHI\ i,t + \beta 3 ROE\ i,t + \beta 4 R\&D Intensity\ i,t + \beta 5 GDPi,t + \beta 6 Volatility\ i,t$$

Random Effects Regression 2 (Definitions in table 4) – Sub sample on stock and mixed

This includes all deals with stock or a mix of stock and cash, as the medium of payment.

$$premium\ i,t = \beta 1 TobinsQ\ i,t + \beta 2 HHI\ i,t + \beta 3 ROE\ i,t + \beta 4 R\&D Intensity\ i,t + \beta 5 GDPi,t + \beta 6 Volatility\ i,t$$

Random Effects Regression 3 (Definitions in table 4)– Sub sample on cash

This includes all deals with 100% cash as the medium of payment.

$$premium\,i,t = \beta 1 TobinsQ\,i,t + \beta 2 HHI\,i,t + \beta 3 ROE\,i,t + \beta 4 R\&D Intensity\,i,t + \beta 5 GDPi,t + \beta 6 Volatility\,i,t$$

Table 4: Variable Definitions

GDP	*GDP is the average industry growth rate*
HHI	*HHI is a proxy for industry concentration*
Premium	*Premium is the average premium per industry*
R&D Intensity	*R&D Intensity is the industry average research and development to net sales ratio.*
ROE	*ROE is the industry average return on equity*
TobinsQ	*TobinsQ is the industry's average TobinsQ ratio*
Volatility	*Volatility is the average volatility of valuation for the industry.*

5.3 ANOVA

We make use of ANOVA in order to compare means between industries in our sample. ANOVA tests is not enough to interpret causal relationships but are relevant for understanding what might be driving the differences in our sample. Thus, the subsequent section on descriptive statistics provides analyses both through time and across industries.

6. Descriptive Statistics

In this section, we provide detailed insights and descriptive information about our sample. Both cross-sectional, between industries, but also through time.

6.1 Deal Overview

As mentioned, and in conformity with our sample, the time period 2010-2020 has been characterised by the US government providing corporations a helping hand in terms of advantageous funding conditions, quantitative easing, and subsidizing, resulting in share price rallies (Hitchcock et al., 2018). Low interest rates also enabled companies to access cheap debt

and take advantage of M&As. Thus, the average yearly premiums are to be considered high through the entire decade in our sample.

Table 5: Deal premium: summary statistics

Year	Mean	Median	SD	Min	Max
2010	37.70	30.30	44.30	-66.67	177.90
2011	30.50	18.84	62.80	-79.60	390.20
2012	48.07	27.20	132.00	-99.90	1330.70
2013	22.90	18.00	31.90	-78.50	164.00
2014	25.20	19.14	32.30	-90.20	151.60
2015	24.48	21.19	32.30	-66.00	219.00
2016	55.08	21.66	28.40	-47.30	3140.30
2017	31.32	18.10	54.80	-49.40	405.80
2018	17.45	13.76	34.40	-91.50	287.10
2019	59.68	17.99	31.40	-99.70	3039.40
2020	25.23	22.20	22.22	-13.80	165.60

There are also differences across industries in our sample. As an example, the average premium in the service industry between 2010-2020 were 67.70% compared to 19.70% in the utility industry and 13.77% in the retail industry (see table 5). Our sample is quite balanced in terms of deals per year, but we see a reduction in deals in 2020 (see table 4). A plausible explanation might be Covid-19 and a universal reduction in purchasing power.

Table 6: Deal premium: summary statistics per industry

Industry	Mean	Median	SD	Min	Max
Banks	33.50	18.60	81.80	-79.70	1330.70
Finance, Insurance and Real Estate	20.20	13.00	40.30	-51.90	390.20
Manufacturing	32.20	26.75	43.50	-99.98	300.00
Mining	23.37	19.09	39.32	-91.58	165.58
Retail	13.77	10.47	31.40	-99.70	94.03
Services	67.70	22.14	348.60	-37.20	3140.30
Transport and Communications	24.40	25.34	31.40	-55.20	108.33
Utilities	19.70	15.58	20.60	-17.80	83.45

Figure 2: Average premiums for the banking, manufacturing, and service industry

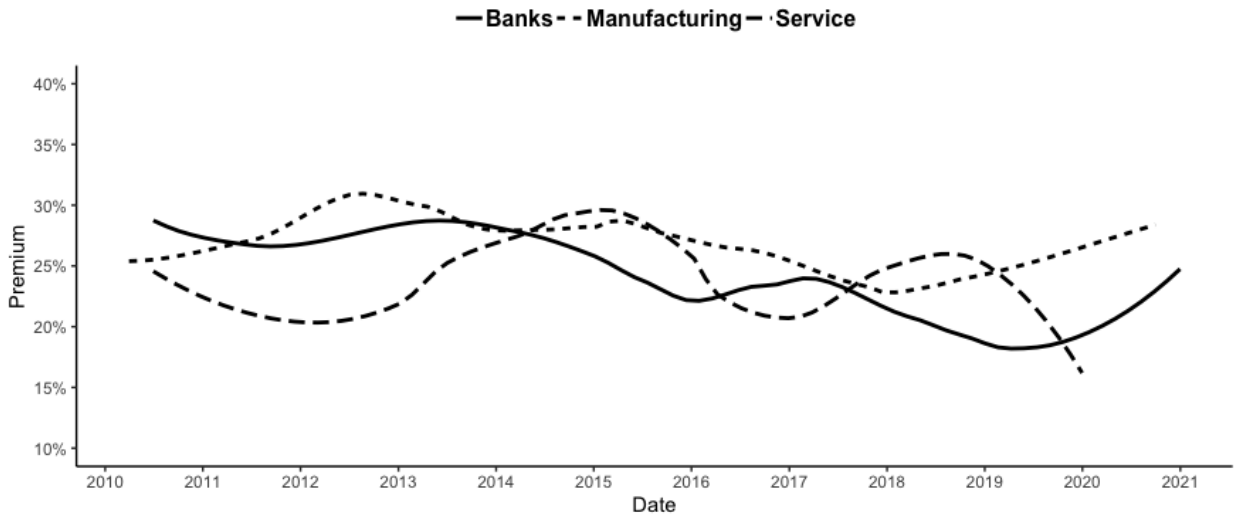

Table 7: Deal sample distribution

Year	Count	Percent
2010	99	8.36
2011	85	7.18
2012	110	9.29
2013	114	9.63
2014	135	11.40
2015	133	11.23
2016	120	10.14
2017	110	9.29
2018	131	11.06
2019	92	7.77
2020	55	4.59
Total	1184	100

6.2 Variable Overview

In this sub-section, we present differences across our independent variables. In specific, we conduct ANOVA tests.

Table 8: Average variable values

Variables	Industry							
	Banks	F.I.R.	Manuf.	Mining	Retail	Service	Transp.	Util.
Premium	33.5	22.20	32.20	23.37	13.37	67.70	24.40	19.70
Tobin	0.98	1.03	1.39	1.39	1.71	1.68	2.21	0.98
HHI	0.04	0.02	0.01	0.03	0.06	0.02	0.02	0.04
ROE	0.03	0.08	0.00	-0.25	0.01	-0.02	0.02	0.03
RnD	0.00	0.02	1.28	0.01	0.00	0.06	0.03	0.00
GDP	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
Vol	3.87	4.38	5.36	10.17	5.06	5.25	4.98	3.87

In the ANOVA analysis we test for differences in means in our sample. The results indicate that there is a significant difference in means in every variable except "R&D expense", between the industries. However, as the ANOVA test examines means across the entire time period without controlling for time dimensional differences, the tests does not necessarily tell the whole story. See appendix A.4.5 for complete ANOVA.

In order to better understand the variation between industries, and how the variables might affect premium, we turn to regression analyses.

7. Results

In this section, we examine the results from our random effects regressions presented in section 5. The descriptive statistics in section 6 gave valuable insights into how premiums vary, both through time and among industries. However, our desire is to gain a deeper understanding of how our industry variables affect premiums. Therefore, we now analyse our regression results in order make inference about our hypotheses.

7.1 Random Effects

Our Hausmann specification test states that random effects is the optimal model for our analysis (see appendix A.5.5).

In the table below, we present the results from our random effects regression. Contrary to what we expected, our hypothesis and previous research, there are some differences. As an example, and regardless of the medium of payment, Madura et al. (2012) identified a positive relationship between merger premiums and industries experiencing strong growth, industries with more research and development expenditures and highly concentrated industries.

Specifically, in Madura's study, GDP and R&D is significant at the 1% level regardless of the medium of payment. In addition, HHI is significant at the 1% level in the sample of stock and mixed, but at the 5% level in the total sample and in the cash sub-sample.

Table 9: Random Effects regression output

	Dependent variable: Premium		
	Total sample of mergers	Cash sub-sample	Stock sub-sample
Tobin's Q	0.419***	0.836**	-0.066
	(0.130)	(0.393)	(0.070)
Herfindahl's Index	-0.557	3.954	1.259
	(4.593)	(11.346)	(2.422)
Return on Equity	0.002	-0.004	-0.001
	(0.006)	(0.016)	(0.003)
R&D	0.0002	0.019	-0.025
	(0.071)	(0.220)	(0.031)
GDP Growth	-2.880**	-2.489	0.591
	(1.131)	(4.676)	(0.596)
Volatility of Valuation	0.010	0.019	0.008
	(0.011)	(0.040)	(0.006)
Constant	-0.315	-1.047	0.290**
	(0.265)	(0.734)	(0.132)
Observations	352	184	257
R^2	0.050	0.026	0.015
Adjusted R^2	0.033	-0.007	-0.008
F Statistic	18.147***	4.778	5.028

Note: Standard errors in parenthesis *p<0.1; **p<0.05; ***p<0.01

According to our hypothesis, we expect merger premiums to be higher for industries with higher Q ratios. Tobin's Q is positively related to premiums in our total sample and in our cash sub-sample. A result that is statistically significant at the respective 1% and 5% level.

As the ratio is a measure of the market value of a company to the replacement cost of its assets, it is widely used to determine whether companies are overvalued or undervalued. Some

researchers would therefore argue that a lower Tobin's Q value should make investors require a higher compensation for a lower market to book value of equity ratio.

One the other side, Lang et al. (1989) suggests that companies with higher Q ratios are better managed than companies with lower Q ratios. An attempt to generalize the argument by Lang et al. (1989), would imply that companies in industries with higher Q ratios are better managed than companies in industries with lower Q ratios. However, as our entity of analysis is industries and not companies, we are not able to say anything about whether the quality of management is related to premiums or Q values. It is more likely that the Q ratio represents other characteristics that in some way vary with industries.

Additionally, Fu et al. (2016) discovered that if Tobin's Q is a proxy for investment opportunities, there should be a positive relationship between the ratio and operating performance, justifying a higher premium. Even though we cannot say anything about whether Q ratios indicate strong operating performance or well managed companies, we see a positive relationship between high Q values and industry premiums. Hence, industries with a high average level of Tobin's Q values should be able to generate higher synergies and premiums.

HHI, ROE, R&D and Volatility is not statistically significant regardless of the medium of payment. Thus, we are not able to provide evidence to support our hypotheses of higher industry HHI, ROE, R&D and Volatility, leading to higher premiums. Furthermore, we are not able to provide support for our hypothesis of higher industry GDP growth leading to higher premiums, as the variable is negatively related to premium at the 5% level in our total sample.

One possible explanation on the latter, might be related to the more or less continuous GDP growth in the last decade. This may have led to increased bidding activity and competition from acquirers in quarters when certain industries experienced slower growth, driving up premiums. As a result, the required return from the market may have decreased if it was assumed that low quarterly growth would continue, leading to more attractive deals at lower prices.

However, the more or less continuous GDP growth in the last decade has caused low year-to-year variation. Consequently, it might be hard to explain premiums as the variation among industries might be even smaller. Following that reasoning, it arguably makes sense that Madura et al. (2012) identified a positive relationship between GDP growth and premiums, as the period 1986-2007 were characterized by more volatility. Thus, it should be more variety in the growth between industries as well.

Even though our results are representative for another period of analysis, we are not able to replicate the study by Madura et al. (2012). Thereby, the results have implications for the robustness and might indicate that there is no regularity in the population, or that the relationship is more complex than reflected in the estimated model. Consequently, we proceed by conducting a disaggregated OLS robustness regression on individual deals (see section 8.4).

8. Robustness

In this section we discuss challenges related to interpreting our results as causal, looking closer into heteroskedasticity, multicollinearity, misspecification and omitted variable bias. We conduct robustness tests and correct our analysis accordingly. At last, we run a more comprehensive robustness test by a disaggregated OLS regression.

8.1 Causality

In our total sample and in our sub sample on cash, we identify that a higher industry Tobin's Q indicate higher premiums. As well as a negative relationship between industry GDP growth and premiums in our total sample. Nevertheless, we are careful in interpreting a causal relationship between the variables and premiums.

There may, for instance, be other variables and factors not included in our sample that explains why premiums vary, violating the Gauss Markov assumption of omitted variable bias. Examples of such could be volatility of GDP growth in each industry, policies on industries or capital liquidity. The latter two, were both statistically significant in the studies by Madura et al. (2012), regardless of the medium of payment.

We measure premium by subtracting the stock price one day prior to the deal announcement from the price per share and dividing by the stock price one day prior to the deal announcement. However, there might be situations where rumours of the deal are leaked to the public, disrupting our measurement of the stock price prior to the deal announcement. In such cases, the price might rise significantly prior to the announcement. However, we argue this concerns a minority of the deals.

At last, we assess the robustness of the methodology presented by Madura et al. (2012). In specific, we conduct a disaggregated robustness test using cross-sectional data and OLS regressions (see 8.4 on methodology robustness).

8.2 Heteroskedasticity

Heteroskedasticity does not cause bias or inconsistency in the estimator, but the standard errors and test statistics are no longer valid (Wooldridge, 2019, p. 263). In order to test for heteroskedasticity, we conduct a Breusch-Pagan test to determine whether there is a pattern in our residuals. The Breusch-Pagan test involves regressing the squared residuals on the independent variables and are in similarity with the White test a well-known procedure (Wooldridge, 2019, p. 270). In addition, we also plot the residuals and examine the patterns ourselves.

Plotting our residuals and the Breusch-Pagan test indicates the presence of heteroscedasticity. Nevertheless, there is a potential issue that can arise when attempting to correct for heteroscedasticity in econometric models. This issue is related to the fact that the correction itself is something that needs to be estimated and, like all estimates, it is subject to error. As a result, the correction process itself can introduce additional errors, potentially outweighing any benefits gained from the correction. To illustrate this, consider the scenario where a correction for heteroscedasticity is applied to a sample that is actually homoscedastic. In this case, the correction would only serve to introduce errors, rather than remove them. Additionally, it is not always possible to know with certainty whether a correction is necessary or whether it will actually lead to an improvement in the model, as the characteristics of the population cannot be directly observed in a sample. This means that, in some cases, using a simple linear regression model (OLS) may be more appropriate.

8.3 Multicollinearity

High, but not perfect, correlation between two or more variables is called multicollinearity (Wooldridge, 2019, p. 90). In fact, multicollinearity violates none of the Gauss Markov assumptions but a large beta (β) in relations to its standard deviation might cause a problem. Therefore, we must be aware of high degrees of correlation among our independent variables, but also small sample sizes.

Even though there is no specific number where we can conclude multicollinearity is a problem, there are statistics for individual coefficients (Wooldridge, 2019, p. 90). In order to assess whether our independent variables might have problems of multicollinearity, we conduct a VIF test.

The test clearly indicates (see appendix A.5.1) that our independent variables do not suffer from multicollinearity, with an average VIF-value close to 1.

8.4 Methodology Robustness

As a robustness check, we run disaggregated OLS regressions on our sample. As measuring on an industry level yields small variations among the variables, we run regressions on individual takeover premiums. Hence, instead of using industry averages, we conduct OLS regressions using individual target-specific R&D, ROE and Tobin's Q. In addition, we assign each target with their corresponding industry values on GDP, Volatility and HHI. Thus, the industry variables are assigned to each individual target, as opposed to our aggregated analysis where the entity of interest were industries. This sub-section provides details on how we collected our sample and calculated our variables. However, we start by assessing the results.

Table 10: Disaggregated OLS regression

	Dependent variable: Premium		
	Total sample of mergers	Cash sub-sample	Stock sub-sample
Tobin's Q	0.0001*	-0.007	0.00003
	(0.0001)	(0.021)	(0.0001)
Herfindahl's Index	-0.021**	-0.036***	-0.007
	(0.009)	(0.014)	(0.013)
Return on Equity	-2.039**	-3.626**	-0.524
	(0.923)	(1.517)	(1.224)
R&D	0.025***	0.022***	0.073***
	(0.006)	(0.006)	(0.023)
GDP growth	0.183	-1.223	0.767
	(0.550)	(1.249)	(0.598)
Volatility of Valuation	0.010**	0.032***	0.001
	(0.005)	(0.009)	(0.005)
Constant	0.253***	0.181**	0.267***
	(0.036)	(0.073)	(0.047)
Observations	674	292	382
R^2	0.057	0.139	0.037
Adjusted R^2	0.049	0.121	0.022
Residual Std. Error	0.336 (df = 667)	0.347 (df = 285)	0.321 (df = 375)

F Statistic	6.779*** (df = 6; 667)	7.693*** (df = 6; 285)	2.425** (df = 6; 375)

Note: Standard errors in parenthesis *p<0.1; **p<0.05; ***p<0.01

The disaggregated OLS regression, regardless of the medium of payment, indicates a positive relationship between R&D and premiums. The result is in conformity with our hypothesis and statistically significant at the 1% level for all samples.

Therefore, industries with high R&D values are associated with higher premiums in our model. A plausible explanation might be that the R&D expenditures are associated with unexploited and potential synergies. In that context, R&D expenditures is a proxy for future growth. Another explanation, considering we analyse time series data, might be that the industry average merger premium level is positively related to R&D in the industry through time.

The Herfindahl-Hirschman Index is negatively related to premiums in our total sample and in our sub sample on cash. The result is statistically significant at the 5% level for the total sample and at 1% level for the sub sample on cash. Madura et al. (2012) also identified a negative relationship in their sub-sample on cash, but a positive relationship in their total sample.

Our results contradict our hypothesis that merger premiums would be higher for more concentrated industries. A possible explanation for this could be that competition and bidding activity increase in less concentrated industries, driving up premiums. In other words, there may be more acquirors competing in these industries rather than a few companies with dominant market shares. However, it is important to note that the Herfindahl's index, which measures market concentration, is based on simple calculations, and may not fully capture the complexity of certain industries and markets. As a result, HHI may not be a reliable indicator of competition, as corporations may face competition from multiple industries and segments.

Volatility of valuation is positively related to premiums in our total sample in and in our sub sample on cash. A result that is in conformity with our hypothesis and statistically significant at the 5% level for the total sample and at the 1% level for the cash sub-sample.

One possible explanation might be that acquirers attempting to overtake targets in industries with high relative volatility of valuation, are more reluctant to paying by stock. Thus, uncertainty regarding the valuation of targets might give acquirers an incentive to pay by cash. If several acquirers simultaneously engage in the merger, the increased competition might lead to higher premiums.

ROE is negatively related to premiums in our total sample and in our sub sample on cash. Both results are statistically significant at the 5% level. However, considering our hypothesis, we would expect merger premiums to be higher for industries with higher ROE. The result is also contrary to Madura et al. (2012) who identified a statistically significant positive relationship.

As we are not able to replicate the results by Madura et al. (2012), the robustness test sheds light on that not all papers on the subject are replicable, and that might be a reason to be critical to some empiricism. In other words, the methodology used by Madura et al. (2012) might be a matter of concern.

Ordinary least squares (OLS) are easily applied to estimate multiple regression models (Wooldridge, 2019, p. 103). Each slope estimate is able to measure the partial effect of the corresponding independent variables on the dependent variable "premium", while holding other independent variables fixed. Our OLS model examines the relationship between target characteristics and premiums. Even though our sample consists of data from various points in time, we analyse cross-sectional data and make inference about the period as whole.

After extracting all essential data from Compustat, our sample consists of 674 transactions. The sample distribution is provided in Table 11.

Table 11: Steps to final sample in disaggregated regression

Sample Filters	#Of deals
Date Announced: 1.1.2010 to 31.12.2020	
Acquiror Public Status: Public	40136
Target Public Status: Public	9524
Deal Status: Completed	2924
Acquisition Technique: Not Tender Offer	2427
Form of the Deal: Not Partial Acquisition	2260
Target Nation: US	2260
Acquirer Nation: US	2036
Complete Premium Information	1197
Targets within our range of SIC codes	1184
Complete Financial Information	674

Table 12: Disaggregated sample distribution by payment form

Payment method	# Of deals	Percent
100% Cash	292	43.32
Stock and mixed	382	56.68

Table 13: Disaggregated sample distribution per year

Year	N	Percent
2010	54	8.01
2011	45	6.68
2012	69	10.2
2013	61	9.05
2014	77	11.4
2015	72	10.7
2016	77	11.4
2017	54	8.01
2018	76	11.3
2019	54	8.01
2020	35	5.19
Total	674	100

Our entity of analysis is now on individual deals, as opposed to our aggregated analysis on industries. That includes “HHI”, “GDP Growth” and “Volatility”, previously mentioned as industry variables. These industry variables are now used to explain each targets individual deal premium.

R&D

We extract research and development to net sales for each target company one quarter prior to the quarter of the announcement of the deal. The reason we use the R&D intensity one quarter prior to the quarter of the announcement of the deal, is to capture the intensity applicable prior to the merger. Thus, we get R&D intensity ratios for all target companies one quarter prior to their respective announcement quarter.

As an example, if merger X is announced in May 2011, the deal is assigned the targets R&D value for the quarter January, February and March (Q1) 2011.

Ticker codes for all target companies are used in order to extract data from the Compustat Capital IQ database and match premiums with R&D values. In specific, we make use of Compustat's "Financial Ratios Firm Level by WRDS" subordinated to "Financial Ratios". However as "Financial Ratios Firm Level by WRDS" only produces monthly values, we calculate the targets quarterly value by averaging the monthly values.

ROE

We calculate ROE for each target company one quarter prior to the quarter of the announcement of the deal. Following the same reasoning as for R&D, we extract ROE values one quarter prior to the quarter of the announcement of the deal such that we capture the value applicable prior to the merger.

As an example, if merger X is announced in May 2011, the deal is assigned the targets ROE value for the quarter January, February and March (Q1) 2011.

Ticker codes for all target companies are used in order to extract data from the Compustat Capital IQ database and match premiums with ROE values. In specific, we make use of Compustat's "Financial Ratios Firm Level by WRDS" subordinated to "Financial Ratios". However as "Financial Ratios Firm Level by WRDS" only produces monthly values, we calculate the targets quarterly value by averaging the monthly values.

Tobin's Q

We calculate our independent variable "Tobin's Q" for each target company one quarter prior to the quarter of the announcement of the deal. As for the variables mentioned above, we use the quarter prior to the quarter of the announcement of the deal such that we capture the Q value applicable prior to the merger.

As an example, if merger X is announced in May 2011, the deal is assigned the targets Tobin's Q value for the quarter January, February and March (Q1) 2011. (See section 4 for details regarding the calculations of the ratio).

Thus, we get Q ratios for all target companies one quarter prior to their respective announcement quarter. Ticker codes for all target companies are used in order to extract data from the Compustat Capital IQ database and match premiums with Tobin's Q values. In specific, we make use of Compustat's "Security Monthly" and "Fundamentals Quarterly".

8.5.1 Industry Variables

In order to calculate “HHI”, “GDP Growth” and “Volatility of Valuation”, we separate targets by industries. These variables are meant to explain why premiums vary based on industry characteristics. As opposed to the aggregated analysis with average industry variables assigned to average industry premiums, we now assign each targets individual deal premium to average industry variables.

HHI

We calculate HHI for every industry one quarter prior to the quarter of the announcement date of the deal. Thus, by assessing the quarter prior to the quarter of the announcement date, we arguably capture the industry concentration applicable prior to the merger.

As an example, if merger X is announced in May 2011, we assign the target with its corresponding industry HHI value for the quarter January, February and March (Q1) 2011.

Thus, all targets with the same deal announcement quarter and industry, are given the same HHI value. In order to obtain HHI values for the different industries, we extract sales data for all companies covered in the Compustat database. In specific, we make use of Compustat “Fundamentals Quarterly”. Thereafter we sort all the companies into industries based on their SIC-codes, before calculating the industry average index-values for each industry in the quarter prior to the deal.

GDP Growth

We assign each target company with the growth rate in the quarter prior to the quarter of the announcement date of the respective deal. Thus, by assessing the quarter prior to the quarter of the announcement date, we capture the growth applicable prior to the merger.

As an example, we assign the same growth rate to all target companies with the same deal announcement quarter, belonging to same industry.

An alternative would have been to use GDP growth for the US as a whole, instead of the value added per industry. However, we argue that the variety in growth among industries contributes to greater variation in the variables and thereby is more suited to explain premiums.

Volatility of Valuation

We assign each target company with the volatility value one quarter prior to the quarter of the announcement date of the deal. Thus, by assessing the quarter prior to the quarter of the announcement date, we capture the volatility applicable prior to the deal.

For example, we assign the same volatility value to all target companies with the same deal announcement quarter, belonging to the same industry.

An alternative would have been to use the volatility for the US stock market, instead of the volatility per industry. However, we argue that the variety in volatility among industries contributes to greater variation in the variables and thereby is more suited to explain premiums.

9. Conclusion

In similarity with Madura et al. (2012), we believe there is a lack of attention focused on explaining variations in premiums across industries and through time. While many researchers have attempted to explain premiums by deal characteristics, we explain premiums by macroeconomic and industry factors.

In conformity with Madura et al. (2012), we discover variation in the quarterly average premiums among industries for a given quarter, which indicates that the cost of the merger is segmented by industries. In other words, acquirers will have to pay higher premiums for targets in certain industries and in certain time periods.

In our total sample and in our sub sample on cash, we identify that a higher industry Tobin's Q indicate higher premiums. This supports our hypothesis that merger premiums are higher for industries with higher average levels of Tobin's Q. In addition, but contrary to what we expected and our hypothesis, we discover a negative relationship between GDP growth and premiums in our total sample. Lastly, we are not able to find support for our hypotheses regarding "HHI", "ROE", "R&D" and "Volatility".

Madura et al. (2012), regardless of the medium of payment, identified a positive relationship between merger premiums and industries experiencing strong growth, industries with more research and development expenditures and highly concentrated industries. Therefore, and in conclusion, we are not able to replicate the results of Madura et al. (2012).

As a robustness check, we conduct a disaggregated cross-sectional OLS regression. As measuring on an average industry level yields small variations among the industries, we

disaggregate our sample in order to analyze individual deals. We also assess the quarter prior to the quarter of the deal announcement, as opposed to the same quarter in the aggregated analysis. In terms of robustness, the positive relationship between R&D and premiums is the only significant result that is in conformity with Madura et al. (2012). Nevertheless, the robustness test arguably sheds light on that not all papers on the subject are replicable, and that the methodology presented by Madura et al. (2012) might have certain challenges explaining premiums.

Consequently, the results might indicate that there is no regularity in the population, or that the relationship is more complex than reflected in the estimated model. For that reason, we are careful in interpreting a causal relationship between our variables and premium.

10. Further Research

Considering the small variation on our industry variables, we believe the topic is better understood analysing individual deals. Such analyses also open up for a larger set of variables as the research is no longer restricted to ratios meant to explain industry characteristics. We therefore encourage scholars to build on the subject with a target and deal specific approach.

We also believe that similar studies where the entity of interest is industries, are more suited in more volatile decades or time periods. This as some industries will perform better in economic booms and some will perform better in economic downturns, resulting in greater variation in the variables.

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Appendix

A. Sample Creation

Table A.1: Steps to final sample in aggregated dataset

Sample Filters	#Of deals
Date Announced: 1.1.2010 to 31.12.2020	
Acquiror Public Status: Public	40136
Target Public Status: Public	9524
Deal Status: Completed	2924
Acquisition Technique: Not Tender Offer	2427
Form of the Deal: Not Partial Acquisition	2260
Target Nation: US	2260
Acquirer Nation: US	2036
Complete Premium Information	1197
Targets within our range of SIC codes	1184

Table A.2: Steps to final sample in disaggregated dataset

Sample Filters	#Of deals
Date Announced: 1.1.2010 to 31.12.2020	
Acquiror Public Status: Public	40136
Target Public Status: Public	9524
Deal Status: Completed	2924
Acquisition Technique: Not Tender Offer	2427
Form of the Deal: Not Partial Acquisition	2260
Target Nation: US	2260
Acquirer Nation: US	2036
Complete Premium Information	1197
Targets within our range of SIC codes	1184
Complete Financial Information	674

B. Variables

Table B.1: Variable definitions and data sources

Variable	Definition	Data source
GDP growth	*GDP is the quarterly average industry growth rate*	Bureau of Economic Analysis (BEA)
Herfindahl's Index	*HHI is a proxy for industry concentration*	Compustat
Premium	*Premium is the quarterly average premium per industry*	SDC
R&D Expense	*R&D Intensity is the industry average research and development to net sales ratio.*	Compustat
Return on Equity	*ROE is the industry average return on equity*	Compustat
Tobin's Q	*TobinsQ is the industry's TobinsQ ratio*	Compustat
Volatility of Valuation	*Volatility is the quarterly volatility of valuation for the industry.*	Kenneth French data library

C. Descriptive Statistics

Table C.1: Summary statistics for panel data

Statistic	N	Mean	St. Dev.	Min	Median	Max
Premium	352	0.334	0.642	-0.997	0.237	7.861
Tobin	352	1.496	0.436	0.952	1.427	2.791
HHI	352	0.026	0.015	0.007	0.019	0.091
ROE	352	0.494	5.317	-2.261	0.035	83.074
RnD	352	0.176	0.615	0.000	0.012	7.761
GDP	352	0.006	0.029	-0.147	0.007	0.128
Vol	352	5.263	3.465	0.256	4.195	23.678

Table C.2: Summary statistics for disaggregated data

Statistic	N	Mean	St. Dev.	Min	Median	Max
Premium	674	0.259	0.345	-1.000	0.206	2.714
Tobin	674	14.961	345.645	0.539	1.141	8,974.966
HHI	674	0.024	0.014	0.007	0.019	0.080
ROE	674	-0.022	2.744	-22.041	0.059	60.973
RnD	674	0.177	2.256	0.000	0.000	56.773
GDP	674	0.004	0.024	-0.114	0.006	0.128
Vol	674	4.593	2.732	0.592	3.983	21.770

D. Results

Table D.1: Random effects regression output

	Dependent variable: Premium		
	Total sample of mergers	Cash sub-sample	Stock sub-sample
Tobin's Q	0.419***	0.836**	-0.066
	(0.130)	(0.393)	(0.070)
Herfindahl's Index	-0.557	3.954	1.259
	(4.593)	(11.346)	(2.422)
Return on Equity	0.002	-0.004	-0.001
	(0.006)	(0.016)	(0.003)
R&D	0.0002	0.019	-0.025
	(0.071)	(0.220)	(0.031)
GDP Growth	-2.880**	-2.489	0.591
	(1.131)	(4.676)	(0.596)
Volatility of Valuation	0.010	0.019	0.008
	(0.011)	(0.040)	(0.006)
Constant	-0.315	-1.047	0.290**
	(0.265)	(0.734)	(0.132)
Observations	352	184	257
R^2	0.050	0.026	0.015
Adjusted R^2	0.033	-0.007	-0.008
F Statistic	18.147***	4.778	5.028

Note: Standard errors in parenthesis *p<0.1; **p<0.05; ***p<0.01

Table D.2: OLS regression output on disaggregated dataset

	Dependent variable: Premium		
	Total sample of mergers	Cash sub-sample	Stock sub-sample
Tobin's Q	0.0001*	-0.007	0.00003
	(0.0001)	(0.021)	(0.0001)
Herfindahl's Index	-0.021**	-0.036***	-0.007
	(0.009)	(0.014)	(0.013)
Return on Equity	-2.039**	-3.626**	-0.524
	(0.923)	(1.517)	(1.224)
R&D	0.025***	0.022***	0.073***
	(0.006)	(0.006)	(0.023)
GDP growth	0.183	-1.223	0.767
	(0.550)	(1.249)	(0.598)
Volatility of Valuation	0.010**	0.032***	0.001
	(0.005)	(0.009)	(0.005)
Constant	0.253***	0.181**	0.267***
	(0.036)	(0.073)	(0.047)
Observations	674	292	382
R^2	0.057	0.139	0.037
Adjusted R^2	0.049	0.121	0.022
Residual Std. Error	0.336 (df = 667)	0.347 (df = 285)	0.321 (df = 375)
F Statistic	6.779*** (df = 6; 667)	7.693*** (df = 6; 285)	2.425** (df = 6; 375)

Note: Standard errors in parenthesis *p<0.1; **p<0.05; ***p<0.01

D.3: Anova Tests

Tobin's Q

```
             Df   Sum Sq Mean Sq F value  Pr(>F)
Industry      7  2098976  299854   3.192 0.00242 **
Residuals   834 78338737   93931
---
Signif. codes:  0 ‚Äò***‚Äô 0.001 ‚Äò**‚Äô 0.01 ‚Äò*‚Äô 0.05 ‚Äò.‚Äô
0.1 ‚Äò ‚Äô 1
342 observations deleted due to missingness
```

Herfindahl's Index

```
             Df  Sum Sq  Mean Sq F value Pr(>F)
Industry      7 0.20078 0.028682    1256 <2e-16 ***
Residuals  1176 0.02686 0.000023
---
Signif. codes:  0 ‚Äò***‚Äô 0.001 ‚Äò**‚Äô 0.01 ‚Äò*‚Äô 0.05 ‚Äò.‚Äô
0.1 ‚Äò ‚Äô 1
```

Return on Equity

```
             Df Sum Sq Mean Sq F value   Pr(>F)
Industry      7    202  28.794   4.192 0.000151 ***
Residuals   793   5447   6.869
---
Signif. codes:  0 ‚Äò***‚Äô 0.001 ‚Äò**‚Äô 0.01 ‚Äò*‚Äô 0.05 ‚Äò.‚Äô
0.1 ‚Äò ‚Äô 1
383 observations deleted due to missingness
```

R&D expense

```
             Df Sum Sq Mean Sq F value Pr(>F)
Industry      7     36   5.093   1.214  0.292
Residuals   810   3397   4.194
366 observations deleted due to missingness
```

GDP growth

```
             Df Sum Sq   Mean Sq F value   Pr(>F)
Industry      7  0.015 0.0021490   3.727 0.000533 ***
Residuals  1176  0.678 0.0005765
---
Signif. codes:  0 ‚Äò***‚Äô 0.001 ‚Äò**‚Äô 0.01 ‚Äò*‚Äô 0.05 ‚Äò.‚Äô
0.1 ‚Äò ‚Äô 1
```

Volatility of valuation

```
              Df Sum Sq Mean Sq F value Pr(>F)
Industry       7   2374   339.1   65.79 <2e-16 ***
Residuals   1176   6062     5.2
---
Signif. codes:  0 ‚Äò***‚Äô 0.001 ‚Äò**‚Äô 0.01 ‚Äò*‚Äô 0.05 ‚Äò.‚Äô
0.1 ‚Äò ‚Äô 1
```

E. Robustness

Table E.1: VIF-test for multicollinearity

Variables	Random Effects regression	OLS regression
Tobin's Q	1.006034	3.863566
Herfindahl's Index	1.017483	1.041038
Return on Equity	1.010286	3.918381
R&D expense	1.018417	1.008695
GDP growth	1.007875	1.038482
Volatility of Valuation	1.024047	1.031043
Mean VIF	**1,01402367**	**1,98353417**

Table E.2: Correlation matrix of random effects regression variables

Correlation	Tobin's Q	Herfindahl's Index	Return on Equity	R&D expenses	GDP growth	Volatility of Valuation
Tobin's Q	1					
Herfindahl's Index	-0.060	1				
Return on Equity	0.059	-0.071	1			
R&D expenses	-0.057	-0.305	-0.024	1		
GDP growth	0.033	-0.034	-0.013	-0.021	1	
Volatility of Valuation	0.003	0.068	-0.113	0.076	-0.007	1

Table E.3: Correlation matrix of OLS regression variables

Correlation	Tobin's Q	Herfindahl's Index	Return on Equity	R&D expenses	GDP growth	Volatility of Valuation
Tobin's Q	1					
Herfindahl's Index	-0.026	1				
Return on Equity	0.857	0.011	1			
R&D expenses	-0.003	-0.082	-0.024	1		
GDP growth	-0.041	-0.078	-0.124	-0.008	1	
Volatility of Valuation	0.014	-0.160	-0.027	0.010	0.035	1

Table E.4: Test of regression models

Test		Random effects model	OLS model
Breusch-Pagan / CookWeisberg test for heteroskedasticity	χ^2	9.3966	10.719
	$p>\chi^2$	0.1525	0.09746
Ramsey Reset test	F(6, 661):		3.0449
	p > F:		0.006045

Table E.5: Hausman test

	Chisq	P-value	df	method	alternative
1	13.628	0.034	6	Hausman Test	one model is inconsistent

Table E.6: Residual plot – OLS model